Global Perspectives on Health Geography

Lazarus Chapungu
David Chikodzi
Kaitano Dube *Editors*

The COVID-19 – Health Systems Nexus

Emerging Trends, Issues and Dynamics in Zimbabwe

Springer

Global Perspectives on Health Geography

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Peer Review Process

The book underwent the process of academic blind peer review. The first part involved the screening of abstracts and the invitation to authors with accepted abstracts to submit the full draft manuscripts. The editors removed all author identifications from the manuscripts, making them anonymous before forwarding them for the double-blind peer-review process. Apart from being the international norm, this double-blind peer-review process is mandatory for South Africa–based authors in order to fulfil the requirements of the Department of Higher Education and Training's (DHET's) policy for recognised research outputs for subsidy purposes. The editors presided over the incorporation of all peer-review observations and comments to enhance the quality of the book product, an activity that witnessed a chapter being rejected. However, authors take full responsibility for any liabilities associated with their work, including plagiarism.

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Part I
Introduction

Chapter 1
Introduction: COVID-19-Health Systems Nexus—The Trends and Dynamics

Lazarus Chapungu, Kaitano Dube, and David Chikodzi

Abstract COVID-19 has taken a toll on the global health delivery system, compromising its dexterity to provide efficient and effective health care to societies. For other countries, the pandemic only exacerbated the woes that already existed in the health delivery system. In others, the pandemic shocked the existing systems that appeared ready to deal with infectious pandemics. Apparently, the COVID-19 pandemic had multi-pronged impacts on the health systems that resulted in reciprocal feedback from the health systems, which determined the new patterns and characteristics of COVID-19-related variables. An understanding of the COVID-19-health systems nexus is fundamental for building frameworks for efficient and effective health systems that are resilient and sustainable in the face of the current and future prowling pandemics. This book adopted a diverse and multi-pronged methodological approach to examine the COVID-19-health systems nexus in Zimbabwe, covering a broad range of concepts related to COVID-19 and health systems. The findings show that the World Health Organization's building blocks for health systems in Zimbabwe have been largely weak to effectively manage the COVID-19 pandemic owing to the socio-economic and political instability of that country. Consequently, the health system was further suffocated and disparaged by the pandemic. In turn, the health system reciprocated by determining the trends and dynamics of various COVID-19-related variables, including mortality risks, vaccination issues, policy responses, cases and deaths, among other concepts and variables. The results point to the need for concerted efforts towards a framework that ensures the convergence of the Global Health Security and the Universal Health Coverage philosophies to build health systems that are resilient and sustainable in the context of existing and impending lethal pandemics.

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1.1 Background

The global health systems have improved with regard to the delivery of health-related interventions, especially maternal and child health, as well as reducing the proliferation of malaria, tuberculosis and HIV and AIDS (WHO, 2010, 2022). For example, "the global mortality of children who are 5 years or younger has reduced by half and life expectancy has increased by 5.5 years" (Feng, 2020: 325). Several other improvements at the global level have been reported in literature. However, the improvements have not been universal, neither have they been sufficiently encompassing and sustainable (Lal et al., 2021). A significant segment of the world's poor communities are still grappling with a plethora of health issues emanating from weak national health systems. In some cases, progress made at a national level has not filtered down to the most vulnerable groups; in other cases, health improvement has stalled (Feng, 2020). There are some cases where progress has been reversed (Ağartan, 2020). To that extent, the global health system is not on course to meet the targets of the United Nations 2030 Sustainable Development Goals (SDGs) (Feng, 2020). The emergence of COVID-19 in December 2019 and its subsequent proliferation across the globe have reengineered the trends and dynamics of the health systems, creating a nexus that compounds, exacerbates and reinforces the challenges of health delivery to meet the global health goals.

Effective health systems must have six building blocks that work cordially to determine health outcomes (Stockton et al., 2021; WHO, 2010). These include adequate financial resources, leadership/governance, adequate supplies of essential medicines, adequate health workforce, service delivery and health information systems (Manyazewal, 2017). Failure of one building block will collapse the whole system or compromise its ability to provide the services that lead to the desired outcomes (Stockton et al., 2021). Over the years, well-resourced countries, such as the United Kingdom and the United States among others, have built strong health systems comprising strong institutions and systems with capabilities to effectively manage infectious diseases (Lal et al., 2021). However, the advent of COVID-19 exposed the structural weaknesses in the health systems as the so-called efficient systems were knocked down by the pandemic (Dalglish, 2020). While the systems were well resourced in most aspects, the health information systems and governance were fragmented, leading to failure to contain the proliferation of the COVID-19 pandemic and its impacts (Haldane et al., 2021; Lal et al., 2021).

COVID-19 is regarded as the worst health tragedy in the recent past, perpetuating a myriad of shattering health challenges and austere economic depressions across the world (Nimako & Kruk, 2021). In spite of income level, COVID-19 has posed a serious strain on health systems in both developed and developing countries. Various stakeholders, including politicians, communities, organisations and professionals from various fields, are asking from the health systems more than ever before, anticipating solutions to the COVID-19 predicament from the health systems without disregarding the several other health matters (Nimako & Kruk, 2021). The impact of COVID-19 on global health was significant to the extent that even the most resourced countries had their health system strained beyond their limit (Dalglish, 2020; Lal et al., 2021). It exacerbated the existing inequities between countries, communities and households. It has been reported to have accentuated stillbirths and maternal deaths in low-income countries, reversing the gains that have been made over the years. The global fight against tuberculosis and other infectious diseases has been compromised. In Africa, the health systems are groaning from the vice of COVID-19 through the consequent increase in the demand for financial resources, special medical skills, essential drugs and efficient health information systems from systems that were already struggling with other diseases such as Ebola, malaria and several infectious diseases (Siedner et al., 2020; Vearey et al., 2021).

In turn, the health systems have influenced the trends and dynamics of the COVID-19 pandemic, creating a cyclic nexus where impacts on specific components of the health system become the determinants of COVID-19-related mortality risk, spatial trends of cases and deaths and various other related traits of the pandemic (OECD Health Division, 2020).

In Zimbabwe, the impacts of the COVID-19 pandemic on the health-care system are compounded by the current economic situation, settlement systems and socio-cultural persuasions (Chirisa et al., 2020). The existing fragmented health information system, limited disease surveillance, lack of financial resources, disgruntled health workforce, poor governance and weak service delivery have exacerbated the situation (Mutanda, 2022). COVID-19 has entrenched and reinforced the magnitude of the challenges faced by the health system. Understanding the COVID-19-health systems nexus is fundamental in building strong institutions, refining health service delivery, improving health systems financing, civilising governance and leadership of healthcare delivery and improving the availability of essential medicines and enhancing robust health information systems. The improvement in these building blocks is key in dealing with current and future pandemics. In view of this need, this book explores the COVID-19-health systems nexus in Zimbabwe.

1.2 Global Health Systems: An Overview

According to WHO (2010), there are six building blocks for an effective and sustainable health system. The building blocks include service delivery, health workforce, health information systems, financing, access to essential medicine and leadership and governance. The building blocks are expected to lead to an efficient health system with improved health outcomes. Figure 1.1 shows the building blocks for a robust health system and the expected outcomes.

A health system comprises six building blocks, each of which contributes to the system's resilience to shocks emanating from epidemics and pandemics. Governance

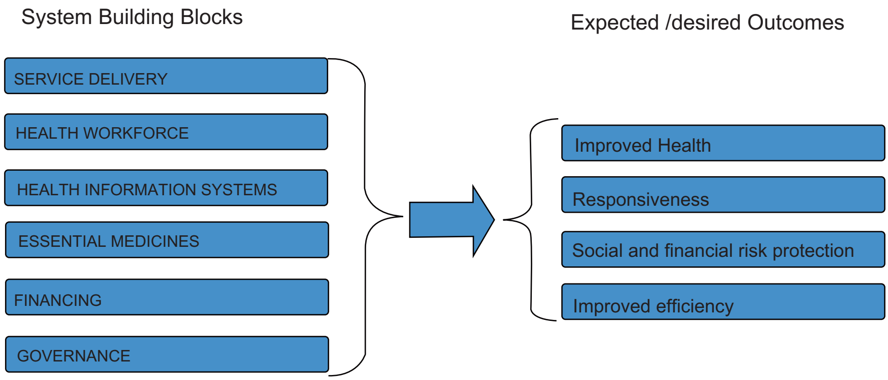

Fig. 1.1 Health system building blocks and the expected outcomes. (Source: Authors, adapted from WHO (2010))

and health information systems provide the foundation on which overall policy instruments for the other blocks are built. Financing and health workforce are the fundamental input components. Their availability contributes significantly to strengthened health systems. Access to essential medicines and technologies and service delivery then provide a complete system that can deliver in terms of health improvement, the responsiveness of the system, social and financial protection and improved system efficiency.

Global Health Security (GHS) and Universal Health Coverage (UHC) are the two key perspectives that underpin the global health-care system. While they are mutually exclusive, they pursue different policies practically (Lal et al., 2021). GHS is premised on the prevention, detection and reaction to public health threats at a global scale to protect societies worldwide from infectious diseases (Erondu et al., 2018). To be effective, the GHS must embed International Health Regulations (IHR) to guide the development of surveillance, communication and coordination capacities, commonly known as the core capacities (Erondu et al., 2018; Lal et al., 2021). However, GHS does not cover Primary Health Care (PHC) functions such as curative services, patient management and clinical surges, which are developed and managed locally.

Meanwhile, the global health system comprises the perspective of Universal Health Coverage (UHC), which depends on access to efficient and effective health services without financial burden (Erondu et al., 2018; Friedman et al., 2020; OECD, 2020). There is a link between UHC and PHC. This implies that the failure of UHC will ultimately lead to inefficient and ineffective PHC systems. However, Lal et al. (2021) observed that although UHC facilitates and enhances PHC, the UHC interventions have the propensity for neglecting infectious diseases' coercions and ineffectively managing the core capacities (surveillance, communication and coordination) of health care. Rather, most UHC interventions have focused on health insurance and individual health service (Erondu et al., 2018; Lal et al., 2021; Razavi et al., 2020).

The World Health Organization (WHO) has shown the desire to focus on both GHS and UHC, with a determined prioritisation of health emergencies and UHC (Lal et al., 2021; WHO, 2022). Evidence shows that countries with policies and procedures aligned with both frameworks have fared better regarding COVID-19 management, and they are set to perform better in the recovery process (Friedman et al., 2020; Lal et al., 2021). For example, Thailand, South Korea, Taiwan, Vietnam and Hong Kong have implemented COVID-19 measures with strict and high stringency as well as effective public health communication, and their grounding in the UHC philosophy has buoyed their dexterity to swiftly control the pandemic as of July 2020. Taiwan covered 99.9% of the national health insurance, and this facilitated "epidemic prevention, integrated medical data, unified information platforms and safety nets for vulnerable populations" (Lal et al., 2021: 63). In Vietnam, a grounded UHC approach enabled cooperation between the government and its citizens to adopt a culture of surveillance, mass testing and rigorous contact tracing.

Singapore also demonstrated the effectiveness of having a convergence between GHS and UHC.

Although WHO makes concerted efforts to foster the convergence of the two perspectives (GHS and UHC) in order to strengthen the global health system, political veracities and resource scarcity force policymakers to go with one agenda (WHO, 2022). It is important to note that gaps will always exist in the global health management system due to geopolitical dynamics and many other dynamic socioeconomic factors (Alilio et al., 2022; Ibn-Mohammed et al., 2021). Of note is the system's fragmented nature, even at the country level. For example, despite the huge investments into the health system, with impressive public and private laboratories, well-resourced and innovative pharmaceutical and technology entities and a highly capacitated public health national institute, the United States found itself having huge numbers of COVID-19 cases and fatalities due to a fragmented health-care system (Tromberg et al., 2020). States within the United States run separate public health systems, and there has been reluctance to build a unified system leading to lack of coordination and unified enhancement of core capacities, and this has hindered the country's dexterity to deal with the COVID-19 pandemic (Lal et al., 2021). The picture holds for the global health system, where fragmentation has taken a toll on effective health management.

1.3 The COVID-19-Global Health Systems Nexus

The regional- and national-level response to the proliferation of the COVID-19 pandemic varied enormously from "swift and proactive at best to haphazard and negligent at worst" (Lal et al., 2021: 61). In view of resource and health policy differences, the variability of approaches, strategies and pragmatism in tackling COVID-19 can be expected, but the pandemic has pushed virtually all the health management systems to their edges, exposing the cracks and crevices in public health systems, even in countries with impressive Global Health Security indices (Dalglish, 2020).

COVID-19 exposed structural and systemic weaknesses in the global health-care systems (Al Knawy et al., 2022). There is a perceptible deficiency in investment in the global health system to bolster its capacity to prepare and respond to fast-spreading infectious diseases (Lal et al., 2021; OECD Health Division, 2020; Sovacool et al., 2020). This is compounded by the existence of health-care data in silos, making it inaccessible to individual entities to improve their systems or collaborate and ensure interoperability (Al Knawy et al., 2022). The unequal availability of health-care data across the world compromises the integrity and quality of health outcomes for communities (Chingono et al., 2022). The fragmented nature of data and health-care delivery systems has jeopardised the dexterity of global health systems to tackle the COVID-19 pandemic with the efficiency and effectiveness it deserves (Breitenbach et al., 2021; Lal et al., 2021). For example, the digital health-care systems, which are the cog for efficient health delivery at a global level in a pandemic situation, were highly fragmented at the onset of the COVID-19 pandemic resulting in its failure to support health-care and patient management systems at all levels (Al Knawy et al., 2022). Due to this fragmentation, there was an irregular assemblage of data for public health surveillance.

Globally, only a sizeable number of communities had systems ready to deal with pandemic situations, with proficient systems that capture data to effectively monitor and assess cases of disease outbreaks (Lal et al., 2021). Even the most developed countries like the United States and the United Kingdom, which were ranked the best in terms of preparedness to deal with infectious pandemics, found their systems inadequate (Dalglish, 2020). Some countries found themselves stuck with analogue contact tracing systems that could not be updated rapidly to catch up with the overwhelming burden of the COVID-19 pandemic (Al Knawy et al., 2022). The United States' reliance on fax technology was regarded as a bottleneck in the health delivery system during the pandemic's peak. Similarly, in Australia, the paper-based contact tracing system proved impossible due to the upsurge in the number of cases and fatalities. In view of these inadequacies, it became a daunting task for countries to develop up-to-date, quintessential public health policies and well-planned response and coordination systems.

To this extent, sound health delivery systems with the ability to manage global pandemics rely on efficient use of data using electronic health records (EHR). In mature systems, a single EHR can be used across several health-care facilities within a health-care institution, making case handling much faster and more efficient (Lal et al., 2021). The interoperability of health systems for data transfer and management is key in global health management, especially in times of a rapidly spreading disease. However, as much as health professionals, scientists and policy makers recognise this, it was never implemented, resulting in the vulnerability of global health systems in the face of the marauding COVID-19 pandemic (Al Knawy et al., 2022; OECD Health Division, 2020). Thus, the global health system can only be strengthened through digital health and data science to foster effective use and management of data.

COVID-19 has revealed that the global health system is fragmented and largely underfunded. More so, it is shepherded by an institution (WHO) which appears not to be self-determined and pragmatic enough to swiftly deal with the emerging menacing global pandemics. The magnitude of life losses, sector-specific frailties and economic fragilities orchestrated by the COVID-19 pandemic bears testimony to the need for radically reimagined framework for global health governance. To enhance the deftness of the global health system in dealing with atrocious pandemics like COVID-19, there is a need for robust primary health-care systems at the local society level, a twenty-first-century and audacious WHO, a strong IHR buttressed by state compliance and a sustainable human and financial resource base. The need for concerted effort towards the convergence of GHS and UHC cannot be overemphasised.

1.4 The African Context

On 31 December 2019, the world became alert to the emergence and proliferation of SARS-CoV-2, a coronavirus that causes COVID-19. On 11 March 2020, pursuant to its epidemiological characteristics, the disease was declared a global pandemic by the World Health Organization (WHO). Before April 2020, about 46 African countries had reported its presence in their territories, with a cumulative total of 4857 officially confirmed cases and 155 casualties. Since then, the cases of COVID-19 have been fluctuating, with episodes of huge waves that overwhelmed the health systems across the African continent. Figure 1.2 shows the trend of daily new confirmed COVID-19 cases per million in Africa.

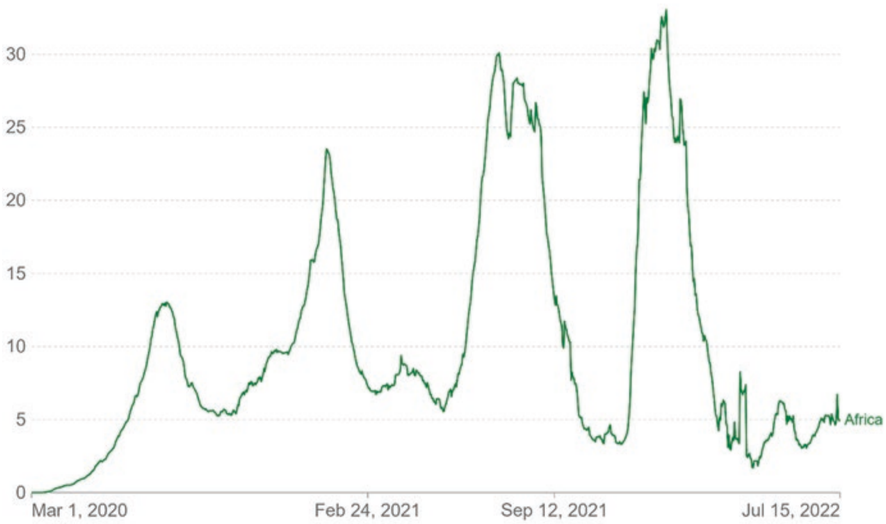

Fig. 1.2 Daily new confirmed COVID-19 cases per million in Africa. (Source: Johns Hopkins University CSSE COVID-19 data)

The huge waves shown in Fig. 1.2 were associated with enormous upsurges in COVID-19 cases and related deaths, which impacted the six components of the health systems in Africa, including health service delivery, workforce, information systems, essential medicines, financial as well as leadership and governance system.

African governments and public health authorities responded to the proliferation of the COVID-19 pandemic by creating a COVID-19 task force through the Africa Centres for Disease Control and Prevention (Africa CDC) (Debes et al., 2021). The task force comprises working groups focusing on surveillance, infection prevention and control, clinical management, laboratory diagnosis, risk communication and community engagement (Africa CDC, 2020). The framework adopted by Africa CDC is quite comprehensive as it includes aspects of the HHC and the GHS approach to health-care management. In addition, a multifaceted funding mechanism for the prevention, control and treatment of COVID-19 was adopted (Debes et al., 2021). However, although the CDC provided an oversight of the COVID-19 situation and guidance to the African Union and national governments, the pandemic still wreaked havoc within the health sector, and its impact on the health sector, in turn, influenced its spread.

The impact of the COVID-19 pandemic on Africa's health system is difficult to quantify, but it is evident from the series of COVID-19 waves experienced across the continent that the pandemic placed enormous pressure on the health delivery system. Consequently, millions of people's lives are at risk as the pandemic has further strained a system that was already struggling with its core capacities (Tessema et al., 2021). The high mortality risk in Africa, as depicted by the case fatality rate, crude mortality rate and infection fatality rate, is a proxy indicator of the lack of resilience of the health systems. Figure 1.3 shows the case fatality rate for Africa in relation to case fatality for other continents over time.

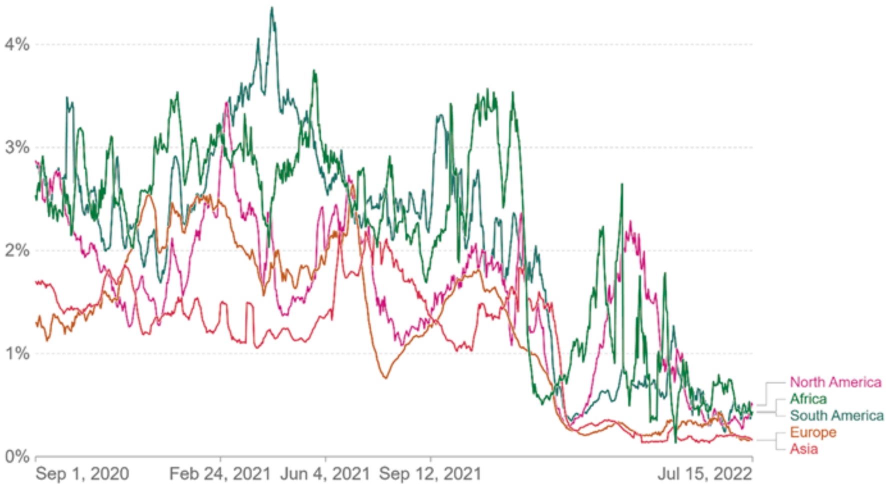

Fig. 1.3 Moving average case fatality rate of COVID-19. (Source: Johns Hopkins University CSSE COVID-19 data)

As shown in Fig. 1.3, Africa, in comparison with other continents, had its case fatality ratio fluctuating above that of other continents most of the time. The response strategies to COVID-19, underpinned by the six components of health-care systems, determine the mortality risk indicators such as the case fatality rate. The high case fatality rate for Africa depicted in Fig. 1.3 is a proxy indicator of a less efficient and effective health management system.

The cocktail of measures put in place to contain COVID-19 drained resources that were supposed to be used for other routine preventive health-care and treatment services (Alilio et al., 2022). Some studies have reported cases where specific chronic care health services were either denied or delayed due to the COVID-19 pandemic impact (Pierre et al., 2020; Schwartz et al., 2021). More than 50 per cent of the patients with HIV in Rwanda scheduled to receive antiretroviral treatment could not have access to treatment due to the COVID-19-induced lockdown (Pierre et al., 2020). In Kenya, female sex workers could not have access to routine medication and antiretroviral treatment (Gichuna et al., 2020).

Most countries in Africa adopted and implemented the protocol and guidelines espoused by WHO to prevent and control the proliferation of COVID-19 (Tessema et al., 2021). This included the establishment of mandatory isolation and treatment units where hydroxychloroquine, chloroquine and chloroquine-azithromycin were used for treatment (Otitoloju et al., 2020) in the early phases. However, the health systems for most countries lack national guidelines to take care of country-specific determinants of successful prevention and control of the pandemic. For example, Semaan et al. (2020) found that in Uganda, there were no national guidelines for health services provision among pregnant women during the peak of the pandemic.

The health systems in Africa were also affected by the COVID-19 pandemic by destabilising the security and confidence of the personnel manning it. A number of studies (Debes et al., 2021; Deressa et al., 2021; Semaan et al., 2020) have shown that some health-care workers suffered mental problems associated with the pandemic. For example, in Mali and Mozambique, workers have suffered mental health problems related to the stressful COVID-19-affected working environment and the fear of being infected. In Mali, about 72 per cent of the participant health workers in a study confirmed having experienced some symptoms of mental illness such as depression, insomnia and anxiety (Sagaon-teyssier et al., 2020). In Mozambique, about 50 per cent of the health workers indicated that they feel very vulnerable and unprotected, and this has increased stress levels within the health sector, compromising the viability and soundness of service provision (Semaan et al., 2020).

Semaan et al. (2020) noted that in the early phases of the COVID-19 pandemic, Africa's health system was characterised by three major preparedness bottlenecks, namely, lack of essential equipment, inadequate surge capacity and limited testing ability. These challenges continued throughout the various waves of COVID-19. To that extend, the COVID-19 case statistics in Africa might have been more than reported due to limited testing capacity (Makoni, 2020). This posed a danger to the whole health system as community transmission of the virus would occur without knowing. A plethora of impacts are associated with the identified bottlenecks in the health system. These include a reduction in service provision and missed booked appointments by patients who are on chronic care (Mohammed et al., 2020).

Other challenges within Africa's health delivery system include limited infrastructure, unmotivated workforce, shortage of medical practitioners with critical care skills and inadequate specialised facilities (Tessema et al., 2021). In urban areas, there is high population which overwhelms the available medical facilities. The transport system is not efficient to manage emergencies to the extent that the poor, who cannot afford private transport, have high chances of dying before they reach to a medical facility. Poor road network and infrastructure compounds the problem of inefficient health services delivery (Kouamou et al., 2021; Tessema et al., 2021).

1.5 The COVID-19-Health Systems Nexus: The Zimbabwe Experience

On 20 March 2020, Zimbabwe recorded its first case of COVID-19. By June the same year, cases had increased to 279, most of which were reported to be residents returning from the neighbouring South Africa (Chirisa et al., 2020). Some cases were observed in people who were travelling from the United Kingdom, the United States and Dubai (Chirisa et al., 2020). Significant efforts were made to prevent its rapid spread. Isolation and treatment centres were established across the country, and testing services were put in place. Residents returning from other countries were quarantined (Makoni, 2020). However, although there were concerted efforts to prepare for the COVID-19 pandemic, the health system was already struggling with the outbreaks of malaria in Manicaland, Masvingo and Mashonaland East and Mashonaland Central (Gavi et al., 2021). Besides malaria, there was a disease burden from cholera, typhoid and other infectious diseases that were straining the health system (Gavi et al., 2021).

The best approach to detect cases and treat them was mass testing (Dzinamarira et al., 2021). However, efforts were made, but the testing was only limited to people with risk of developing severe conditions, symptomatic people as well as symptomatic health practitioners. This was mainly due to the lack of capacity in terms of resources and equipment (Chiyaka et al., 2022; Mutanda, 2022). In addition, the equipment to manage cases in isolation centres was limited, intensive care unit beds were in short supply, and ventilators were scarce. This created a situation where the health delivery system in the country was overwhelmed by disease burden, resulting in an increase in the number of fatalities and an increase in the number of COVID-19 cases (Makoni, 2020; Makurumidze, 2020; Mutanda, 2022).

The health system status at this time resulted in an increase in mortality risk as indicated by high case fatality rate, infection fatality rate as well as crude fatality ratio. In terms of case fatality rate, Zimbabwe was among the leading countries in Africa as well as in the world. Figure 1.4 shows the COVID-19 case fatality rate for

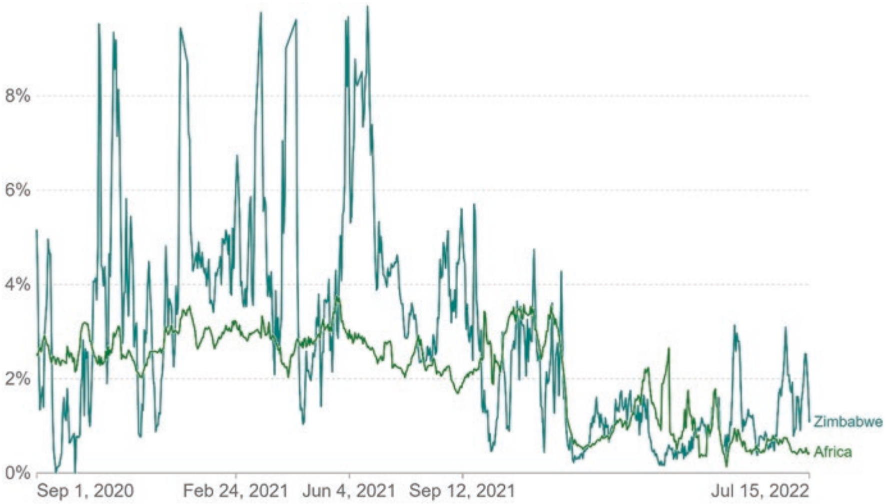

Fig. 1.4 COVID-19 case fatality rate in Zimbabwe and Africa between March 2020 and July 2022. (Source: Johns Hopkins University CSSE COVID-19 data)

Zimbabwe from the onset of the pandemic until July 2022 in relation to cases across Africa.

As shown in Fig. 1.4, the case fatality rate in Zimbabwe, throughout the COVID-19 waves, was higher than the average rate across the African continent. The state of the health management system contributed significantly to this pattern. Thus, the health system has been lacking in most of the components that determine the efficiency and sustainability of a health system. There was, for example, limited surveillance, inadequate supply of essential drugs, restricted health workforce and limited financial resources, and the governance structures were not effective to control and manage the proliferation of the COVID-19 pandemic (Chirisa et al., 2020; Chiyaka et al., 2022; Dzinamarira et al., 2021; Makoni, 2020; Mutanda, 2022).

There is a series of reciprocal connections between COVID-19 and health systems. COVID-19 and its associated response mechanisms, including national lockdowns, quarantine, social distancing and sanitisation, among others. The response mechanisms had impacts on the health delivery systems. However, health systems also responded through influence on the trends and dynamics of COVID-19. For example, the COVID-19-weakened health systems are the determinants of mortality risk as depicted by the case fatality rate and high infection fatality rate. Figure 1.5 shows the COVID-19-health systems nexus based on experiences in Zimbabwe.

As shown in Fig. 1.5, COVID-19 has put a strain on the health system through imposing additional burden of resource demands. For example, there was a shortage of special skills to handle COVID-19 cases in several quarantine centres and hospitals. The demand for extra workforce with special skills imposed a strain on the already under-staffed health system (Chingono et al., 2022). In addition, the pandemic occurred during a period when the more than 15,000 nurses were on strike

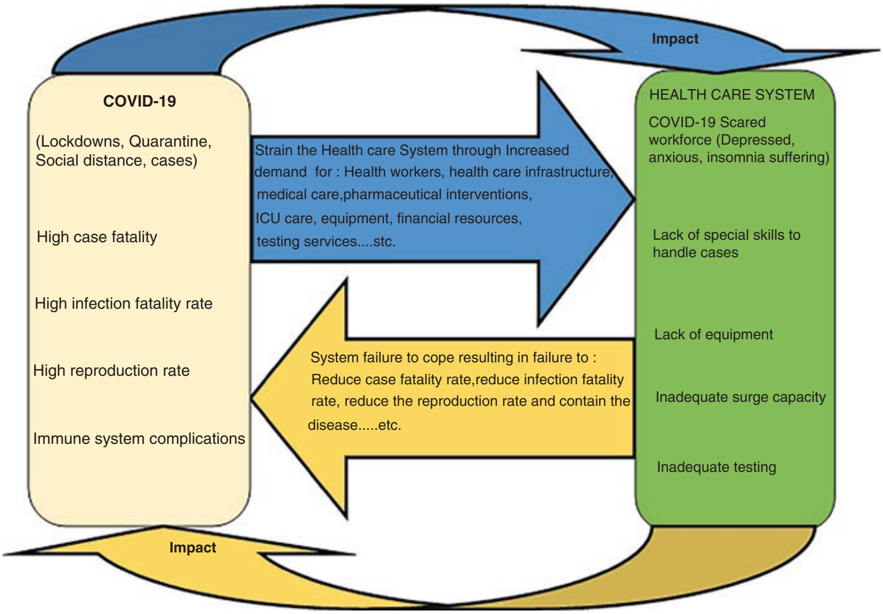

Fig. 1.5 The COVID-19-health systems nexus based on Zimbabwe experiences. (Source: Authors)

over salaries that had depreciated due to the inflationary economic environment in Zimbabwe (Makoni, 2020). At the same time, senior medical practitioners were also threatening to join the strike. This affected virtually all the six components of Zimbabwe's health system but mainly health-care services, including "obstetric, dialysis, acute medical and surgical, and chronic HIV care" (Makoni, 2020: 457). This, in turn, affected service delivery on COVID-19 treatment and care, contributing to an increase in community transmission and case mortality risk. The weak health system as a result of poor health service delivery might have also contributed to Zimbabwe being among the countries with very high case fatality ratio in the world (WHO, 2022).

In any health system, human resources are the cog for efficient and effective functionality. The shortages of health workers had a toll on Zimbabwe's health system. At Parirenyatwa hospital, the leading referral hospital in Zimbabwe, some patients were turned away, and the hospital had staff to support 30 out of 300 beds that had been set aside for COVID-19-related cases. Even in situations where the patients are not turned away, shortages of health workers resulted in treatment delays, resulting in deaths and increased cases of patients developing disabilities related to delayed attention (Makoni, 2020). Furthermore, the few available health workers were traumatised by the COVID-19 pandemic. They were concerned about their exposure to risk, and several of them got infected due to lack of personal protective equipment (PPE) (Chingono et al., 2022; Mukwenha et al., 2020). The sanitizers used across the country were not monitored for efficiency and effectiveness, compounding the challenges related with the management of the pandemic (Marumure et al., 2022).

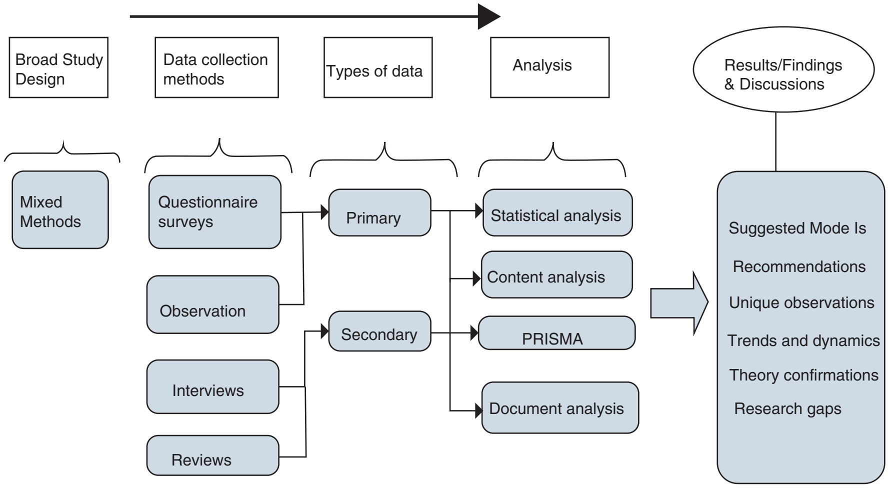

Fig. 1.6 Methodological framework. (Source: Authors)

1.6 Materials and Methods

This book volume is premised on a diverse and multi-pronged data collection and analysis framework informed by the mixed methods research design (Fig. 1.6).

Several theme-specific research techniques and approaches were adopted ranging from qualitative to quantitative. Case studies were deliberately widely adopted due to their ability to provide in-depth empirical analysis of specific concepts, sectors or geographical areas. As shown in Fig. 1.6, data collection was performed through questionnaire surveys, interviews, field observations and document reviews. The methods were employed to gather data from various geographical areas that formed part of this research. Statistical analyses of trends and variable dynamics were performed using various statistical packages, depending on author preferences and familiarity. Other data analysis methods included the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework for analysis. Content and thematic analyses were also performed for some of the chapters.

1.7 Book Outline

The book's key message is on the nexus between COVID-19 and the health systems in the context of impacts and response mechanisms. In view of the diversity of concepts and variables related to COVID-19 and health systems, the book is divided into sections, each focusing on a specific relevant theme. The introductory chapter sets the tone by providing a synthesis of the health systems status from a global to a Zimbabwean perspective with a deliberate focus on the components that determine the effectiveness, efficiency and sustainability of health systems. The chapter also introduces COVID-19 within the context of the health-care management systems, with emphasis on the nexus between the two. The introductory section is followed by a section which focuses on health system dynamics in a COVID-19 environment. In this section, there are chapters that focus on the spatial and temporal trends of the pandemic, public safety and health systems in the context of COVID-19 in Zimbabwe, devolution as health governance paradigm amidst the COVID-19 pandemic in Zimbabwe, strategic opportunity of operationalising One Health concept case of Zimbabwe, analysis of the dynamics of COVID-19 pandemic using the SEIR model with uncertain parameters characterised by a stochastic susceptible population, indigenous health practices and lifestyles and virtual communities in supporting access to health services during COVID-19 pandemic.

There are some restrictive measures put in place to control and manage the proliferation of the COVID-19 pandemic. These restrictions had implications on the health delivery systems. Thus, the book contains a section that focuses on COVID-19 restrictive measures and related impacts. There are three chapters under this section. The first one is titled “Decongesting Global Cities as Part of Health Reform in the Era of COVID-19: Impacts and Implications for Zimbabwe”. This is followed by a chapter which looks at the synergies and trade-offs between COVID-19 measures and the progress towards SDG 15 with a focus on implications on health systems in Zimbabwe. The last chapter in this section examines the impact of COVID-19 on economic development in Zimbabwe and the health management system. The focus of this chapter is on the broader perspective of COVID-19 including how the restrictive measures also impacted economic development.

The world responded to the proliferation of the COVID-19 pandemic through vaccination programmes. In this book, there is a section which looks at vaccine uptake and diplomacy. This section comprises three chapters. The first chapter looks at COVID-19 vaccination hesitancy, interrogating the trends and impacts on Zimbabwe’s health delivery system. This is followed by a topic on the complexities of public health communication on COVID-19 vaccination in social media and lastly, a chapter that examines COVID-19 vaccine diplomacy with a focus on tracking the Chinese, Indian and Russian global pathways and undertones with the aim to draw lessons for Zimbabwe and the Southern African region. The last section of the book contains the conclusion, which makes a deliberate focus on the emerging trends, issues and policy implications of the concepts and issues covered by all chapters in the book.

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Part II
Health System Dynamics in a COVID-19 Environment

Chapter 2
The COVID-19 Pandemic in Zimbabwe: A Spatial and Temporal Perspective

Evans Chazireni, Lazarus Chapungu, and Godwell Nhamo

Abstract Numerous pandemics have ravaged the world since prehistoric times. Some of the prevalent pandemics include the flu pandemic (1889–1890), Spanish flu (1918–1920), AIDS (1981–present) and the H1N1 swine flu pandemic (2009–2010). As pandemics occur, their incidence and prevalence rates are spatially heterogeneous, and the spatial distributions change over time. Understanding the national spatial distribution, temporal epidemic trends and transmission patterns of COVID-19 contributes to providing timely information for the national response to the pandemic. This chapter examines the Zimbabwean COVID-19 pandemic spatial patterns and temporal trends to enable decision-makers to prioritise vulnerable regions and plan appropriately as informed by the temporal patterns. A quantitative research design was adopted, which involved statistical computations and mapping of COVID-19 variable data obtained from web-based repositories. Results indicate spatial variability in the proliferation of COVID-19, with the most populated areas experiencing higher infection rates. There is a significant increase in the monthly new infections and new deaths, while the cumulative infection rates show some phases of steep increase. The case fatality rate has flattened. Policymakers and stakeholders must design strategies that respond to the spatial and temporal trends for optimal containment of the pandemic.

Keywords COVID-19 · Spatial and temporal patterns · Case fatality rate · Infections

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2.1 Introduction

Since late 2019, the world has been grappling with the coronavirus disease of 2019 (COVID-19), which was first observed in Wuhan, China (Mohammed et al., 2021). Scientific inquiry has established that COVID-19 originates from a virus known as severe acute respiratory syndrome coronavirus 2 (SARs-CoV-2) (Forman et al., 2021). The symptoms of infection include fatigue, fever, dry cough, loss of smell, breathing difficulties, lung infection and diarrhoea (Huang et al., 2020; WMHC, 2020). The widespread transmission of COVID-19 led the World Health Organization (WHO) to recognise the disease as a pandemic on 11 March 2020, when it was reported in every continent worldwide (Guner et al., 2020; WHO, 2020). By the time of finalising this write-up, the pandemic had hit almost all countries worldwide with numerous negative impacts on the health system, economy and society. Zimbabwe has not been spared from the devastating impacts of the pandemic and reported its first case of COVID-19 on 20 March 2020.

As pandemics occur, their incidences and prevalence rates are spatially heterogeneous, and the spatial distributions change over time. Understanding the national spatial distribution, temporal epidemic trends and transmission patterns of COVID-19 contributes to providing timely information for the national response to the pandemic. There are considerable geographic dissimilarities in the occurrence and predominance of COVID-19 in Zimbabwe. As in many other countries, the spatial variation in the distribution of the disease has been attributed to a plethora of driving forces, including the physical environmental conditions, the nature of public health interventions, the area's preparedness, the individuals' underlying health conditions and the general access to health facilities. Fedele and Francesco (2021) argue that concerning the health conditions of individuals, the risk of contracting a respiratory disease increases if the individual has conditions such as chronic diseases, vitamin deficiency and obesity. The main transmission routes of the COVID-19 virus in humans are direct contact, aerosol and droplets (Yan et al., 2020; Lu & Shi, 2020; Aziz et al., 2020). Numerous scholars (Lu et al., 2020; Benvenuto et al., 2020; Chen, 2019) have, however, confirmed that COVID-19 infection is zoonotic, transmitted from animals to humans.

The movement of people plays a significant role in the spread of infectious diseases (Gayawan et al., 2020a). This applies to COVID-19 since SARS-CoV-2 spreads quickly between people. The factors that influenced SARS-CoV-2's late transmission in Africa remain veiled in obscurity, but it may be relatively due to the limited mobility of the population across the international boundaries (Martinez-Alvarez et al., 2020). Most African countries reported the influence of international travel from Europe in their first COVID-19 cases (Adegboye et al., 2021). To confirm the influence of mobility on the spread of COVID-19, the first cases in Africa were observed in countries with highly internationally mobile populations, Egypt and Nigeria (Gayawan et al., 2020a, b). The disease's initial spatial and temporal trends on the African continent indicated a slow spread until the cases increased abruptly in the last week of March 2020 (Gilbert et al., 2020).

In the early phases of the pandemic, there was concern among health experts about its proliferation in Africa due to its preparedness to deal with a pandemic of that magnitude (Gayawan et al., 2020a, b). The health systems in most African countries are underfunded, and consequently, their capacity to effectively deal with a vicious pandemic like COVID-19 is compromised. Early detection and control of diseases are shrouded in inefficiency due to poor infection surveillance and inadequate data transmission, among other factors (El-Sadr & Justman, 2020; Adekunle et al., 2020). Thus, the need for up-to-date spatial and temporal trend data and information about an infectious disease cannot be overemphasised, given its importance in enabling efficient combating of the spread of diseases.

Several statistical models have been applied to predict infection rates of COVID-19 (Gayawan et al., 2020a; Wang et al., 2020a). However, Adegboye et al. (2018) observed that mapping disease incidence, fatality rate and related deaths to identify geographic concentration and patterns is the sine qua non for comprehending the epidemiology of the disease and is a necessity for effective planning, containment and preventive action (Gayawan et al., 2020b). Spatial mapping of COVID-19 has been done by some studies (Gayawan et al., 2020a; Kang et al., 2020; Arab-Mazar et al., 2020). However, most of them focused on the spatial dimension without a focus on the temporal distribution. More so, in Zimbabwe, the spatial and temporal trends of COVID-19 have not been keenly taken into account to assess space-time dynamics to enhance the containment capacity. In view of this gap, this study explores the temporospatial trends of the disease between March 2020 and March 2022.

2.2 Materials and Methods

The study focuses on Zimbabwe, a developing country in Southern Africa which shares borders with South Africa (to the south), Zambia (to the northwest), Mozambique (to the northeast) and Botswana and the Caprivi Strip of Namibia (to the southwest) (Fig. 2.1). According to Worldometer (2022), Zimbabwe's population is estimated at 15.2 million people, with a density of about 38 people per km^2. As of 20 March 2022, there were 224,452 confirmed cumulative cases of COVID-19 and 5429 COVID-19-related deaths (Hannah et al., 2022). The country has 10 provinces and 61 administrative districts. The ten provinces (Fig. 2.1) are used as spatial units of analysis in this chapter. This is because the data on COVID-19 is unavailable on lower spatial scales of analysis, such as districts in the country.

This study examines the spatial and temporal trends of COVID-19 in Zimbabwe. It employs a quantitative research design coupled with document analysis to understand the factors behind the trends. The period considered in this study stretches from March 2020 to February 2022. Data on monthly infections, cumulative cases and deaths were obtained from interactive COVID-19 dashboards, including the Our World in Data platform managed by the University of Oxford, ZimStats dashboard and Zimbabwe's Ministry of Health and Child Care website.

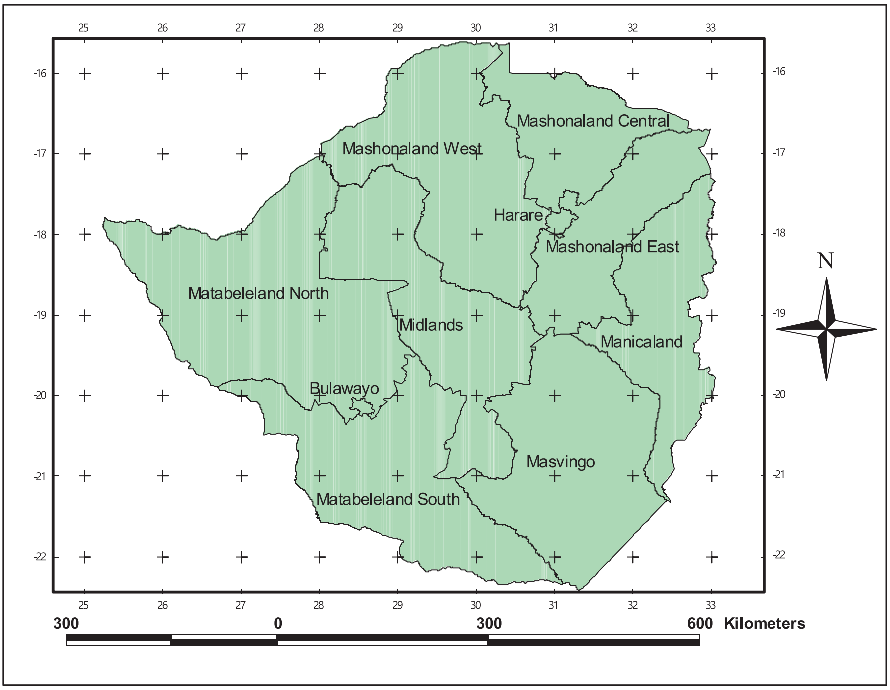

Fig. 2.1 Study area map; provinces of Zimbabwe. (Source: Authors, 2022)

Both exploratory and confirmatory analysis approaches were used to determine statistical temporal trends of COVID-19 between March 2020 and February 2022. For spatial trends, statistical thematic maps were used, employing colour intensity to correspond with the aggregate summary of COVID-19 proliferation in the country's provinces, which were used as the spatial enumeration units. The COVID-19 statistical data were first subjected to a Kolmogorov-Smirnov normality test before it was analysed to determine the significance of the trends using the Mann-Kendal (*M-K*) test in XLSTAT 2020. The *M-K* test detects monotonic trends in a data series (Chapungu & Nhamo, 2021) and has the dexterity to deal with values which are omitted and values under the detection boundary (Kocsis et al., 2020). Equations 2.1–2.3 show the procedure for computing the *M-K* test:

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \operatorname{sgn}\left(Xj - Xk\right) \tag{2.1}$$

Where S is the Kendall score. Sgn $(x) = \{1 \text{ if } x > 0, 0 \text{ if } x = 0, -1 \text{ if } x < 0\}$ (Mann, 1945)

The variance of S is calculated from Eq. (2.2)" (Chapungu & Nhamo, 2021):

$$\mathrm{Var}(S) = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{p-1}^{g} tp(tp-1)(2tp+5) \right] \tag{2.2}$$

Where g is the number of tied groups and *tp is the number of observations in the* pth group. After computing the variance, the Z value (Z_{MK}) is computed in Eq. (2.3)" (Chapungu & Nhamo, 2021):

$$\begin{aligned} Zmk &= \frac{s-1}{\sqrt{\mathrm{VAR}(S)}} \text{ if } S > 0 \\ &= 0 \text{ if } S = 0 \\ &= \frac{s+1}{\sqrt{\mathrm{VAR}(S)}} \text{ if } S < 0 \end{aligned} \tag{2.3}$$

Tehran et al. (2021) propounded that a positive M-K statistic Z_{MK} shows an affirmative change in the pattern of the variable, whereas a negative Z_{MK} signposts a declining inclination. The values less than 0.05 show significant changes at 95% confidence level, while the values greater than 0.05 indicate no significant change.

As a data validation strategy, Zimbabwe's national testing capacity was determined and compared with the WHO recommended standard. From the official report (as of 12 January 2022), the testing capacity in Zimbabwe was approximately 19,914 tests per week. If this is compared to the WHO standard, which recommends performing 1 test per 1000 populations per week, the test capacity in Zimbabwe is above the WHO standard.

2.3 Presentation of Results

2.3.1 Spatial Distribution of COVID-19 Cases

Results show that the burden of COVID-19 varies geographically across provinces. Figure 2.2 shows the spatial distribution of the cumulative cases of COVID-19 in the provinces of Zimbabwe.

As shown in Fig. 2.2, Harare has extremely high cases of COVID-19. As of 18 March 2022, the cumulative cases of COVID-19 in the province had gone above 95,000. This was followed by Manicaland Province, with a cumulative total between 55,000 and 60,000. Mashonaland East and Mashonaland West had cumulative cases between 45,000 and 55,000 by the time this study was conducted. Bulawayo had a moderate number of cumulative cases of COVID-19, around 42,000. Finally, there is a group of provinces with the lowest cumulative cases of COVID-19. The remaining provinces had below 40,000 cumulative cases, with Mashonaland Central being the least affected with less than 25,000 cases. Masvingo and Midlands provinces

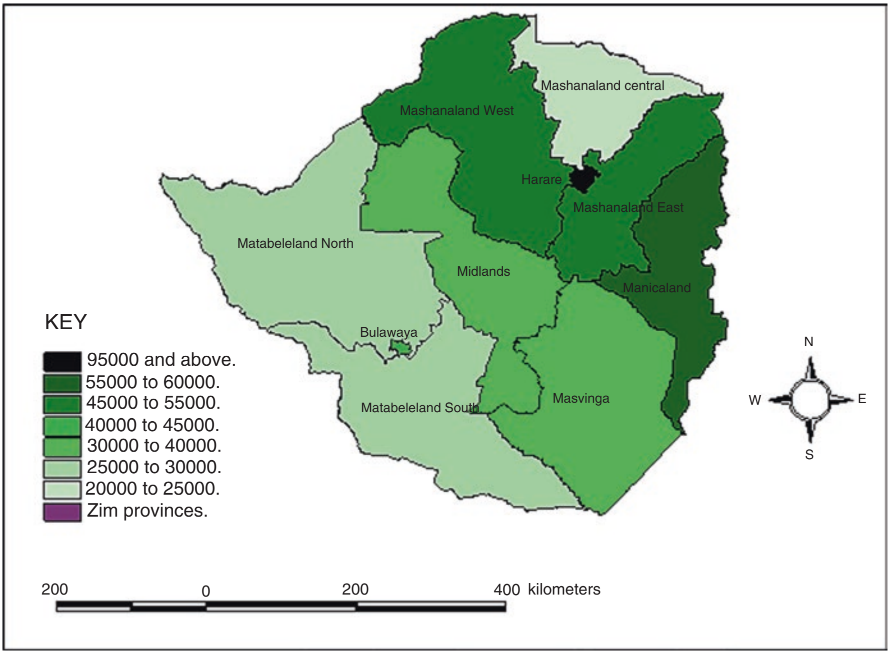

Fig. 2.2 The spatial pattern of confirmed cumulative COVID-19 cases in Zimbabwe as of 28 March 2022. (Source: Authors, data from Johns Hopkins University CSSE COVID-19 data)

had cumulative cases slightly higher than that of Matabeleland South and Matabeleland North.

The high number of cumulative cases across the provinces was influenced by periodic waves of COVID-19 upsurge, which occurred four times between March 2020 and February 2022. Figure 2.3 shows the cases across provinces during the periodic upsurges commonly referred to as waves.

As shown in Fig. 2.3, the fourth wave contributed most of the confirmed cumulative cases across the provinces. During the fourth wave, Harare had more than 45,000, comprising nearly 50% of the total number of cases in the province as of 18 March 2022. This was followed by Mashonaland East and Mashonaland West, with close to 29,000 cases each during the December 2021–January 2022 fourth wave. These were closely followed by Manicaland Province, with above 25,000 cases during the same period. The other provinces experienced less than 20,000 cases during this period, with Mashonaland Central experiencing the least number of cases.

This study observes a pattern showing an increase in wave intensity with time. The first wave contributed about 11,000 cases in the most affected province. During the second wave, the number increased to around 13,000 in the most affected province. This was followed by another increase in the third wave to above 27,000 and, lastly, in the fourth wave, about 29,000.

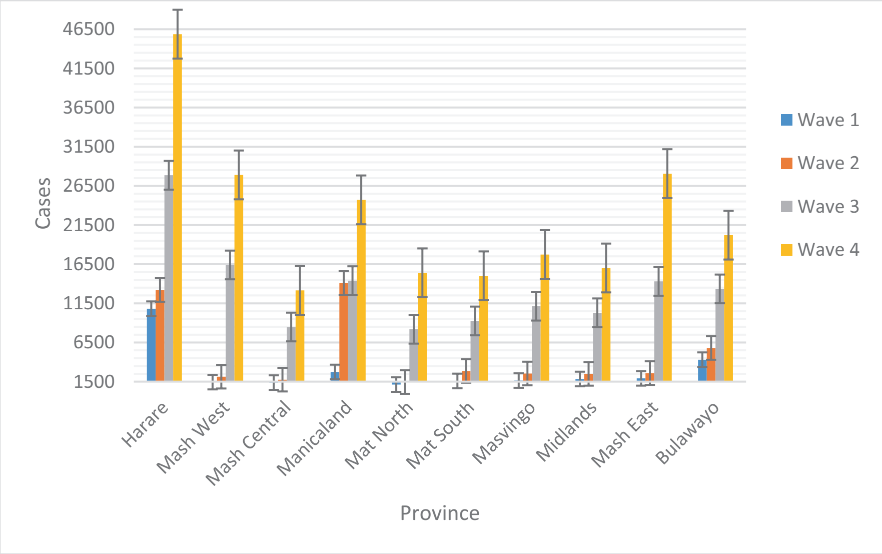

Fig. 2.3 The number of confirmed cases per province during the four-wave periods. (Source: Authors, data from Johns Hopkins University CSSE COVID-19 data)

2.3.2 Temporal Trend of COVID-19 in Zimbabwe

Dynamic change is an inherent feature of infections as they affect countries or parts of countries. COVID-19 in Zimbabwe has not been spared from such a general global trend. As alluded to earlier, there have been four waves during the occurrence of COVID-19 in Zimbabwe. Figure 2.4 shows the changes that have taken place in the spatial pattern of the cumulative cases of COVID-19 over time from the first wave to the fourth wave.

Figure 2.4 shows that Harare province dominated the four waves concerning the number of COVID-19 cases. It is observed, however, that the epicentres of the hotspots of the disease have shifted during the four waves. During the first wave, cumulative cases were high in the provinces with the biggest cities in the country, namely, Harare, Bulawayo, Mutare and Gweru. During the second wave of the disease, the diffusion of the disease was significant in the expansion diffusion type, i.e. the spreading of the disease through a population in an area in such a way that the number of those influenced grows progressively larger (Walter, 2000). The south-western and eastern parts of the country had higher cases of COVID-19 during the second wave, as shown in Fig. 2.4.

During the third and fourth waves, there was generally a shift in the centre of gravity of the pandemic towards the provinces of the country in the northern and eastern parts of the country except for Mashonaland Central Province, which remained with comparatively low numbers of cumulative cases of COVID-19

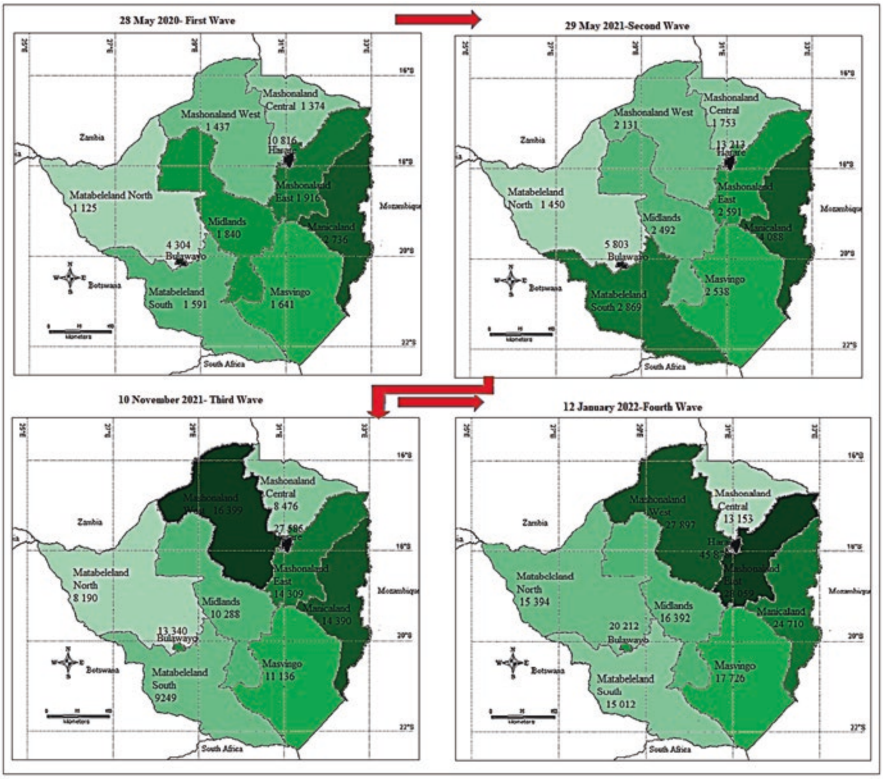

Fig. 2.4 Changes in the magnitude of periodic upsurges in COVID-19 cases. (Source: Authors, data from ZimStats (2022))

during all the four waves. On the other hand, Harare and Manicaland provinces had comparatively high numbers of COVID-19 cumulative cases throughout all four waves. Apart from the changes in the spatial patterns that occurred in the provinces during the different waves, Zimbabwe experienced a considerable increase in cumulative cases of COVID-19 since the beginning of the pandemic in the country, as shown in Fig. 2.5.

As indicated in Fig. 2.5, the gradient of the cumulative cases changes with time, with periods of waves having very steep gradients. The four waves can easily be identified, showing upsurges depicted by steep gradients. Periods of steep gradients (June–July 2020, December 2020–January 2021, July–August 2021 and December 2021–January 2022) were followed by phases of relative stability. As shown earlier, the steep gradients were mainly enhanced by highly populated areas characterised by highly mobile populations. While it is expected that the cumulative cases show a continuous increase in numbers, monthly cases have fluctuated throughout the pandemic, with some months having as low as 8 cases, while others had more than 7000. Figure 2.6 shows the monthly cases over the pandemic period.

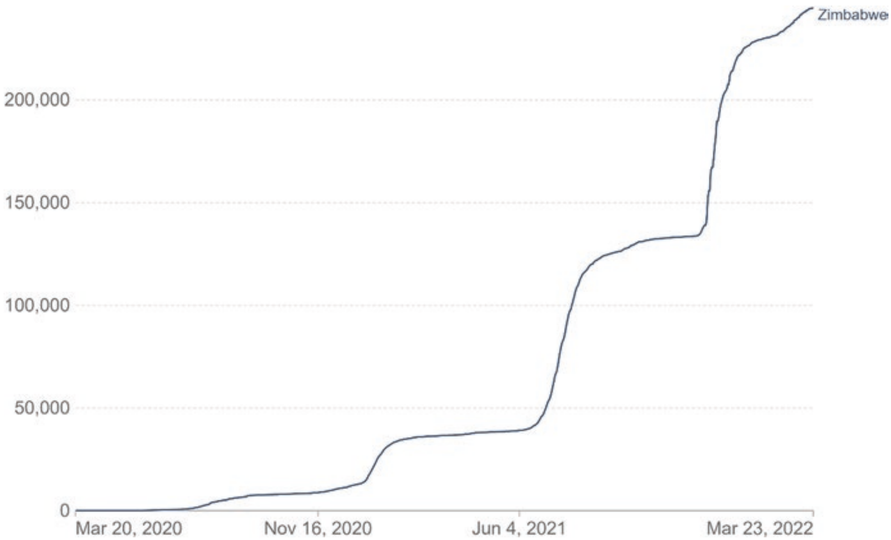

Fig. 2.5 Cumulative cases between March 2020 and March 2022. (Source: Authors, data from Johns Hopkins University CSSE COVID-19 data)

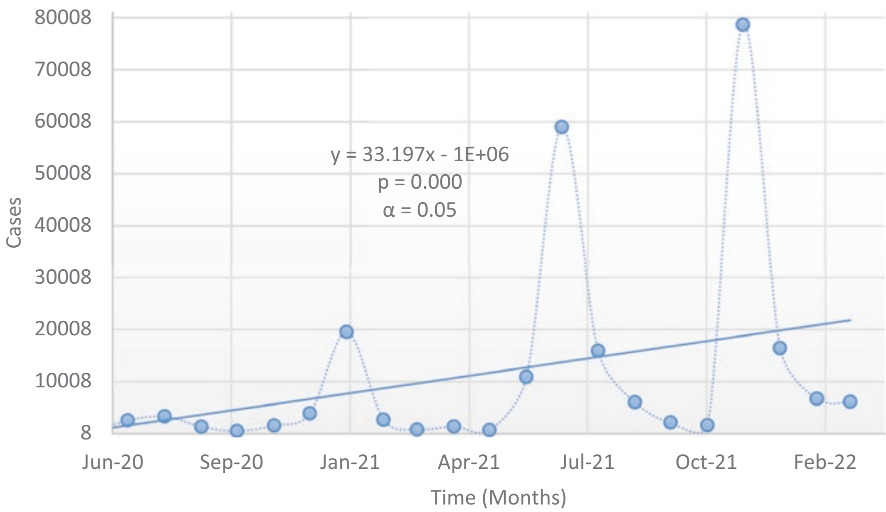

Fig. 2.6 Trend of monthly COVID-19 new infections in Zimbabwe. (Source: Authors, data from Johns Hopkins University CSSE COVID-19 data)

Figure 2.6 shows a statistically significant ($p = 0.000$; $\alpha = 0.05$) increase in the number of monthly COVID-19 new infections. A statistically significant increase implies that action must be taken to control the proliferation of the pandemic as more new people are conducting the virus every month. However, the fluctuations

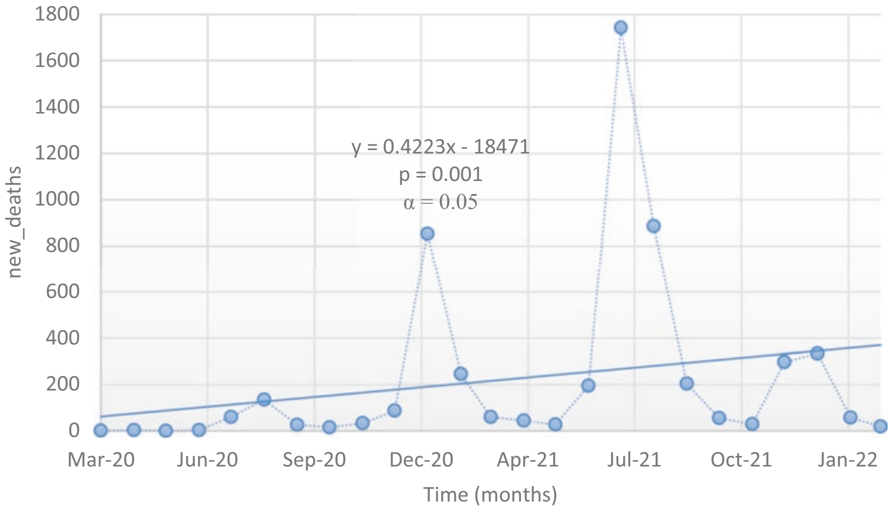

Fig. 2.7 Temporal trend in new monthly deaths related to COVID-19. (Source: Authors, data from Johns Hopkins University CSSE COVID-19 data)

are mainly a function of periods of a huge upsurge of cases. As observed earlier, the wave or periods of case upsurge are becoming more intense with time, with some phases exceeding 45,000 cases in one geographic location only.

The statistically significant temporal trend of new infections is associated with an increasing trend in monthly new deaths. The Mann-Kendall trend tests reveal that the trend for monthly new deaths in Zimbabwe is increasing ($p = 0.001$; $\alpha = 0.05$), as shown in Fig. 2.7.

The COVID-19-driven monthly death rate has been on the increase since the outbreak of the pandemic. As shown in Fig. 2.7, there is a significant increase in the number of people who die from COVID-19 per month with time. The increasing cases of infection mean more people are exposed, and the probability of fatalities increases. It appears that Zimbabwe's health management system has managed to withstand the onslaught of COVID-19 with regard to the case fatality rate. Figure 2.8 shows the case fatality rate over the 2-year period.

The case fatality rate is considered a weak indicator in determining whether a health system is well managed or not, but it gives a general indication of whether the chances are high that an infected person will die from COVID-19. As shown in Fig. 2.8, at the beginning of the pandemic, the case fatality rate was very high but decreased with time until it reached a point where it was almost stable over time. This can be attributed to a cocktail of pharmaceutical and non-pharmaceutical interventions introduced due to increased knowledge about the pandemic.

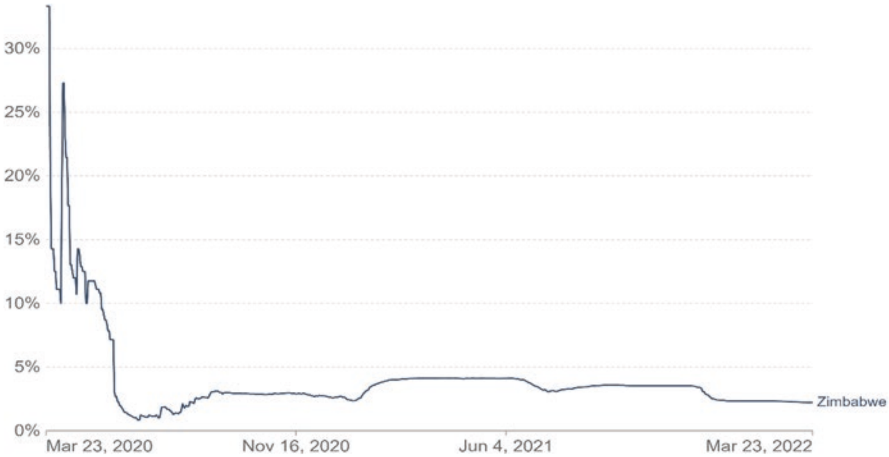

Fig. 2.8 COVID-19 case fatality rate between March 2020 and March 2022. (Source: Authors, data from Johns Hopkins University CSSE COVID-19 data)

2.4 Discussion

2.4.1 Spatial Pattern

The study has observed spatial variability in the prevalence of COVID-19 in Zimbabwe. The spatial variations evolve at the instigation of a plethora of factors. This confirms Gayawan et al. (2020a, b)'s observations that the proliferation of COVID-19 is spatially variable as determined by several variables. The provinces with high numbers of cumulative cases in the country are Harare, Bulawayo, Manicaland, Mashonaland West and Mashonaland East. One of the reasons to explain the comparatively higher cumulative cases of COVID-19 in those provinces is that they are located in areas harbouring large cities with high populations, making the transmission of SARS-CoV-2 easier than in areas that are sparsely populated. The virus is transmitted from infected persons through airborne transmission. Hence, the higher the population density, the more likely it is to efficiently transmit the virus (Wang et al., 2021). Besides population density, the characteristics of the population also determine the level of exposure to and transmissibility of the virus. Cities have a highly mobile and agile group of people who have greater chances of travelling to other countries where infections are high.

On the other hand, lower cumulative cases of COVID-19 in Masvingo, Matabeleland South and Matabeleland North can also be attributed to comparatively lower population numbers in the smaller urban areas in the provinces and lower population densities in the surrounding rural areas. The Midlands Province is an exception because cumulative cases are comparatively low despite the big city (Gweru) in that province. Previous studies by numerous scholars (Bhadra et al., 2021; Kadi & Khelfaoui, 2020; Alam, 2021; Wong & Li, 2020) support the positive relationship between high population density and high cumulative cases of COVID-19. The potential spreading risk of communicable disease is high when the population size and population density are large. Higher population density leads to more significant reports of COVID-19 diffusion.

In line with the distance decay law, the diffusion process of disease is associated with geographic interaction (Chen, 2019; Banks, 2014). Distance decay propounds that the further a place is from a source, the less it is affected by a disease, and the inverse is true. Mashonaland West Province is near Harare Province and has a more significant linkage with that province. The province (Mashonaland West) had high cumulative cases of COVID-19, which can be attributed to the strong linkage and proximity of the province with Harare Province. Mashonaland West Province also has a suitably developed transport network linking it with Harare Province and has a highway linking Zimbabwe with Zambia. Coelho et al. (2020) and Zhong et al. (2020) noted that various ways of transference provide an indispensable way for the diffusion of the virus. Transport routes in Mashonaland West, thus, serve as diffusion channels of COVID-19.

Meteorological factors also affect the spatial pattern of the cumulative cases of COVID-19 in Zimbabwe. Some provinces such as Harare, Bulawayo, Manicaland and parts of Mashonaland West and Mashonaland East experience lower temperatures and higher precipitation in the country. On the other hand, lower cumulative cases of COVID-19 in Masvingo, Matabeleland South and Matabeleland North can also be attributed to a comparatively higher temperature and lower precipitation. Evidence of the impact of meteorological factors such as precipitation and lower temperatures leading to higher incidence and prevalence rates of COVID-19 has been given by previous scholars (Oliveiros et al., 2020; Shahzad et al., 2021; Wang et al., 2020a, b; Sajadi et al., 2020). Climate conditions are thus significant predictors of coronavirus as they are critical in transmitting infectious diseases. Low temperatures, high humidity and high precipitation tend to increase the diffusion of COVID-19. Therefore, this chapter argues that warmer and drier parts of Zimbabwe are expected to have lower cumulative cases of COVID-19. As Gramsone aptly stated, "Some scientists think that the high temperatures make life harder for the virus that causes COVID-19" (Gramsone, 2020: 17).

2.4.2 Temporal Trends of COVID-19

This study employed the Mann-Kendall trend test to ascertain the temporal trends in monthly COVID-19 cases, monthly COVID-19-induced deaths and case fatality rate. It has established a significant trend in the temporal trends of monthly new infections and the number of deaths. The likelihood of coming into contact with an uninfected individual is less than the possibility of coming into contact with an infected person, resulting in a decrease in the number of new cases. Initially, from 21 March 2020 to 01 August 2020, there were few cases of the disease. This can be described as the lag phase of the disease diffusion. This is possibly because the pathogens (coronavirus) are still familiarising with the new conditions (human body), or the stage might have overlapped with the incubation phase of the disease. There are also chances that due to a few people infected at the initial stages, the prospect of coming into contact with an exposed individual is shallow, resulting in a low number of new cases.

After 05 August 2020, there is the acceleration phase of the disease. There is an increase in the number of infected people interacting within specific spatial contexts, and disease diffusion occurs. There has been an explosion of COVID-19 cases. That exponential phase marks the period of a swift upsurge in COVID-19-infected people in Zimbabwe. Such an exponential trend is inevitable. Epidemics typically obey the law of exponential growth in their initial stages, particularly for infectious diseases (Zhu et al., 2021). Under such conditions, $R_0 > 1.0$, where each existing infection causes more than one new infection, more people contract the disease and the interaction between infected and uninfected people increases. During the period, the prospect of coming into contact with an uninfected person increases, and the number of new cases increases. The curve is souring upwards as the disease diffusion wave has broken out of the source region and is spreading out rapidly across the spatial landscape of Zimbabwe.

2.5 Conclusion

This study has examined the spatial and temporal patterns of COVID-19 in Zimbabwe. COVID-19 has become a significant challenge to the health systems of countries worldwide. It is imperative that the spatial and temporal patterns of the disease be understood in Zimbabwe. Based on the analysis of the cumulative cases in the spatial and temporal patterns of COVID-19 in Zimbabwe, it emerged that the disease rapidly spread to all provinces of Zimbabwe. The highest cumulative cases were found in Harare Province of the country. Other provinces with high numbers of COVID-19 cases were Manicaland, Mashonaland West, Bulawayo and Mashonaland East provinces. The provinces are characterised by comparatively low temperatures, high rainfall and high population densities. All such conditions are conducive to the fast spreading of the pandemic. Meteorological factors, population sizes and density had a significant impact on the spatial pattern of COVID-19 in Zimbabwe. The spatial distribution of the disease was characterised by expansion diffusion outwards from the initial hotspot centres in the country.

On the other hand, comparatively low cumulative cases of COVID-19 were identified in the provinces in the southern and western parts of the country (Masvingo, Matabeleland South and Matabeleland), as well as Mashonaland Central in the northern part of the country had low cumulative cases of COVID-19. The provinces are generally hot and dry, which creates conditions which limit the spreading of COVID-19. The country has experienced four waves of COVID-19. During the four waves, the spatial patterns of the cumulative cases of COVID-19 were generally shifting northwards. During the waves, some provinces experienced increases in the

COVID-19 cases, while others experienced some decline. Apart from such a trend, it also emerged from the study that the total cumulative cases of COVID-19 increased sharply from March 2020 to March 2022. Analyses of spatial and temporal distribution characteristics of COVID-19 indicated that Zimbabwe was changing with time and was unevenly geographically distributed.

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Chapter 3
Public Safety and Health Systems in the Context of COVID-19 in Zimbabwe: Gaps and Prospects

Kelvin Zhanda

Abstract Until recently there has been a paucity of scholarly and policy attention given to public safety systems with respect to emergency public health disasters such as the novel COVID-19 in developing countries. The chapter explores and examines the institutional frameworks around public safety and health systems amid the COVID-19 pandemic in Zimbabwe with the aim of building safe and healthy societies. The chapter employed qualitative research paradigm utilising extensive review of secondary data sources. Thematic content analysis was engaged for data analysis. Results indicate that the possibility of public safety violations has depended on the impact of COVID-19 to the public health system and harshness of livelihood shortages during the lockdown period. Thus, the COVID-19 pandemic has become more of a public safety concern much than a mere health concern in Zimbabwe. While the Zimbabwean government operationalised the Civil Protection Act and instituted a number of COVID-19 containment measures (statutory instruments, plans and policies) backed by law enforcement, public health and safety agencies have neglected the firm integration of safety systems in their provisions. Given the need for law enforcement in a public health crisis, Zimbabwe law enforcement entities' conduct has, however, impacted on some public safety issues. As such, the chapter establishes the basis for recasting the public safety and health entities among other relevant multi-stakeholders as they interlink in enforcement of health-safety protocol and integrated public safety planning which is evidently absent in Zimbabwe as exposed by COVID-19. The chapter concludes that Zimbabwe needs public safety frameworks which are resilient and interoperable to strengthen health-safety systems' capacity through policy reforms for controlling pandemics to ensure safer communities.

Keywords COVID-19 · Policy · Public health-safety · Law enforcement

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3.1 Introduction and Background

The outbreak and subsequent spread of coronavirus disease 2019 (COVID-19) pandemic around the globe (Liu et al., 2022) has been anything but far-reaching threat to all facets of human life. According to the data from the World Health Organization (WHO, 2020b), as of 22 December 2020, 1.6 million deaths were reported globally. These statistics had increased to over 278 million cumulative cases and 5.4 million cumulative deaths worldwide as of 27 December 2021 (Liu et al., 2022). The fatal consequences of COVID-19 have compelled people to regularly take extraordinary safety precautions (Agojo, 2021: 363) aided by WHO's COVID-19 safety protocols such as quarantine or isolation of international travellers, widespread testing and tracing secondary contacts. Since the WHO, on 12 March 2020, declared COVID-19 a global public health emergency of high international concern (Liu et al., 2022), several countries all over the world have reacted quickly, instituting medical and non-medical interventions to prevent and reduce the rate of infections (World Bank, 2020). The main non-medical public and personal intervention measures (underpinned by laws of the states) included prohibition of public gatherings, travel curfews, the closure of non-essential services, social distancing, wearing of face masks and handwashing. These measures work hand in hand with medical resources such as ordinary hospital beds, intensive care unit beds, ventilators and health personnel (nurses, doctors, pharmacists) to ensure effective control (Liu et al., 2022).

In Africa, the first measures taken by governments were to restrict cross-border movement and limit air travel (Worldometer, 2020; WHO, 2020a) with South Africa being the first in sub-Saharan Africa (SSA) (Pearson et al., 2020). Governments began implementing measures in accordance with WHO guidelines to contain the spread of the virus since it became clear that the border closures were not effective. However, other scholars contend that such COVID-19 control measures presented challenges for many countries especially in SSA (Pearson et al., 2020) where overstrained health systems, vitiated critical infrastructure and poor public health surveillance affected their latent efficacy (Mackworth-Young et al., 2021). Zimbabwe is one of the countries plagued by COVID-19. As of 29 December 2020, the country had recorded 13,325 cumulative cases, 359 deaths and 11,067 recoveries (Worldometer, 2020). Despite Zimbabwe's poor public health-care system and emergency preparedness, the government pronounced a series of national lockdowns. The lockdown measures were put in place to flatten the COVID-19 transmission curve and to prepare the health system for management of the anticipated impact of the disease (Mhlanga & Ndhlovu, 2020).

The efficacy of the COVID-19 prevention and control measures is largely determined by other factors which are related to the country's ability to react to public health disasters (Liu et al., 2022), economic conditions and multi-sectoral approaches. For example, public safety and health security and gross domestic product can go a long way tackling a pandemic. Ramifications of 'shelter in home' measures in a country already experiencing socio-economic problems like Zimbabwe (Zhanda et al., 2022; Nhapi, 2019) have become unprecedented. Besides, the negative approaches on fundamental human rights (Mavhinga, 2020), through, inter alia, convulsive responses by the law enforcement agents, and reduced access to basic needs such as food. Social distance and quarantining in the townships of Zimbabwe were seemingly a perfect fit of impossibility, and to enforce the COVID-19 containment regulations only appeared to worsen the situation (Zhanda et al., 2022). In the time of COVID-19 pandemic, public safety is a serious concern. As such, the activities that the public must carry out to safeguard and protect the mass population from harmful impacts of safety risk threatening behaviours (Al-Bsheish et al., 2021) are so critical.

Until recently, nevertheless, research in SSA has hardly explored and examined the interactions between public safety and health in determining safety and health outcomes especially in the times of pandemics and disasters. While there is growing body of studies profiling the impact of previous pandemics such as Ebola in West Africa (Boozary et al., 2014), severe acute respiratory syndrome in 2002, MERS (Snowden, 2019) and the ongoing COVID-19 pandemic on health-care providers, very few have delineated and investigated the impact of epidemics and pandemics on public safety institutions (Schweig, 2014). Since response measures are critical to health emergencies, Von Gottberg et al. (2016: 1) echo that contemporary studies on pandemic preparedness are mainly focused on health-care services. In the United States, the George Mason University's Center for Evidence-Based Crime Policy and International Association of Chiefs of Police started a partnership in March 2020 to conduct a multi-wave study so as to document the evolving impacts of COVID-19 on public safety and law enforcement agencies (Lum et al., 2020). Moreover, a global research study was conducted by Motorola Solutions in conjunction with Goldsmiths and the University of London to better comprehend how public safety entities around the globe adapted to overcome emerging challenges (Steinberg, 2021). The study found loopholes in public safety systems and ample evidence for the great need for innovation to ensure that people and property are safe and protected amid the COVID-19 pandemic. As such, Steinberg (2021) argues that the global pandemic has ignited a new era of public safety innovation.

Why would a pandemic like COVID-19 be a public safety question, as opposed to a mere public health problematic? In an attempt to address this research question, the present chapter presents the intricacies of safety and health, moving away from 'conventional' occupational safety and health but integrating other sectors and community participation. Maintaining adequate responsive capacity and functioning of health systems amid the pandemic depends largely on the functioning of critical infrastructure, which includes an array of national and municipal services ranging from public safety, emergency service, power and water supply, public transport, traffic surveillance and waste management (Itzwerth et al., 2006). There is an emerging recognition that the novel coronavirus is a public safety threat in developing countries particularly in Zimbabwe. The COVID-19 pandemic has posed a public safety risk in Zimbabwe. Being described as a 'global public bad' (Baldwin & di Mauro, 2020), the COVID-19 pandemic threatens public safety, and it means that any failure to curtail the virus threatens the safety of every citizen within the country. Amid the COVID-19 era, safety issues such as violence (Humphreys et al., 2020), fire and robbery, among other crimes, were reported not only in SSA countries such as South Africa, Malawi and Zimbabwe (Newham & Du Plessis, 2020). However, while safety agencies were restrained by lockdown rules, their roles were compromised by a number of factors which include, inter alia, resources and human capital. To this end, law enforcers as safety agencies were called upon to enforce COVID-19 containment regulations such as lockdowns, social distancing, quarantines and proper wearing of face masks and to provide security in health centres full of COVID-19 patients, as well as ensuring that when vaccines became available in limited quantities, these could be distributed to the areas with the pressing need for them. These have also divided their attention, leaving gaps in the public safety fraternity. In order to contain the virus and address its devastating secondary effects, multi-sectoral action is needed, roping in, inter alia, public safety in focus.

Yet, in direct contrast to the Zimbabwe national COVID-19 responses that have been taken, far less has been considered about public safety challenges exhibited in policies and plans (see MoHCC, 2020). Notably, public safety and fundamental human rights are interlinked (Caruso, 2017). This entails that the violation of human rights through health governance interventions amid the COVID-19 pandemic has impacted on public safety. A selected number of the measures taken to fight the COVID-19 have been considered extreme as they encroached on basic human rights (Mavhinga, 2020). These include rights such as right to education and freedom of assembly and movement, halting various cultural and religious activities. Regardless of the complexity of pandemic environment, the lockdown regulations were still supposed to be reasonable and proportionate (Maulani et al., 2020). The continued rise of public safety concerns amid the COVID-19 has stirred public health policy responses that are alive to the concerns of the community besides having another problem at hand. Like elsewhere across the globe, if Zimbabwe wants to flatten the curve of the pandemic and protect lives, it needs to speak to the safety of the people in the country, including vulnerable communities.

In line with these perspectives, the present chapter explores the intricacies between public health and public safety, paying specific attention on how public safety systems and approaches vis-à-vis public health responses affect health and safety outcomes amid pandemics. These arguments draw on research from the public health, public safety and public policy circles, and the study will deliver an array of practically feasible propositions for implementing the public health-safety model. Specifically, this discourse's primary purpose is to present and examine various ways in which public safety and public health agencies in Zimbabwe have responded to the COVID-19 pandemic and how best the country can learn from its 'undoing' so as to aid its communities' resilience to safety and health problems now and in the future. The chapter explicates the role of the community, security departments and public safety and health entities as they interlink in enforcement of COVID-19 containment directives and with various stakeholders' responses to COVID-19. The basis for which public health and public safety institutions in Zimbabwe should respond to the health and/or other national crises was thus laid. This scholarly work contributes to the field of public safety and health and emergency management by enhancing public safety and health system preparedness and response challenges, which were unknown concerning the response measures to biological hazards and disasters. Through gaining the safety preparedness perspectives, experts in public emergency situation and response (Hooper, 1999) will then serve to shed light on the public safety and health field as to what risks and preparatory requirements are associated with pandemic response. Therefore, the chapter builds a basis for an integrated public safety planning and development which is evidently absent in Zimbabwe. The chapter recommends public safety frameworks which are resilient and interoperable to strengthen health-safety systems' capacity through policy reforms for controlling pandemics to ensure safer communities.

3.2 Conceptualising Public Safety-Health Systems

While there are a number of crucial links and similarities between public health and safety (Caruso, 2017: 2), it is important to start conceptualising them separately in order to bring an understanding of their nexus in a public crisis like COVID-19. Nevertheless, while there are various ways of defining public safety and different scholarly accounts of what public health intends to achieve, what is clear is that both are primarily prerogatives of the state. For years, public safety has been understood to be the first duty of government by policy- and decision-makers (Friedman, 2021). Friedman (2021) posed three critical questions: But what is meant by 'public safety'? What precisely does it entail to be safe? And more to the present point, what is required as part of government's obligation to assure that each and every one of us is safe? One might think, probably, that the questions themselves make a fetish of a term: what can it possibly matter if something is viewed as 'public safety' or 'not public safety'? Friedman argues that the answer to the first question (what is public safety?) may seem plain, evident even, but it is not. Public safety was also seen as an umbrella term under which social and situational approaches could not be juxtaposed but rather fused.

At the same time, events such as the economic turmoil it has unleashed, rising homicide rates in major cities, terrorism, widespread protests over police violence supported by demands to defund the police (Richards et al., 2006) and the current COVID-19 pandemic all underscore the importance of answering the question correctly. At the centre of public safety are the concepts of 'protection and security'. Conceptually, the term 'public safety' was used interchangeably with 'crime prevention'. Even so, the latter was viewed to be overly narrow and closely associated with police-related duties and responsibilities (Crawford, 2002).

Since issues of 'protection and security' are at the centre of public safety, scholars have tended to define public safety rather narrowly, largely in terms of the 'protection' role, that is, protecting people from violent harm to property or person from natural elements and third parties (Friedman, 2021). But, is protection really all there is to public safety? There are extensive harms that can occur by narrowly focusing on public safety as protection and also neglect all the other elements of human safety. For many people, being safe depends on the sufficient availability of food, clean water and air, housing, a basic income and the means to acquire it, a job and education (Friedman, 2021). It might also include health insurance, health care and freedom from discrimination. Arguably, if public safety includes one or all of these elements, then public safety as the government's obligation to ensure people are safe should be understood more broadly than it is in present years. Thus, public safety needs to expand to include many of the other circumstances that threaten individual safety beyond violent harm. When public safety is deliberated in the public domain, it typically has been assumed to mean freedom from violent and physical harm and injury to one's person and to one's property, in particular from violent crime or events (Steinberg, 2021). Certainly, and nonetheless, people also do not feel safe if they are forced to sleep on the streets and to forage in trash cans for food or are facing starvation. If they are lacking an education and cannot earn a living or find a job, they do not feel safe if they are confronting grievous illness or if they face health-care costs they cannot afford (Friedman, 2021).

In America, for example, it was the conclusion that government had failed the people of Flint, Michigan, in its obligation to provide them clean water; government conceded as much (Crawford, 2002; Friedman, 2021), and the government similarly was understood to have failed in the time it took to restore power to the people of Puerto Rico following Hurricane Maria. Therefore, governments across the globe by common consensus are responsible for addressing the COVID-19 pandemic which is currently affecting people. But how far should the governments' duty to provide public safety extend? If clean water does, it also includes clean air? If electricity, what about food or housing or education and job opportunity for that matter? If fighting COVID-19 pandemic, what about health care in general? These questions bring to light the importance of understanding the inexorable linkages of public safety and health systems as they interlink in policy and practice during public health emergency.

Public safety governance is quite complex given its embodiment of many institutions (Friedman, 2021) and a myriad of sustainable human development inputs (WHO, undated) such as health, human security, livelihoods, education and governance (see Fig. 3.1). Thus, public safety knows no physical boundaries as it has affected rural and urban enclaves throughout human history. However, the rate at which they have been affected has increased mainly as a result of a number of factors that include poor civil protection governance frameworks, lack of political will, corruption and the decay of social capital (Crawford, 2002). From 1993 to 1999, the average safety violations recorded were 428 per annum, but this figure had increased to an average of 707 of such events per year from 2000 to 2004 (Crawford, 2002). This highlights how both the rural and the urban environments, especially in low-income countries, are subject to a number of safety risks and hazards. Public safety problem originated from a series of emergency activities in the face of social activities and crises (Crawford, 2002) and lack of emergency and disaster preparedness (Hooper, 1999). Figure 3.1 illustrates that public safety is multidimensional, and as such, it calls into focus system approach to ensure communities are safe during a pandemic. This signifies the problems faced during the COVID-19 pandemic across the globe.

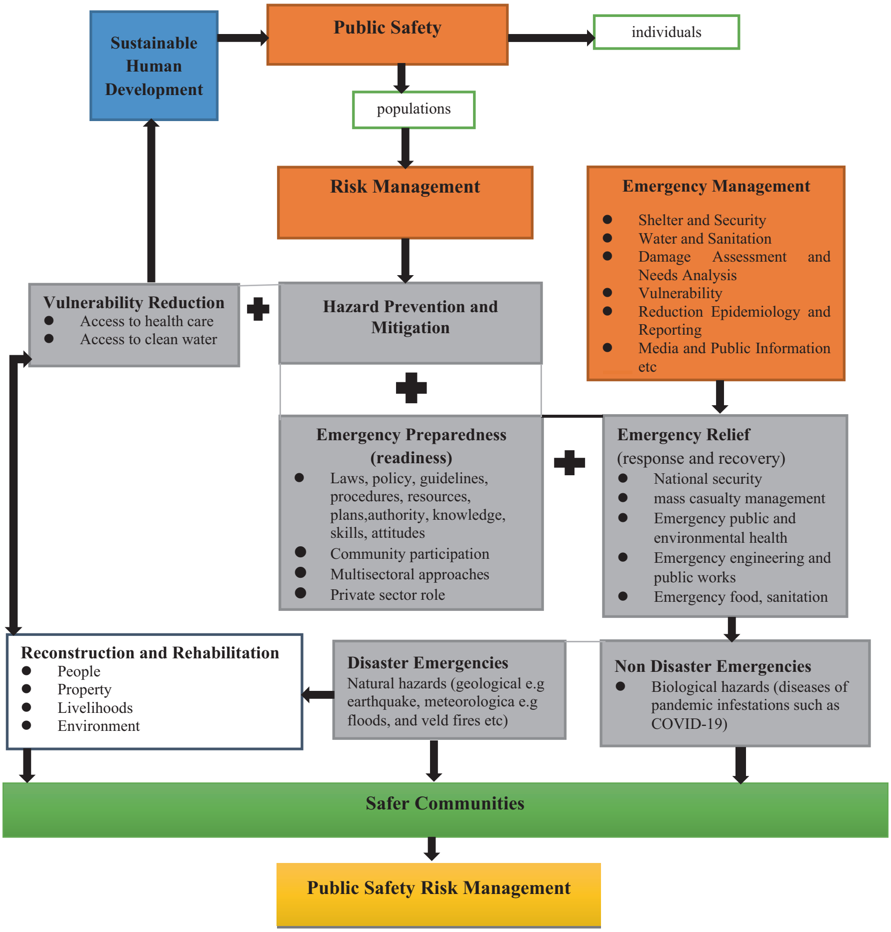

Fig. 3.1 Public safety framework. (Source: author's creation, data based on WHO (undated))

According to Faden and Shebaya (2015), public health has four distinct characteristics: (i) it is a public or collective good; (ii) its promotion involves a particular focus on prevention; (iii) its promotion often entails government action; and (iv) it involves an intrinsic outcome orientation. These characteristics can equally be applied to the concept of public safety. First, in public health, the object of concern is populations not individuals. Thus, public health is, by its very nature, a public, communal good, where the benefits to one person cannot readily be individuated from those to another (Faden & Shebaya, 2015). One can say the same thing for public safety – it too is a communal good. The societal goods we seek in the safety and criminal justice system such as safety, security and justice are aimed at the collective good, and the policies employed to achieve them are designed and implemented with the public good in mind (Caruso, 2017). Some of these may be part of the public safety and health that national governments must provide, and some may not. Therefore, until authorities rethink what constitutes safety, it will not direct them more sufficiently.

The rethinking of concepts of public safety and public health particularly in the purview of their connection and implementation from policy to practice are decisive in rallying public health and safety entities to incorporating both concepts into the recuperation process as well as reshaping the health emergence philosophy of the country (Snowden, 2019). This binds that public safety-health is an ongoing requirement for many countries across the globe, which should be the top priority due to increasing dangers to the communities, the environment and its people (Richards et al., 2006). Therefore, in some countries, local institutional responses have taken place within programme and policy frameworks amid the COVID-19 pandemic that aim at coordinating contributions by health agencies (Maulani et al., 2020) and safety agencies from both the private and state circles. However, exposure and risk to infectious pandemics or diseases and its implications are determined by the size, age and level of operational and financial sustainability of the country's public health and public safety institutions.

3.3 Safety Systems and Health Systems in Zimbabwe: An Overview

This section presents contextual premises upon which the study on implications of pandemics like COVID-19 on the public safety and health systems in Zimbabwe can be built upon. Studies on public safety in Zimbabwe are very limited, and as such, it is of scholarly interest (Crawford, 2002) for this chapter. The existing public safety institutions are mandated to maintain their operations so as to ensure the safety of the communities they are obligated to serve (Ministry of Local Government, 2009) at law. Unlike South Africa which has the Public Safety Act, Zimbabwe has no specific legal statute on public safety to govern the operation of all safety agencies in the country with the ultimate goal of maintaining people's safety nationwide. According to Section 219 of the Constitution of Zimbabwe Amendment (No. 20) Act of 2013, the Police Service is responsible for *protecting lives* and property of the people, maintaining law and order, enforcing and upholding the law and preserving the internal security of the country (GoZ, 2013). Law enforcement services to maintain law and order, protect the public and property as well prevent crimes are provided by the Zimbabwe Republic Police (ZRP) housed under the Ministry of Home Affairs and Cultural Heritage. The same legal document, Section 213 subsection 2(b), outlines the deployment of defence forces in support of the ZRP and other civilian authorities in the event of an emergency of disaster (GoZ, 2013).

In addition, public safety and civil protection systems in time of disasters are premised on the Civil Protection Act (CPA) of 2001 (Chapter 10:06). The CPA establishes a civil protection organisation (CPO), a national platform comprising of line ministries, state enterprises, private sector and NGOs whose regular activities are related to emergency responses (Ministry of Local Government, 2009). The

CPA directs every district and province to have responsibility for the protection and preservation of the lives and property for their citizens. The responsibility for the implementation of the CPA lies with the Department of Civil Protection (DCP), which falls under the Ministry of Local Government. DCP provides guidance to the state and downwards in dealing with emergencies and disasters as well as physical assistance to areas that fail to cope in an emergency (Department of Civil Protection, 2012). The DCP is supported by the Commissioner of the ZRP, Zimbabwe Red Cross Society, Secretary of the Ministry of Health, the fire brigade, military commanders, Director of Prisons and Director of Civil Aviation. These can appoint subcommittees, though not clear in the CPA, drawn from government line ministries and NGOs (Mavhura, 2016). These include, inter alia, the Zimbabwe National Water Authority, Zimbabwe Electricity Supply Authority and United Nations (UN) agencies such as UN Development Programme, International Organization for Migration and NGOs such as Zimbabwe Red Cross Society, Save the Children, Oxfam GB and World Vision (Mavhura, 2016). The functions and roles of these entities are critical for underpinning citizenry safety in the country.

Zimbabwe's present health-care delivery system can be simply described as 'weak and unsafe'. Talking of achieving universal health coverage, the central pledge of the United Nations' 2030 Agenda for Sustainable Development (UN General Assembly, 2016) in the commitment to 'leave no one behind', Zimbabwe is not anywhere close to meeting the target. Zimbabwe initially got off to a good start following independence, with the 1980s witnessing several positive gains in health service delivery (Nhapi, 2019: 161). Health institutions were strong as they facilitated 'health for all' policy with massive health infrastructure and health services spread to within reach of the vast majority of the population, even in rural areas (World Bank, 1992). In the 1990s, however, increasing professional and public anxiety over declining quality, equity and access in health services and increasing demands on people to pay out-of-pocket for professional care were witnessed (World Bank, 1992). The public health system of Zimbabwe is comprised of the seven tertiary care institutions (provincial hospitals), 1331 primary care institutions (rural health centres and clinics), 179 secondary care institutions (district and missionary hospitals) and 14 quaternary care institutions (central hospitals) (Tren et al., 2007).

Notably, even prior to the outbreak of COVID-19, Zimbabwe's health sector was precarious, under-financed and understaffed (Maulani et al., 2020). Access to specialised care is highly unequal, exemplified by the common practice of African elites seeking health care abroad (Nyazema, 2010). As of 2017, Zimbabwe's health system was battling with quite a number of diseases as patients succumbed to treatable diseases such as malaria, cholera, typhoid and other cardiovascular ailments. While health indicators such as life expectancy, morbidity and mortality have relatively improved over the past two decades (Maulani et al., 2020), other health threats such as child mortality, maternal health and malaria, tuberculosis, and human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) and other elementary health services remain a challenge to date (Nhapi, 2019). Overall access to quality health services, however, is very low, especially in remote areas of the country. Zimbabwe has a total number of 214 hospitals (public and private) out of which 120 are government hospitals to serve a population of over 15 million people (Mackworth-Young et al., 2021). WHO (2020b) reports a huge doctor to patient ratio with an estimated 7200 nurses and 1600 physicians for every 10,000 people and a health sector vacancy rate of over 50%. Mackworth-Young et al. (2021: 85) observe periodic work stoppages by health-care workers protesting against under-resourcing of Zimbabwe's health system and meagre salaries. This further restricted the health sector's capacity and resilience to respond to the health disasters such as cholera and COVID-19. The outbreak of Ebola health crisis in West Africa, for example, had showed the fatal repercussions (measured in mortality rate) of a public health crisis under a health system deficient of resilience are significant (Boozary et al., 2014). This situation has not been peculiar to Africa only as was the case in Italy's Lombardy region where the health-care system was strained from COVID-19 to the extent that authorities were asking retired doctors to come out of retirement and student nurses fast-tracked to graduation (Al-Arshani, 2020). Zimbabwe also lacks amply accessible health insurance which translates to mean that the majority of people have no medical aid (Nhapi, 2019).

While the public sector provides 65% of health-care services (Nhapi, 2019; Tren et al., 2007). Zimbabwe's funding of the health sector has been stalled mainly by the plummeting economy characterised by hyper-inflation, over 90% unemployment rate (Mukoka, 2020), corruption, poor public service delivery and poor, if not inconsistent, policies in resource allocation. This leaves many countries in the Global South's health systems unprepared for tackling respiratory health problems. As such, health systems mainly in Africa have been plagued, yet health experts advised that an extended COVID-19 pandemic would engender numerous hospitalisations, which would seriously strain the health systems' capacities (WHO, 2020b) of the countries. Unsurprisingly, Zimbabwe has struggled to produce and acquire COVID-19 testing kits, ventilators and necessary personal protective equipment (PPE) (Muronzi, 2020). Thus, COVID-19 cases and fatalities in Zimbabwe were recorded. At the centre of these problems, one would anticipate that the government must respond in a way that strikes a balance of safety systems and health of the communities.

The threat of COVID-19 on health systems in low-income countries could be exemplified and exhibited by the crisis faced by high-income countries in the United States, Asia and Europe (Jennings & Perez, 2020). Therefore, if developed countries with state-of-the-art health facilities and adequate funding were severely affected, the worst could be expected for developing countries, particularly those already suffering from the same challenges faced by health systems in Zimbabwe articulated in the preceding paragraphs. This, therefore, means the danger of a potential spread of the COVID-19 in Zimbabwe could spell a public disaster of unprecedented degree.

3.4 Methodology

A qualitative paradigm was employed for this chapter, which mainly utilised secondary data sources. According to Teti et al. (2020), qualitative methods are crucial in deciphering public health disasters like COVID-19, its impacts on humans and subsequent responsive strategies. The chapter aims at providing guidelines for public safety and health risk assessments and implementation of preventive and protective measures. As such, the chapter engaged qualitative paradigm to provide explanations on how Zimbabwe has been coping to the COVID-19 pandemic focusing mainly on the nexus of public safety and public health systems. The collection of relevant data was done through extensive document review and scanning of various literature sources. Therefore, a desktop review was used to collect data. Secondary data sources such as books, journal articles, press publications and reports were used. Data from applicable literature and documents were reviewed in order to understand public safety and health agencies' position during the COVID-19 pandemic.

A large number of reviewed literature were published recently, between 2016 and 2022 ($n = 65\%$ and $n = 35.8\%$), directly focused on the COVID-19 pandemic. The author collected and reviewed over 89 documents. Of these, >80% were published peer-reviewed scholarly articles, 17 (2.8%) were government documents, 12 (7.1%) were from non-governmental organisations (NGOs), and 2.1% were from the press. The Zimbabwe Preparedness and Response Plan, Statutory Instruments. The chapter was also woven using empirical data constructs obtained from the World Health Organization Statistics and Africa Centres for Disease Control and Prevention (Africa CDC).

Literature review was done on thematic topics that identify the effects of COVID-19 on public safety and health agencies among other first responders to decipher the implications of the pandemic on the safe and healthy Zimbabwe society. The author identified areas of key interest that are related to public safety and health (public safety and health institution, first responders). These areas involve safety risks, public health mandates, demand for public emergency services, demand on crime, liveability exposure, PPE availability and use, communications, public health and safety and human resources. Each of the topics intersected with different unmediated and mediated effects on public safety and health players. This research approach had a few limitations concerning the scope of the study and, perhaps, comprehensiveness. The chapter relied on data researched between March 2020 and late November 2021. However, new research will continue to emerge (Zhanda, 2020) on the impact of the interface of public safety and health amid COVID-19. The research focuses on enforcement (police), and emergency medical services, and also accounted for other entities which provided services during the COVID-19 pandemic such as emergency departments, corrections, courts and security.

Data were classified into themes, and thematic content analysis was engaged in analysing the data and to draw meanings from it. From literature, key public safety and health concepts alongside some COVID-19 themes were selected to figure the content of literature to be analysed and reviewed. Synthesis was conducted from the themes, and conclusions were drawn. The limitations of the study are that findings on the gaps and prospects of the public safety and health systems amid the COVID-19 pandemic may not be directly generalised to other countries in the Global South and beyond. However, important lessons can be drawn and go on to influence policy. Findings from the study on the experiences and public safety-health in Zimbabwe can be applied and generalised to other countries in sub-Saharan Africa and beyond.

3.5 Results and Discussions

3.5.1 State of Public Emergency

On 11 February 2020, the World Health Organization (WHO) officially declared COVID-19 a worldwide pandemic rendering it a public health emergency of international concern (WHO, 2020b). The International Health Regulations (IHR) adopted by the World Health Assembly in 2005, which are binding on all WHO member states, provide a regulatory framework for international management of public health emergencies (WHO 2008).

In accordance with the legal obligation imposed on each member state to notify WHO of events that may constitute a 'public health emergency of international concern' within its borders (WHO 2008), the government of Zimbabwe notified WHO concerning these developments (MoHCC, 2020). As a critical step to ensure public safety and safeguard public health and battle COVID-19, the *President of Zimbabwe* made a declaration on 23 March 2020, under the Civil Protection Act, that a state of disaster existed across Zimbabwe with immediate effect (MoHCC, 2020). Such declaration of state of disaster is clearly set out in Section 27 of the CPA which gives the President power to declare state of emergency if any disaster of a nature and extent that require extraordinary measures to assist and protect the persons affected or likely to be affected by the disaster in any area within Zimbabwe.

Through the Statutory Instrument 76 of 2020 on Civil Protection (Declaration of State of Disaster: Rural and Urban Areas of Zimbabwe) Notice 2020, COVID-19 was declared as a national disaster (GoZ, 2020) and a national lockdown for 21 days was announced on the 27th of March 2020 through the (COVID-19 Prevention, Containment and Treatment) (National Lockdown) Order, 2020 contained in Statutory Instrument 83 of 2020 declared national lockdown except for essential services and exempted cases for a period of 21 days (see https://www.veritaszim.net/node/4072). This was accompanied by the Public Health (COVID-19 Prevention, Containment and Treatment) Regulations 2020 published as Statutory Instrument 77, 2020, made under the Public Health Act (see http://zimlii.org/zw/legislation/si/2020/99) that declared the disease a formidable epidemic disease. These legal instruments have led to the setting up of public safety and health machinery in the form of various arms of the state such as the Zimbabwe Republic Police (ZRP), for purposes of containing COVID-19 health emergency and its concomitant problems.

Moreover, channels were open towards the mobilisation of resources necessary to battle the disaster as well as to provide governmental support to affected and vulnerable communities. The 'legal' response to the pandemic shows the efforts to protect the citizens.

3.5.2 Public Health Systems Amid COVID-19

Although the field of medicine is important in the detection, prevention and treatment of COVID-19, health crisis control frameworks in Zimbabwe are grounded on public health principles and regulated by public health law. Under the Zimbabwe Public Health Act, there are a number of legal provisions dealing with infectious diseases and powers to manage (control and prevention) formidable diseases, many of which have been engaged in the COVID-19 containment orders. In line with the WHO obligation, Zimbabwe's health institutions supported by the government have developed, strengthened and maintained its national capacity to detect, assess, report and effectively respond to public health disasters and risks (WHO 2008). The public health approach to COVID-19 in Zimbabwe has been spearheaded by the Ministry of Health and Child Care (MoHCC) providing much-needed technical support to all sectors of the economy, communities and health-related institutions. While the basic public health strategies in response to diseases such as COVID-19 traditionally focus on prevention, control, testing and surveillance (MoHCC, 2020), the MoHCC adopted a timeline of priority activities centred on infection prevention and control (IPC) and policies and standard operation procedures.

3.5.3 Public Safety and COVID-19 Pandemic

The COVID-19 pandemic has shown the critical and necessary role of public safety institutions (PSI) as 'first responders' in protecting all Zimbabweans from public safety risks. Public safety risk is a biological hazard proportional to vulnerabilities and preparedness (WHO, undated). Hence, COVID-19 can be classified as a biological hazard. Perry (2007) regards a hazard as a determinant of the types of risks such as disease and death. Vulnerabilities or readiness are determinants of how much risk (risk modifiers) and determines pre-impact risks and preparedness determines post impact risks (Perry, 2007). While Civil Protection Planning Committees must be established under the CPA to enhance preparedness, it has not been possible to observe if any such committees have been established. Public safety risks in Zimbabwe during the COVID-19 pandemic can be viewed as the potential outcomes from the exposure of communities to COVID-19 biological hazards. According to Perry (2007), public safety risks are reduced by minimising exposure to hazards through mitigation and prevention, reducing vulnerabilities of people, livelihoods, property, environment and services and increasing preparedness of responders.

PSI which fall into the civil protection system of Zimbabwe (Ministry of Local Government, 2009) which include professionals striving to ensure the safety and security of citizens have been given leeway to operate under the COVID-19 restrictive measures. These include police (national and municipal), firefighters (occupational and voluntary), national border officials, public safety communicators, correctional services officers and paramedics. PSI around Zimbabwe have responded to COVID-19 in several ways, such as public campaign awareness about the coronavirus. At the outset of the COVID-19 pandemic, safety agencies had promptly responded to COVID-19, with the majority receiving some kind of guidance and training on the PPE to ensure safety of officers. As elaborated earlier on, the Zimbabwe Republic Police (ZRP) is one of the critical stakeholders within the country's public protection and security architecture, and its resilience amid the pandemic matters most to the safety of people across the country. The ZRP facilitated the COVID-19 exemption letters. The ZRP was supported with local authorities as the Morgan Report in 1990 in the United States, for example, advised that local government authorities should be provided 'statutory duties' for crime prevention and, collaborating with the police, for promotion of public safety (Jones et al., 2020).

Public safety risks in Zimbabwe amid the COVID-19 crisis could be understood by exploring the impact on PSI and the recipients of safety services, the public. Prior to the COVID-19 pandemic, PSI reported a number of occupational stressors which include insufficient resources. Casoni (2019: 1) observed that in past events, disaster relief and public protection institutions, such as ambulance service, fire brigades and the police, have always had many challenges to effectively carry out their work owing to organisational and technical bottlenecks. Hence, deadly COVID-19 pandemic challenges, such as the risk of personal and familial contagion (Mbulayi et al., 2021), have somewhat further intensified strains on PSI. This stresses out that appropriate measures and risk assessment must underpin primary prevention of COVID-19 among individuals, workers and businesses. Other risks intensified by COVID-19, such as harassment, discrimination and violence (Zhanda et al., 2022; Humphreys et al., 2020) stigma, and protracted use of personal protective equipment (PPE) have been observed. These have posed public safety concerns.

The Zimbabwean central and local governments have been at the front line of ensuring that the public is safe. While public safety entities have the obligatory duty of managing crises (natural and man-made), the rate and impact of COVID-19 required attention to crafting crisis and emergency management plan of action while also acquaintance necessary community services. The general public, consumers and workers were protected. Citizens should continue to enjoy their right to healthy and safe living conditions in the context of COVID-19. Nevertheless, the ongoing COVID-19 pandemic has imposed financial and human costs on public safety and health entities that risk exposure to the pandemic. Table 3.1 uses the WHO public safety emergency and risk management framework to measure or assess the reported COVID-19 response progress by the Ministry of Health and Child Care (2020) and other related entities in line with the goal of ensuring the health and safety of people amid the COVID-19 pandemic in Zimbabwe.

Table 3.1 Scores of public safety in Zimbabwe during COVID-19 pandemic

Public safety emergency and risk management	Scores of reported progress
Damage assessment and needs analysis	Assessments of status of preparedness of major isolation health facilities and points of entry, February 2020
Epidemiology and reporting	Epidemic preparedness and response task force Zimbabwe's national preparedness and response plan for COVID-19 of 2020
Mass casualty management	Designation of isolation hospitals at Thorngrove (Bulawayo) and Wilkins (Harare) infectious Diseases hospitals
Hospital planning	Wilkins hospital renovations for containing COVID-19 patients Expand testing capacity to National Virology Laboratory and Mpilo central hospital Support hospitals to develop business continuity plans
Curative care	COVID-19 vaccines
Shelter (place of safety) and security	Nothing recorded
Water and sanitation	Promote access to water and sanitation in public places and health facilities Monitor infection prevention and control and WASH implementation in health-care facilities
Control of communicable disease	Infection prevention and control Policy and plan (see Zimbabwe guidelines for the management of COVID-19, 2020) Personal protective equipment (COVID-19 PPE Policy 2020), COVID-19 control regulations and law enforcement
Food and nutrition	Nothing recorded
Reproductive health	Nothing recorded
Psychosocial needs	Nothing recorded
Medical supplies and logistics	Develop chops for logistics, procurement and supply management Carry out inventory of all supplies based on WHO package of commodity Form central stock reserve of essential medicines, vaccines and supplies Weekly meetings of logistics thematic technical department
Media and public information	Information dissemination COVID-19 campaigns COVID-19 hotline call 2019

Source: Author, data from WHO (undated); MoHCC (2020)

3.5.4 *Public Health Systems and Public Safety Systems: Nexus*

The COVID-19 pandemic has confirmed the fact that public safety and public health are natural allies. Promotion of public safety amid the pandemic espouses itself fittingly with a public health approach for various reasons as it shares many of the special characteristics of pandemics (Schweig, 2014). Public safety institutions in Zimbabwe have been working alongside public health-care officers and have proven to be critical for curtailing the COVID-19 pandemic. The health system has indispensable and persistent obligation to people for their entire lifespan. It is important to healthy and safe development of individuals, households and the society. Therefore, health care is an applicative and tangled issue requiring extrinsic thinking beyond the health parameters of the present pandemic per se. The health system crisis is just one of the many threats Zimbabwe is facing during the COVID-19 pandemic. Despite having experienced disaster events such cholera and tropical cyclones in Zimbabwe, public protection and disaster relief agencies which include the police, ambulance service and fire brigades have always had a number of challenges to efficaciously conduct their work due to structural and technical and issues.

Poor-resourced public protection and safety systems in Zimbabwe have been much confined to work-related safety issues than to public health issues. It emerged that the expansion of environmental health services during the coronavirus crisis through the enforcement of laws for safe water, sanitation and hygiene has not been given the same emphasis with the 'safe workplace' dictum. As such, the COVID-19 pandemic has become more of a public safety concern much than a health concern in Zimbabwe. Despite the relative safety to humans' lives and possessions and the rising aggregate crime rates experienced across Zimbabwe amid the pandemic, governing threats to personal human safety and social order have become huge governmental preoccupations. These, however, should be a focal point for policy responses and attention, activities and actions towards the coronavirus situation in the country. Nevertheless, the fears born and fed by subjective and existential safety voids and insecurities have become very genuine in their consequences (Muchena, 2020).

In terms of public safety and health risk assessment, the potential effects for the public can be determined by their vulnerability context. In this regard, public safety officials in consultation with health personnel, and with support from infection prevention and control experts, should regularly conduct a community safety risk assessment for COVID-19. The goal would be therefore to determine the level of risk for potential exposure related to various safety violations and to plan and implement adequate measures for risk prevention and mitigation. The challenge is that health entities have less authority and often difficult processes to agree on what or whose public safety 'orders' to abide by. This raises questions on the risks from coordination problem with serious health and public safety overtones in the country. In terms of coordination between public and private actors via an emergency response mechanism, it appears there is no lucid reference to coordination with private players in the COVID-19 prevention regulations. Interoperability among the agencies to firstly respond belonging to contrastive players has also become very difficult and coordination actions among the agencies. Moreover, refurbishment and management of overburdened telecommunication infrastructure has become a major issue though it boosts technical responses to the COVID-19 pandemic, especially given the coordination gaps between public safety and public health institutions in Zimbabwe.

3.5.5 Law Enforcement and COVID-19 Pandemic

There are clear links between law enforcement and public health (Jennings & Perez, 2020) as the law enforcement agencies are obligated to work with public health agents to curtail the spread of the disease, serve communities and ensure public order. However, law enforcement officials have not deliberated about the ramifications of a type of public disaster that could devastate public safety agencies' operations (Laufs & Waseem, 2020). There has never been an expedient time than the current to examine the short- and long-term effects of the COVID-19 pandemic on law enforcement in Zimbabwe and to unravel law enforcement's conduct and ongoing strategies being implemented to ensure public safety and flatten COVID-19 as well minimising health risks of law enforcement officers.

Enforcement of COVID-19 mandatory orders has brought connotations on public safety and health systems. As explained in the foregoing sections, the government of Zimbabwe has taken emergency interventions to protect its mass population and slow the spread of the virus. Measures and regulations including lockdowns, social distancing and travel restrictions required the role of law enforcement agencies. This is ultimately supported by establishing legal penalties for violations of the regulations (Friedman, 2021). Since the initial lockdown in March 2020, law enforcement agencies, which are part of public safety agencies, were working together with the government (central and local) and public health officials to curtail the spread of COVID-19, serve local communities and maintain public safety. The ZRP (see www.zrp.gov.zw) and ZDF spearheaded the enforcement. As provided for in the Zimbabwe's Civil Protection Act, the ZRP in conjunction with the ZDF were given authority within the national COVID-19 pandemic response apparatus to do so. The ZRP, through a joint venture with the ZDF, has embarked on community patrols and roadblocks to enforce COVID-19 preventive and control measures. The ZRP ensured that public gatherings except funerals are prohibited and compliance was observed as well as facilitating COVID-19 essential services exemption letters. The ZRP has conducted community outreach initiatives, reassigned personnel to COVID-19 hotspot areas, implemented safety precautions for its officers as well as restricted access to its offices (Ntali, 2021). Thus, the law enforcement officials have been challenged with balancing the regular duties of maintaining public safety and order with the urgent need for emergency responsiveness to COVID-19. As experienced in countries such as South Africa (Newham & Du Plessis, 2020), this has created additional service burden and need for law enforcement institutions. This sits at the top of police services as the ZRP officers are expected to preserve public order and continue community policing operations though under a greater strain on resources.

The COVID-19 pandemic has also uncovered some significant barriers to law enforcement, pertinent to public health regulation enforcement and, ultimately, overtones on public safety. Zimbabwe law enforcers are no exception because they were faced with a number of challenges. Given the risk of COVID-19, enforcement agencies were at the high risk of contracting the virus. In light of a situation like this, the Africa Centres for Disease Control and Prevention (Africa CDC) have urged law enforcement agencies to protect the public and officers. Although law enforcement agents have played a pivotal role, Mackworth-Young et al. (2021) have called into question their professional conduct to ensure that the public is safe amid the COVID-19 pandemic. In a pandemic, the conduct of control and prevention regulation enforcers is important. Organisations such as the Zimbabwe Peace Project have accused the law Zimbabwe's enforcement agents of selective enforcement of the law (Maulani et al., 2020). The law enforcement agents were observed not abiding by social distancing and wearing face masks, which is thus a public health-safety concern (Mavhinga, 2020). These challenges have been aggravated by the fact that the authorities were bemoaning shortage of resources in fighting the pandemic (Mackworth-Young et al., 2021).

In a pandemic like COVID-19, resources for law enforcement will quickly become engulfed (Lum et al., 2020; Laufs & Waseem, 2020), and law enforcement agencies like the ZRP will then need to balance their operations and resources between the emerging public duties and routine service demands. This has highly demanded technological innovation which is highly required in public safety during times of public emergency (Steinberg, 2021). Frontline agencies in law enforcement and emergency response needed to adapt quickly to meet the health security and safety needs of the communities they serve. Newham and Du Plessis (2020) argue that the ability of law enforcement agents to ensure public safety and maintain order during the lockdown depends on their rapid preparedness for a new mission. This is particularly important because the responses needed to be accomplished with much diminished personnel, as the ZRP officers and their household members might become infected which then compromise the health and safety of the public. In other instances, however, as observed by Laufs and Waseem (2020), some police workforce may consider that the risk of continuing to report to their work offices is just too colossal to their families and themselves.

3.5.6 Crimes and Safety of Individuals and Property

Crimes threaten safety and health of the public especially during a period of pandemic (Schweig, 2014). The lockdown measures in Zimbabwe have had direct impact on a number of criminal activities and organised crimes, which have stopped, slowed or increased. Although authoritative conclusion on the impact of COVID-19 control measures on public safety may be affected by the dynamics of the virus, Newham and Du Plessis (2020) reported that restrictions of public movements have yielded some safety outcomes.

Zimbabwe has faced different crimes during the lockdown period. The ZRP has recorded a decline in criminal cases between 30 March and 15 April 2020, mainly owing to the heavy presence of law enforcement agents across the country (Nemukuyu, 2020) especially in urban areas. According to the crime statistics, the ZRP recorded 27 murder cases between 30 March and 15 April 2020, whereas 46 cases were reported during the same period in 2019 (Nemukuyu, 2020). Moreover, 65 planned robberies were reported across Zimbabwe in the first 17 days of the lockdown, a lesser figure compared to 150 cases reported to the ZRP in 2019. The ZRP also received two cases of motor vehicle theft in the first 17 days of the lockdown, while five cases were reported during the same time last year. As reported by Nemukuyu (2020), the ZRP Assistant Commissioner explained that due to lockdown, people are staying safely at home protecting their properties. The presence of police officers and the military in communities has reduced crime rates, and many roadblocks worked to ensure that stolen items cannot pass through roadblocks undetected.

However, the COVID-19 pandemic-induced lockdown has come with it organised crimes on robbery, theft and property crimes. Incidents of violence, especially family violence (Zhanda et al., 2022), as well as alcohol and drug misuse were intensified. Zhanda et al. (2022) observed a 36% increase of domestic gender-based violence, lack of household peace and instability in Zimbabwean urban areas such as Harare and Gweru owing to lockdown measures. However, due to the victims of violence's inability to report to the police stations due to lockdown (Zhanda et al., 2022), the ZRP recorded only 193 domestic violence cases between 30 March and 16 April 2020, a decrease from 678 cases in 2019 (Nemukuyu, 2020). Zimbabwe is battered by socio-economic and governance factors signified by the Zimbabwe Vulnerability Assessment Committee of 2019 and the International Poverty Line, which reported a parity index of US$1.90 with 5.5 million people in rural areas and 3.9 million people in urban areas regarded as food insecure (Zhanda et al., 2022: 9). Confining these poor households under lockdown for months has compounded tensions among people leading to incidents of domestic and sexual violence (Zhanda et al., 2022). This can go a long way in negatively affecting the safety of households and the battle against COVID-19. Likewise, the Police Service in South Africa had received 2320 complaints of gender-based violence in the first week of the national lockdown, 37% higher than the weekly average of 87,290 gender-based violence cases reported in 2019 (Newham & Du Plessis, 2020). Eisner and Nivette (2020) posit that criminological theory indicate that lockdown measures could trigger off causes for an increase and reduction in crime rates and anti-social behaviours, especially property and violent crime.

Under the changing set of the Zimbabwe's COVID-19 control measures, alcohol outlets, bottle stores, bars and other on-site alcohol retailers were closed, which only left supermarkets open for alcohol purchase. This was informed by the fact that these places for alcohol sales are potential breeding grounds and super-spreaders of the coronavirus (Newham & Du Plessis, 2020), and the use of alcohol undermines COVID-19 control and preventive measures such as social distancing and proper wearing of face masks. While the aim of the public protection and health agencies was to ensure that people are safe through complying with the laws, alcohol can lead to non-compliance (Newham & Du Plessis, 2020). According to Maulani et al. (2020), during the first 4 months of lockdown, the ZRP officers arrested at least 100,000 people and charged them for violating COVID-19 control rules. Crimes are 'infectious', but rather than being transmitted by bacteria or virus, they are transmitted through unruly behaviour (Crawford, 2007) which can be fuelled by substance abuse. In South Africa, for instance, temporary alcohol sales prohibitions were instituted which led to significant reductions in crimes, accidents and other alcohol-related hospitalisations (Newham & Du Plessis, 2020). This can reduce the burden and pressure on the country's law enforcers and emergency services so as to maintain public order while simultaneously protecting people from COVID-19. The reduced strains on the public safety and health-care systems are mainly important during the time when they are at capacity as a result of the COVID-19 pandemic.

Nevertheless, reported crimes such as burglary, robbery and theft declined significantly, with a more than 50% decrease in many countries (Mackworth-Young et al., 2021). The decrease was higher in countries with stricter lockdown measures, and Zimbabwe is one of such countries. It is more likely that the decline was not only due to a decrease in the number of crimes committed but also in the reporting of crimes (World Bank, 2020) and mass public communication. These tend to dispense tangible reminds of the vulnerabilities and anxieties of people amid the COVID-19. As such, it gives immediacy and credibility to the threats from which fears over public safety are deemed to emanate and intensify. Unlike in Zimbabwe, in the Netherlands and New York City, crime dropped by 17% between 16 and 22 March 2020, although vehicle theft increased by 52% in New York City (Newham & Du Plessis, 2020). While the ZRP cannot be ubiquitous across the entire Zimbabwe during COVID-19 time, crime surveillance and mapping during the public health crisis is important as it uses a number of techniques developed to study patterns of diseases. Further, when researchers and scientists map incidents of safety violations, they often discover that spatial clusters of crimes match spatial clusters of diseases (Schweig, 2014). The Centres for Disease Prevention and Control established the Violence Epidemiology Branch, which (now the Division of Violence Prevention) observed that lack of public safety has a significant risk to health.

3.5.7 Outdoor Activities, Crime and COVID-19

Due to the COVID-19 prevention regulations which regulate, restrict and, if considered necessary, ban gatherings at places of amusement, recreation and public entertainment, public safety during the COVID-19 pandemic at the leisure, outdoor and other public spaces has deteriorated. Nkala (2020) observed this especially in high-density neighbourhoods of the cities such as Harare, Bulawayo and Mutare. As observed by Schweig (2014), the most deterrent to human crimes and violence is not a neighbourhood saturated with police officers; it is a neighbourhood active with residents. The idea is that a healthy community or settlement would be, certainly, a safe community. The ZRP's department of fitness training and enhancement sections are part and parcel of an innovative initiative targeted at measuring whether improvements of community health can contribute to promoting public safety in most unsafe neighbourhoods of cities and towns. It emerged that the ZRP has not implemented health-related initiatives in public spaces that have been under-used by residents and overtaken by crime perpetrators during the COVID-19 pandemic (Ntali, 2021). The rationale is that as people increase outdoor physical activities such as sporting, cycling, dancing and power walking, they could increase their presence in public spaces, enhance their health as well as regain ownership and control of their communities. However, this has become difficulty due to the pressing need for social distancing mostly during the early stages of the pandemic.

3.5.8 Citizens' Safety and Health as Fundamental Human Rights

The current Constitution of Zimbabwe assures every citizen an array of fundamental human rights as part of the bill of rights (GoZ, 2013). The same supreme law lays the base for the institutional, policy and legal frameworks that reinforce the progressive realisation of such rights. The rights include the right to health care, the right to food and water, the right to work, the right to sanitation and housing and the right to education (GoZ, 2013). Some of the COVID-19 control and prevention measures introduced in Zimbabwe to tackle COVID-19 have had implications on these human rights, a threat on safety and health of the public.

While the responses to curb COVID-19 were essential for ensuring health and safety of the public entangled complexity where some human rights were affected. The rights that were impinged on include, inter alia, the right to employment (Section 65), the right to freedom of movement (Section 66) and environmental rights (Section 73) (GoZ, 2013) and the right to education. However, scholars, Snowden (2019), and Fott (2014) argue that as the legal principle s*alus populi suprema lex esto* ('the health (or welfare, good, salvation, felicity) of the people is the supreme law'; or 'Let the welfare of the people be the highest law', public health must be the highest and supreme law, and then everything else follows from it. The interesting case in point for this principle in Zimbabwe is the case of *Stringer v Minister of Health and Child Care & Sakunda Holdings* case number HH 259–20 delivered on 1 April 2020 (see http://zimlii.org/zw/legislation/si/2020/99). The court stated as follows:

> even if there was a threat to the environmental rights of the applicant as an individual, this is a case for application of the principle Salus Populi Suprema Lex…which is the foundation of the Constitution of Zimbabwe…and should apply in cases of extreme emergency when the welfare of the people has to be protected and a trade-off has to take place between the safety of the people and the rights of an individual…

The conclusion drawn from this case is that human rights must be comprehensively understood and protected in a manner that does not expose the safety of the public. The current Zimbabwe's Constitution states that in an appropriate case, human rights and freedoms may be restricted where public safety, public health and public interest are so in demand. What is crucial is that the human action taken to save the public health, interest and welfare must be right. All actions taken must be more reasonably imperative to safeguard the welfare of the general public from the danger that is threatening it.

As opined by Mohan (2003: 162), a forceful claim for establishing a right to safety emerges in a society where mass population feel the need for a norm on which to base an actionable demand for protection from social, physical or emotional damage. The 6th World Conference on Injury Prevention and Control held in Montreal, Canada, finalised a draft charter on the people's right to safety. Moreover, the General Assembly of the United Nations adopted the Universal Declaration of Human Rights (UDHR) in 1948 with Article 3 of the same Declaration asserting that everyone has the right to security, liberty and life. The UDHR also asserted the rights to live in good health. By adopting these charters, conventions and declarations, citizens are able to claim a safer environment in which to live, safer living conditions, safer products and safer working conditions. The emerging issue of human rights with its particular focus on public safety and health provides a fitting opportunity to bring together experts from these fields with diverse perspectives and sentiments on the value of recognising the emerging issues.

3.5.9 Community Policing Amid COVID-19: In Need of Partnerships?

The COVID-19 pandemic has contributed to uncertain and unprecedented challenges for community policing. This was more challenging in the high-density neighbourhoods of Zimbabwe wherein overcrowding (Mackworth-Young et al., 2021) and a number of COVID-19 control orders were breached. As argued by Laufs and Waseem (2020), emergency situations such as pandemics can have a lasting impact on public trust in the police and police-community relations (Jones et al., 2020). While police response to emergency events and disasters such as COVID-19 can promote public safety and well-being and remove people from harm's paths, weak police response can ruin public confidence and trust in the police forces (Laufs & Waseem, 2020).

The Zimbabwe police forces, local authorities and public safety agencies have partnered with health agencies to respond to the coronavirus pandemic and successes when using public health strategies to solve community problems. However, they need multi-stakeholder partnerships to hone their approaches and bring improved outcomes in terms of safeguarding public safety and health. It emerged from the study that individual community dwellers have lacked the capacity to decipher whether the strategies they use are completely effective towards taming the COVID-19 challenges. As argued by Schweig (2014), community policing is key among the methods to make huge strides into the public safety mainstream. This can ensure that communities are safer and healthier at the same time. In the United States, for instance, public health and safety agencies adopted strategies centred around community engagement and collaboration to solve safety-related community problems (Richards et al., 2006). Policing's capacity to successfully respond to any public emergency, be it public health or other public crises, is strongly linked to the police agency's will and ability to partner with multi-stakeholders and its planning as well as preparedness (Laufs & Waseem, 2020).

3.5.10 Towards Public Safety-Health Behavioural Approaches

Safety and health systems' performance is critical for tackling and measuring public health crisis and other social ills that come with it. Al-Bsheish et al. (2021) put forward the idea of main safety behaviours which are centred on social distancing, wearing a face mask and hygiene to be practised by the public during COVID-19 pandemic. However, as was the case in Zimbabwe, without public safety performance and compliance, the pandemic will not be manageable. Public safety participation and public safety compliance are key related but distinct parameters for measuring safety outcomes (Yang et al., 2021; Clarke, 2012) in a pandemic environment. Examples of the outcomes include lockdown-related safety breaches, deaths, accidents and human injuries. Safety compliance entails the core activities that individuals and the public need to do so as to maintain safety in their places (Yang et al., 2021), for example, correct wearing of PPE and hygiene practices. Evidence from Zimbabwe reveals that there have been a reported number of non-compliance cases (Mackworth-Young et al., 2021) in maintaining social distances, avoiding social gatherings and respecting curfew times. The ongoing COVID-19 in Zimbabwe is a typical biological hazard that has impacted on public safety outcomes due to some cases of non-compliance. Nonetheless, public safety using PPE and through observing risk reduction tended to be adversely correlated with neighbourhood crimes. Thus, public safety compliance behavioural approach among mass population is beneficial in providing public safety, from individuals and households to work. Participation in safety matters entails individuals' voluntary behaviours that could develop a safety-supportive environment rather than directly guaranteeing individual safety (Neal, Griffin, & Hart, 2000). Of course, public safety is a fundamental responsibility of the state, and participation of Zimbabwean people could ultimately enhance responses to the COVID-19. The Civil Protection National Policy requires every citizen of Zimbabwe to assist where possible to limit or avert the adverse effects of disasters (Ministry of Local Government, 2009). With close to 17 million Zimbabwean population, public safety and health agencies will not cope with countrywide safety non-compliance; thus, participation is critical.

3.5.11 Entwining Public Health and Public Safety

As evidenced from the study, public health and law enforcement entities have just begun to realise the effectiveness of public safety and health partnerships towards containing the pandemic at the same time maintaining public safety. In order to further promote such joint actions, endowment needs to bring together public health experts, police chiefs, policy-makers and researchers from across Zimbabwe for constructive round-table discussions to chart the way forward. They need to agree that, due to poor economy of the country, as budgets are tightening across ministries and sectors, the traditional ways of ensuring public safety and fighting crime are changing more particularly with the coming of the COVID-19 pandemic. This can identify opportunities for collaborations between law enforcement and public health officials. Subsequently, funding for crime prevention programmes involving joint initiatives between the two areas that are critical during and after the coronavirus pandemic.

3.6 Conclusions and Recommendations

The chapter has sought to explore and examine the nexus of the public health-safety amid the COVID-19 pandemic which can help in mapping the way towards improving safety and health institutions in Zimbabwe and other countries in the Global South. It was noted that the ability of health and safety care services to keep up medical and non-medical services during the COVID-19 pandemic was affected by lack of coordination, staff members' infections as well as resource determinants. The primary responsibility of public safety and health institutions is their authoritative exertion of power to deliver safety services to the citizens so as to protect them from the disruptive impacts of biological and/or natural hazards such as COVID-19. The chapter concluded that the health and safety systems have left public safety and public health systems very 'loose' to contain the coronavirus pandemic and its associated impacts. The pandemic has reminded people in developing countries and perhaps developed nations that they live in the unsafe, insecure and disorderly times in the history of humanity. The dangers threatening human lives have increased as their safety has become precarious. In this age where people feel more traumatised, insecure, threatened and frightened, public policy responses and governance have to be more inclined to security and safety of the people. Accurate reporting and communication concerning public safety-health will improve understanding of the safety and health risks, enhancing the capacity to offer right policy prescriptions to relevant institutions. This promotes the provision of suitable post-pandemic or disaster assessment. Safe and healthy communities are fundamental for public health disaster responses and are the cornerstone upon which policy guidance for the re-opening of the economy must be based. The effective health approaches and management of COVID-19 will be largely measured on the ability to maintain public safety. Basically, understanding the nexus of public safety and health institutions during a health emergency is thus a fundamental requirement for impelling the entire public health responses and preparedness. A number of interventions executed in curtailing the COVID-19 and other possible future pandemics should be considered if they are actionable and viable recommendations for public safety and health agencies operating during a pandemic. Results from the chapter establish the foundation in which modern-day governance of public protection should be rethinked with obsessive quest on the part of multi-agency for safety, security and order. This enables the government to inform and infuse diverse overtones of public health emergency aspects to everyday life of people.

Based on the findings and discussions, the chapter proffers the following recommendations: the future public safety systems should be resilient and interoperable responding to public health crisis, supporting the health services and responses of the Ministry of Health and other public health entities. Thus, the development of advanced safety and health surveillance technologies for public health-safety emergency networks as support of Zimbabwe's public health-safety systems in confrontation of the deadliest health crises. The COVID-19 pandemic prompts defensive actions and suspire life into institutional quests for public safety and security. Scientific and empirical research needs to profile the experiences of the public safety agencies providing essential services to the community. The government of Zimbabwe also needs to initiate safer community programmes which can take the nations' public safety approaches out of the tapered confines and ways of formal public policing and include a wider stratum of societal control methods, formal and informal, operating at the local level. Coordination with non-state actors is also crucial. Public safety behaviours need to be linked to the laws and control regulations to facilitate compliance by the public. The ZRP needs to embrace digital policing and also cloud-based technologies for decentralised operations to position public safety agencies to be better prepared for the events of the future.

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Chapter 4
Devolution as a Health Governance Paradigm Amidst the COVID-19 Pandemic in Zimbabwe: Convergences and Divergences

Kelvin Zhanda and Leonard Chitongo

Abstract The emergence of COVID-19 has re-affirmed the importance of devolved governance models for enhancing health systems in curtailing pandemics of this nature. The exercise of devolution in Zimbabwe is embedded in the constitution. In addition, the state has a legally enshrined role to play in safeguarding public health. Fulfilling such a role requires the state to govern in a manner which respects all citizens and ensures an equitable distribution of resources and services across the country. The objective of this chapter is to examine the opportunities and constraints associated with devolution as a governance model by investigating its efficacy in curbing the spread and devastating effects of COVID-19 in Zimbabwe. The research methodology involved an extensive literature review of published documents, press releases and reports aided by content analysis. The findings presented in the chapter show that devolved governance is vital in ensuring that prevention measures against COVID-19 are befitting to the local context as it enhances efficiency, accountability and coverage in the delivery of COVID-19 response services. Operations of local-level health front-line institutions in Zimbabwe have been impacted by the lack of decision space and high bureaucracy as the levels of decision-making are not closer to the local communities. If devolution were fully in place, COVID-19 containment measures would have been easy to implement, thereby enhancing the control of the spread of the virus and minimising its health and socio-economic impacts in Zimbabwe. Therefore, the chapter recommends the devolution of power and responsibilities to sub-national tiers of government, the equitable allocation of national

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resources and the participation of local communities in the determination of and responses to public health emergencies within their areas. In conclusion, devolution of decision-making powers from national government to local governments is one of the pre-conditions towards shaping an inclusive public health policy and building health-resilient communities.

Keywords COVID-19 · Devolution · Health governance · Zimbabwe

4.1 Introduction

As reported internationally, a virus which falls in the family of the betacoronavirus 2 (COVID-19) was detected in Wuhan, China, in December 2019 (World Health Organization 2020). China announced the lockdown of Hubei Province on 23 January 2020 as a response to the COVID-19 pandemic (Gumbu et al., 2020). Since then, COVID-19 has spread across the entire globe such that by 27 December 2021, 278 million cumulative cases and 5.4 million human deaths had been reported (World Health Organization 2020). In the Global South, Africa in particular, the number of confirmed COVID-19 cases as of 17 June 2020 were at 270,660 with 72,490 deaths. The highest number of COVID-19 cumulative cases (n = 80,412; 29.7%) and deaths (n = 1674; 23.1%) were recorded in South Africa (Madhi et al., 2020; Government of South Africa, 2020) followed by Morocco with 524,475 (Galal, 2021). In Zimbabwe, the first case of COVID-19 was recorded on 21 March 2020 (Zhanda, 2020), and by 13 April 2020, the country had recorded 14 cases and 3 COVID-19-related deaths (Murewanhema & Makurumidze, 2020). The COVID-19 pandemic has had intense impact on the lives of all Zimbabweans, affecting all corners of society and the economy.

A wide array of measures to curb transmission of COVID-19, enable health services to cope with cumulative cases and deaths and support the economy have been put in place across Zimbabwe. Like many countries across the globe, Zimbabwe instituted lockdown measures and social distancing restrictions to curtail the spread of the virus. Although the virus is deadly on itself, these responsive measures have wreaked profound havoc on people's livelihoods, and regrettably people lost their lives (Murewanhema & Makurumidze, 2020).

As countries reacted to the COVID-19 pandemic, some have centralised decision-making, whereas others, such as India (Kosec & Mogues, 2020a), Germany and the United States, have left key policy response choices to state sub-national governments, or even municipalities (Kosec & Mogues, 2020b), giving a green light for individualised and localised measures. While scholarly attention has largely focused on global and national COVID-19 policy responses, these endeavours will eventually need to be undertaken by sub-national institutions. In this regard, it is the nature and character of local governments, and their relationship with a broader set of devolved governance configurations across scales, which is likely to play a pivotal role in determining the outcomes of different interventions, with significant implications for the trajectory of COVID-19 infection. However, this approach is viable only if the sub-national governments receive sufficient support and there is strong coordination across all tiers of government (OECD, 2020). While China, for instance, finally had positive results in battling COVID-19, its decentralised administrative system initially contributed to gradual response by the Wuhan local government which brought about fatal outcome for all countries across the globe (Dutta & Fischer, 2021). The Indian government, after initially responded with a centrally directed COVID-19 pandemic response, has turned to a devolved strategy, with the merits of such approach witnessed (Kosec & Mogues, 2020b). Moreover, these same approaches affected productive and social services that were important to peoples' lives in Ethiopia, in 2000 (Kosec & Mogues, 2020b). Such varied experiences and perspectives have framed a discussion concerning the (de)merits of a devolved governance and decentralised service delivery in pandemic response (see OECD, 2020), especially in low-income countries which are vulnerable to COVID-19 impacts due to weak health systems. Devolution is thus an important theme to explore in understanding contemporary public health governance. In the United Kingdom, for example, the devolutionary process which was introduced in 1999 (Tomaney, 2016) has stirred debates over the control and management of COVID-19 with the UK and Scottish governments responded with varying degrees of success (Morphet & Clifford, 2014).

Devolution theoretical arguments and rationale speak to why local-level government entities perform well on quite a number of grassroots national government functions including public health responses. In this chapter, we advance three principal reasons for devolved governance's efficacy in health governance, particularly in COVID-19 response. Firstly, due to devolution of government, local governments are likely to be more responsible and responsive to the peoples' urgent necessities as they are embedded in (or closer to) the communities that they serve (Dutta & Fischer, 2021). Besides being more accessible to the general public as compared to centralised governments, devolved governments are integrated in a motivator structure that can make them more accountable to local needs (Morphet & Clifford, 2014). This could be a result of legal obligations, unspecific threat of public legal opinion and vitiated individual reputation (Dutta & Fischer, 2021). Secondly, devolution connects sub-national governments closely to the people and hence is able to steer context-specific grassroots conditions (ZILGA, 2021). On the contrary, in centralised states, local governments are often far more knowledgeable about grassroots needs, able to garner key local players, correctly positioned to assess activities at the local level and able to evaluate and address context-specific problems that arise. Lastly, devolution of government powers and responsibilities legitimises local government more than external stakeholders for conducting various kinds of governmental regulatory or restricted functions. In most countries in the Global South like Zimbabwe, South Africa and Uganda, local government officials are directly elected by the public. The public's capability to engage with their local government leaders may similarly add the legitimacy of their actions. According to Longstaff and Yang (2008), trust in devolved governance can be an important factor in effective communication management in times of disasters. Quinn et al. (2013) observed that distrust in government entities often obstructs concerted effort and cooperation with public health orders particularly in crisis times, as seen during the H1N1 pandemic in 2009. These tenets of devolved governance are more likely to be crucial for the ongoing COVID-19 pandemic.

This chapter proffers an exploratory analysis of how sub-national tiers of governments are being operationalised for COVID-19 pandemic prevention and control in Africa with specific focus on Zimbabwe. As the COVID-19 continues to ravage the country, it is of paramount importance to examine how well the central, provincial, metropolitan and local tiers of the state deliver critical health services that avert health and socio-economic disasters and lead citizens to wellbeing. Critical infrastructure and essential services such as clean drinking water, sanitation and hygiene (WASH), housing, food systems and other critical health infrastructure to supporting vulnerable grassroots populations during and after the pandemic. Evidence from the study shows that despite having over 92 elected sub-national governments and with critical aspects of a devolved governance system in place (ZILGA, 2021: 13), Zimbabwe has arguably failed to thoroughly undertake distensible mobilisation of local governments to contain the pandemic. A critical question that develops is why Zimbabwe faces challenges in its countrywide COVID-19 responses emanating largely from marred intergovernmental relations despite having (since colonial era) a comparatively devolved governance system. Zimbabwe's lack of democratic and 'transparent' institutions could leave important health and economic services neglected as local societies respond to the pandemic. The desirability and significance of devolution as a key form of decentralisation (Rondinelli & Cheema, 1983) lies in the appropriation of authority to institutional levels that are best placed to deal with specific issues. As such, the COVID-19 pandemic has pointed out to the need for institutions that are better-placed to deal with the deadly virus. Additionally, the centralisation of the country has left the fight of COVID-19 more strenuous than it should be. Apparently, Zimbabwe is a 'centralised' jurisdiction or state, hence the need for devolution. While the pandemic, in some ways, has been a 'unifying' force, as the entire country's institutions became seized with responding to this huge existential health hazard through coordination and collaboration, the centralisation of the country's governance has left the fight of COVID-19 more strenuous than it should be. Moreover, despite the devolution agenda being a central tenet of local governance since Zimbabwe's Constitutional Amendment (No. 20) Act of 2013, it would not be practically implemented until 2018 when the Second Republic Government of Zimbabwe rose into power (Chigiya-Mujeni, 2021). Unfortunately, the outbreak of the COVID-19 has somehow derailed the take-off of devolution in Zimbabwe.

The economic, social and health crisis of COVID-19 in Zimbabwe has been an additional extension of tension and pressure on the calls over devolution issues already strongly advanced. In this chapter, we focus on devolution in Zimbabwe and its ramifications for the curtailment of the coronavirus in the country. Our focus in Zimbabwe was informed by the fact that the devolution agenda is currently at its heights and pressure mounting within political and scholarly discourses. Since the inception of its heated constitutional debate, which could have across-the-board penalties for its governance in Zimbabwe, there have been little if not tangible outcomes regarding its implementation. Arguments posed in the chapter engage with whether such debates on devolution have spawned lessons that policy-makers, stakeholders, scholars and general public can draw upon to cement the role that substate tiers can play towards development of Zimbabwe, particularly in the case of battling with the health challenges – COVID-19. Therefore, the COVID-19 pandemic has presented an opportunity to examine the health dimensional benefit possibility of devolution, especially if it were fully in place when the pandemic strikes Zimbabwe in 2020. Health emergency responses, planning and preparedness, should be closely interwoven with notions about localism and regionalism, inorder to make interventions resilient and sustainable. The weaknesses of local governments (rural and urban councils) in responding to COVID-19 (with variable degrees) is embedded not only in the legislation but also in political and socio-economic capacity shown in Zimbabwe's governance philosophy restraining the sub-national government's response capacity and potential (Mutenga, 2021). We proffer arguments that a raft of lockdown measures, based on devolution in facilitating COVID-19 testing, data, demographics and apt measures for countrywide economic sustenance, including, inter alia, social safety net support and a greater emphasis on human health and livelihood resilience, can save lives, as well as limit financial costs and ease long-term impact of the pandemic.

We particularly examine the relationships between public health governance and devolved functions of local authorities in the Zimbabwean government since March 2020. This is mainly important in the context of Zimbabwe where a gap exists in which discussions about devolution have not been focused towards public health governance. However, there have been no discussions of devolved health planning systems and their resultant effects in each region or province of the country. While we proffer the discussions around the execution of policy divergences within developing countries such as Zimbabwe following devolution, we revolve on the relationships between the intergovernmental- and local-level health-related institutions and entities that hold policy vital functions in a 'model' devolved Zimbabwe governance. While the current body of scholarly literature has noted the implication of devolution, there has been no contemplation on the connections between these entities and the centre-local model of a devolved country.

4.1.1 Devolution in Theory

The theoretical foundations of devolutionary ideals are traceable as far back as 507 B.C. to the classical contributions of Cleisthenes, a leader in Athens who introduced a system of governmental reforms dubbed '*demokratia*', meaning 'rule by the masses or people' (Tomaney, 2016). This saw the birth of democracy, paving way for the establishment of mountain-side courts open to the citizens, led by lottery-selected jurors. These developments allowed Athenians to make decisions which directly affected their communities. Tomaney (2016) echoes that devolution on groups of powers and privileges, associated with the performance of public service, is an ancient governmental practice.

The concept of devolution is defined and conceptualised in multiple varying ways with its meanings (Jacobs & Chavunduka, 2003) and nomenclatures evolving over time. Nonetheless, what matters most is to frame and address the following questions around the concept of devolution: what is devolution? What does it mean in practice? And why do countries or states have or must have devolution? Different scholarly perspectives view the concept of devolution through a collection of diverse and overtly inconsistent analytic lenses. Such divergence is widened by differences between scholars researching about devolution as it applies to the general public governance and administration field, in contrast to the scholars that seek to apply devolutionary tenets specifically to the health sector. Still, critical questions abound when one seeks to appraise the actual results and efficacy of devolution on urgent policy issues within health systems especially its impact on the capacity to render long-term responses and resilience to pandemics or to build coordinated healthcare networks. As such, it clearly appears that devolution can cover a number of possible evaluations, with what appears to be positive outcomes in certain contexts or to some scholars becoming negative in other contexts or to other scholars.

Although typically defined in the fields of policy-making, public management and planning, as the process where central government transfers executive, legislative, administrative as well as financial decision-making powers to sub-national governments that have legally recognised jurisdictions within which they deliver public services to areas to whom they are accountable (Bankauskaite & Saltman, 2007), it has different characteristics for different scholars. Scholars such as Bankauskaite and Saltman (2007) argue that the concept of devolution is closely linked to decentralisation and the two concepts are often interchangeably used although they are distinct in practice. Devolution is the handover of authority to autonomous local-level tiers of executive government, such as district and provincial councils, which are lawfully established as separate entities of governance. On the other hand, Sherwood (1969) does not consider devolution to be a legitimate form of decentralisation. Sherwood (1969) argues that devolution is a concept quite separate from decentralisation, in that it entails the divestment of functions by the central government and the creation of tiers of government not in the direct control of the executive government. He opines that devolution typify a concept of separateness in public governance. Sherwood (1969) goes on to argue that decentralisation and devolution are different phenomena as 'decentralisation' denotes an intra-organisational structure of relational power, while devolution denotes an inter-organisational structure. By and large, devolution is the transfer of governmental powers, responsibilities, resources, accountabilities and authority from national to sub-national tiers of government (ZILGA, 2021). Devolution exists in a unitary state wherein administrative and political power is 'equally' distributed between a national government and local spheres of the government, for instance, local authorities, metropolitan and provinces.

These various conceptions of devolution can be simply interwoven to mean the multi-stakeholder instrument on and process for transferring authority from central government to the sub-national tiers of government with the aim of promoting sustainable democratic governance. Moreover, devolution fosters equitable distribution of resources and participation of communities in decision-making concerning issues affecting them. The aim of devolution is to promote and ensure state accountability and delivery to the public. Therefore, governance policy thrust needs to push devolution that enhances effectiveness and efficiency of operations of local government institutions, by minimising bureaucracy through lowering of policy-making closer to the citizens (ZILGA, 2021). It is also viewed as important to improving accountability and legitimacy of state (political) institutions, enhancing the efficiency of public services, fostering the growth of regional and local economies as well as incubating innovation of policies (Moyo & Ncube, 2014; Tomaney, 2016). In Kenya and Zimbabwe, for example, devolution has been an inherent part of the constitutional reform, with the aims of establishing a more inclusive governance system, redistributing central government's power and sharing resources more equitably.

4.1.2 Devolved Governance in Zimbabwe: Brief Overview

This section is important for understanding devolved governance structures in Zimbabwe, which is critical for harnessing countrywide health systems towards battling COVID-19 and other diseases of the same nature. Despite being a contentious topic in Zimbabwe, devolution is vastly researched in Zimbabwe (see Chikwawawa, 2019; Mapuva, 2015; Muchadenyika, 2015; Nhede, 2013; Chirisa et al., 2013; Chigwenya, 2010), focusing much on its implications on constitutionalism, democracy and accountability rather than service delivery particularly health services. Understanding the contemporary context of devolution in Zimbabwe requires a concise narrative on the trajectory and implementation of devolution built upon Zimbabwe's administrative decentralisation which started as early as 1883. However, detailed account of this background is beyond the purview of this chapter. In 1980, Zimbabwe inherited a three-way and dichotomous local government system comprised of urban councils, 'white' rural councils and 'black' rural local authorities fragmented along racial lines (Masundu-Nyamayaro, 2008). Nevertheless, in 1984 and 1985, the government laid out the new local government structures. This saw the introduction and establishment of village, ward, district, provincial and national development committees so as to promote bottom-up development planning in which development issues were identified and crafted at village level, directed through the ward, district and provincial levels to the national level (Chigwata et al., 2017). The rationale was that the national (central) development plan should contain the priority views of this at the village and ward level. By the year 2000, it turned out clearly that decentralisation had failed to yield projected outcomes as the central government lacked commitment to it and spirit of making local government a separate sphere (Gasper, 1991). In emphasising the absence of devolution in Zimbabwe, Chigwenya (2010) denoted that 'decentralisation without devolution' in the country will have limited impact on development.

The promulgation of Zimbabwe's new constitution (Amendment (No. 20) Act of 2013) in May 2013 ushered in devolution as the uttermost form of decentralisation in Zimbabwe. Such constitutional response was compelled by protracted grievances concerning regional imbalances in development and service delivery outcomes as well as the centralisation of the central government powers and public sector resources. Since then, devolution has been a central tenet of local governance, though it would not be practically implemented until the Second Republic that rose into power in 2018 (Chigiya-Mujeni, 2021; ActionAid, 2014). The Zimbabwean government is currently pushing the devolution agenda as it considers it as a pillar to attaining upper middle economy status by 2030 (Zimbabwe Economic Policy Analysis and Research Unit (ZEPARU) 2020: 1). The framework and parameters for devolution are enshrined in Section 264 of the Constitution of Zimbabwe Amendment (No. 20) Act of 2013 (Chikwawawa, 2019) and Devolution and Decentralisation Policy (GoZ, 2020). This is supported by other subsidiary legal pieces such as the Rural Councils Act (Chapter 29: 13), Urban Councils Act (Chapter 29: 15), Rural Councils and Administration Act (Chapter 29: 11) and Regional, Town and Country Planning Act (Chapter 29: 12), which need review and amendments to align with the country's Constitution. The process to amend the Provincial Councils and Administrative Act (Chapter 29: 11) to align with the Constitution is underway.

To facilitate devolution, Section 5 of the Constitution of Zimbabwe organises the government at three levels mandated by Section 264(1) of the Constitution to implement the devolution agenda. These are national government, provincial and metropolitan councils and local authorities (see Fig. 4.1). The powers exercised by these sub-national tiers of government are derived from a number of Acts of Parliament which include, among others, the Rural District Councils Act [Chapter 29: 13]; the Urban Councils Act [Chapter 29: 25]; the Regional, Town and Country Planning Act [Chapter 29: 12]; the Environmental Management Act; the Water Act; the Public Health Act; the Shop Licensing Act; and the Roads Act. The national tier of

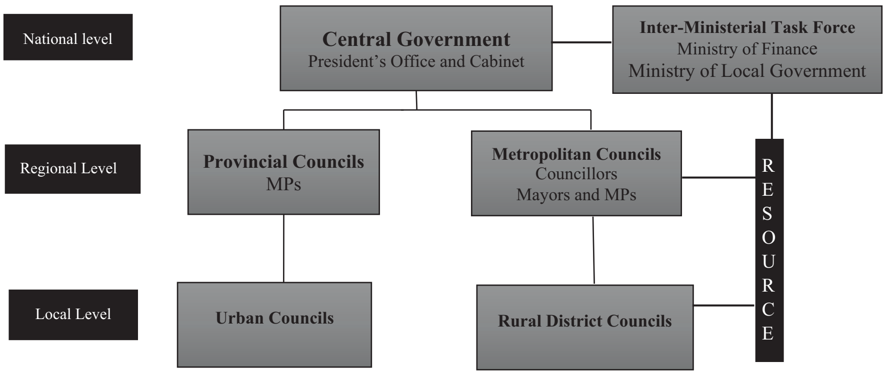

Fig. 4.1 Zimbabwe's three-tiered system of governmental structure. (Source: Authors)

government is the executive arm of government which is composed of ministers appointed by the president in accordance with the Constitution (ZEPARU, 2020). As a unitary state, Zimbabwe is governed by one executive arm of the government. The central government is followed by the second tier of government (provincial and metropolitan councils) of elected and proportional representation public representatives elected using constitutional provisions contained in Chapter 14 (2: 268) (for provincial councils) and Chapter 14 (2: 269) (for metropolitan councils). Lastly, the third tier is the local government level which includes urban councils (UCs) and rural district councils (RDCs) (Webinar IV, VI, 2020; Chigwata & de Visser, 2018). The country has 92 democratically elected councils that in the main prepare and approve their budgets and raise resources locally to finance their activities.

The distribution and mobilisation of resources, policy-making decisions, political power and administrative responsibilities and governance are meant to be devolved through the stated tiers of government (Muchadenyika, 2015). The provincial and metropolitan councils have important functions which consist of planning and implementation of economic and social development activities; coordination and implementation of government programmes; promoting tourism and developing facilities for the same purpose; planning and implementation of measures for the conservation and management of natural resources; and monitoring and evaluation of the use of resources (GoZ, 2020). However, ZILGA (2021) raised concerns regarding the political and technical powers bestowed upon the provincial and metropolitan councils. On the other hand, the RDCs and UCs have a range of powers and responsibilities as assigned by their respective Acts of Parliament. These include welfare services and basic municipal services which include, inter alia, public health; provision of housing (including serviced residential plots) and public utilities (such as electricity); education; water, sanitation and sewerage management; and waste management. These functions are critical infrastructure during the period of a pandemic like COVID-19. In the same way, for a country to be considered 'developed', the health of its citizens has to be safeguarded.

Scholars Muchadenyika (2015) and Chikwawawa (2019) argue that devolution enshrined in Zimbabwe's 2013 Constitution is not yet implemented because the 'old' governmental structures still dominate and stakeholders have revealed the troubles of implementing devolution without subsidiary statutes to implement the provisions of the Constitution. In contrast, ZILGA (2021) and GoZ (2020) have a different perspective as they report that Zimbabwe has most of the critical aspects of a devolved system in place and has undergone some of the reforms necessary for effective implementation of devolution. The Zimbabwe Local Government Association (ZILGA) (2021) has uncovered that national government is unwilling and unable to implement devolution fully. Experiences of local government practitioners reveal scepticism, frustration and mistrust pertaining central government's devolution endeavour. Presently, the design of devolution and its implementation are not spearheaded by an intergovernmental platform, and thus, it is weak and slow on local government's voices (ZILGA, 2021; Chikwawawa, 2019).

4.1.3 *Zimbabwe's Devolved Emergency and Disaster Risk Governance*

The Zimbabwe disaster management portfolio is relatively devolved from the national and the sub-national tier of the government in order to facilitate local communities' participation in decision-making concerning their challenges. The emergency management system in the country is spearheaded by civil protection entities at the national, provincial and district levels in accordance with civil protection legislative arrangements (GoZ, 1989). The hierarchical structure (see Fig. 4.2) starts from the Office of the President which means that national disasters are handled at the highest level from the top to bottom and bottom-up approach which then enhances coordination across all institutions involved. Since the Civil Protection Act sets the functional and legal relationships among the relevant institutions, a coordinated approach is manifest in a way that all the relevant government departments, local authorities' parastatals, non-governmental organisations (NGOs) and private sector can have a niche in disaster risk management process (Ministry of Local Government, 2009). The national civil protection includes key ministries including the Home Affairs, Ministry of Information and Ministry of Finance for the allocation of funds.

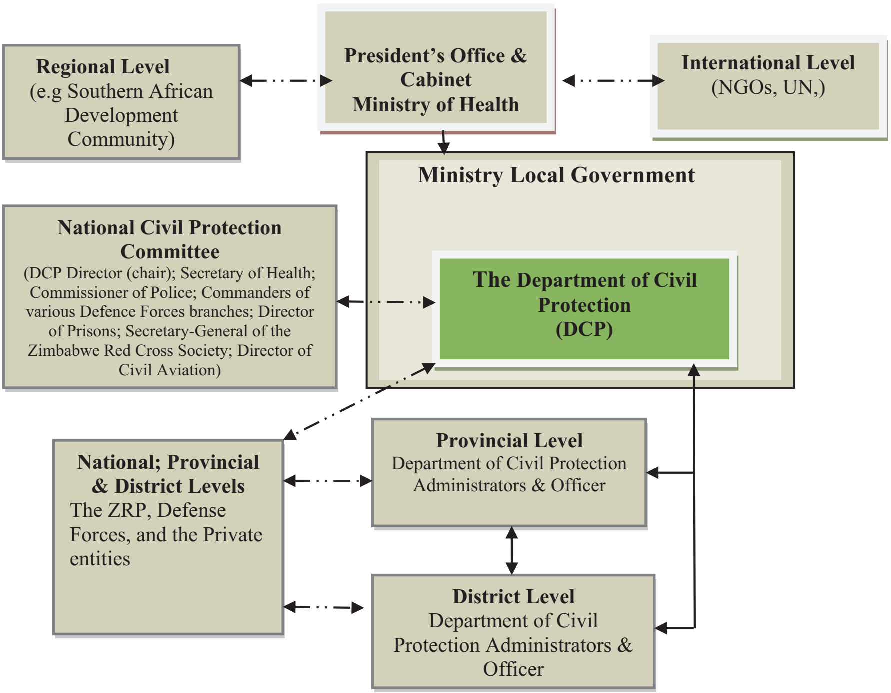

Fig. 4.2 Devolved structure of the disaster management system in Zimbabwe. (Source: GoZ (1989))

Besides facilitating coordination, this devolved structure ensures effective emergency responses and preparedness. Ultimately, the national, provincial, district, local authority, non-profit and private sector levels are required to plan for disasters by producing operational plans for emergency preparedness and response, and the plans would be brought into operation in the event of a disaster (GoZ, 1989; 2001). To enhance coordinated efforts, localised plans which would specify the mechanisms and procedures for issuing responsive procedures are expected to merge into the national plan (Ministry of Local Government, 2009).

4.1.3.1 Health System Devolved Governance in Zimbabwe

Zimbabwe's public health system has undergone extensive processes akin to decentralisation and devolution reforms. The country's healthcare system has retained a number of the arrangements since the first quarter of 1980, though lack of funds and recent wearing down of health workers for sustaining health operations have restrained the capacity of the decentralised health structures (Osika et al., 2010). This widened the divide between the function and structure of the decentralised structures as originally prescribed.

An overriding theme of decentralisation dominated the health delivery system of Zimbabwe, with health services provided at four levels: quaternary, primary, secondary and tertiary. Between 1990 and 2000, when the country's health system was not relying on foreign donors' substantial support, the government lured various new players which then managed particular 'areas' of the health system (Osika et al., 2010). Zimbabwe has also an extensive network of private healthcare providers, comprising of faith-based and for-profit healthcare providers. The private healthcare providers have more decision-making discretion and function generally with limited control from the central government except for regulatory obligations (GoZ, 2020) as they are more autonomous. For instance, pharmaceutical management actors became semi-autonomous players in which funds were generated from returns for the services they provided.

The decentralised health governance structure in Zimbabwe embodies elements of devolution. The devolved structures of the public health system are represented by health committees which are present at the provincial, district and rural health clinic levels. At the lowest level of the health system, there are rural health clinics, and their strategic support comes from rural district councils (Osika et al., 2010) and financial and administrative support from the District Health Councils (DHCs). In theory, Provincial Medical Directorates (PMDs) and DHCs administer their functions with input from provincial- and district-level health committees that provide community oversight and supervision. Principally, these committees are autonomous structures made up of local leaders, civil society and community members that were put in place via the Health Services Act. Hospitals and rural health clinics receive strategic input and direction from hospital- or clinic-specific committees as well, while they receive financial and technical support from the PMDs and DHCs (Osika et al., 2010). As such, these health entities receive input from the devolved structures in the Zimbabwean health system.

However, it should be underlined that Zimbabwe's health system has recently reverted towards centralisation. The MoHCC has been gaining more control over policy-making, with the health system increasingly becoming reliant on donor funds, for example, from USAID and the United Nations and European Union, for supporting significant health programmes (Osika et al., 2010). At the national level, the health system of Zimbabwe is defined by a centralised decision-making body, the MoHCC, which is responsible for health policy, regulation, mobilisation and allocation of resources, human resources planning, surveillance, monitoring and evaluation and liaising with NGOs and donors. Additionally, the MoHCC approves of human capital employment at the district and provincial levels and provides administrative guidance on coordinating responses to public health issues. For instance, during the cholera outbreak in 2008, MoHCC coordinated responses. This is consistent with assertions by WHO that ministries of health are responsible for overseeing health development through the enhancement and implementation of principal health system functions, including governance (regulation and policy-making), provision of health services and healthcare financing, and providing inputs for health development such as human resources for biomedical technology and health. This role largely contributes to increasing equity in access to healthcare, particularly in rural and remote areas where qualified private providers, concerned about their income, are in limited supply. While its national MoHCC still retains responsibility for national policy formulation and planning, it devolved some functions to district-level administrative units, such as operation of health centres and village health teams (Osika et al., 2010).

The complex structure illustrated in Fig. 4.3 provides for central government control and local communities' input. The reality in practice, however, has proven to be quite different. Zimbabwe has many health planning structures in policy though they faced a plethora of problems on the ground, subverting their role in health systems, especially in lifting the priorities of low-income communities. These problems were summarised by Stewart et al. (1994): ambiguities in authority and roles; top-down selection of members; constricted powers for generating local revenue; lack of regular elections; lack of direct participation of many traditional and civic leaders; lower levels' deficiency of control of substantive level of resources; dominance of technical over elected personnel; low levels of beneficiary feedback and participation; weak relationship between sectoral budget allocations and district/provincial plans; lack of interest in these structures by health staff who do not see themselves as accountable to these structures; lack of clear feedback to communities; lack of incentives for local committee members; and weak planning capacity. A good number of the PMDs and DHOs are understaffed, and only 35% of district hospitals and 29% of provincial hospitals still have a functioning health committee (Osika et al., 2010). Rural health clinics have fared better; 65% of them still receive support from the RDCs. The weakness of these committees has meant that hospitals and health clinics have received less strategic support from local authorities and communities. As a result, the devolution of strategic oversight to community committees has not worked as well as originally planned.

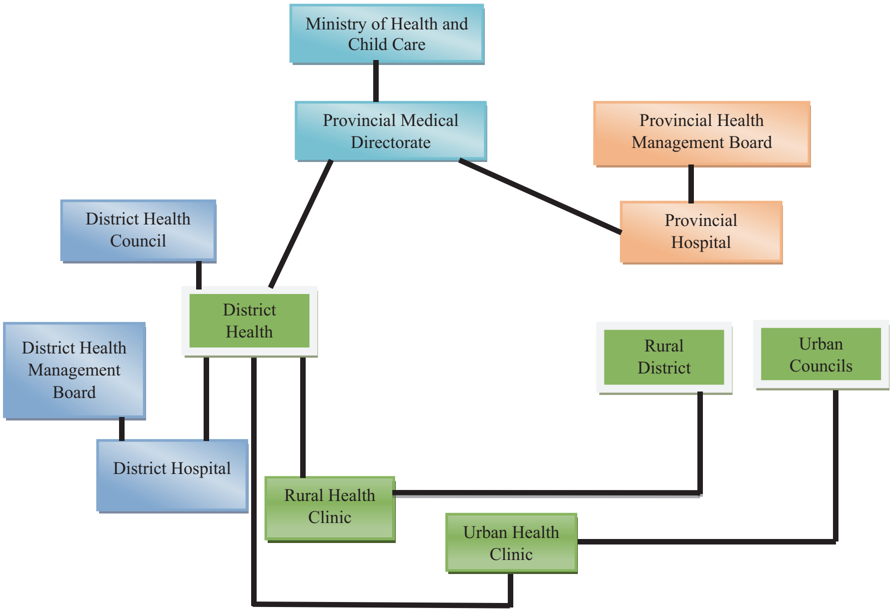

Fig. 4.3 A visual outline of the devolved health system of Zimbabwe. (Source: Authors)

In the devolved system, health governance occurs at national and sub-national levels (McCollum et al., 2018: Kimathi, 2017). As such, devolution in Zimbabwe entails health governance should take place at central, provincial and metropolitan and local levels. The RDCs and UCs have a range of powers and responsibilities which include welfare services and basic municipal services which include public health; provision of housing and public utilities (such as electricity); water, sanitation and sewerage management; waste management; and education. This supports the view by some proponents of devolution that health provision should be one of the core functions of local government in a devolved government system. Section 96(3) of the Urban Councils Act states: ‘Every council shall appoint a health and housing committee which shall be responsible for health and housing matters relating to the councils’. On the other hand, Sections 25 of the Second Schedule and 34 of the First Schedule of the Rural District Councils Act oblige council:

> subject to any other law, to provide and operate hospitals, clinics and dispensaries and to take any measures or provide any facilities which are considered necessary for the maintenance of health, including dental health.

These roles are experienced in many countries such as Brazil, where the Unified Health System places the responsibility of health planning primarily at the municipal level, and in such process, which is carried out every 4 years to make resource allocation decisions and establish health regulations and guidelines, results from situation analyses at municipal and state levels are considered (Pan American Health Organization, 2008).

4.2 Research Design and Methodology

The chapter employed a qualitative approach as it permitted the inductive collection of sufficient data through seeking to understand the 'how' and 'why' questions concerning devolution and public health services in specific contexts (Pope & Mays, 1995) in a COVID-19 environment. The study was largely based on extensive review of secondary sources of data and six webinars conducted in Harare, Zimbabwe. The document review sources include academic journals and a multiplicity of Internet sources. Document review is based on secondary data which is not specifically collected for this purpose. This has implications on validity of the results as the data can be over- or under-rated. However, cross-validation was undertaken in which many articles (> 45) were consulted to come to a real conclusion. Secondary data sources were utilised in this chapter because they give a quick and comparatively easy method of acquiring a comprehensive understanding of devolution and health services nexus amidst COVID-19 in Zimbabwe. A desk review approach aids in collecting, organising and synthesising information (Shuttleworth, 2008). We consulted Acts of Parliament and the Government of Zimbabwe's issued guidelines and orders for COVID-19 management in the form of documents. Overall, we reviewed over 25 documents related to COVID-19, consisting of acts, guidelines, directives and orders, as well as newspapers (press) releases. In addition, a number of documents which underpin devolution were consulted including the Devolution and Decentralisation Policy.

We also thoroughly read the Public Health Act and Civil Protection Act, 1989, under whose provisions the lockdown was imposed. During the early days of the lockdown, major notifications and guidelines relating to COVID-19 was primarily being issued by the Ministry of Health and Child Care (MoHCC) (GoZ, 2020). In addition, we scoured the Zimbabwean Government's websites of the Ministry of Health and Child Care, Ministry of Local Government and Ministry of Home Affairs. We particularly focused on sections titled 'coronavirus', 'publications', 'news' and 'resources' to take out relevant data specific to COVID-19, with data on COVID-19 control measures, localised lockdown, essential services and local COVID-19 responses. In addition, we got similar COVID-19 containment and local government-related documents issued by the national government tiers of local authorities with their departments of health, and development, on the respective government online websites.

Newspaper articles that carried stories on devolution, COVID-19 and other related publications were also used. These include national news media like *The Herald*, *Sunday Mail* and *Newsday*. Newspaper articles though not quite reputable for scientific research helped the authors to gather up-to-data information and clarify the COVID-19 situation in Zimbabwe. Furthermore, they help in our understanding of the possible prospects and challenges of interventions and programmes which reduce the nature and severity of the pandemic. Thus enabling a deep introspective into understanding the country's devolution model as a development strategy. This makes it easy to come up with informed recommendations for future policy interventions.

At last, the authors closely followed the proceedings of webinars (*n* = 6) about the role of national government and local authorities on devolution (Webinar I, 21 September 2020; Webinar II, 21 September 2020; Webinar III, 22 September 2020; Webinar VI, 28 September 2020; Webinar IV, 22 September 2020) co-organised by the Zimbabwe Local Government Association, National CEO's Forum for Rural District Councils and civil society organisations in Zimbabwe. These online discussions helped further complement and corroborate data gathered through desk reviews, thus providing at least some ways to triangulate the findings and contextualise them within broader governance processes occurring across Zimbabwe between March 2020 and December 2021 (the period of our research) amidst the COVID-19 pandemic. Thematic content analysis was used to analyse the data so as to come out with reliable and valid information. Selected COVID-19 and devolution themes were chosen from the literature to explore the content to be analysed.

4.3 Results and Discussion

4.3.1 Devolution and Public Health in Zimbabwe

There is a legal basis for a nexus between public health and devolution in Zimbabwe and ultimately ripple effects in practice. These have not been observed in scholarly works, and this knowledge gap is pivotal in the present chapter in bringing out the state of devolution agenda as a panacea for public health disasters in Zimbabwe. The exercise of devolution in Zimbabwe is embedded in the Constitution (see Box 4.1) and the Devolution and Decentralisation Policy (Webinar II, III, 2020). The Constitution of Zimbabwe resonates with the core ideals of devolution.

Box 4.1 Section 264(2) of the Constitution of Zimbabwe Outlining Objectives of the Devolution of Government Powers and Responsibilities

(a) To give powers of local governance to the people by enhancing their participation in the exercise of the powers of the state and in making the decisions that affect them.
(b) To promote democratic, effective, transparent, accountable and coherent government.
(c) To preserve and foster the peace, national unity and the indivisibility of the Republic.
(d) To recognise the right of communities to manage their own affairs and to further their development.
(e) To ensure the equitable sharing of local and national resources.
(f) To transfer responsibilities and resources from the national government to create sound financial bases for provincial and metropolitan councils and local authorities.

Source: GoZ (2013).

The state has a legally enshrined role to play in safeguarding public health as stated plainly in Section 29 of the Constitution of Zimbabwe and Section 76 of the Constitution. Every citizen and permanent resident of Zimbabwe has a right to healthcare, and the state must take reasonable legislative action and other measures, within the limits of resources available to it, to achieve the progressive realisation of the right to healthcare (GoZ, 2013). Section 29 of the Constitution explicates the role of central government in the realisation of public and individual health within the borders of Zimbabwe (see Box 4.2).

Box 4.2 Section 29 of the Constitution of Zimbabwe on the State's Role on Health

(1) The State must take all practical measures to ensure the provision of basic, accessible and adequate health services throughout Zimbabwe.
(2) The State must take appropriate, fair and reasonable measures to ensure that no person is refused emergency medical treatment at any health institution.
(3) The State must take all preventive measures within the limits of the resources available to it, including education and public awareness programmes, against the spread of disease.

Source: GoZ (2013)

Devolution has over the recent past years been advocated as a preferable governance model for enhancing health systems (Kimathi, 2017; WHO, 2016). Yet, despite having strong legal framework for health planning, Zimbabwe still lacks an ample governance framework for consistently establishing the basis on how devolution can help achieve inclusive health goals especially during the public health crisis. Although promoting service delivery particularly health in the country may have been implicit in Zimbabwe's devolutionary process, apparently, it was not the primary driver.

The government has budget allocated funds for devolution in line with Section 301(1)(d) of the Constitution since 2019 fiscal. These funds are meant for infrastructure development in water, health, education and roads within all districts across the country. The delivery of these services relies largely on and is determined by the powers and responsibilities of the tiers of governments. The Constitution of Zimbabwe outlines the objectives of devolution of government powers and responsibilities (see Box 4.1) which is thus a measure of recognition of the status of provincial and metropolitan councils and local authorities in health governance in the country. The Rural and Urban Councils Act bestow power on devolved local authorities to carry out health service delivery.

4.3.2 Central and Local Governments' Responses: Decision Space on Health Matters?

Following the WHO's urge to take bold action to contain the spread of COVID-19, (WHO, 2020a, b). Zimbabwean government took a number of measures including a 21-day nationwide lockdown, on 24 March 2020. This sudden announcement became a bombshell to citizens countrywide; however, literature review reveals that some local authorities had notification before that the lockdown measures would be enacted. The national lockdown was premised on Zimbabwe's declaration of the COVID-19 pandemic as a national disaster (notification) in terms of Section 27 of the Civil Protection Act through gazetting of the Civil Protection (Declaration of State of Disaster: Rural and Urban Areas of Zimbabwe) (COVID-19) Notice. This is important from the perspective of health governance as the disaster management process in Zimbabwe extends from the national tier to local tiers of governments, with interactions and coordination among various institutions and actors, since the legal instrument also establishes a legal foundation for local authority's intervention.

At the national level, the MoHCC is responsible for providing stewardship and guidance, and at the sub-national level, mainly departments of health are responsible for implementing the orders from the top echelon of government in the delivery of health services. The central government through the MoHCC has led the development of a COVID-19 National Preparedness and Response Plan (CNPRP). As of 6 March 2020, the government has provided ZWL$two million to the MoHCC for implementation of the CNPRP (Ministry of Health and Child Care, 2020). Priority was given to provinces to conduct self-readiness assessments of their isolation facilities and points of entry to strengthen sensitisation and training of districts on COVID-19 as well as procurement of personal protective equipment (PPE). As part of capacity building of MoHCC personnel on case management and infection prevention and control for COVID-19, the government seconded four MoHCC workers and personnel from local authorities to partake on training conducted by the WHO, Africa Centres for Disease Control and Prevention and other partners (GoZ, 2020). For risk communication and coordination, national and sub-national Rapid Response Teams have been activated in all the districts, provinces and cities in addition to two Inter-Agency Coordination Committees and Inter-Ministerial Meetings on Health. In a devolved state, risk communication and coordination is quite easy (VGN International, 2020) as facilitated by express consultations multi-entities of government modelled around local tiers of the government as provided in Chapter 14 of the Constitution of Zimbabwe.

Under the Civil Protection Act, the central government issued guidelines to the local authorities for actions to be undertaken by urban councils and rural district councils and other local entities, such as healthcare and community workers. However, evidence shows that local authorities tended to have limited resources and means to implement these orders (Kosec & Mogues, 2020a) especially to control the spread of infection with mass testing and contact tracing. As such, local authorities were instructed to work together with frontline health workers and local community members such as village health workers (VHW). Most of these personnel are appointed by the Ministry of Health and Child Care their function is to work with to develop a comprehensive health plan. The COVID-19 pandemic has burdened an already strained healthcare system in Zimbabwe. Given that public health services at central government health institutions are being overwhelmed and overburdened as a result of the phenomenon of rural-to-urban migration, the central government should have a renewed policy thrust of ensuring equitable development throughout the country through accelerated devolution (Kasu et al., 2021: 90).

As earlier mentioned, the local government system of Zimbabwe is premised upon a devolved system as enshrined in the Constitution of 2013. Over the years, the Zimbabwean urban local government institutions have encountered a number of challenges whose implications on healthcare delivery are not only far-reaching but important for understanding their capacity for battling COVID-19 and its concomitant stressors. The challenges are structurally embedded in the socio-economic and administrative dimensions (OECD, 2020). Notwithstanding its profound impact on local governance around the globe (VGN International, 2020), COVID-19 has put local governments in developing countries at the front line in grappling with the negative outcomes of this unprecedented public health (VGN International, 2020) and economic crisis. Local authorities in Zimbabwe have been among the 'first responders' to respond to the COVID-19 pandemic through a number of measures. Local authorities across the provinces have moved swiftly to implement laid national policy of COVID-19 pandemic preventive strategy to protect their local areas (The Herald, 2021). The Beitbridge Rural District Council has been carrying out awareness campaign and ensured that its 16 health centres have nurses professionally trained to handle the increasing COVID-19 cases (The Herald, 2021). The Masvingo City Council has completed the refurbishment of Rujeko Clinic which was designated as the first provincial COVID-19 isolation centre. Zhanda (2020) observes that local authorities have seized the pandemic as opportunity to revamp dilapidated public structures and facilities most of which are of the informal sector businesses. The provincial and district civil protection committees, for example, in Kwekwe and Masvingo, have scaled up public awareness to prevent coronavirus. On 2 March 2020, the Bulawayo City Council held a sensitisation meeting which was attended by 28 healthcare employees drawn from the health centres in the city.

The rationale for devolving the sector was to allow the sub-national governments to design innovative models and interventions that suited the unique health needs in their contexts, encourage effective citizen participation and make autonomous and quick decisions on resource mobilisation and management possible issues.

4.3.3 Local Authorities and the Provision of Health Critical Infrastructure

Critical infrastructure entails facilities, assets, systems, networks and other elements that human society depends on to maintain public health, safety and economic vitality (Pescaroli & Alexander, 2016). Critical infrastructure can also be defined as goods and services, asset and system which are essential for everyone and important for supporting key societal functions, such as safety, health, security or economic or social wellbeing of people. Examples of critical infrastructure include, inter alia, health and public health, water, waste disposal, energy, emergency services, food, telecommunication and transport. Local authorities in Zimbabwe are essential critical infrastructure providers, and local health systems, like other institutions in Zimbabwe, rely on critical infrastructure. In Zimbabwe, health services are also within the service delivery matrix of the sub-national governments which include the critical infrastructure. As explicated earlier, the RDCs and UCs are mandated by laws to deliver basic services which include, inter alia, public health, WASH services and waste management. These functions underpin the responses against COVID-19, given the centrality of these services to control and prevent infectious diseases and their secondary effects. Thus, the purpose of devolution is to create and strengthen independent levels of government that are mandated to perform defined functions (Muchadenyika, 2015). The Constitution guarantees basic services such as healthcare, water, sanitation and a clean environment (GoZ, 2013) all of which are critical for controlling a pandemic (see Table 4.1). The absence or failure of any of these services can, within a short time, affect the entire segments of society or businesses.

Through the implementation of intergovernmental fiscal transfers, local authorities have been able to address infrastructure development deficits in record time (ZILGA, 2021). Clinics have been built, roads have been rehabilitated, and various service delivery equipment such as refuse trucks, graders and tippers have been procured (ZILGA, 2021). Devolution has led to an increase in health facilities in Zimbabwe. Mberengwa RDC and Gokwe Town have used devolution funds to construct Garinyama Clinic and Mapfungautsi Clinic, respectively. These local authorities like other local authorities countrywide started receiving devolution funds in

Table 4.1 Critical infrastructure and importance to COVID-19 in Zimbabwe

Critical infrastructure	Importance on COVID-19
Health	Health systems capacity and resilience against pandemics (WHO, 2020b) Minimising cumulative mortality rates
Water	Clean water for handwashing (e.g. safe hands campaign) Proper and frequent sanitation and hygiene Recovery phase on secondary impacts of COVID-19
Waste management	Barrier to human-to-human transmission of COVID-19 virus
Transport	
Energy services	
Emergency services	Public safety and security
Telecommunications	Working from home Online education Digital connectivity during lockdown
Housing	Facilitates shelter-in-home measures First line of defence against

2019 (The Herald, 2021). These allocations, however, need to increase so that local authorities can facilitate the people can progressively realise their health rights during COVID-19. As argued by Chikwawawa (2019: 19), devolution in a unitary state contributes to the improvement of efficiency and effectiveness in governance as well as in the delivery of public services.

Essential infrastructure services such as supplies of food, power and water outside health centres have get disrupted and became unavailable. Another major challenge for councils is to mitigate the impact of COVID-19 on their local economies. For COVID-19 response management and planning, the health system needs to consider not only health-related strategies but also the wider systems upon which health institutions depend, inside and outside the health system anchored on local authorities' role to provide essential services.

4.3.4 Fiscal Devolution and Health Services Financing

Undoubtedly, the extent to which sub-state governments have access to and control over revenue or fiscus determines, to a greater extent, their response to local health problems, COVID-19 in particular. The erosion of sustainable service delivery in 2021 was aggravated by the way in which intergovernmental fiscal support is managed, facilitated and allocated. Although the national treasury purports to be in support of devolution by providing financial support, there is no clarity on how financial support is arrived at in the absence of a formula to ascertain accountability and transparency (Marumahoko & Nhede, 2021). The Government of Zimbabwe acknowledges that as the implementation of the devolution is at its peak, local authorities and provincial and metropolitan councils will not have sufficient financial capacities to provide critical services such as water provision, sanitation, health and education devolved to them (GoZ, 2020) because they require funding, with short- to long-term refund tenure. Without any form of support from national government, urban councils continue to perform certain functions such as primary healthcare and library services without being compensated for it (Marumahoko, 2020a: 7). These challenges have been worsened by fiscal centralism, a phenomenon that leads to shortfalls of local authorities' serious powers to raise finance on their own (Chigwata, 2017). This is so because they are wholly reliant on resources from the national government's Ministry of Finance and Economic Development. The question as to whether rural and urban councils are empowered by Zimbabwean law to raise their own revenue is a critical factor which is commensurate with their health service responsibilities which require funds. Councils derive a large number of their revenues mainly from health, education and road grants, property tax, trading accounts and tariffs for services rendered.

The execrable conditions of the local health system on testing and contact tracing, distribution and administration of personal protective equipment (PPE), closure of some hospitals due to lack of proper COVID-19 PPE for health personnel and more importantly release of meagre funds to local authorities indicate that local authorities in Zimbabwe lack financial support and control. Evidence shows that 5% release of funds in 2020 by the national government to local authorities was insufficient (Chigiya-Mujeni, 2021) despite the fact that the Constitution prescribe that not less than 5% of Zimbabwe's revenue in the national budget be allocated to local authorities in order to improve service delivery. The central government is also devolving finances to local authorities at a slow pace. This negatively affected the performance of rural and urban councils especially service delivery in their jurisdictions. Chigiya-Mujeni (2021) argues that the underfunding of the local health systems was exposed at the onset of the pandemic as most local authorities' health facilities did not have ventilators or oxygen. Clearly, lack of access to finance affects local governments to support their health obligations amidst the COVID-19 pandemic. In 2021, the matter of rural district councils and urban councils being burdened with unfunded mandates has not been given due consideration to minify the burden on councils (Marumahoko & Nhede, 2021) and amends in an environment characterised by a decrement in own revenue sources due to COVID-19-induced lockdown.

In municipal clinics, Marumahoko and Nhede (2021) observed that urban councils have continued to attend to patients including those with symptoms associated with COVID-19 without charging heft amount. This function or role is not self-funding, and rural district councils and urban councils use their own revenue to fund such functions. As such, Marumahoko and Nhede (2021) argue that it is clear that the national government is not working with urban and rural local government in a cooperative, interactive and facilitatory way to realise meaningful service delivery. In addition, taking into account the feeble financial position of local authorities in Zimbabwe, there is a risk of plunging the country into yet another public health hazards. However, the central government has always not only turned to meddle in the operations of the local authorities but to blame urban councils for poor service delivery.

Cuts of public spending as part of central macro-economic policy called austerity and also due to COVID-19 have aggravated rural and urban council's disinvestment which further undermines the capacity and resources of local government. This presents challenges to the democratic accountability and capacity for redistribution of devolution projects (OECD, 2020), which include health services provision such as building clinics and public ablution facilities as well as water, sanitation and waste management infrastructure. At present and in the future, more demand for council services and a significant free fall in council revenues will jeopardise the support on access for many beneficiaries of councils' health and other related services.

4.3.5 Health Entities, Local Autonomy and Decision Space

The local communities of Zimbabwe are bearing the brunt of the COVID-19 pandemic. Local autonomy as put forward by Chigwata and de Visser (2018) generically denotes the extent to which sub-national governments have discretion in partaking their obligations and duties. Local autonomy prompts discretion to law-making, adopting policies and implementing decisions within a framework of provincial and national laws though subjected to regular supervision. The COVID-19 pandemic has brought about the importance of embracing such local autonomy as a powerful instrument in fighting the pandemic in Zimbabwe.

Devolution enhances efficiency and effectiveness of operations of local COVID-19 frontline institutions, by minimising bureaucracy as levels of decision-making are closer to the citizens. COVID-19 containment measures would be easy to implement and thus control the spread of the virus. The transfer of authority, power and responsibility and the sharing of resources for shaping an inclusive public health policy play a crucial role in COVID-19 containment.

4.3.6 Quarantine, Isolation, Testing and Contact Tracing

Quarantine, isolation and testing have been approved as the core strategies to curtail the spreading of coronavirus (WHO, 2020a). Scientific evidence has shown that the key to responding appropriately to the COVID-19 pandemic is aggressive widespread testing of the community to detect the virus positive cases which allows for effective contact tracing, isolation of those infected for 14 days and monitoring for those cases that progress to more severe illness (Jokwiro, 2020). In order to slow the spread of COVID-19, to reduce pressure on health services, Zimbabwean government has tried with varying degrees of success to follow WHO guidelines to quarantine or isolate international arrivals, isolate moderate and mild cases (in public facilities or at home), institute mass testing, hospitalise severe and moderate cases and trace and quarantine secondary contacts.

The central government, through Statutory Instrument 83 of 2020, compels local authorities to make land or premises available for isolation and quarantine to help on the control and prevention of COVID-19:

> By written order addressed to any local authority the Minister may require such local authority to set aside and make available during the period of national lockdown any land or premises adequate for the quarantine or isolations of more than fifty (50) persons at a time who are infected with or suspected of being infected with COVID-19, and to comply with the directions of any specified enforcement officer for the management of such land or premises. (GoZ, 2020: 453)

Centres for isolation of suspected COVID-19 cases have been initially set up at Thorngrove Infectious Disease Hospital in Bulawayo and Wilkins Infectious Diseases Hospital in Harare (GoZ, 2020). In spite of the fact that MoHCC has continued to strategically establish other isolation facilities in Gweru, Mutare, Kadoma and Masvingo, local authorities have relied upon institutional isolation which includes using public facilities such as schools to supplement isolation centres (The Herald, 2021) rather than self-isolation at home. This has been much necessitated by limited availability and poor quality of health facilities, thus leading to limited compliance of COVID-19 safety protocols.

In terms of testing, Kwak et al. (2020, 4) asserted that the national government has to provide COVID-19 diagnostic kit to the local to boost their responsive capacity. The Zimbabwean health system lacked the capacity to carry out significant countrywide and community-wide testing programme. Rapid antigen diagnostic tests were introduced to reinforce its COVID-19 response, hitting a daily rate of 4000 tests, a fourfold increase reached within just 2 months after the method was launched in November 2020. The rapid tests have been a game changer, according to the Deputy Director Laboratory Services at the MoHCC (WHO Zimbabwe, 2021). Initially, COVID-19 tests were conducted through the standard polymerase chain reaction in a major laboratory in the capital Harare and later decentralised to the provinces. Even then this was hamstrung by shortages in the supply of reagents due to global competition and longer turnaround time for test results. The rapid diagnostic tests have been distributed to clinics in rural areas, and results are received 20–30 minutes (at the minimum), a time reduction from up to 1 week in certain cases when results through the polymerase chain reaction testing had to be sent back to far-flung localities (World Health Organization Zimbabwe, 2021).

While the government has managed to some degree to detect and prevent entry of the COVID-19 through diagnostics and screening health centres, it faced a stumbling block of limited health infrastructure and equipment such as testing kits and a lack of accessibility by grassroots people to testing. Zimbabwe has the National Medical Reference Laboratory in the capital city Harare as the only laboratory that has the COVID-19 diagnostic capacity. Despite an increase in the testing rates, the per capita testing rates have remained very low, below 1.5 tests per 1000 people compared to over 35 in high-income countries, especially as a result of lack of important supplies (World Health Organization Zimbabwe, 2021).

While contact tracing is also crucial to taming COVID-19 transmission chains and curtailing the spread of the virus, with weak sub-state health departments in Zimbabwe, it has become close to impossible. This is different with countries with contact tracing maximum experience, for example, in Pakistan for polio, it has been able to institute systems at the community level (OECD, 2020). Regarding this, it is of the essence for Zimbabwe to recast devolution in line with health governance to respond to and subdue COVID-19 crisis.

4.3.7 Localised Lockdowns

While COVID-19 has become a global public health emergency of high international concern. The Government of Zimbabwe has realised the efficacy of the local-level approach to respond to surging COVID-19 cases, and it turned to ensure that local outbreaks of the virus are managed speedily and effectively. Among the areas that localised lockdown was imposed were Chitungwiza, Kwekwe District in Midlands Province and Kariba and Hurungwe districts in Mashonaland West Province. This approach was critical given an inability by the communities to comply with the shelter-in-home measures (OECD, 2020) coupled with law enforcement agencies' (national and municipal) capacity to enforce these measures across all areas of the country.

This is also important in combating new COVID-19 variants within the country. The COVID-19 pandemic needs to be fought at a local level due to the nature of the respiratory virus which spreads very rapidly through droplets generated when an infected person coughs or sneezes or through an airborne aerosol. The local people, when there are symptoms of COVID-19 infection, have to voluntarily block the migration of the people to another province or district and start mass diagnosis (Kwak et al., 2020). Therefore, the local government should consider locking down for a certain period of time in the local community. This needs to be strongly accompanied by quarantine as mentioned in the preceding section. Kwak et al. (2020) support this perspective that while carrying out the mass diagnosis, in many instances, the risk of secondary coronavirus infection is very high that the local authorities have to quarantine the confirmed cases strictly and separate uninfected people from the disease.

4.3.8 Community Public Health Actions: Networks and Local-Level Solutions

Zimbabwe has been lacking an organic network in and out of the central government including localising the tracking tasks. Evidently, little has been done in the country to equip and prepare local healthcare institutions and health professionals to competently handle cases of coronavirus (Mackworth-Young et al., 2021). This has pointed out to the importance of devolution to enhancing the government preparedness and managing the pandemic as the roles of local governments and communities are especially important. Many actors (including local people in remote areas) need to participate in order to overcome the threat of COVID-19.

Government community engagement as part of devolution has proved to be important for responding to the pandemic. As put forward by Mackworth-Young et al. (2021: 86) in their empirical study of healthcare workers and communities' viewpoints on COVID-19 and on early pandemic responses in Zimbabwe, community engagement should be an inherent pillar of an endeavour to address COVID-19 in sub-Saharan Africa from the outset, rather than a second thought. This pillar should include openness to feedback from the community and community leaders (Mackworth-Young et al., 2021). Therefore, central government health entities need to engage with communities as active participants of health response efforts, not as mere passive beneficiaries. Community engagement in the form of constructive engagement with local community leadership, mobilising local community surveillance groups as well as working with women and their organisations, worked well in Ebola in West Africa (Boozary et al., 2014). People occupy the centre of health systems and services as they play various roles, as key stakeholders of health; as consumers and recipients of healthcare services; as providers and makers of the inputs, goods and services for health; as contributors to funding of health systems; and as nationals in shaping and directing the implementation of the policies and standards that build health systems. The bulk number of people in Zimbabwe are de jure nationals only to continue to be omitted from participation in health and social life, whether through bureaucratic authority or centralisation of political power or some sort of socio-economic deprivation. This exclusion escalates when community people are not engaged to provide their input on health plans and policies which leads them to losing access to health services.

4.3.9 Public Accountability and Efficiency: Checks and Balances

Studies have shown that to increase accountability for public healthcare systems, responsibility for healthcare costs needs to be allocated to sub-national tiers of the state, supported by unconditional block grants to local governments and new forms of management of healthcare entities (Bankauskaite & Saltman, 2007). Without devolved governance, corruption will be a stumbling block affecting transparency and accountability.

While corruption is a known and pervasive ‘cancer’ in Zimbabwe’s governance (Chiweshe, 2017), COVID-19 has validated the fact that corruption is deeply rooted in governance matters of the country and rife in public offices. Widespread corruption was revealed in national government including the so-called Drax Scandal, wherein the Minister of MoHCC, Obadiah Moyo, was arrested and charged with corruption case for unprocedurally awarding a $US60 million contract for COVID-19 medical supplies to Drax International LLC which then sold supplies to the government at inflated prices (Chingono, 2020; Zimbabwe Peace Project, 2020a, b). This led to him being fired from the government by the president. The chief epidemiologist Portia Manangazira was also arrested for recruiting her 28 relatives as community health workers in $800,000 COVID-19 awareness programme funded by the Africa Centres for Disease Control and Prevention (Chingono, 2020). The fund was supposed to cater for the training of about 800 community health personnel, but her family members were paid $600 every month. There were other reports of COVID-19 test kits and personal protective equipment donated by UNICEF went missing. Moreover, this occurred at a time when the health system of Zimbabwe is crumbling. Kenya has also experienced corruption during the COVID-19 pandemic where mass graft was under the popular hashtag ‘COVID-19 Billionaires’, exposing Kenya Medical Supplies Authority for awarding tenders worth billions to dubious companies (BBC News, 2020). This led to inefficiency; supply of sub-standard equipment; hyperinflation of COVID-19 supplies’ prices; logistical bottlenecks in medical supply replenishment rates at public health centres in the counties; occasioned shortages in drugs and reagents for COVID-19 intensive care services, treatment and testing; as well as shortages in PPEs for frontline healthcare workers as reported by Council of Governors together with frontline workers in Kenya (BBC News, 2020). This mis-governance was a result of the lack of devolved health structures with decision-making powers on resource allocation and the power to detect areas of priorities amidst health crisis. Centralisation of decision-making power is a bad recipe for health governance. As Fonshell (2018) puts it, centralisation of power is a catalyst for corruption.

Devolution proponents Pemberton and Lloyd (2008) and Morgan (2006) contend that devolution of power controls corruption and to some extent all forms of inefficiency. Onyango et al. (2012) also contends that devolution puts in place checks and balances in the governance arena. The fact that resources are distributed to local communities makes it easier for them to manage them in a transparent and accountable way. Any abuse of public resources can easily be traced and exposed. In line with the prudent use of public resources, strong local institutions have the potential to accelerate economic growth which in turn promotes national development.

4.3.10 Local Democracy in COVID-19 Control

As put by Louis Brandeis, the US Supreme Court Judge, devolved governance builds 'laboratories of democracy'. During the time of public health crisis like COVID-19, it is no easy task to take measures that do not restrict some fundamental democratic values and human rights. For example, lockdown measures have affected right to education, freedom of movement and economic rights of citizens (Zhanda et al., 2022). While these measures were 'imperative' that have been implemented in many countries around the globe, the Zimbabwean government have failed to keep such measures to a minimum. Of concern is that amidst the COVID-19 pandemic, there have been human rights abuses countrywide in Zimbabwe. It emerged that there was no due sensitivity to grassroots needs as most of the lockdown measures impacted negatively on local people, the majority of whom are vulnerable. Zimbabwe Peace Project (2020a, b) reports human rights abuses in the form of flogging and harassment of citizens by law enforcement agents mainly the Zimbabwe Republic Police and Zimbabwe National Army. There was a need for considering the local people through consultations rather than taking measures without the views of local people. Moreover, the outstretched power being applied by the state indicates the importance of relinquishing its central oversight to local governments and enhances democracy. In this regard, the non-functionality of the judiciary and parliament and formation of participatory mechanisms and structures could go a long way in promoting a participatory democracy in times of COVID-19.

Devolution makes a democracy stronger by giving communities a say in matters of their concern such as health crisis and the way forward. Excessive control of the central government of Zimbabwe coupled with its discretionary powers has stalled swift responses and initiatives against the COVID-19 pandemic. There has been no consultative process, and as such, important decisions could not be made expeditiously.

4.3.11 'Universal' Health Coverage Problematic

Devolution of Zimbabwe's health sector should be about strengthening the entire health system performance from central to local levels. This improves the ability of health systems to provide sustainable health services that are more equitable, inclusive, efficient and responsive to grassroots communities' needs. Evidence indicates that the COVID-19 pandemic has left a number of people in Zimbabwe unable to visit health facilities such as clinics because of the prevention and containment measures and the fear of contracting the virus (WHO Zimbabwe, 2021). This has thwarted health equity by impacting hard on communities and households which are marginalised and vulnerable with limited access to essential health services. These social groups have missed out on essential health services such as maternal, sexual and reproductive health, access to medicines, immunisation and treatment of chronic or non-communicable diseases. It was reported that more than 80% of facilities experienced a decline in uptake of essential health services, leading the Zimbabwean government to channel efforts towards ensuring that people could access and obtain services they need as well as maintaining safety in patients and health workers (WHO Zimbabwe, 2021). The WHO Zimbabwe in conjunction with the Universal Health Coverage Partnership has worked hand in hand with the MoHCC and provided technical assistance to strengthen the delivery of health services at rural and provincial health facilities during the pandemic.

In this regard, devolution improves the robustness and coverage of health sectors and other related sectors to fight against COVID-19. Moreover, this also ensures participation of local communities in the determination of their health priorities within their areas.

4.3.12 The Limitations of Devolution Model on COVID-19 Curtailment

Devolved governance is not without its shortfalls when it comes to battling health disasters. A number of challenges have been experienced during the COVID-19 by the health sector at sub-national level, thus affecting quality service delivery. These challenges are far-reaching and wide-spanning relationships between local authorities and national government, resources, infrastructure and legal framework. The COVID-19 pandemic has brought to light a long-standing problematic on centre-local relations in Zimbabwe. In Zimbabwe, where devolution is still in its initial implementation stage, the COVID-19 pandemic has thrown into even sharper relief the long-standing tensions between the central and local government. The concentration of power has exposed governments' failures in upholding the values of devolution as governments all over the world instinctively entered into '"top-down command and control" mode – centralising even further the decision space in the face of the stark regional differences in the spread and impact of the COVID-19.

Local authorities in Zimbabwe have been bedevilled with monumental challenges which include capacity gaps, human capital deficiency, lack of critical institutional and legal infrastructure and rampant corruption (Marumahoko, 2020). According to Kimathi (2017), the net effect of these challenges is the stagnation of healthcare and even a reversal of some gains according to health indicators. Policymakers and scholarly proponents of devolution claimed that devolution yields improved public accountability, sustainability and the empowerment of the poor and vulnerable groups (Bardhan, 2002) and health coverage. COVID-19 has shown the importance of having a complete recalibration of Zimbabwe's governance procedures and processes.

4.4 Conclusions and Recommendations

The chapter has articulated the public health dividend and efficacy of devolution in the fight against COVID-19. If devolution were fully in place in Zimbabwe, COVID-19 containment measures would have been easy to implement, thus enabling the control of the spread of the virus to successive waves of the pandemic. The ongoing COVID-19 pandemic presents an opportunity to address the historical underperformance of local tiers of the national government in changing and enhancing the resilience of local communities in fighting their local problems, including health crises such as COVID-19. More importantly, it emerged that devolution's success must be measured by its ability to act as a 'governance laboratory', showcasing and experimenting health policies and responses in one local area, district or province for the benefit of the entire country. Thus far, while devolution in Zimbabwe is gaining political impulse, it has lacked institutionalisation in supporting the health functions of the local authorities. Devolution in Zimbabwe has the potential to propel the containment of COVID-19.

The devolution is critical to taming the national disasters that seem to affect regions based on the administrative and political power to command or channel resources towards a crisis of concern. The devolution of power and responsibilities to sub-national tiers of government will ensure the equitable allocation of national resources and the participation of local communities in the determination of and responses to public health emergencies within their area. Nevertheless, in the fight against COVID-19 in Zimbabwe, coordination between the three tiered systems of government is not an end unto itself; it is only enviable to the extent that it brings better outcomes in subduing the COVID-19 and saving lives.

The chapter proposes forward-looking initiatives in building on devolution to create locally tailored solutions that will deliver more health and socio-economic benefits and resilience, if they are tailored to the local context. The challenges encountered during the COVID-19 pandemic have the potential to bring about reflections and lessons as thrusts on devolved governance and not only for the health sector but the whole service delivery system. The chapter also established that an effective liaison between central and sub-national actors is crucial, even with comparatively little support and resources. To enhance sub-national authorities' and health entities' capacity to battle the COVID-19 pandemic, the central government together with the local authorities needs to operate more closely with each other, to ensure capacity building around the devolved public health system. This strategy, however, draws much on the resilience and ingenuity of involved players that often go above and beyond 'the day job'. In addition, the national government has to support the rural and urban councils in building such institutional capacity, particularly on human resources for health development. In the context of COVID-19, the central government of Zimbabwe should also establish strategies for localised testing systems in the localised lockdowns.

Devolution should stretch towards uprooting the corruption that affects the healthcare system at all tiers of the government as witnessed during the COVID-19 pandemic. Sub-national governments and the devolved healthcare system in Zimbabwe need to espouse individual and aggregate performance reporting and public accountability for the COVID-19 control measures. Despite the fact that all local authorities have different financial standing and budget requirements, still, it would be crucial that the local governments work together to formulate a policy framework with agreed strategies, objectives and plan of action to ensure public health disaster governance.

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Chapter 5
Global COVID-19 Pandemic: A Strategic Opportunity for Operationalizing One Health Approach in Zimbabwe

Aaron Mabaso, Taona Museva, Emmerson Chivhenge, Godwin K. Zingi, and Leonard Chitongo

Abstract One Health (OH) is an integrated and holistic approach for prevention and control of infectious diseases at the human-animal-ecosystem interface. The OH approach recognizes the interconnectedness and interdependency of humans, animals, and environmental health. The on-going COVID-19 pandemic has served as a reminder on the importance of OH, thereby providing an opportunity to operationalize the OH approach in response to the current and future pandemics. The purpose of this chapter is to assess the prospects and constraints of operationalizing OH approach in Zimbabwe. The chapter is based on desktop research, focusing on peer-reviewed journal articles and official government documents such as policy documents, budget statements, and progress reports. The results show that Zimbabwe is not currently prioritizing the operationalization of the OH approach. The opportunities of implementing the OH approach include an existing supporting legal and institutional framework and open-source database management systems and geospatial technology. The constraints include resource-limited public and animal health systems, water and sanitation challenges, and increased human-domestic animal-wildlife interactions.

Keywords One Health · Human-animal-ecosystem interface · Infectious diseases · Operationalize

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5.1 Introduction

The on-going COVID-19 pandemic has reinforced the importance of One Health (OH) approach as a response strategy for reducing health risks at human-animal-ecosystem interface (Ruckert et al., 2020). Globally, there is an increase of emerging and re-emerging zoonoses, accounting for 70% of emerging infectious diseases (World Bank, 2012). On average, there is a new infectious disease emerging in humans every 4 months (UNEP, 2016). Zoonoses are infectious diseases caused by pathogens such as bacteria, viruses, fungi, and macro-parasites which are naturally transmissible between humans and animals (Deem & Brenn-White, 2020). Spillover events are happening at an escalating rate (Deem & Brenn-White, 2020), and most of the infectious diseases originate in wildlife, with domestic animals often serving as an epidemiological bridge between wildlife and human infections (UNEP, 2016).

There are several emerging zoonotic diseases that have made world headlines over the last few years which include Middle East respiratory syndrome (MERS), Rift Valley fever, severe acute respiratory syndrome (SARS), Ebola, West Nile virus, bird flu, and Zika virus disease (UNEP, 2016). There are also neglected zoonoses which are less headline-grabbing, such as anthrax, bovine tuberculosis, rabies, and several parasitic diseases (UNEP, 2016; World Bank, 2012). These zoonoses outbreaks have shown the interdependence of human health, animal health, and ecosystem health (Destoumieux-Garzón et al., 2018).

There are several factors responsible for the emergence and re-emergence of infectious diseases, and most of these factors are closely interlinked with ecosystem's health (UNEP, 2016). The main risk factors of infectious diseases are associated with ecological disturbances or environmental changes such as climate change, habitat destruction and fragmentation, environmental pollution, illegal trade in wildlife, and growing antimicrobial resistance (Calistri et al., 2013; de Macedo Couto & Brandespim, 2020; UNEP, 2016; World Bank, 2012). The West African Ebola outbreak was triggered by deforestation that resulted in an overlap of human and wildlife habitats (Jorwal et al., 2020). Although not yet conclusive, circumstantial evidence available links the origin of COVID-19 virus to Wuhan wet markets which are hotspots for spillover events (Bonilla-Aldana et al., 2020; Fasina et al., 2021).

Zoonotic diseases pose a threat to animal and human well-being, economic development, and ecosystem integrity (UNEP, 2016). Without effective response, zoonoses outbreaks can result in pandemics with potentially devastating impacts at global scale (World Bank, 2012). Pandemics greatly affect health systems, economies, and global health security (Buregyeya et al., 2020; Ruckert et al., 2020), and infectious diseases are also a threat to wildlife conservation (Cunningham et al., 2017a). The magnitude and impact of the on-going COVID-19 pandemic is unprecedented in modern times (Häsler et al., 2020).

Effective response to zoonosis health threat needs a forward-looking and coordinated approach in the detection, prevention, and control of emerging and re-emerging infectious diseases at the human-animal-ecosystem interface (Gruetzmacher et al., 2021). Prevention and control of zoonosis pandemics requires a holistic approach to health risks at the human-animal-ecosystem interface, such as the integrated OH approach (Buregyeya et al., 2020; Schmiege et al., 2020; World Bank, 2012). The OH approach recognizes the interconnectedness and interdependency of the humans, animals, and environmental health, and in turn it offers a more integrated, holistic, and proactive response to zoonoses (Buregyeya et al., 2020; Kelly et al., 2020).

Despite strong advocacy for OH approach, its practical implementation remains limited across the globe (Kelly et al., 2020; Ruckert et al., 2020), and its influence on most operational health policies has been insignificant (Jorwal et al., 2020). The on-going COVID-19 pandemic is expected to significantly influence the broader implementation of OH programmes (Fasina et al., 2021). Scientists had predicted the pandemic; however, little was done in response, and consequently, the world has witnessed the exorbitant cost of inaction (Gruetzmacher et al., 2021). The impacts of the pandemic could have been greatly reduced by adopting a precautionary OH approach to hazards and coordinating in advance a global preparedness plan that bridged all the normal sectoral and disciplinary silos (Gruetzmacher et al., 2021). The current COVID-19 pandemic has brought enormous multifaceted impacts, but it also provides an opportunity to operationalize the OH approach in response to the current and future pandemic (Deem & Brenn-White, 2020). It is under this background that this study seeks to assess the prospects and constraints of operationalizing the OH approach in Zimbabwe.

5.2 One Health Concept

The OH concept originates from the "One Medicine" concept, which recognized the intersection of human and veterinary medicine in response to zoonoses (Destoumieux-Garzón et al., 2018; Jorwal et al., 2020). After the outbreak of SARS in 2003, the "One Medicine" concept evolved into an improved all-inclusive "One World – One Health" concept or simply "One Health" (Jorwal et al., 2020). The novelty was the incorporation of the ecosystem health (Destoumieux-Garzón et al., 2018). Therefore, the OH concept is based on the knowledge that human and animal health are interdependent and connected to the ecosystem's health (OIE, 2021).

There is no single, internationally agreed definition of OH, although several have been suggested (Mackenzie et al., 2014). The most commonly used definition is by the American Veterinary Medical Association (AVMA) which defines OH as "collaborative efforts of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals and our environment" (King et al., 2008, p. 260).

Although there are several definitions of OH, some common salient features can be drawn from these definitions:

- Holistic and integrated approach that recognizes the inextricable interconnectedness and interdependency of human, animal, and environmental (natural and

Fig. 5.1 OH Conceptual Framework. (Source: Centers for Disease Control and Prevention [CDC] (2022))

built) health (Buregyeya et al., 2020; de Macedo Couto & Brandespim, 2020; Mackenzie et al., 2014).
- Proactive and forward-looking approach for detection, prevention, monitoring, control, and mitigation of emerging/re-emerging diseases at the human-animal-ecosystem interface (Gruetzmacher et al., 2021; World Bank, 2012).
- Coordinated and collaborative approach: multi- and cross-sectoral and multi- and interdisciplinary approach (Fasina et al., 2021; Kelly et al., 2020; Mackenzie et al., 2014).
- Multi-scale approach: action at global, regional, national, and subnational/local levels (King et al., 2008).

These key features of OH concept are reflected in the Berlin Principles formulated in 2019 which were adopted at the "One Planet, One Health, One Future" conference. The Berlin Principles updated the Manhattan Principle through the reintegration of ecosystem health and integrity while also addressing the current pressing issues of climate change and antimicrobial resistance (Gruetzmacher et al., 2021). An illustrative conceptual framework of OH (Fig. 5.1) also captures the salient components of the concept.

5.2.1 *Benefits of One Health Approach*

OH approach has several benefits highlighted in literature which include the following:

- Investment in OH schemes for zoonoses response has significant benefits, and the required OH investments are modest when compared to the costs of zoonoses outbreaks under the business-as-usual approach (World Bank, 2012).

- Increasing coordination and collaboration reduces the gaps and removes unnecessary duplication of responsibility among the human, animal, and environmental health systems (Kelly et al., 2020; World Bank, 2012). The approach helps in breaking sectoral and disciplinary silos which affects the timely and effective disease outbreak response (Häsler et al., 2020).
- OH approach addresses multifaceted health issues and risk factors at the human-animal-ecosystem interface, thereby enhancing resilience of systems (Agrimi et al., 2021).
- The OH approach improves human, animal, and ecosystems health at different scales (global, national, and local) through collaboration among all the health sciences (King et al., 2008).

5.3 One Health in Practice

In recent years, OH has gained considerable recognition which has led to the adoption of several OH initiatives across the globe (Fasina et al., 2021; Kelly et al., 2020). The key features of these OH initiatives include coordination, capacity building, information sharing, tool development and collaborative research (Fasina et al., 2021), resources (e.g. laboratory) sharing, and the application of an evaluation framework (Mackenzie et al., 2014). There are multiple best case practices of OH at global and regional level.

5.3.1 Global Level

At global scale, the operationalization of OH concept is being led by the UN agencies, namely, the World Health Organization (WHO), World Organisation for Animal Health (OIE), and Food and Agriculture Organization (FAO). These UN agencies came up with a tripartite agreement on allocation of tasks and coordination of international activities aimed at solving health risks at the animal-human-ecosystem interfaces (World Bank, 2012). However, the effectiveness of this collaboration among the three UN agencies (WHO, OIE, and FAO) is being affected by some differences in scope, priorities, and resources (Mackenzie et al., 2014).

There are several countries across the globe that have established national OH units within or supported by government and varying in scope and resources (Mackenzie et al., 2014). Canada is one of the few countries that have implemented the OH approach with much success, by integrating the human and veterinary diagnostic services at different levels that include the administration, laboratory research, and emergency response (World Bank, 2012). Another good example of OH working in practice is found in Mongolia, where coordination platforms which were set up between human and animal health sectors are proving effective in managing food safety and emergency disease issues (Mackenzie et al., 2014).

The US Agency for International Development (USAID) is engaged in a key global OH initiative focused on establishing an international early warning system for pathogens with spillover potential (World Bank, 2012). In 2009, PREDICT, a project of USAID's Emerging Pandemic Threats (EPT) programme, was launched to enhance global capacity for surveillance of zoonotic viruses with pandemic potential (USAID, 2014). PREDICT has been implemented in 31 countries and has significantly strengthened the capacity for early detection and discovery of new and known viruses (USAID, 2014). These achievements are being attained through working in collaboration with relevant stakeholders that include government departments, non-government organizations (NGOs), and research institutions and local organizations (Kelly et al., 2020; USAID, 2014).

There are also cases where OH approach is being used in response to the ongoing COVID-19 pandemic. For example, in New South Wales, state authorities worked in collaboration with animal health veterinarians and epidemiologists with the aim of leveraging disease outbreak knowledge and offering technical support structures for application to the COVID-19 emergency (Häsler et al., 2020).

5.3.2 Regional Level

There has been extensive adoption of OH in sub-Saharan Africa, evidenced by 291 OH initiatives across the region (Fasina et al., 2021). Some countries in the region, such as Uganda, are considered as hotspots for infectious disease epidemics due to several outbreaks of diseases which include Ebola, Marburg, plague, Rift Valley fever, yellow fever, and Crimean-Congo haemorrhagic fever (Buregyeya et al., 2020). In response to these public health threats, Uganda embraced the OH approach to improve its capacity to respond effectively to possible outbreaks through prevention and control of infectious diseases. The achievements include formation of a multi-sectoral National One Health platform, the National OH Strategic Plan, and OH communication strategy aimed at strengthening engagement across sectors and stakeholders (Buregyeya et al., 2020).

In Kenya, FAO through the Global Health Security Agenda's Zoonotic Diseases and Animal Health in Africa (GHSA-ZDAH) funded by the USAID has promoted several OH initiatives through policy formulation, staff training, capacity building in national veterinary laboratories, and disease surveillance (Fasina et al., 2021). There are also innovative OH partnerships that have been established in the region with the support of different institutions from developed nations. These partnerships include the South African Centre for Infectious Disease Surveillance (SACIDS) focused at improving the region's capacity in zoonotic disease surveillance and early detection, diagnosis, and control and the One Health Central and East Africa (OHCEA 2013), a partnership of 14 institutions of public and veterinary health in Ethiopia, Democratic Republic of the Congo, Kenya, Tanzania, and Uganda (Mackenzie et al., 2014).

Rwanda successfully integrated OH into its response systems to infectious diseases and to COVID-19 pandemic (Igihozo et al., 2022; Karim et al., 2021). Some of the major achievements include the formulation of OH strategic plans and policies, incorporation of OH into higher and tertiary education curriculum, development of multi-disciplinary rapid response teams, and decentralization of animal and human health laboratories to strengthen surveillance (Igihozo et al., 2022). To address COVID-19, Rwanda crafted in advance a National Preparedness and Response Plan and set up a multi-sectoral COVID-19 Joint Task Force to coordinate the response to the pandemic (Igihozo et al., 2022; Karim et al., 2021). Rwanda managed to expeditiously implement OH-informed response to COVID-19 through the use of existing OH structures (Igihozo et al., 2022).

The One Health Research, Education and Outreach Centre in Africa (OHRECA) is another OH initiative being implemented in response to COVID-19 pandemic. OHRECA was established in 2020 to promote networking, knowledge sharing, critical OH thinking, and applied research in the region (Fasina et al., 2021). There is also the African OH University Network that brings together members from health and research institutions from eight nations with the aim of providing a virtual platform for knowledge exchange on COVID-19 response (Häsler et al., 2020).

5.3.3 One Health Implementation Challenges and Gaps

Despite this broad support, implementing OH approaches in practice still proves challenging (Kelly et al., 2020; Fasina et al., 2021). Fasina et al. (2021) provide a comprehensive review of the challenges and gaps affecting OH initiative in sub-Saharan Africa. Some of the challenges highlighted by Fasina et al. (2021) include poor communication and information sharing among OH stakeholders; limited capacities (financial, technical expertise, technology infrastructure, and laboratory services); overreliance on external funding; economic and socio-political instabilities/insecurities; and limited OH operational research.

Numerous studies (e.g. Destoumieux-Garzón et al., 2018; Fasina et al., 2021; Mackenzie et al., 2014; Schmiege et al., 2020) have highlighted that several OH initiatives have failed to adequately include the environmental (natural and built) issues by focusing narrowly on human-animal health issues. Most policy and strategic framework documents and publications on OH approach are largely focused on the response to emerging zoonoses originating in domestic and wildlife animals and/or their interactions, without really considering the role of inclusive and health ecosystems (Destoumieux-Garzón et al., 2018). However, COVID-19 outbreak is demonstrating the importance of the natural and built environments in the response to health threat at human-animal-ecosystem interface (Schmiege et al., 2020).

5.4 Methods

The chapter was based on desktop research with the general focus on Zimbabwe and the on-going One Health initiatives. The review was carried out from peer-reviewed journal articles and official government documents such as policy documents, statutory instruments and acts, and reports. The general search engines such as Google Scholar and Semantic Scholar were used to come up with the relevant literature to guide the study, and a number of keywords were used. Keywords and combinations were used, and these were in the "abstract, title, keywords and topic" following the approach used by Chivhenge et al. (2022) such that there was easy identification of the literature on Zimbabwe. The most common words used in the study were "Zimbabwe", "One Health", "zoonoses", "human-animal-ecosystem interface", and "COVID-19 pandemic". The aspect of COVID-19 was very recent which started in 2019, and hence, the filters were used from 2019 to present, and for some other elements such as One Health, the 10-year rule of thumb was used meaning that literature was filtered from 2012 to 2022. Grey literature was only used if it was part of seminal concepts such as OH which emanated around 2003.

5.5 Results

This section is going to present results on the OH initiatives being implemented in Zimbabwe and the opportunities and constraints of operationalizing a holistic and integrated OH approach in the country.

5.5.1 One Health Initiatives in Zimbabwe

Zimbabwe has mainly ad hoc OH initiatives which include its participation in international OH programmes: OH Antimicrobial Resistance National Action Plan, SAFE (Transforming Zimbabwe's Animal Health and Food Safety Systems) project, PACMAN (Diagnostic Platform for the Control of Animal Diseases) project, and Cross-Sectoral Zoonotic Committees.

5.5.1.1 Participation in International One Health Programmes

Zimbabwe is a member of the Global Health Security Agenda (GHSA) – a network having 70 nations and international and non-government organizations and companies in the private sector, coming together to provide health security worldwide. The year 2014 saw the launching of GHSA, bringing together nations towards the promotion of OH methodologies and enhancing capabilities of preventing, detecting, and responding to health risks. In the 70 member countries across the globe, the

GHSA is a launchpad which is used to coordinate and serve for the initiation and development of OH national policies and strategic plans (Kelly et al., 2020). Some of GHSA's main ideas such as the Joint External Evaluation (JEE) tool have been adopted by WHO, with the aim of promoting compliance with the International Health Regulation (IHR) of 2005. Zimbabwe participated in the Joint External Evaluation of IHR core capacities in 2018 (WHO, 2018).

5.5.1.2 OH Antimicrobial Resistance National Action Plan

One of the tangible OH initiatives in Zimbabwe is a national action plan (NAP) on antimicrobial resistance (AMR) – Zimbabwe One Health Antimicrobial Resistance National Action Plan (2017–2021). The NAP was developed according to the OH approach, after conducting a robust situation analysis on AMR (WHO, 2018). The strategic objectives of the NAP covered education, training, and awareness, surveillance to improve detection of the AMR, infection prevention and control, rational use of antimicrobials, and investment into research and development (Government of Zimbabwe, 2017). A multi-stakeholder and cross-sectoral team was involved in the preparation, implementation, and evaluation of the plan. Some of the key stakeholders included the Ministry of Health and Child Care (MHCC); Ministry of Environment, Climate, Tourism and Hospitality Industry (MECTHI); Ministry of Lands, Agriculture, Fisheries, Water, and Rural Resettlement (MLAFWRR); WHO; FAO; and OIE.

Funding constraints are affecting the execution of the OH AMR national action plan, as the existing sentinel surveillance sites only have the capacity of monitoring two of the eight WHO priority pathogens (WHO, 2018). However, currently there are no documented evaluation reports on the implementation of the NAP. A review study by Harant (2022) on the implementation of NAP in African countries showed that consistent reporting of progress and allocation of funds were non-existent in most of the countries.

5.5.1.3 SAFE Project

Another OH initiative in Zimbabwe is the SAFE (Transforming Zimbabwe's Animal Health and Food Safety Systems) project whose thrust is capacity building for the purpose of controlling animal disease, sanitary and phytosanitary, and promoting food safety (Zimbabwe Agricultural Growth Programme [ZAGP], 2019). SAFE is a European Union (EU)-funded project led by FAO working in collaboration with the Department of Veterinary Services (DVS) under the MLAFWRR and the Department of Environmental Health (DEH) under the MHCC. The main aim of the SAFE project is transformation of local animal health and food safety systems to boost productivity in livestock and safety of food for consumers allowing access to local, regional, and global markets (ZAGP, 2019). The project is being implemented at national, provincial, district, and ward levels, covering 30 rural districts and 18 border areas in Zimbabwe.

Some of the achievements of the SAFE project include the development of a new Environmental Health Technician (EHT) Curriculum (FAO, 2022). The revised curriculum managed to align training of EHTs with international best practices on food safety and new approaches in environmental health. The SAFE project also managed to renovate tick-borne disease (TBD) vaccine production unit and supported the preparation of a national tick-borne disease control strategy (ZAGP, 2022). The disease control strategy was aimed at the sustainable control of TBDs for ruminant animals as part of a main intervention strategy to deal with livestock health issues targeting a reduction in their morbidity and mortality.

5.5.1.4 PACMAN Project

PACMAN (Diagnostic Platform for the Control of Animal Diseases) is another OH initiative in Zimbabwe that is narrowly focused on animal health. The PACMAN project is focused on developing the capacity of Zimbabwe's agricultural sector in the early detection, monitoring, as well as mitigation of animal and zoonotic diseases (French National Research Institute for Sustainable Development [IRD], 2020). The 3-year project (November 2020 to November 2023) is being implemented by the French Development Agency (AFD) and the French Agricultural Research Centre for International Development (CIRAD), working in partnership with the IRD, Faculty of Veterinary Sciences of the University of Zimbabwe, and DVS under MLAFWRR.

The PACMAN project complements the activities initiated through the CAZCOM project (Strengthening Zimbabwe's Capacity for Animal and Zoonotic Disease Control). CAZCOM was a 2-year project (2019–2021) coordinated by CIRAD. The achievements of the project include human capital development focusing on zoonoses response, as well as establishing a molecular biology laboratory guided by global standards (CIRAD, 2021).

5.5.1.5 Cross-Sectoral Zoonotic Committees

Zimbabwe has established Zoonotic Committees – a OH platform for coordinated zoonoses response which brings together ministries (MHCC, MLAFWRR, and MECTHI) responsible for management of zoonotic diseases (WHO, 2018). The Zoonotic Committees at national (inter-ministerial committee) and subnational (provincial and district committees) levels hold meetings on a monthly basis for the purposes of sharing information and coordinating the delivery of health interventions. These interventions include surveillance, prevention, monitoring, and control of zoonoses with particular priority on rabies, anthrax, trypanosomiasis, salmonellosis, avian influenza, and brucellosis (WHO, 2018). However, some of these committees are not functional or fully functional, mainly due to limited resources (Gombe et al., 2010; Makurumidze et al., 2021).

5.5.2 *Opportunities for a Holistic One Health Approach in Zimbabwe*

The OH approach builds on available capacities but is unique in terms of creating a platform for coordination and collaboration among disciplines and sectors with more extensive health benefits (Kelly et al., 2020). The factors that can promote the successful implementation of the OH approach in Zimbabwe include a relevant legal and institutional framework, opportunities for open-source database management systems and geospatial technology, and existing cross-border OH initiatives.

5.5.2.1 Relevant Legal and Institutional Framework

Zimbabwe has the relevant legal and institutional framework to support the implementation of OH approach. The existing legislation covers all the key issues necessary for human, animal, and ecosystem health. The key legislation includes Public Health Act (Chapter 15:17) of 2018, Animal Health Act (Chapter 19:01) of 2001, and Environmental Management Act (Chapter 20:27) of 2005 (Table 5.1). The Public Health Act (Chapter 15:17) has provisions for communication and coordination between the DVS and MHCC when responding to notifiable disease outbreaks.

In addition to Acts of Parliament, the legal framework that supports the OH approach includes several statutory instruments such as by-laws for urban and rural local authorities. There are also international and regional regulations, for example, the IHR of 2005 that supports the integrated disease surveillance across international borders. Although the existing legislation provides a solid foundation for the holistic adoption of OH approach, there is a need to review or update some of the legislation so as to incorporate specific OH provisions.

Zimbabwe also has the relevant institutional framework to facilitate the successful implementation of the OH approach. The institutions include government ministries, departments, and parastatals that cover all the key sectors for OH (Table 5.2). All these institutions are operational at national, provincial, and district level. The

Table 5.1 Existing legal framework

Sector	Legislation and policy
Public Health	Public Health Act [Chapter 15:17] Food and Food Standards Act [Chapter 15:04] Medicines and Allied Substances Control Act [Chapter 15:03].
Animal Health	Animal Health Act [Chapter 19:01] Veterinary Surgeons Act [Chapter 27:15]
Environmental Health	Environmental Management Act [Chapter 20:27] Parks and Wild Life Act [Chapter 20:14] Forest Act [Chapter 19:05] Communal Land Forest, Produce Act [Chapter 19:04] Water Act [Chapter 20:24]

Table 5.2 Existing institutional framework

Sector	Government ministry	Government department or parastatal
Human health	Ministry of Health and Child care	Department of Environmental Health, Department of Epidemiology and Disease Control
Animal health	Ministry of Lands, Agriculture, Fisheries, Water, and Rural Resettlement	Department of Livestock and Veterinary Services
Environmental health	Ministry of Environment, Climate, Tourism and Hospitality Industry	Environmental Management Agency; Zimbabwe Parks and Wildlife Management Authority; Forestry Commission

urban and rural local authorities also play a significant role in the adoption and implementation of OH approach at local level. In addition, there are several higher and tertiary education institutions which can play an important role in OH training and research.

Some levels of coordination and collaboration (a key feature of OH approach) already exist through information sharing across various sectors and levels, using multi-sectoral channels and platforms (e.g. multi-stakeholder committees and task forces). The multi-sectoral platforms include the Inter-Agency Coordination Committee on Health (IACCH), National Task Force on Cholera Elimination (NTFCE), Inter-Ministerial COVID-19 Task Force, and Zoonotic Committees at national, provincial, and district level. IACCH is a multi-sectoral and multi-disciplinary committee responsible for facilitating resource mobilization as well as managing response to public health emergencies, which is normally activated during major health emergencies such as the 2018 cholera outbreak (WHO, 2018). International development partners such as WHO, OIE, FAO, and UNICEF are also actively involved in some of these platforms. However, there are still a lot of improvements required to achieve effective coordination and collaboration necessary for successful implementation of OH approach.

5.5.2.2 Open-Source Database Management Systems and Geospatial Technology

Advances in technology for data collection, manipulation, and interpretation are expected to transform the methods for monitoring changes in the earth's natural systems and the detection of disease pathogens, with subsequent improvements in decision-making (Osterhaus et al., 2020). There are free and open database management systems (DBMS) such as WHONET, District Health Information Software version 2 (DHIS2), and the Rabies Epidemiological Bulletin (REB) which are valuable to developing countries like Zimbabwe. WHONET is a free access application for the management and analysis of microbiology laboratory data with a primary focus on antimicrobial resistance surveillance, and DHIS2 is a free, open-source software platform for collecting, analysing, visualizing, and sharing data. Some laboratories in Zimbabwe are already using these DBMS, and the country's health system has come up with an indicator-based human disease surveillance system through the use of DHIS2 (WHO, 2018).

Zimbabwe can also fully utilize the easily accessible geospatial technology (such as QGIS and open satellite imagery data) in the surveillance, monitoring, and control of infectious diseases. Geospatial technology is valuable in analysing spatio-temporal trends, patterns, and relationships at the human-animal-ecosystem interface. Currently, the DVS is applying GIS in mapping risks related to foot and mouth disease (FMD), anthrax, and rabies (WHO, 2018). The Zimbabwe National Geospatial and Space Agency (ZINGSA) that was established in 2018 also enhances the prospects of implementation of OH approach. ZINGSA is set to launch its first satellite ZIMSAT-1 in 2022 which is going to improve access to geospatial data that can be used in the surveillance and monitoring of infectious diseases.

5.5.2.3 Existing Cross-Border Initiatives

Sub-Saharan African countries can take advantage of several existing cross-border OH initiatives, to implement national- and subnational-level OH initiatives (Fasina et al., 2021). Zimbabwe can benefit from the SADC Protocol on Health, the Isdell: Flowers Cross Border Malaria Initiative (IFCBMI), and the Trans-Limpopo Malaria Initiative (TLMI). The SADC Protocol on Health exists to coordinate the regional efforts on epidemic preparedness, mapping prevention as well as control. IFCBMI is committed to the elimination of malaria through community mobilization within the shared borders of Angola, Namibia, Zambia, and Zimbabwe and is implemented by a number of partners, among them, health ministries and religious ministries from these four countries (Gordon et al., 2019). The TLMI seeks a reduction in malaria transmission in Matabeleland South Province (Beitbridge municipality) of Zimbabwe and the Limpopo Province (Musina municipality). Its major focus is hinged on ensuring the harmonization of policy and management of malaria interventions such as managing cases, vector control, surveillance, and health promotion across the bordering districts of Zimbabwe and South Africa (Moonasar et al., 2012).

5.5.3 Constraints for a Holistic One Health Approach in Zimbabwe

There are several constraints in operationalizing the OH approach in Zimbabwe which include limited resources in the health system, water and sanitation challenges, and increased human-domestic animal-wildlife interactions.

5.5.3.1 Resource-Limited Public Health System

Zimbabwe's healthcare system has limited financial, physical capital, and human resources which is significantly limiting capacities for public healthcare. The absolute expenditure of government on health and as a share of gross domestic product (GDP) demonstrates the government's commitment to health (Piatti-Fünfkirchen et al., 2018). Zimbabwe's actual domestic health spending and national budget allocation are below the recommended African Union's targets for sustainable domestic health financing. The government's expenditure on health as a percentage of total government expenditure averaging 8.3% for the period of 2017–2022 falls short of the Abuja Declaration target of 15%. The average domestic health expenditure as a percentage of GDP was 1.3% for the same period and is also below the Africa Scorecard target (>5%). The failure to meet these funding thresholds indicates insufficient health sector funding by the government (Table 5.3).

The actual domestic health spending for the period 2017 to September 2021 was less than external funding from development partners (Fig. 5.2). On average, the Zimbabwean government contributed only 43% of the total actual health spending, compared to 57% from external sources. This financing trend indicates high dependence on external funding, which is unsustainable considering the unpredictability issues associated with external financing (UNICEF, 2021b).

Physical capital investments are being compromised by low budgetary allocation and weak execution rate, with recurrent costs accounting for the greater proportion of the national health budget (UNICEF, 2021b). As a proportion of total national health budget, capital budget was cut from 31% in 2020 to only 17% and 15% in 2021 and 2022, respectively (MoFED, 2021; UNICEF, 2021b). Weak execution of the capital budget is evidenced by underperformance averaging 71% over the period 2018–2020 (UNICEF, 2021b). In 2020, capital expenditure only accounted for 4.2% of total actual expenditure against a budget target of 31%, and for January–September 2021, it was 4% against a target of 17% (MoFED, 2021; UNICEF, 2021b). This low budgetary allocation and weak execution of capital budget for health, and non-prioritization of capital expenditures by development partners, has greatly compromised physical capital investments. For example, the Ministry of

Table 5.3 Zimbabwe government's healthcare financing (2017–2022)

Health expenditure indicators	Actual health spending					Budget allocations	
	2017	2018	2019	2020	Jan–Sept 2021	2021	2022
Domestic expenditure (US$ millions)	$341	$635	$134	$206	$288	$672	$1342
Domestic health expenditure as % of total government expenditure	5.9%	7.1%	7%	10%	7%	13%	12.7%
Domestic health expenditure as % of GDP (%)	1%	1.1%	0.8%	1.7%	0.8	2.3%	2.3%

Source: Ministry of Finance and Economic Development [MoFED] (2020, 2021), UNICEF (2020, 2021a, b)

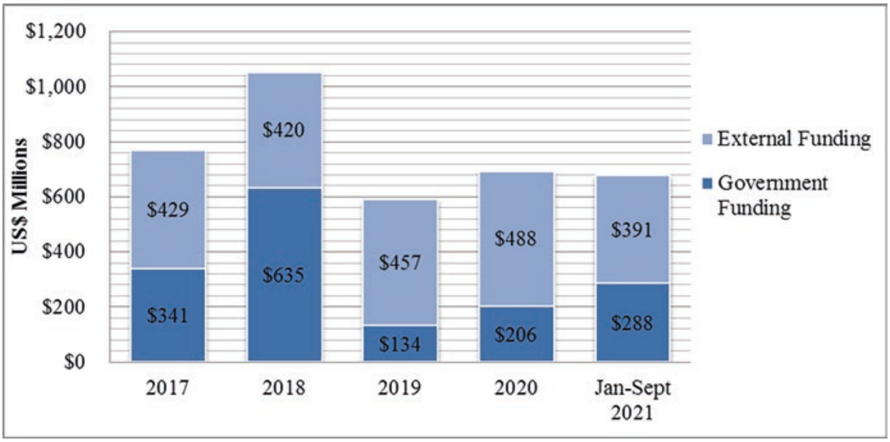

Fig. 5.2 Zimbabwe's sources of health financing (2017–2021). (Source: Authors, data from MoFED (2021), UNICEF (2020, 2021a, b))

Health and Child Care (2017) notes that inadequate budgetary allocation for laboratory services is affecting the attainment of standardized laboratory equipment and reagents and maintenance of existing equipment leading to frequent breakdowns.

The public health sector in Zimbabwe is also greatly affected by inadequate human resources, and there is persistent staff turnover in the government's health sector (Dzinamarira & Musuka, 2021). In 2018, Zimbabwe had 0.14 physicians and 1.85 midwives/nurses per 1000 population which is below the Sustainable Development Goals (SDGs) index threshold of 4.45 midwives, nurses, and doctors per 1000 population (WHO, 2021). The Health Service Board's staff returns of December 2021 had a 16% vacancy rate of the total positions in the public health sector. The vacancy rates' breakdown for selected key positions is as follows: medical doctors, 26%; nursing staff, 18%; laboratory/pathology staff, 26%; surveillance and health information systems staff, 15%; and infrastructure, engineering, and equipment maintenance staff, 34% (Health Service Board, 2021). The problem of inadequate health personnel has been exacerbated by deterioration in working conditions in Zimbabwe as health professionals leave for other countries where conditions of service are attractive (Dzinamarira & Musuka, 2021; Kanyumba & Msosa, 2020). These factors have led to brain drain as critical and experienced health professionals are leaving the country in search for better opportunities. According to the Health Service Board, 2246 nurses and doctors resigned in 2021 to take job opportunities in the region and beyond.

The inadequacy of critical resources is negatively affecting implementation of important public health programmes which include the malaria control, biosafety, and biosecurity programmes. Financial constraints are affecting malaria control initiatives such as the annual indoor and outdoor residual spraying and free distribution of insecticidal nets, leading to recurrence of malaria outbreaks (Mbunge et al., 2021). In addition, there is inadequate funding to support the oversight and enforcement of biosafety and biosecurity (WHO, 2018). Insufficient resources have also affected COVID-19 response as frontline workers (doctors, nurses, and supporting staff) have been working without adequate personal protective equipment (PPEs) (Chigevenga, 2020).

5.5.3.2 Limited Capacity of Animal Health Systems

Zimbabwe's animal health system has limited capacity in the management of animal diseases, evidenced by persistent livestock disease outbreaks, particularly cattle diseases (Auditor-General [AG] Report, 2018). A total of 166,997 cases of various cattle diseases and 22,895 cattle deaths were recorded countrywide for the period 2015 to May 2018 (Fig. 5.3). The cattle disease cases during this period included FMD with 53,026 cases and a case fatality rate (CFR) of 11%, tick-borne diseases with 23,224 cases and CFR of 27%, and anthrax with 288 cases with a CFR of 90% (AG Report, 2018). Zimbabwe also experienced major outbreak of tick-borne diseases with high CFRs during the 2019/2020 and 2020/2021 agricultural seasons. The 2019/2020 season recorded 46,715 tick-borne disease cases with a CFR of 72%, and the 2020/2021 season had 25,036 recorded cases and a CFR of 50% (The Herald Zimbabwe, 2022).

According to the Auditor General Report (2018), the DVS is facing challenges of limited resources which are limiting the capacity of the department in the prevention and control of livestock diseases. One of the challenges is inadequate laboratories as the DSV only have three provincial laboratories and a Central Veterinary Laboratory in Harare (AG Report, 2018). DSV is also facing a challenge of shortage of vehicles for their operations, and the available vehicles in 2018 only constituted 28% of the required fleet. In 2018, DSV had high vacancy rates of critical positions,

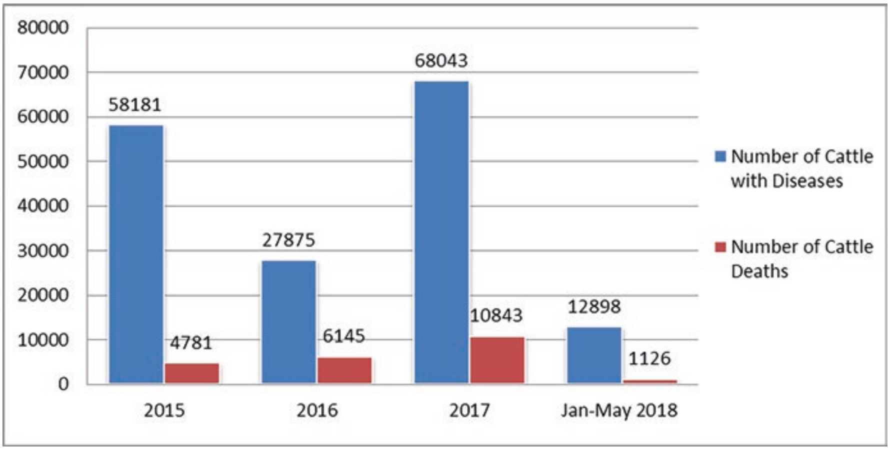

Fig. 5.3 Cattle disease cases and death (2015–May 2018). (Source: Authors, data from AG Report (2018))

which include district veterinary officers, government veterinary officers, and health inspectors, which had vacancy rates of 72%, 64%, and 62%, respectively (AG Report, 2018). In addition, there were no veterinary epidemiologists in all eight provinces, which is a key position in animal disease prevention and control.

The limited capacity of the animal health systems is affecting animal disease prevention and control strategies which include annual FMD and anthrax vaccination programmes. During the 2015–2018 period, the FMD and anthrax vaccination programmes were not being carried out regularly as expected, and most of the vaccinations were done in response to disease outbreaks (AG Report, 2018). The other affected programmes include dipping for prevention of tick-borne diseases and tsetse control programme for the prevention of trypanosomiasis. According to the AG Report (2018), the dipping programme missed its target of dipping session by 23% over the 2015–2018 period, and the tsetse control missed its target of tsetse eradication by 48% during the same period. Rabies prevention and control programmes have also been affected by limited resources, which have restricted dog vaccination programmes to fix-point vaccination campaigns (WHO, 2019). Zimbabwe has a Stepwise Approach towards Rabies Elimination (SARE) score of 1.5 out of 5 which shows limited capacity in the prevention and control of rabies (Coetzer et al., 2019).

5.5.3.3 Increased Human-Animal-Ecosystem Interface

In recent years, Zimbabwe has witnessed increased human-animal-ecosystem interface, thereby increasing the risk of diseases emerging and spreading between species (FAO, 2017). These interactions between humans, wildlife, and domestic animals have been more intense in areas close to national parks and conservancies. Wild animals are a reservoir for pathogens affecting humans and domestic animals (FAO, 2017; Mackenzie et al., 2014), and domestic animals are often regarded as an epidemiological bridge for infections between wildlife and human beings (UNEP, 2016). Zimbabwe is experiencing increased encroachment into wildlife habitats (national parks and protected areas) due to changing human settlement and land-use patterns, illegal livestock movement, and inadequate separation of buffalo/cattle populations in areas close to national parks (FAO, 2017). The boundary fences between game parks and farms that used to separate livestock from wildlife are no longer available due to non-maintenance and vandalism (AG Report, 2018).

An increase in the interface between livestock and wildlife has also been witnessed in the Great Limpopo Transfrontier Conservation Area (GLTFCA), as the adjacent rural communities move their livestock into the game park in search of pastures and water (Gadaga et al., 2016). This creates opportunities for spillover events (Gadaga et al., 2016), and as a result, transboundary animal diseases (TADs) are on the rise, posing a threat to the health and livelihoods of these local rural communities (FAO, 2017). For example, rural communities neighbouring Gonarezhou National Park, in Chiredzi South, are experiencing recurrent outbreak of FMD commonly transmitted by the wild buffalo to livestock (FAO, 2017; Gadaga et al., 2016; Guerrini et al., 2019).

Zimbabwe is also witnessing increased mining activities in protected areas, which is also intensifying human-wildlife interactions, thereby increasing the chances of spillover events. There were coal mining activities in Hwange National Park, which were later stopped after objections were raised by several stakeholders. There are also on-going mining activities (mainly illegal) in Chimanimani National Park, Umfurudzi Game Reserve, and Matusadona and Mana Pools, and several other national parks are under consideration for prospecting and exploration activities (Ndlovu et al., 2021). Despite a lot of effort to clear tsetse flies from the Zambezi valley, the flies and trypanosomiasis disease persist, mainly due to increased human, livestock, and wildlife interactions (Cunningham et al., 2017b).

5.5.3.4 WASH Challenges

Zimbabwe is continuously experiencing a water, sanitation, and hygiene (WASH) crisis which often leads to recurrent waterborne disease outbreaks. The water and sanitation challenges have been attributed to the two major cholera outbreaks, one in 2008/2009 with over 100,000 cases and over 4000 deaths and in 2018/2019, which had 10,000 cases and 69 deaths (Government of Zimbabwe, 2018). According to Zimbabwe's WASH statistics (Fig. 5.4), 60% of the population has access to basic drinking water, and only 37% has access to basic sanitation facilities. The WASH challenges are worse in the rural areas where access to basic drinking water and sanitation is at 51% and 34%, respectively, meaning the majority of the population has no access to clean water and sanitation.

The WASH challenges are largely a result of limited investment in water and sanitation services. WASH expenditure in Zimbabwe has only averaged 3.3% of the national budget over the 2018–2021 period, which falls short of the Sanitation and Water for All (SWA) recommendation of 7% per year (UNICEF, 2021c). WASH investments are also affected by disproportionate budget allocation, with water resources investments dominating WASH budget (Jones et al., 2019; UNICEF, 2021c). The budget allocation for dam construction has averaged 60% of the total WASH spending, which is crowding out critical downstream investments such as water supply, reticulation, and wastewater disposal (UNICEF, 2021c). In dealing with inadequate WASH investments, in 2021, the Zimbabwean government embarked on an initiative to drill boreholes in both urban and rural areas, under the presidential borehole drilling scheme. The programme is expected to improve access to basic drinking water in both urban and rural areas. However, urban areas should prioritize investments in the main water supply systems, with boreholes being used on complementary basis.

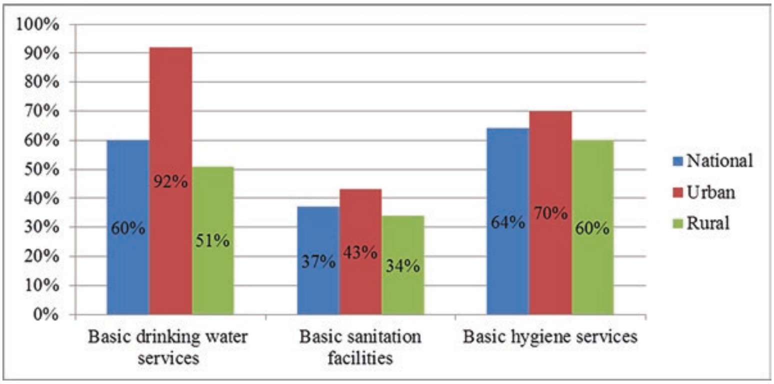

Fig. 5.4 Population with access to basic water, sanitation, and hygiene services. (Source: Authors, data from ZIMSTAT and UNICEF (2019))

5.5.3.5 Risk Cultural and Behavioural Practices

Socio-cultural factors are important in the success of the OH concept. Culture determines the success of all intervention strategies in the health sector, more so, where health outcomes are determined by an intersection of human, animal, and environment. There are some religious beliefs such as the indigenous apostolic doctrines, particularly the Johanne Marange apostolic sect, which negatively shape healthcare-seeking behaviour through emphasis on faith healing (Machekanyanga et al. 2017; Mapingure et al. 2021). The doctrine of these religious groups is against the use of vaccinations, and this practice exposes the followers and others to vaccine-preventable diseases and deaths. The 2009–2010 measles outbreaks in Southern Africa were linked to objections and vaccine hesitancy by apostolic sect members (Gerede et al., 2017; Machekanyanga et al. 2017). Therefore, poor healthcare-seeking behaviour, such as vaccine hesitancy among the apostolic groups, presents challenges on the operationalization of the OH approach.

There are also risk behavioural practices in the rural communities which include consuming meat from livestock dying from unknown causes and butchering moribund animals for consumption purposes (Chirundu et al., 2009; Gombe et al., 2010; Makurumidze et al., 2021). The previous anthrax outbreaks in Zimbabwe have been attributed to these risk practices (Chirundu et al., 2009; Gombe et al., 2010; Makurumidze et al., 2021). Studies have also shown that the risk factors associated with contracting rabies include lack of comprehensive knowledge about rabies and owning unvaccinated dogs (Chikanya et al., 2021; Spargo et al., 2021).

5.6 Discussion

The results show that Zimbabwe is not currently prioritizing the operationalization of the OH approach. The identified OH initiatives are being implemented on an ad hoc basis with a narrow focus on human and animal health issues. The scope of all the on-going initiatives fails to adequately integrate environmental issues, particularly ecosystem integrity, which is the case with most OH initiatives being implemented across the globe. Several studies (e.g. Destoumieux-Garzón et al. (2018); Fasina et al. (2021); Mackenzie et al. (2014); Schmiege et al. (2020)) have shown that most OH initiatives fail to adequately include the environmental (natural and built) issues by focusing narrowly on human-animal health issues. Although the on-going initiatives fail to meet the holistic and integrated quality of OH approach, they provide a good base for extending the scope in the future. According to Mackenzie et al. (2014), there is a general consensus on the need for a narrow and practical focus while developing the necessary capacities for a broader approach in the future.

The on-going OH initiatives being implemented show that there is recognition of OH in Zimbabwe as an alternative approach of responding to the increasing health threat of infectious diseases. This appreciation of OH approach is expected to be reinforced by the on-going COVID-19 pandemic. The frequent emergence of infectious diseases and their associated impacts in Zimbabwe call for the need to establish national OH platforms, policies, and strategic frameworks, utilizing the existing capacities such as the supporting legal and institutional framework. The Zimbabwe OH AMR National Action Plan of 2017–2021 is a valuable governance strategy that provides a good platform, which can be used in formulating comprehensive national and subnational OH strategic frameworks.

The highlighted constraints show that Zimbabwe has some challenges to overcome in operationalizing OH approach. One of the critical constraints is the limited capacity in the public health systems evidenced by failure to meet the minimum thresholds for universal healthcare set at regional and global scale. Zimbabwe's public health system is characterized by high vacancy rate of key health positions and a staff establishment below the SDGs index threshold of 4.45 doctors, nurses, and midwives per 1000 population. The domestic health expenditure as a share of the national budget averaging 8.3% also falls short of the Abuja Declaration recommended threshold of 15%. There is also high dependency on external funding in the public health system, with external sources contributing 57% on average to the actual public health expenditure. Two of the on-going OH health projects, namely, PACMAN and SAFE, are being funded from outside the country, which also shows dependency on external funding and sponsorships. This high dependency on external funding is unsustainable, and it is a challenge affecting most countries in sub-Saharan Africa. External sources are contributing more than 90% of OH funding in sub-Saharan Africa (Fasina et al., 2021).

According to Mackenzie et al. (2014), limited resources necessitate collaborations among relevant sectors, and this is one of the factors promoting the successful implementation of OH programmes in developing countries. Therefore, in operationalizing OH in Zimbabwe, the limited resources can be taken as an opportunity of fostering coordination and collaboration among different sectors responsible for implementing the OH approach. Although the WASH challenge and increased human-animal-ecosystem interactions are highlighted as constraints, these two issues also provide the rationale for operationalizing OH approach in Zimbabwe. These factors and the recurrent outbreak of livestock diseases and rabies show that the country is at high risk of infectious diseases, thereby necessitating the OH approach.

5.7 Conclusion

The on-going COVID-19 pandemic has reinforced the importance of One Health (OH) approach in responding to infectious diseases at the human-animal-ecosystem interface. The purpose of this chapter was to assess the prospects and constraints of operationalizing OH approach in Zimbabwe. The results show that Zimbabwe is not currently prioritizing the operationalization of the OH approach. To successfully implement the OH approach, the country needs to build on the existing legal and institutional framework, taking advantage of the available DBMS and geospatial technology opportunities. There is also a need to address challenges of limited capacities in the public and animal health systems and inadequate water and sanitation. The study recommends the development of holistic and integrated national OH platforms, policies, and strategic frameworks necessary for the operationalization of OH approach.

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Chapter 6
An Analysis of the Dynamics of COVID-19 Pandemic in Zimbabwe Using the Extended SEIR Model with Treatment and Quarantine

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Abstract The World Health Organization (WHO) predicted that unless effective measures were taken in Africa, as many as 44 million people would be infected by the COVID-19 virus with up to 190,000 fatalities in the first year alone. The Zimbabwean government tasked public and private institutions to produce non-pharmaceutical interventions (NPIs) such alcohol-based hand sanitizers (ABHS) alongside implementing social distancing measures such as quarantining and lockdowns as tools to prevent community transmission. The use of non-pharmaceuitical interventions such as handsanitizers and facemasks and an significant influx of returning residents especially those that came through undesignated entry point whose COVID-19 status is unknown, among other factors, have made it difficult to estimate epidemiological parameters for the COVID-19 pandemic in Zimbabwe. This chapter therefore examines the dynamics of the COVID-19 pandemic using an extended susceptible-exposed-infectious-removed (e-SEIR) model under these conditions of uncertainty in Zimbabwe. Computer simulations of different scenarios illustrate that quarantine and treatment reduce infection rate and fatalities by a significant margin. To slow the spread of COVID-19, considerable attention should

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also be devoted to strengthening contact tracing and detection of people suspected of being exposed.

Keywords SEIR · Compartmentalization · COVID-19 · Simulations · Differential equations · Model parameters

6.1 Introduction

The global COVID-19 epidemic has demonstrated the urgent need to assess quantitatively the concerns related to the pandemic within each country. For efficient and effective delivery of health, governments rely on accurate and precise demographic and epidemiological data which show the evolution of any disease within and outside of its own borders. Most governments in the global north relied heavily on real-time modelling tools to show the trajectory of the COVID-19 pandemic in order to flatten the curve (Currie et al., 2020).

The Government of Zimbabwe responded to the COVID-19 pandemic by instituting a variety of measures including coordination, planning, and monitoring as early as 24 January 2020 before the declaration of COVID-19 as a public health emergency of international concern on 30 January 2020 by WHO (Government of Zimbabwe, 2020). The first infection in Zimbabwe was recorded on 20 March 2020 (Murewanhema et al., 2020). After 21 days of lockdown which started on 30 March 2020, the government extended this by an initial 2 weeks after 21 April 2020 with the same restrictions as in the first 21 days. Three days before the end of the first 2-week extension, another 2 weeks' extension was affected from 4 May 2020. From 18 May, the Zimbabwe instituted an indefinite lockdown (Tom et al., 2020) to mitigate against the effects as the first wave (Murewanhema et al., 2020).

These efforts by the Government of Zimbabwe resulted in some urban dwellers in Zimbabwe abandoning city dwelling preferring to go to the countryside to protect their health (Chirisa et al., 2021). Corporate entities were encouraged to help the government, while public institutions were tasked to come up with efforts to mitigate and contain the spread of COVID-19 such as the production of hand sanitizers and facemasks (Mahomva, 2020).

Attitudes to Zimbabwe's response have ranged from bemusement about the lockdowns and restrictions (Mackworth-Young et al., 2021) to describing the measures as ineffective (Mutanda, 2022) and lacking in transparency (ZIMCODD, 2021) of a country which had long been experiencing economic downturn (Makombe, 2021). By the first anniversary of the outbreak in Zimbabwe in March 2021, the Zimbabwe government launched an ambitious vaccination program (Murewanhema et al., 2022) amid the drawback of skepticism and hesitancy (Tinashe et al., 2022) in Zimbabwe and Southern Africa in general (Dzinamarira et al. 2021). The vaccination process is still ongoing albeit at a much-reduced rate with most restrictions having been relaxed or lifted altogether.

There does not seem to be any record of the Zimbabwean government using modelling studies to implement COVID-19 policy. This is not unique to Zimbabwe as research shows that at least 6% of the African countries were meaningfully contributing to modelling studies (Njoki et al., 2022). However, a few simulation studies have been undertaken in Zimbabwe. An artificial neural network approach was used to recommend the robust use of control measures in the wake of increasing COVID-19 infections (Nyoni, 2020). A simple basic model revealed a seasonal dependency of the COVID-19 infections (Ndlovu et al., 2022), while a generalized mixture model recommended the prioritization of children, women, and non-travelers as risk from getting infected (Zidana et al., 2020). The current study aims to contribute to the growing body of knowledge on modelling of infectious diseases in Zimbabwe to inform policy. The chapter employs an extended SEIR model to help in future management and control of infectious disease outbreaks. The results of our parameterized model are compared to actual data collected in Zimbabwe between 20 March 2020 and 20 March 2021 to validate the model presented in this paper.

6.2 Literature Review

Various mathematical models have been used to provide best fit of available data and concomitantly predict the trajectory of infections and deaths due to COVID-19 in the world and the African continent. A review of 74 simulation studies focused on Africa showed that only 3 African countries (6%) were meaningfully contributing to modelling studies (Njoki et al., 2022). In Eswatini, predictions of infections and mortality have been performed using the Bayesian predictive tools (Dlamini et al., 2022). A deterministic model was used to assess how detection of COVID-19 infections through testing is important in the control of the spread of infections in Ghana (Mushanyu et al., 2021). Significant work was undertaken in studying the pandemic by various models in Morocco which has a significant body of work on simulations (Barkia et al., 2021; Layelmam et al., 2020; Lotfi et al., 2020; Marfak et al., 2020; Sinkala et al., 2021; Tamtam & Tourabi, 2021; Zakary et al., 2020; Zine et al., 2020). Some research has also taken place in Nigeria (Abioye et al., 2021; Iboi et al., 2020; Ogundokun et al., 2020; Samson et al., 2020). One model used in Nigeria was derived from first principle without mention of the much-used classical SIR/SEIR models. South Africa has also utilized modelling approaches (Kersting et al., 2021; Nyabadza et al., 2020) as well as countries such as Tunisia (Chaari & Golubnitschaja, 2020; Fredj & Chérif, 2020). Some simulation studies have been performed by researchers in Malawi (Mangal et al., 2021; Mwakilama, 2021; Oyekale & Maselwa, 2021), and only in Malawi do we seem to have evidence of the government directly using modelling predictions in its COVID-19 intervention with the help of international partners (Malawi Ministry of Health And Population, 2020). As such, the work modelling COVID-19 in Africa appears limited.

Useful models significantly inform policy interventions while relying on available data to construct and provide the best fit for forecasting the timeline of infectious disease outbreaks (Martin-Moreno et al., 2022). Globally, models were used to measure the efficacy of government responses to COVID-19 (Kersting et al., 2021) inclduding making decisions on the use of non-pharmaceutical interventions (Thompson, 2020) gauge the interplay and trade-off between implementing lockdowns to save life and opening up trade to save the economy (Darden et al., 2022), and determine vaccine effectiveness (Mukandavire et al., 2020) and the impact of lockdown to the school system (Azevedo et al., 2020) among many variables investigated. More often than not, the parameterization of these models has the same original basis of the classical SIR or SEIR model (Carcione et al., 2020; Godio et al., 2020; Martin-Moreno et al., 2022; Peng et al., 2020; Rod, 2020) developed almost a hundred years ago by Kermack&McKendrick (1927). The SIDARTHE model was used by one group to arrive at the basic reproduction numbers Ro of 4 at the beginning of the pandemic falling to 1 by the end of the first year (Amouzouvi et al., 2021). The WHO-affiliated researchers employed the modified Markov chain model to predict a worst-case scenario of 44 million infections and 189,579 deaths on the African region if governments did not implement appropriate measure to contain SARS-CoV-2 (Cabore et al., 2020).

Not every model is useful as demonstrated by some research which has ambitiously predicted the end of the pandemic in Africa by the end of 2020 with a total of 279,000 cases which is clearly not the case (Sinkala et al., 2021). What seems to be the very first simulation of COVID-19 also optimistically estimated the end of pandemic in China to take place within 2 weeks of the simulations in February 2020 (Peng et al., 2020). Additionally, while some models may have good credentials, they run the risk of being considered wrong (Archibong & Jessica, 2021) because in order to avoid the worst-case scenario forecasted by the same models during public emergencies, governments impose stringency measures to reduce the human cost of the pandemics. Literature reveals that by the first anniversary of the first recorded case in Africa, 2,795,424 infections had been recorded, while 74,841 deaths had been confirmed (Impouma et al., 2021). Two years into the pandemic, Africa had cumulative cases of about 7,110,817 and 155,505 deaths (Bwire et al., 2022).

The infections data fall far below the lower limit predictions from WHO model of 29 million infections accompanied by 82,735 fatalities (Cabore et al., 2020). Another study has also shown that by 13 January 2021, the cumulative infections were 3,113,963 with a total death toll rate of 74,619 (Frost et al., 2021). The number of deaths given by Bwire et al. (2022) falls within reasonable limits of data given by Frost et al. (2021), while curiously the number of infections by the former researchers is lower in spite of them reporting at a later date. This heterogeneity and disparity of information fed into the different models which are also parameterized differently make it difficult to make comparisons. What is not in doubt though is that the number of infections in Africa has been much lower than had been predicted (Bwire et al., 2022). Structural problems such as a lower testing capacity are some of the reasons given for the low numbers in Africa (Chitungo et al., 2020) along with a young age and fewer comorbidities compared to countries in the global north

(Lawal, 2021) and early stringent responses by many African government (Wamai et al., 2021).

6.3 Methods

6.3.1 Model Background

The compartmentalized diagram of the SEIR model is shown in Fig. 6.1. The diagram shows the compartments of the different subclasses of the population under investigation. Individuals in the birth compartment move into susceptible class (S) at a rate $\Lambda(t)$. When in the susceptible class (S), some move into the insusceptible compartment (P) at a rate $\alpha(t)$, some die naturally at a rate $\Phi(t)$, and the other proportion move into the exposed compartment (E) at a rate $\beta(t)$.

Those in the exposed compartment (E) move at a rate $\gamma(t)$ into the infected compartment (I). A certain proportion of the infected individuals move into the quarantine compartment (Q) at a rate $\delta(t)$, while another proportion move into the recovered compartment (R) at a rate $\lambda(t) + \xi(t)$, and the remaining proportion move into the death compartment (D) at a rate $\mu(t) + \Phi(t)$. The quarantined individuals recover from the disease at a rate $\kappa(t)$, while the other proportion succumb to the disease at a rate $\varepsilon(t) + \Phi(t)$. Therefore, the equations that describe the dynamics of the COVID-19 virus are derived from the changes in state of the classes in the compartmentalized diagram.

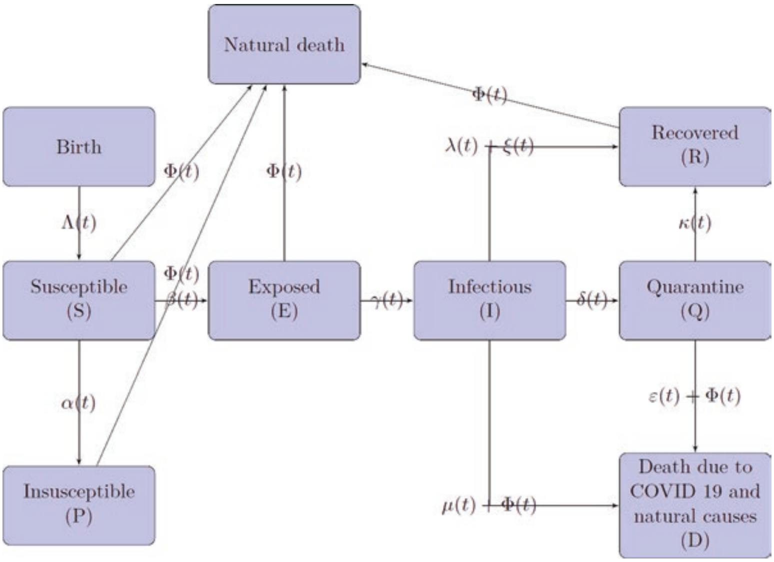


Fig. 6.1 Compartmentalized diagram of the SEIR model. (Source: Authors)

6.3.2 The Model Equations

6.3.2.1 Assumptions

1. The total number of individuals is not constant over time. The variable *N(t)* represents the total population size; thus.

$$N(t) = S(t) + P(t) + E(t) + I(t) + R(t) + Q(t)$$

2. An average susceptible makes an average number $\beta(t)$ of adequate contacts (i.e., contacts sufficient to transmit infection) with others per unit time.
3. At any time, a fraction $\mu(t) + \Phi(t)$ of the infected leave class $I(t)$ due to death, and $\mu(t)$ is considered to be the fatality rate of the specific disease.
4. There is no entry into or departure from the population, except possibly through death from the disease.
5. The rate at which individuals are treated is proportional to the number of patients as long as this number is less than a certain threshold number, and becomes constant thereafter.

The evolution of the expected equation terms from the compartmentalized diagram in Fig. 6.1 is as follows: the susceptible (S) population class decreases over time, thereby feeding the exposed (E) class at a rate $\beta(t)$ and the insusceptible (P) class with rate $\alpha(t)$. The class of the insusceptible (P) is a fraction of the susceptible (S) population who, for various reasons, becomes protected from the disease. Worth noting is the fact that the exposed (E) class is temporary. After a latent period $\frac{1}{\gamma}$, on average, the individuals move from the exposed (E) class into the infectious (I) class, from which newly infected individuals are generated over time from the susceptible (S) class.

On testing, individuals who test positive (who detect infective) are quarantined (Q) to avoid contagion. This class then dissociates into recovered (R) or death (D) cases. This results from various reasons such as healthcare system effectiveness, age, or comorbidity of other diseases. Assuming that the rate of treatment is proportional to the number of patients as long as this number is below a certain threshold and becomes constant thereafter, the dynamics of $S(t)$, $P(t)$, $E(t)$, $I(t)$, $Q(t)$, $R(t)$, and $D(t)$ can be described by the following system of equations, that is,

$$\frac{dS(t)}{dt} = \Lambda - \beta(t)\frac{E(t)S(t)}{N} - \left(\alpha(t) + \Phi(t)\right)S(t) \tag{6.1}$$

$$\frac{dP(t)}{dt} = \alpha(t)S(t) - \Phi(t)P(t) \tag{6.2}$$

$$\frac{dE(t)}{dt} = \beta(t)\frac{E(t)S(t)}{N} - \left(\gamma(t) + \Phi(t)\right)E(t) \tag{6.3}$$

$$\frac{dI(t)}{dt} = (\gamma(t) + \Phi(t))E(t) - \begin{pmatrix} \delta(t) + \mu(t) + \Phi(t) \\ +\xi(t) I(t) - \lambda(t) R(t) \end{pmatrix} \tag{6.4}$$

$$\frac{dQ(t)}{dt} = \delta(t) I(t) - (\varepsilon(t) + \kappa(t) + \Phi(t)) Q(t) \tag{6.5}$$

$$\frac{dR(t)}{dt} = (\lambda(t) + \xi(t)) I(t) + \kappa(t) Q(t) - \Phi(t) R(t) \tag{6.6}$$

$$\frac{dD(t)}{dt} = \varepsilon(t) Q(t) + \mu(t) I(t) \tag{6.7}$$

6.3.2.2 Analysis of the Equilibrium Points

The equilibrium points are now analyzed. In actual fact, there exist two equilibria, namely, the disease-free equilibrium point (DFEP) and the endemic equilibrium point (EEP). The former exists in the absence of the disease, unlike the latter that exists in the presence of the disease. As such, the following is obtained.

6.3.2.3 The Disease-Free Equilibrium Point

The disease-free equilibrium point (DFEP) is found when:

$$\frac{\mathrm{d}S(t)}{\mathrm{d}t} = \frac{\mathrm{d}E(t)}{\mathrm{d}t} = \frac{\mathrm{d}I(t)}{\mathrm{d}t} = \frac{\mathrm{d}Q(t)}{\mathrm{d}t} = \frac{\mathrm{d}R(t)}{\mathrm{d}t} = \frac{\mathrm{d}D(t)}{\mathrm{d}t} = 0 \tag{6.8}$$

The equation

$$\frac{\mathrm{d}P(t)}{\mathrm{d}t} = \alpha(t) S(t)$$

is excluded since this equation is not affected by the presence or absence of the disease. From Eq. (6.2), the exposed class has nothing, that is $E = 0$. Substituting $E = 0$ into Eq. (6.1), the result becomes $S = \dfrac{\Lambda}{\alpha + \Phi}$. The focus is on the DFEP, implying that $I = 0$. Then substituting $E = 0$ and $I = 0$ into Eq. (6.4), the result becomes $R = 0$. So, substituting $I = 0$ into Eq. (6.5), the result is $Q = 0$. Finally, $D = 0$, meaning that there is no disease-induced death in the model. Then the DFEP, $\mathbf{X_0}$, is given by

$$X_0 = (\mathrm{S,E,I,Q,R,D}) = \left(\frac{\wedge}{\alpha + \Phi}, 0,0,0,0,0 \right) \tag{6.9}$$

Next, discussion of the basic reproduction number of the system (1–7) is done using the next-generation matrix method. The system (1–7) has the disease-free equilibrium point. Let

$$X = \left(S, E, I, R, Q, D\right)^T ,$$

and then the system (1–7) can be written as

$$X' = F\left(X\right) - V\left(X\right) \tag{6.10}$$

where

$$F\left(X\right) = \begin{pmatrix} \dfrac{\beta ES}{N} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

and

$$F\left(X\right) = \begin{pmatrix} \left(\gamma + \Phi\right)E \\ -\left(\gamma + \Phi\right)E + \left(\delta + \mu + \Phi + \xi\right)I + \lambda R \\ -\Lambda + \dfrac{\beta ES}{N} + \left(\alpha + \Phi\right)S \\ -\delta I + \left(T + \kappa + \Phi\right)Q \\ -\lambda I - \left(\kappa + \xi\right)Q \\ -TQ - \mu I \end{pmatrix}$$

are the new infection and the transfer matrices, respectively, of the model. The Jacobian matrices of $F(X)$ and $V(X)$ at the *DFE* point X_0 are, respectively, given by

$$DF\left(X_0\right) = \begin{pmatrix} F & 0 \\ 0 & 0 \end{pmatrix}$$

and

$$DV\left(X_0\right) = \begin{pmatrix} V & 0 \\ J_1 & J_2 \end{pmatrix}$$

where

$$F = \begin{pmatrix} \frac{\beta S}{N} & 0 & \frac{\beta E}{N} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

and

$$V = \begin{pmatrix} (\gamma + \Phi) & 0 & 0 \\ -(\gamma + \Phi) & (\delta + \mu + \Phi) & 0 \\ \frac{\beta S}{N} & 0 & \frac{\beta E}{N} + \alpha \end{pmatrix}$$

Now V^{-1} is found using the adjoint matrix method (AMM), that is,

$$V^{-1} = \frac{1}{\det V} \operatorname{adj}(V)$$

to obtain

$$V^{-1} = \frac{1}{(\gamma + \Phi)(\delta + \mu + \Phi)\left(\frac{\beta E}{N} + \alpha\right)}$$

$$\begin{pmatrix} (\delta + \mu + \Phi)\left(\frac{\beta E}{N} + \alpha\right) & 0 & 0 \\ (\gamma + \Phi)\left(\frac{\beta E}{N} + \alpha +\right) & (\gamma + \Phi)\left(\frac{\beta E}{N} + \alpha\right) & 0 \\ -(\delta + \mu + \Phi)\frac{\beta S}{N} & 0 & (\gamma + \Phi)(\delta + \mu + \Phi) \end{pmatrix}$$

Therefore,

$$FV^{-1} = \begin{pmatrix} \frac{(\gamma + \Phi)\beta S}{N} - \frac{\beta E S}{(\gamma + \Phi) N (\beta E + (\alpha) N)} & 0 & \frac{\beta}{N}\left(\frac{\beta E}{N} + \alpha\right) \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

is the next-generation matrix of the system (1–7).

The spectral radius of

$$FV^{-1}\text{is}\rho\left(FV^{-1}\right)=\frac{m+\sqrt{m^2+4n}}{2}$$

where

$$m=\frac{(\gamma+\Phi)\beta S}{N}-\frac{\beta ES}{(\gamma+\Phi)N(\beta E+\alpha N)}$$

and

$$n=\frac{\beta}{N}\left(\frac{\beta E}{N}+\alpha\right)$$

Hence, the basic reproductive number of the system (1–7) is given by

$$R_0=\rho\left(FV^{-1}\right)=\frac{m+\sqrt{m^2+4n}}{2} \tag{6.11}$$

The conclusion is made via a lemma:

Lemma 1: The disease-free equilibrium X_o is locally asymptotically stable.

6.3.2.4 Equilibria

Here, the focus is mainly on finding equilibria of system (6.1–6.7) in this section and discussing them. Firstly, the disease-free equilibrium in Eq. (6.9) always exists when $I \leq I_o$. An endemic equilibrium of system (6.1–6.7) satisfies the system in (6.12)

$$\begin{aligned}
\Lambda-\beta(t)\frac{E(t)S(t)}{N}-(\alpha(t)+\Phi)S(t) &= 0\\
\beta(t)\frac{E(t)S(t)}{N}-(\gamma(t)+\Phi(t))E(t) &= 0\\
(\gamma(t)+\Phi(t))E(t)-(\delta(t)+\mu(t)+\Phi(t)+\xi(t))I(t)-\lambda(t)R(t) &= 0\\
\delta(t)I(t)-(\varepsilon(t)+\kappa(t)+\Phi(t))Q(t) &= 0\\
(\lambda(t)+\xi(t))I(t)+\kappa(t)Q(t)-\Phi(t)-\Phi(t)R(t) &= 0\\
\varepsilon(t)Q(t)+\mu(t)I(t) &= 0
\end{aligned} \tag{6.12}$$

When $0 < I \leq I_o$, system in (12) has an equilibrium point given by Eq. (6.9).

If $R_o > 1$, system (12) admits a unique positive solution $X* = (S*, E*, I*, Q*, R*, D*)$ given by

$$
\begin{aligned}
S^* &= \frac{(\gamma+\Phi)}{\beta}N \\
E^* &= \frac{\Lambda}{(\gamma+\Phi)} - \frac{(\gamma+\Phi)}{\beta}N \\
I^* &= \frac{1}{\delta+\mu}\left(\Lambda - \frac{\alpha(\gamma+\Phi)}{\beta}N\right) \\
Q^* &= \frac{\kappa}{\lambda(\delta+\mu)}\left(\Lambda - \frac{\alpha(\gamma+\Phi)}{\beta}N\right) \\
R^* &= \frac{t^*}{\delta+\mu}\left(\lambda - \frac{\kappa^2}{\lambda}\right)\left(\Lambda - \frac{\alpha\gamma}{\beta}N\right) \\
D^* &= \frac{t^*}{\delta+\mu}\left(\mu - \frac{\kappa\varepsilon}{\lambda}\right)\left(\Lambda - \frac{\alpha(\gamma+\Phi)}{\beta}N\right)
\end{aligned}
\tag{6.14}
$$

where

$$R^* = \int_{t*}^{0} \lambda I^* \mathrm{d}t + \int_{t*}^{0} \kappa Q^* \mathrm{d}t \text{ and } D^* = \int_{t*}^{0} \varepsilon Q^* \mathrm{d}t + \int_{t*}^{0} \mu I^* \mathrm{d}t$$

for some constant time, $t^* \in [0, T]$. The eigenvalues of the Jacobian matrix of the system (12) are now analyzed in order to obtain the results about the local stability of these equilibria. The general Jacobian matrix J is given by

$$
\mathcal{J} = \begin{pmatrix}
\left(\frac{\beta E}{N} - \alpha\right) & -\frac{\beta S}{N} & 0 & 0 & 0 & 0 \\
\frac{\beta E}{N} & \frac{\beta E}{N} - (\gamma+\Phi) & 0 & 0 & 0 & 0 \\
0 & (\gamma+\Phi) & -(\delta+\mu) & 0 & 0 & 0 \\
0 & 0 & \delta & -(\varepsilon+\kappa) & 0 & 0 \\
0 & 0 & \lambda & \kappa & 0 & 0 \\
0 & 0 & \mu & \varepsilon & 0 & 0
\end{pmatrix}.
$$

The Jacobian matrix evaluated at $\mathbf{X_0}$ is given by

$$\mathcal{J}x_0 = \begin{pmatrix} -\alpha & -\frac{\beta\Lambda}{\alpha N} & 0 & 0 & 0 & 0 \\ 0 & \frac{\beta\Lambda}{\alpha N}-(\gamma+\Phi) & 0 & 0 & 0 & 0 \\ 0 & (\gamma+\Phi) & -(\delta+\mu) & 0 & 0 & 0 \\ 0 & 0 & \delta & -(\varepsilon+\kappa) & 0 & 0 \\ 0 & 0 & \lambda & \kappa & 0 & 0 \\ 0 & 0 & \mu & \varepsilon & 0 & 0 \end{pmatrix}.$$

The eigenvalues are obtained from

$$\det\begin{pmatrix} -\alpha-\lambda & -\frac{\beta\Lambda}{\alpha N} & 0 & 0 & 0 & 0 \\ 0 & \frac{\beta\Lambda}{\alpha N}(\gamma+\Phi)-\lambda & 0 & 0 & 0 & 0 \\ 0 & (\gamma+\Phi) & -(\delta+\mu)-\lambda & 0 & 0 & 0 \\ 0 & 0 & \delta & -(\varepsilon+\kappa)-\lambda & 0 & 0 \\ 0 & 0 & \lambda & \kappa & 0-\lambda & 0 \\ 0 & 0 & \mu & \varepsilon & 0 & 0-\lambda \end{pmatrix} = 0.$$

These are $\lambda_{1,2} = 0$, $\lambda_3 = -\alpha$, $\lambda_4 = \frac{\beta\Lambda}{\alpha N}-(\gamma+\Phi)$, $\lambda_5 = -(\delta + \mu)$, and $\lambda_6 = -(\varepsilon + \kappa)$.

Therefore, the Jacobian matrix evaluated at the endemic equilibrium point $\mathbf{X_1}$ is given by

$$\mathcal{J}x_1 = \begin{pmatrix} (\gamma+\Phi)-\alpha-\frac{\beta\Lambda}{(\gamma+\Phi)N} & -(\gamma+\Phi) & 0 & 0 & 0 & 0 \\ \frac{\beta\Lambda}{(\gamma+\Phi)N}-(\gamma+\Phi) & -2(\gamma+\Phi) & 0 & 0 & 0 & 0 \\ 0 & (\gamma+\Phi) & -(\delta+\mu) & 0 & 0 & 0 \\ 0 & 0 & \delta & -(\varepsilon+\kappa) & 0 & 0 \\ 0 & 0 & \lambda & \kappa & 0 & 0 \\ 0 & 0 & \mu & \varepsilon & 0 & 0 \end{pmatrix}.$$

The eigenvalues are obtained from

$$\det = \begin{pmatrix} c-\lambda & -(\gamma+\Phi) & 0 & 0 & 0 & 0 \\ \frac{\beta\Lambda}{(\gamma+\Phi)N}-(\gamma+\Phi) & -2(\gamma+\Phi)-\lambda & 0 & 0 & 0 & 0 \\ 0 & \gamma & -(\delta+\mu+\Phi)-\lambda & 0 & 0 & 0 \\ 0 & 0 & \delta & -(\varepsilon+\kappa+\Phi)-\lambda & 0 & 0 \\ 0 & 0 & \lambda & \kappa & 0+\lambda & 0 \\ 0 & 0 & \mu & \varepsilon & 0 & 0-\lambda \end{pmatrix} = 0$$

where

$$c = (\gamma+\Phi) - \alpha - \frac{\beta\Lambda}{(\gamma+\Phi)N}.$$

The eigenvalues obtained are

$$\lambda_{1,2} = 0, \lambda_3 = -(\delta+\mu+\Phi), \lambda_4 = -(\varepsilon+\kappa+\Phi)$$

and

$$\left((\gamma+\Phi)-\alpha-\frac{\beta\Lambda}{(\gamma+\Phi)N}-\lambda\right)\left(-2(\gamma+\Phi)-\lambda\right)+(\lambda+\Phi)\left(\frac{\beta\Lambda}{(\gamma+\Phi)N}-(\gamma+\Phi)\right) = 0$$

$$\left((\gamma+\Phi)\alpha\frac{\Lambda}{(\gamma+\Phi)N}\lambda\right)\left(2(\gamma+\Phi)\right)+(\lambda+\Phi)\left(\frac{}{(\gamma+\Phi)N}(\gamma+\Phi)\right) = 0$$

Let

$$A = \alpha - \frac{\beta\Lambda}{(\gamma+\Phi)N}, B = -2(\gamma+\Phi), C = (\gamma+\Phi)\left(\frac{\beta\Lambda}{\gamma N}-\gamma\right).$$

The eq. $(A - \lambda)(B - \lambda) + C = 0$ implies that $\lambda^2 - (A + B)\lambda + (AB + C) = 0$. This gives

$$\lambda_{5,6} = \frac{(A+B) \pm \sqrt{(A+B)^2 - 4(AB+C)}}{2}$$

6.4 Results

This section summarizes the simulation results and model behavior based on the Zimbabwean data. Table 6.1 provides a summary of the COVID-19 parameters from the Zimbabwean dataset that were varied to generate different model simulations. The values were calculated using data obtained from https://www.worldometers.info/coronavirus/country/zimbabwe and https://www.macrotrends.net/countries/ZWE/zimbabwe/birth-rate websites. These figures' statistics depict cumulative fatalities, cases, and recoveries. For model validation, only data from the first year, from 20 March 2020 to 20 March 2021, was used. These parameters were based on previously completed research and well-informed assumptions.

Table 6.2 represents the legend showing the color codes for the graphical simulations.

Figures 6.2 and 6.3 show that the number of deaths is decreasing as the treatment term is introduced. This is shown in the enlarged sections of the graphs. The number of deaths dropped from 8915 to 7949 – a drop of about 966 individuals.

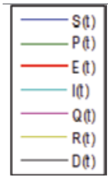
Figures 6.4 and 6.5 show that based on model simulations in Figs. 6.1, 6.2, 6.3, 6.4, and 6.5, the introduction of quarantine has got an effect of reducing the number of deaths. However, its effect is not significantly comparable to that of the treatment factor. The number of deaths dropped from 4475 to 4474 – a reduction by only one individual.

Table 6.1 Model parameters and their source

Parameter	Source
$S_0 = 16{,}000{,}000$	macrotrends.net
$N = 16{,}000{,}000$	macrotrends.net
$\lambda(t) = 0.245$	Estimated
$\Lambda(t) = 0.028$	Estimated
$\Phi(t) = 0.0078$	Estimated
$\mu(t) = 0.01$	Estimated
$\alpha(t) = 0.03$	Estimated
$\gamma(t) = 0.5363$	Ndlovu et al. (2022)
$\delta(t) = 0.009$	Estimated
$\xi(t) = 0.245$	Estimated
$\varepsilon(t) = 0.01$	Estimated
$\beta(t)= 0.183$	Ndlovu et al. (2022)

Source: Authors

Table 6.2 Legend showing the color codes for the graphs below

	$S(t)$ susceptible $P(t)$ insusceptible $E(t)$ exposed $I(t)$ infectious $Q(t)$ quarantined $R(t)$ recovered $D(t)$ death

Source: Authors

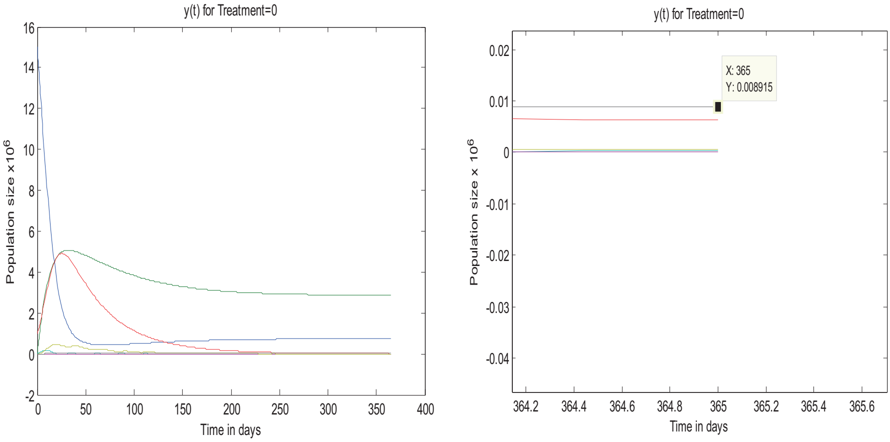


Fig. 6.2 Dynamical behavior of $S(t)$, $P(t)$, $E(t)$, $I(t)$, $Q(t)$, $R(t)$, and $D(t)$ when there is no treatment. (Source: Authors)

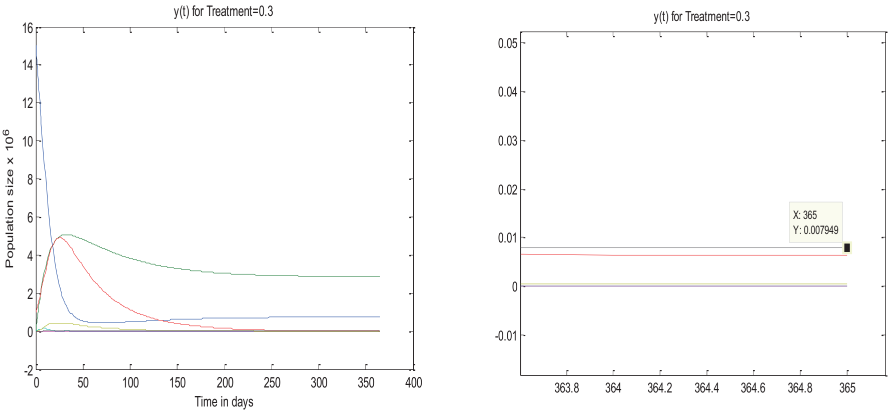


Fig. 6.3 Dynamical behavior of $S(t)$, $P(t)$, $E(t)$, $I(t)$, $Q(t)$, $R(t)$, and $D(t)$ when the treatment factor is 0.3. (Source: Authors)

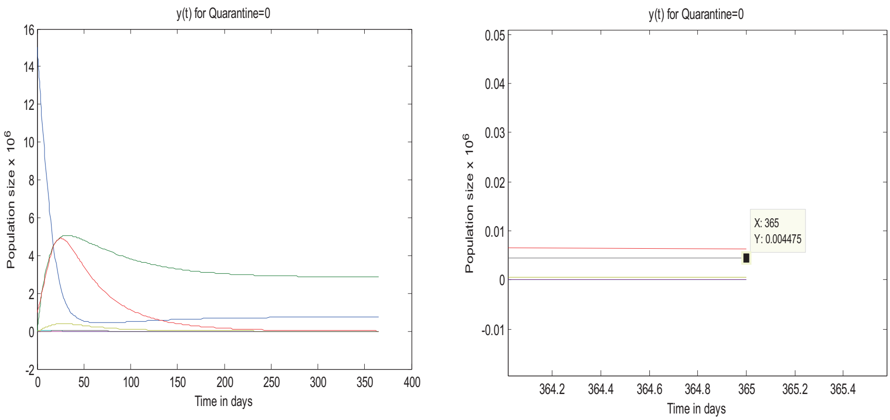


Fig. 6.4 Dynamical behavior of $S(t)$, $P(t)$, $E(t)$, $I(t)$, $Q(t)$, $R(t)$, and $D(t)$ when there is no quarantine. (Source: Authors)

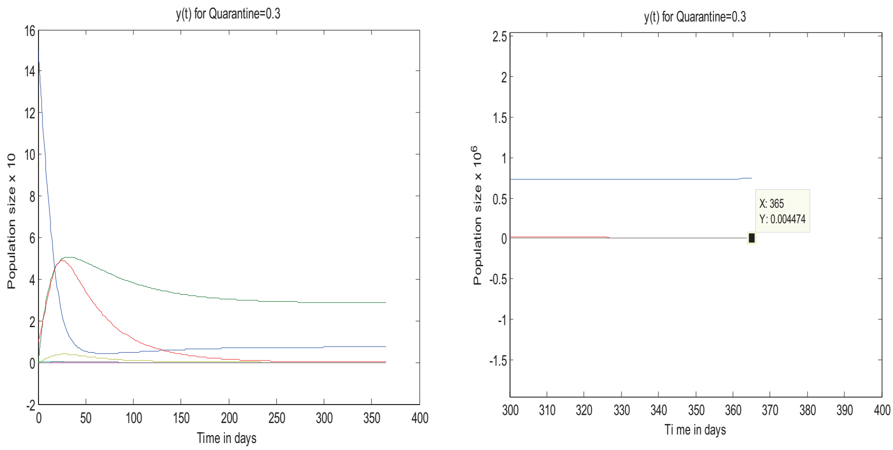


Fig. 6.5 Dynamical behavior of $S(t)$, $P(t)$, $E(t)$, $I(t)$, $Q(t)$, $R(t)$, and $D(t)$ when the quarantine factor is 0.3. (Source: Authors)

6.5 Discussion

Based on model simulations (Figs. 6.2, 6.3, 6.4, and 6.5), it can be inferred that treatment and quarantine of COVID-19 cases are essential for effective and significant reduction of infection and fatality rates. The results show that failure to implement quarantine and/or administer treatment can lead to disastrous public health consequences. The sporadic resurgence of various variants of the virus causes great risk to the global population. The number of deaths estimated from the simulations is above the actual deaths. This is so since occasionally part of the data in ten provinces of Zimbabwe was recalled and amended (Dzinamarira et al., 2021). According to Dzinamarira et al., (2021), this raises concerns about the data's authenticity, correctness, and integrity. Since the model best fit for data recorded in Zimbabwe, it implies that the number of deaths and cases are underestimated. To buttress this, Dzinamarira et al., (2021) indicated that there was little community testing and the testing was mostly focused on points of entry and returns. Lack of adequate test kits and community testing might skew the pandemic picture by favoring imported COVID-19 cases more heavily in the burden.

Notably, it is challenging to determine the real impact of the disease without comprehensive COVID-19 testing throughout the nation. According to a modelling study conducted in China by Hou et al., (2020), there was a significant underestimation of the exposed compartment. This is more likely in the Zimbabwean situation, since the COVID-19 pandemic in China started in December 2019 and in 2020 the first case was reported in Zimbabwe. The predicted deaths from the proposed model and the actual deaths were different. This may be due to uncertainty, for example, the majority of the recorded COVID-19 cases in 2020 occurred among people who had recently returned from South Africa (Chirisa et al., 2021). The COVID-19 instances in Zimbabwe were linked to inbound travelers, mostly from Dubai, the United Kingdom, and the United States, and contact cases of individuals who had traveled (Salcedo & Cherelus, 2020). The community of scientists in general and applied mathematicians in particular need to continue developing more robust models that provide insight into the transmission dynamics of the pandemic.

6.6 Limitations

Due to limited data, parameter estimation is difficult. Since the simulation parameters used were estimated using Zimbabwean data, they may not be applicable to other countries.

6.7 Conclusion and Recommendations

As evidenced by the findings, decision-makers at all levels of government should implement both treatment and quarantine concurrently to combat the epidemics like COVID-19. As the Zimbabwean government has deployed COVID-19 vaccination and lockdown on the population, further work on the model will add these factors into the differential equations for the exposed cases and examine the effectiveness of these control measures. It is also encouraged to include unforeseen events, such as unreported cases, deaths, and cases exported from neighboring countries.

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Chapter 7
Indigenous Health Practices and Lifestyles: Can They Help Zimbabwe Transform Its Health Systems in the Face of the COVID-19 Pandemic?

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Abstract The COVID-19 pandemic has significantly strained the healthcare systems, resulting in a social crisis and widespread public fear. Globally, researchers and health experts have advocated for non-pharmacological and pharmacological preventive measures to lessen the impact on society. Developing countries, known to have weaker health systems, limited resources, and populations with lower socioeconomic status, relied on indigenous systems to survive during the pandemic. This narrative review aimed to assess indigenous health practices and lifestyles in Zimbabwe in light of the COVID-19 epidemic and how these practices and lifestyles impact Zimbabwe's health systems. Information about these indigenous practices and lifestyles was gathered using well-known scholarly databases such as Web of Science, Scopus, ScienceDirect, PubMed, and Google Scholar. Several indigenous lifestyles and techniques, such as diet, handwashing, cultural norms, and herbal medicines, have been discovered and studied in terms of how they aid in the fight against COVID-19. However, it was found that advocating for these indigenous lifestyles and practices as a sole solution to COVID-19 is insufficient. Furthermore, an integrated strategy combining indigenous lifestyles and customs with hospital-based therapies can prevent COVID-19 transmission. Zimbabwe is

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encouraged to go beyond pro- and anti-nonnative measures and suggest a health reform based on indigenous traditions and lifestyles, which might function alone or be effectively and practically linked with WHO COVID-19 prevention initiatives.

Keywords Indigenous health practices · Traditional lifestyles · Health reform · COVID-19 pandemic

7.1 Introduction

Zimbabwe reported its first case of COVID-19 on March 20, 2020, and the number has continued to rise since then (Murewanhema & Makurumidze, 2020). As of January 19, 2022, Zimbabwe had recorded 227,552 confirmed cases and 5276 deaths (MoHCC, 2022), and based on the advice of the World Health Organization (WHO), compounded by the novelty and uncertainties surrounding the containment of COVID-19, the Government of Zimbabwe, like other governments in the region, implemented measures such as enforcing national lockdowns and other myriads of interventions (Murewanhema & Makurumidze, 2020; Shumba et al., 2020), as a way of combatting the spread of the pandemic. All of this was done following the WHO, which concluded that national lockdowns, social distancing, self-isolation, the use of facemasks, the use of surface disinfectants/hand sanitizers, and vaccines are the best measures for containing COVID-19 spread (Siqueira et al., 2020; Summan & Nandi, 2021; Manderson & Levine, 2020; Atangana & Atangana, 2020; Ahn et al., 2020; Pradhan et al., 2020).

However, the interventions resulted in recessions, new social lifestyles, and disruptions in healthcare provision and supply chains, among other consequences (Murewanhema & Makurumidze, 2020; Msimanga et al., 2021). Zimbabwe, a less economically developed country with a high unemployment rate (6%), a high inflation rate (7%), and an already severely weakened and fragile public healthcare system (Shumba et al., 2020), was not immune to the pandemic's wrath. The restrictions exacerbated the situation, pushing socioeconomically vulnerable groups more profound into the shackles of poverty (Dudzai & Wamara, 2021). Unfortunately, even frontline health workers were not spared due to the transmission dynamics of the diseases and the lack of personal protective equipment (Chingono, 2020).

Even in the absence of cases in some countries, the faster Africa accepted and implemented the WHO COVID-19 interventions, the faster it assumed that the spread of COVID-19 could not be prevented in any other way than the ones they proposed. However, with the pandemic's consequences still present in Africa and being felt by people inextricably, people's minds are filled with questions. These include:

1. Why has the government excluded African indigenous practices as one of its COVID-19 policy responses?

2. Why have traditional African practices been overlooked in the fight against COVID-19 (Makanda & Matambo, 2021)?
3. Do we have indigenous practices and lifestyles that can limit the spread of COVID-19 or do people still practise traditional health practices?

The standard response would be that COVID-19 is a new disease, and there was no time to develop indigenous approaches to it (Makanda & Matambo, 2021). Given the alarming severity of the disease in the West at the time, it was better to listen to the countries that had first-hand experience with it.

However, epidemics are not uncommon in Africa (Neerinckx et al., 2010; Frith, 2012; Phoofolo, 1993). One should investigate how Africans have dealt with pandemics or plagues (Bernault, 2020). It is a well-known fact that before the arrival of Western medicine, African traditional healers, diviners, and the elderly had the methods that worked for them in dealing with pandemic diseases (Makanda & Matambo, 2021). Since time immemorial, Africans have used their cultural beliefs (Adeleye et al., 2021) and plants as primary forms of medicine (Chassagne et al., 2021; Ozioma & Chinwe, 2019; Elujoba et al., 2005; McGaw et al., 2005). Many African countries appear to use indigenous practices on COVID-19. Notably, Nigeria, Uganda, Madagascar, and Cameroon reported herbal medicines that can reduce and eliminate COVID-19 symptoms (Titanji, 2021; Kindzeka, 2020), though the advances were met with geopolitical criticism and were not approved by WHO. The fact that there are fewer deaths in Africa and a higher number of deaths from the pandemic in countries with the most advanced health systems (CDC COVID-19 Response Team, 2020) can attest to the efficacy of indigenous African practices to some extent (Fongnzossie Fedoung et al., 2021; Olaopa, 2020). However, the role of African indigenous health practices and lifestyles in containing the spread of COVID-19 in Zimbabwe and on the African continent has not yet been adequately articulated, even though Africans have previously been able to fight pandemics and plagues using culturally based approaches.

As a result, this chapter's main purpose was to critically examine indigenous health practices and lifestyles in Zimbabwe to see if they could aid in the fight against the spread of the COVID-19 disease. Hand hygiene, steaming and phytomedicines, diet, self-isolation/quarantining, and other people's everyday lifestyles are all investigated. To that end, the chapter employs Afro-indigenous health practices and lifestyles to move beyond pro- and anti-nonnative approaches and propose interventions based on indigenous practices that can work alone or be practically and pragmatically blended with Western approaches to combat COVID-19 spread. This type of intervention can be viewed as one of the most critical efforts to improve our understanding of COVID-19 prevention. Such health reforms are expected to improve health delivery and knowledge on the indigenous control and management of COVID-19.

7.2 Overview of Indigenous Health Practices

Indigenous or traditional medicine/healthcare, according to Lazarus (2006), is an integration of knowledge and practices, regardless of whether explicable or not, in the treatment, mitigation, or eradication of physical, psychological, and social diseases. Herbalists, bonesetters, psychological healers, midwives, faith healers, diviners, spiritualists, and even older adults have traditionally used indigenous knowledge and practices to develop methods and materials used in primary healthcare since time immemorial (Dhewa, 2008). Indigenous health practices are reported to be the primary treatment for major ailments such as cancer among the Shona tribes in Zimbabwe (Maunganidze, 2016). For some poor people in the past, it was the first and last line of defence against the most infectious and hereditary diseases that threatened their lives (Madamombe, 2006). Even today, some practices are claimed to go far beyond the physiological body's limits into the spiritual (Makhubele et al., 2020), so the public readily accepts them. The practices involved herbal medicines, diet, self-isolation/quarantining/social distancing and hand hygiene.

Most clinical health therapies can be traced directly or indirectly to herbs (Darko, 2009). Interestingly, herbal medicines have long been essential to Africa's indigenous healthcare system (Alegbeleye et al., 2020). Most African ethnic groups, as expected, rely on plants for primary healthcare, which is scientifically supported by the fact that 89.2% of plant species have been reported to have a wide range of pharmacological properties (Maroyi, 2013a). The same author reported that in rural Zimbabwe, most people believe that herbs are the most effective treatment for most diseases compared to other therapies. According to Chigora et al. (2007), respiratory infections are common in rural areas, especially during the winter, and medicinal plants such as *Lippia javanica*, *Myrothamnus flabellifolius*, *Pellaea sp.*, *Vilex payos*, and *Coleochloa setiflora* are commonly used as part of folkloric medicine. The most commonly used of these plants was *Lippia javanica*, especially herbal tea (Kamanula et al., 2017; Maroyi, 2017). In Zimbabwe and other African countries, the same plant species has a long history of treating ailments such as influenza, bronchitis, coughs, chest pains, colds, and pneumonia, which Chanda-Kapata et al. (2020) and Menni et al. (2020) identified as other COVID-19 symptoms. Furthermore, diarrhoea is a perceived symptom of COVID-19 (Cheung et al., 2020; Villapol, 2020; Thuluvath et al., 2021), and many herbal plants are used to treat diarrhoea in Zimbabwe, including *Lannea edulis*, *Mangifera indica* L., *Carissa edulis*, *Asparagus africanus* Lam., and many others (Maroyi, 2011, 2013b). The same indigenous health practice can be used in COVID-19 management. Cough, catarrh, fever, and joint pain are other COVID-19 symptoms (Biadsee et al., 2020; Goërtz et al., 2020). Before the pandemic, African traditional healers were reported to have treated the same symptoms with concoctions of various plant parts ranging from leaves, roots, seeds, and even the entire plant (Ayima et al., 2021).

Several studies have discussed the significant potential of indigenous herbal medicine practices in providing solutions to Zimbabwe's health system (Makhubele et al., 2020; Maunganidze, 2016; Matthew et al., 2020; Chigora et al., 2007). Despite their importance in modern medicine, indigenous herbal methods have been shrouded in secrecy for some time due to a perceived adversarial relationship between herbalists and their conventional counterparts. However, some other public health experts are sceptical; herbalists are now allowed to treat COVID-19 patients in Zimbabwe (Paudyal et al., 2022). Such doubts are common; even the *Artemisia afra* concoction, believed to relieve respiratory disease symptoms similar to COVID-19, met the same fate (Dandara et al., 2021).

African communities have diverse indigenous knowledge and nutrition practices that ensure adequate food, food quality, and food safety (Oniang'o et al., 2004). Even with the introduction of external ones, some communities continue to rely on their traditional diets (Legwaila et al., 2011). For example, several African communities have consumed indigenous fruits and leafy vegetables as part of their daily diets, especially in rural areas (Gido et al., 2017a, b). Vegetables such as *Amaranthus hybridus*, *Cleome gynandra*, *Bidens pilosa*, *Corchorus olitorius*, and *Adansonia digitata* are common on people's tables in Buhera, Zimbabwe (Chipurura, 2014). More importantly, edible weeds have also been reported to supplement traditional vegetables in some Zimbabwean rural communities (Maroyi, 2013a). In addition to ensuring food and nutrition security, edible weeds, such as *Sonchus oleraceus* L., *Cleome gynandra* L., *Bidens pilosa* L., *Amaranthus hybridus* L., and many others, also provide basic primary healthcare due to their medicinal value (Lewu & Afolayan, 2009; Stepp & Moerman, 2001; Semenya et al., 2012). Several studies have revealed the nutritional value and potential of vegetables and edible weeds to boost people's immune systems (Chipurura et al., 2011; Kwenin et al., 2011; Mibei et al., 2012; Chipurura, 2014; Onyambu et al., 2021), and if the same vegetables and fruits are incorporated into the mainstream health system, this could work in COVID-19 management (Moreb et al., 2021).

Aside from the standard diet, people in pre-colonial Africa had some methods for preserving and preparing food. Shona's dried meat and vegetables, known as *chimukuyu* (biltong) and *musone* (dried vegetables), are common two examples (Nyota et al., 2007; Mapara, 2009). Other indigenous preserves include (1) boiled and dried mushrooms (*hwowa*), (2) smoked fish, and (3) birds and other small animals such as mice boiled and then dried over a fire or smoked (Makanda & Matambo, 2021). This was done to ensure that the meat and vegetables were not discarded, mainly if they had been obtained in large quantities at one time. The excess would be stashed in reservoirs and utilized during times of need, especially when the vegetables are out of season. This could go a long way towards ensuring food availability and quality, even during difficult times like the COVID-19-enforced lockdowns, when people could not access public food outlets.

Indigenous health practices have an impact on the dietary needs of sick people. It is an African custom to prescribe the lifestyles of their sick relatives, particularly what foods they may and may not consume (Croucamp, 2013; Ajako, 2019). People with respiratory problems, for example, are frequently advised to drink herbal tea containing herbs such as *Lippia javanica* (lemon bush), which has been shown to reduce allergic airway inflammation (Mfengu et al., 2021), a reported symptom of COVID-19 (Hardeland & Tan, 2020). Furthermore, certain taboos exist in Africa, including Zimbabwe, regarding what should be considered food. This is significant because some diseases have been reported to be transmitted via the fork. Food, for example, is argued to have played an important role in the COVID-19 outbreak, with early cases linked to the Huanan seafood market, where wild animal trading occurred (Wu et al., 2020).

Access to long-term food stocks and water at home was restricted during the enforced lockdowns. Because income had to be earned daily, communities' ability to comply with preventative measures like social distancing was limited. Like many other sub-Saharan African countries, Zimbabwe has an under-resourced health service, massive unemployment, and densely populated areas and experiences a shortage of essential commodities, for instance, food and water, making lockdowns challenging to comply with and implement (Mackworth-Young et al., 2021). People from different communities do not regularly meet, so most rural community setups are mostly self-sustaining, so social distance is attainable and easily practised. Stay-at-home orders could help minimize COVID-19 exposures, and they have received much support from the public. The COVID-19 patients' stay-at-home arrangement, on the other hand, necessitated a well-ventilated single room and strict adherence to health precautions such as hand cleanliness and medical masks. Despite the need for a COVID-19 patient to avoid contact with other family members (Puig-domingo et al., 2020), such a concept is less feasible in rural communities due to a lack of facilities.

7.3 Indigenous Lifestyles/Culture

7.3.1 Religion

Due to their beliefs and over-dependence on traditional medicine and supernatural interventions, many orthodox communities will find it challenging to use prescribed immunizations, including COVID-19 vaccination programmes (Manguvo & Mafuvadze, 2015). In Zimbabwe, such groups include the Johane Marange sects, who have always been at loggerheads with health officials for discouraging their members from seeking proper healthcare (Matthew et al., 2020; Manguvo & Mafuvadze, 2015). However, this severely impacts COVID-19 control, treatment, and transmission. While the government provides scientific explanations and legislative announcements, Zimbabwean chiefs and spirit mediums inform citizens that their ancestors are enraged and must be appeased (Nhamo & Chikodzi, 2021). In some instances, Zimbabwean church leaders are deceiving their congregations by claiming to have the capacity to safeguard their members from COVID-19 (Matthew et al., 2020). The Shona people of Zimbabwe, like monotheistic religions like Christianity, Judaism, and Islam, have always believed in God (Kazembe, 2009). According to Machingura (2012), being in touch with the spiritual world is crucial in one's birth, throughout one's life, at death, and after death. Among the Shona, *mashavi* (wandering spirits) (Masaka & Makahamadze, 2013) and *mhondoro* (wishful spirits) are potent spirits. Although *mhondoro* and *mashav*i are essential, they are not as crucial as *vadzimu* (Masaka & Makahamadze, 2013). Thus, Shona cosmology emphasizes the importance of *vadzimu* in terms of life and death and good and bad health. However, when their families are offended, *vadzimu* either protect them or withdraws their protection (Masaka & Makahamadze, 2013). The Zimbabwean people also believe in taboos critical to disease prevention and environmental conservation (Mabvurira et al., 2021).

7.3.2 Sunbathing and Fire Warming

Though not documented, sunbathing and fire warming (*kudziya moto*) are Zimbabwean indigenous lifestyle practices. One study in Indonesia concluded that a higher duration of sunlight exposure was associated with more recovery cases from COVID-19 (Asyary & Veruswati, 2020). However, it should be noted that sunlight does not inactivate SARS-CoV-2 and, therefore, cannot prevent the infection. Equally, sunlight was reported to sustain COVID-19 patients' health conditions, which increases the chances of recovering from the disease. Generally, sunlight heightens the immune system and retards influenza's development in the human body (Miller, 2018). This is not surprising given that sunlight initiates vitamin D synthesis, boosting the immune system (Brown et al., 2018). Notably, poor exposure to sunlight has been linked to the activation of influenza (Sagripanti & Lytle, 2007), and this is more likely to be correlated to COVID-19.

Fire warming tends to increase the temperature of the surroundings and could inactivate SARS-CoV-2. However, a study from the State of Pará in Brazil showed that an increase in fire occurrences increases the number of COVID-19-related hospitalizations (Asyary & Veruswati, 2020). Additionally, the COVID-19 mortality risk was more significant in high fire exposure than in the period of low fire exposure (Henderson, 2020). Fire from firewood is associated with wood smoke that may make people more susceptible to respiratory infections, including COVID-19 (Navarro et al., 2021). Using best burn practices such as burning dry and seasoned firewood has been critical in maintaining fire and reducing smoke (Henderson, 2020). Though thermal inactivation of SARS-CoV-2 was reported, the results showed inactivation could occur in less than 30 min, 15 min, and 3 min at 56 °C, 65 °C, and 95 °C, respectively (Batéjat et al., 2021). There is, however, a shortage of information on the link between fire warming and SARS-CoV-2 inactivation.

7.3.3 Diet

Zimbabwean diets are based on traditional food crops (Fig. 7.1), including *Zea mays*, *Voandzeia subterranea*, and small grains (*Sorghum bicolor* and *Pennisetum americanum*) and vegetables (*Cucurbita pepo*, *Sesamum angustifolium*, *Cucumis metuliferus*, and *Cleome gynandra*) (Shava et al., 2009). These indigenous food sources provide necessary nutrients that play a central role in boosting the immune system, providing antiviral defences, overcoming gut microbial dysbiosis, and calming cytokine storms (Nyasha et al., 2021). This indicates that nutritional interventions in Zimbabwean culture can be considered for COVID-19 prevention and treatment. The standard diet of rural and urban Zimbabweans should contain fibres in vegetables. These diets comprise non-digestible carbohydrates such as fructooligosaccharides, inulin, xylan, and xylooligosaccharides, selectively fermented by beneficial gut microbes, often in the lower digestive tract (large intestine and colon).

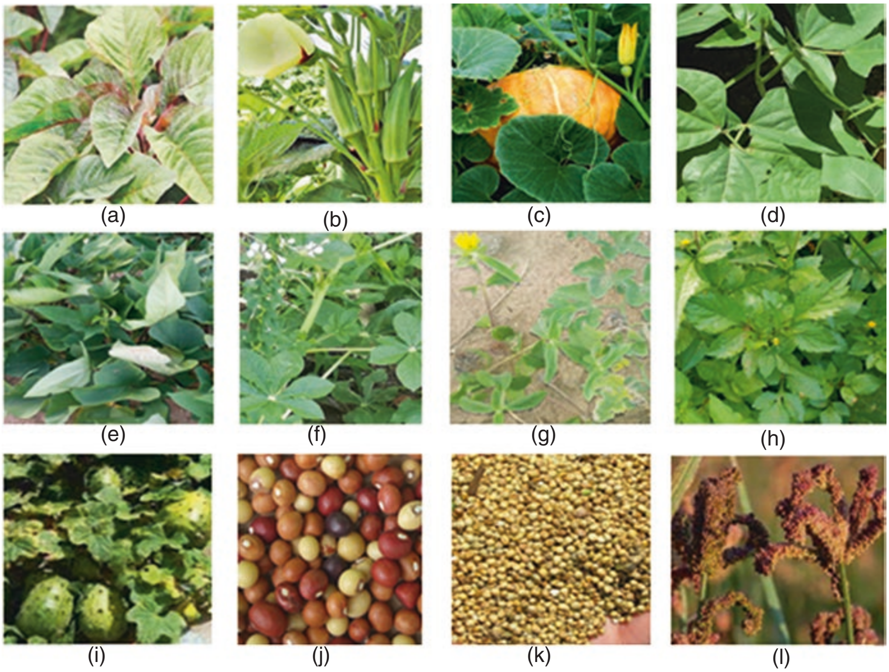

Fig. 7.1 Indigenous food crops, small grains, and vegetables commonly consumed in Zimbabwe: (**a**) *Amaranthus thunbergii* (pigweed leaves/mowa), (**b**) *Abelmoschus esculentus* (okra/derere), (**c**) *Cucurbita* spp. (pumpkin fruit and leaves/manhanga), (**d**) *Vigna unguiculata* (cowpea leaves/munyemba), (**e**) *Ipomoea batatas* (sweetpotato leaves and root fruit/mbambaira), (**f**) *Cleome gynandra* (spider wisp leaves/nyevhe), (**g**) *Dicerocaryum zanguebarium* (ruredzo), (**h**) *Bidens pilosa* (blackjack leaves/mutsine), (**i**) Cucumis metuliferus (African horned cucumber/magaka), (**j**) *Voandzeia subterranea* (Bambara groundnuts/nyimo), (**k**) *Pennisetum americanum* (pearl millet), (**i**) *Eleusine coracana* (finger millet/rapoko). (Source: Authors)

It is now well accepted that the function and composition of the gut microbiota play a role in maintaining host gut health. Modulating the gut microbiota is one of the most significant advances in human health since disturbed or dysbiotic microbiota is linked to various human disorders.

Scientists are now working on medicines or nutritional therapy to heal or repair such ailments (Markowiak & Śliżewska, 2017). Non-antibiotic supplement food additives and fibre-containing diets are required for illness management since they are safe (little to no side effects), ecologically friendly, cost-effective, and natural (Carlson et al., 2018; Markowiak & Śliżewska, 2017). Diet is significant for human fitness and well-being. As a result, the spread of non-antibiotic and environmentally-friendly dietary additives is critical in producing and managing diseases like COVID-19 (Hu et al., 2021; Olaimat et al., 2020). Because of their potential health advantages, prebiotics, probiotics, synbiotics, and plant extracts have sparked much interest (Carlson et al., 2018). Plant metabolites and bioactive compounds have been linked to various medicinal applications. However, the link between prebiotic/probiotic/disease/lifestyle is complicated. A lack of awareness of all these interconnected components may limit the effectiveness of ecological and biological strategies for improving diets and preventing disease outbreaks in humans. Lifestyle has also had a significant role in COVID-19 fatalities in Zimbabwe since most cases have been reported in urban areas. These COVID-19 deaths can be linked to the sorts of foods consumed in these two settings. The rural diet is often higher in fibre, and they consume much sour milk because it is cheaper in rural areas than in urban areas, which contains probiotics from fermented milk and lactic acid, which will boost their healthy gut bacteria. Because antibiotics are scarce in rural locations, individuals often employ herbal treatments for non-serious infections. However, most individuals overuse antibiotics in metropolitan areas, destroying vulnerable beneficial gut flora and dysbiosis. Diet is still one of the most important human and animal health management aspects (Carlson et al., 2018; Hu et al., 2021; Markowiak & Śliżewska, 2017; Olaimat et al., 2020). Healthy diets should be promoted nationwide, and the market for new healthy food items in Zimbabwe should be expanded. More probiotics and prebiotics should be added to yoghurt, cheese, drinks, and fermented milk products. To boost human gut microbiota and immune system, there should be a greater emphasis on eating a nutritious diet rich in fibre, onions, garlic, and ginger (Fig. 7.1). Foods like onions, bananas, garlic, and ginger are high in vitamins and non-digestible carbohydrates (prebiotics), which can be selectively fermented by beneficial gut bacteria, enhancing the human gut immune system and the overall immune system. Because the gut is frequently the site of many illnesses, preserving gut health through dietary feed additives necessitates considerable scientific commitment. Future study is required to compare the gut microbiomes of rural and urban people and examine how various herbal preparations affect the gut microbiota.

7.3.4 Handshaking

When mourners meet at a funeral, they are supposed to shake hands; a custom is known as kubata maoko in Shona (most Zimbabweans' native language) (Musarandega & Chitongo, 2020). Handshakes are essential expressions of consolation in most, if not all, Zimbabwean rural societies (Dzinamarira & Musuka, 2021; Matthew et al., 2020). Because it is unsocial not to shake hands with the bereaved, traditional authorities in rural regions lack the inclination to implement COVID-19 mourner restrictions, making funerals COVID-19 hotspots (Matthew et al., 2020). With the COVID-19 pandemic in Zimbabwean settings, communities must be well-educated to understand how this pandemic is transmitted through handshakes.

Despite its simplicity, promoting regular handwashing remains a big challenge, especially in resource-constrained setups (Bulled et al., 2017). Glassman et al. (2020) and Adegbeye (2020) confirm fears that social distancing and hand hygiene initiatives may not be feasible in sub-Saharan African countries, particularly in lower-income societies where water is mostly available at public boreholes and income is earned informally daily, necessitating daily food purchases. Indigenous knowledge systems have mechanisms for dealing with loss. According to Sanni (2016), looking at most African countries, one can see that the social imaginaries shape whom we remain a problem in every society. Handshakes are meaningful gestures of consolation in most, if not all, Zimbabwean rural societies. In African cultures, the process of consoling is known as *kubata maoko*, which translates to "handshakes". Funerals are now COVID-19 hotspots (Matthew et al., 2020) because it is unsocial not to handshake the bereaved. Based on WHO guidelines, traditional practices and belief systems are incompatible with the COVID-19 regulations.

7.3.5 Social Gatherings

Though the economic crisis has been reported to significantly contribute to poor adherence to COVID-19 control interventions in Zimbabwe, cultural tendencies should not be ignored. Cultural beliefs and values are central to the success or failure of the country's efforts to contain the spread of COVID-19. For instance, in Zimbabwe, funerals can rapidly spread COVID-19 (CDC, 2020). In Zimbabwe, traditional funerals, and burial rituals, especially in rural settings, are associated with large numbers of family and friends attending to pay their last respects. Generally, most of them in Zimbabwe are buried in their rural homes, even if they die in another country (Ndlovu, 2010). Faced with this phenomenon, bodies and mourners are transported across the country, increasing the chances of SARS-CoV-2 transmission (Dzinamarira & Musuka, 2021). At some stage, the Zimbabwean government banned the transportation of corpses across provinces to stem the transmission of COVID-19 (Dzinamarira & Musuka, 2021). However, after a public outcry, the decision was reversed within a few days, indicating the conflict between culture and Zimbabwean health systems. According to some studies, COVID-19 requirements are not being followed, with (1) funeral attendants exceeding the permissible numbers, (2) lack of social distance, and (3) insufficient sanitization procedures for mourners (XinhuaNet, 2021; Dzinamarira & Musuka, 2021). Body-viewing is critical in Zimbabwean culture in that that is where close relatives confirm if they are about to bury the correct person and see the corpse for the last time (Saidi, 2017). Although it is a cultural norm, it can act as COVID-19 peddlers (Matthew et al., 2020).

7.4 Analysis of Transformation of Health Systems

Cultural practices and beliefs, including indigenous health practices and lifestyles, can challenge "modern medicine" or practices that transform Zimbabwe's or Africa's health systems. The severity of COVID-19 is leaving no stone unturned. This chapter examines and investigates indigenous health practices and lifestyles in African communities, particularly in rural Zimbabwe, to determine how they influence modern health systems. Evidence from the communities is critical for understanding the potential positive impacts on health reforms in the face of the pandemic (Table 7.1). This can be used to develop policies that advocate for holistic approaches, which can transform health systems and manage COVID-19 and other pandemics in the future.

7.4.1 Hand Hygiene

Hand hygiene, in general, helps to prevent the spread of various diseases, including COVID-19. In Zimbabwe, handwashing is cultural, with people traditionally washing hands before and after eating. During the COVID-19 pandemic, handwashing with soap and the use of hand sanitizers to clean hands have increased dramatically (Marumure et al., 2022). Cleaning beneath fingernails, scrubbing the fingertips, using soap, and wiping hands on garments or a clean towel are some of the washing practices utilized in Zimbabwe (Friedrich et al., 2017). The health system in Zimbabwe is expected to be positively transformed if cultural hand hygiene practices are incorporated into the mainstream. These practices, however, should be strengthened and implemented in all rural and urban settings. In general, hand hygiene should be supported by the availability of clean and safe water, soaps, and other readily available natural antimicrobials.

Table 7.1 The impact of indigenous health practices and lifestyles on health system transformation

Aspect	Classification	Comments on the transformation of health systems	References
Herbal remedies	Indigenous health knowledge	Herbal remedies can be used to manage COVID-19, thereby benefiting healthcare systems	Kamanula et al. (2017), Maroyi (2017), Madamombe (2006), Chigora et al. (2007), Makhubele et al. (2020), Maunganidze (2016), Matthew et al. (2020)
Diet	Indigenous lifestyle	Ensuring food availability and quality, thereby guarding against malnutrition	Shava et al. (2009), Gido et al. (2017a, b), Nyota et al. (2007), Mapara (2009)
	Indigenous health practice	Indigenous food sources boost the immune system	Nyasha et al. (2021), Semenya et al. (2012), Chipurura et al. (2011), Kwenin et al. (2011), Mibei et al. (2012), Chipurura (2014), Onyambu et al. (2021)
Self-isolation/ quarantining/ social distancing	Indigenous health practice	Difficult to implement due to the shortage of houses; hence, the health systems face challenges in managing the spread of diseases in remote areas	Puig-domingo et al. (2020)
Hand hygiene	Indigenous lifestyle	The traditional lifestyle practices and belief systems on hand hygiene are incompatible with the COVID-19 regulations	Sanni (2016), Matthew et al. (2020)
Religion	Indigenous lifestyle	Some religions discourage their members from seeking formal healthcare, as this negatively affects the health system on management of diseases Some taboos are critical in disease prevention and environmental conservation	Matthew et al. (2020), Manguvo and Mafuvadze (2015), Mabvurira et al. (2021)
Sunbathing and fire warming	Lifestyle and indigenous health practice	This sustains the health conditions for some diseases such as of COVID-19 as this increases chances of recovering	Miller (2018), Sagripanti and Lytle (2007)
Social gathering	Lifestyle	Cultural norm which results in large numbers of family and friends gathering can act as infection peddlers thus compromising health system	Dzinamarira and Musuka (2021), Ndlovu (2010), Musarandega and Chitongo (2020), XinhuaNet (2021)

Source: Authors' compilation

7.4.2 Herbal Remedies

Many rural populations in Zimbabwe rely on herbal treatments to cure various ailments, including diarrhoea and wounds (Maroyi, 2011). Traditional healers and herbalists play a significant role in treating the most severe and contagious diseases that affect their communities (Dhewa, 2008). Many impoverished individuals in Zimbabwe cannot pay healthcare expenses and rely on herbalists or prophets. Although healers work outside of conventional healthcare institutions, disregarding them can have disastrous consequences (Madamombe, 2006). For the sake of the patient's safety, healers and medical physicians must work together. Herbs and antibiotic drugs' dose and synergistic effects should be established and scientifically proven. Traditional healers must be integrated into the health system since many community people seek their aid and understand some of the symptoms of lethal diseases such as COVID-19 to avoid disease transmission. Traditionally, healers used a single razor to treat several patients, but due to increasing understanding of disease transmission, it is now unlawful in Zimbabwe to use a single razor to stop the spread of HIV. Because traditional healers are governed by the Zimbabwe National Traditional Healers' Association, the government must legislate collaboration between healers and the medical profession to administer herbs in the correct dosages and provide scientific evidence for the efficacy and toxicity of the herbs. Healers must be active participants in the health system for Zimbabwe's public health goals to be accomplished. It is not a secret that indigenous medical knowledge is the only capital for most poor rural communities without health facilities. It is necessary to document ethnomedicinal plants having therapeutic benefits scientifically. If herbal medicines have scientific backing, efforts should be made to make them more accessible, easily stored, and precisely administered in hospitals/clinics across the country to reduce antibiotic consumption and overuse. Antibiotics have increased the burden of disease emergence and treatment. Improving the health system by integrating traditional healers, ensuring equitable access to cost-effective therapies and innovation, and promoting health knowledge and healthcare information systems are all required for the large-scale modernization of Zimbabwe's health systems.

Furthermore, incorporating herbal remedies into Zimbabwean healthcare systems is presumably critical to positively transforming healthcare delivery. It is, however, essential to conduct scientific analyses and standardize, label, and incorporate these remedies into our diets. In addition, herbal extracts traditionally used to treat respiratory ailments can also be used to develop teas or formulations that can be taken on a regular or emergency basis. Such teas or formulations would be well-received because they would be therapeutic and profitable.

7.4.3 Diet

Diet is still one of the most important human and animal health management aspects. Healthy diets should be promoted nationwide, and the market for new healthy food items in Zimbabwe should be expanded. More probiotics and prebiotics should be added to yoghurt, cheese, drinks, and fermented milk products. In order to boost human gut microbiota and immune system, there should be a greater emphasis on eating a nutritious diet rich in fibre, onions, garlic, and ginger. As part of disease control and treatment interventions, traditional Zimbabwean vegetables, fermented foods, and foods derived from small grains should be included in the main diets. The incorporation of these foods into the country's main diets has a significant impact on the country's health systems. Though it is believed that these traditional foods transform Zimbabwean health systems, more research into nutrient content, the bioavailability of nutrients, and modern processing techniques are needed.

7.4.4 Indigenous Lifestyles/Culture

Zimbabwe's beliefs, over-reliance on traditional medicine, and supernatural interventions may or may not transform the healthcare system. If religious beliefs, such as those held by the Johane Marange sects (Matthew et al., 2020; Manguvo & Mafuvadze, 2015), are incompatible with vaccination, herd immunity is rendered impossible. This, however, has severe consequences for pathogen mutations, variant development, disease treatment, and transmission. Furthermore, some indigenous cultures may harm health systems, such as the involvement of Zimbabwean chiefs and spirit mediums in advocating for ancestors' enragement while ignoring and dismissing disease control interventions. Furthermore, the negative health system is evident in instances where Zimbabwean church leaders claim to protect their members from COVID-19 and other infectious diseases (Matthew et al., 2020). However, if church leaders, spirit mediums, and chiefs are consulted and educated on health-related issues, they may become critical in positively transforming healthcare systems. The taboos that Zimbabweans believe (Mabvurira et al., 2021) are critical in positively transforming health systems if adequately implemented in the health system mainstream.

7.5 Conclusion

This chapter sought to undertake a critical examination of Zimbabwe's indigenous health practices and lifestyles to see if they could aid in the fight against the spread of the COVID-19 disease. To that end, cultural characteristics must be identified and included in national COVID-19 measures, even if only as an afterthought, to establish a successful pandemic control strategy. When hospital and African indigenous techniques are fully integrated into a fusion that incorporates practical elements, they can effectively combat COVID-19 spread. Traditionalists who advocate for African indigenous practices and lifestyles only in COVID-19 management may be interpreted as missing the winds of change. In the past, Africans had their practices for dealing with disasters such as pandemic illnesses, and they worked for them, but doing the same for COVID-19 can be disastrous. Advocating for the same practices alone as a solution for COVID-19 is not justified for the following reasons: (1) the severity of COVID-19 does not allow for such experimentation; (2) even in African countries that advocated for COVID-19 management, cases and casualties are high; and (3) some beliefs, cultures, and practices can contribute to the spread of COVID-19. On the other hand, while WHO interventions have been lauded for significantly reducing COVID-19 spread and fatalities, many see success in eradicating COVID-19 or developing a cure soon as a mirage. As a result, Zimbabwe and other countries in the sub-Saharan region are encouraged to move beyond pro- and anti-nonnative approaches and propose a health reform based on indigenous practices and lifestyles that can work alone or can be practically and pragmatically blended with WHO approaches to combat the spread of COVID-19.

7.6 Future Perspectives and Research Directions

The indigenous health practices and lifestyles might have a role to play in the management of the COVID-19 pandemic. The introduction or strengthening of some of these indigenous practices might lead to the transformation of the health system in Zimbabwe and other African countries. The general public, especially in rural areas and urban townships, should receive more health education to understand COVID-19 transmission and management better. There should be more coordinated interventions between public health experts and traditional leaders to bridge the gap between indigenous cultural practices and lifestyles and the modern health management systems. Traditional leaders should be immediately educated and resourced to actively participate in the fight against COVID-19 in their respective communities. These leaders are at the centre of the community, so mobilization, debunking pandemic falsehoods, and negotiating concessions on incompatible measures with local cultural norms would be prioritized. Research on indigenous practices and lifestyles to see if they can prevent the spread of the COVID-19 pandemic should be supported. More research should be carried out on the indigenous plants used by the locals as vegetables or food and herbs used for their primary healthcare. The vegetables might be capable of boosting the immune systems, which is very important in managing COVID-19. The phytochemical analysis of the plants used as herbs could lead to new natural drugs that can address the therapeutic need, especially in the current search for a COVID-19 effective cure. Plant extracts' antimicrobial efficacy should be established for handwashing in rural areas. In order to eliminate in-person gatherings, communities should be encouraged to embrace and adopt technologies that decongest the people, for example, in online meetings for wedding ceremonies and other social events. Furthermore, in Zimbabwe, traditional healers or diviners were astute enough to prescribe and advise on traditional treatments for epidemic diseases based on Afro-indigenous practices and lifestyles. Such practices are culturally based and are implemented considering the effects on Ubuntu. Studies and further explanations of such practices should be considered at the national level in order for them to be incorporated into the health system.

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Chapter 8
Virtual Communities in Supporting Access to Health Services During COVID-19 Pandemic: The Implications and Impact on Zimbabwe's Health System

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Abstract The outbreak of the COVID-19 pandemic shook the whole world, altering the usual way of accessing health services. Also, with the extensive use of technology, people have been left to depend on virtual communities for a lot of things including the usual way of accessing health services. Many researchers have looked into the significance of virtual communities in accessing healthcare. This chapter aims to explore the implications and impact of virtual communities in healthcare during the COVID-19 pandemic in the country. It looks at how patients adjust and what still needs to be done to make virtual communities more effective in supporting access to health services. Exploring this role is important in understanding the effects of virtual communities when accessing health services during pandemics. It is also vital in analysing the various roles of virtual health communities and assessing the gap in the supporting literature. A rapid quantitative methodology was used for data collection between March 2020 and January 2021. To establish the knowledge and usage of virtual health communities during the pandemic, an online survey approach was used through questionnaires and interviews in urban and rural setups. Familiarity with virtual health communities was proven to be determined by sex, location, age, health status, and cultural beliefs. The overall assertion of the research

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is that Zimbabweans have embraced the usage of virtual health communities in accessing health services during the pandemic. The study recommends that policymakers take sound steps to ensure accessibility and availability of the Internet, develop native applications and run awareness campaigns for virtual health communities.

Keywords Virtual health communities · Health services · Support · COVID-19 pandemic · Health service access

8.1 Introduction

In early 2020, the coronavirus disease (COVID-19) pandemic began affecting the whole world, including sub-Saharan Africa as well (Pearson et al., 2020). Following the global outbreak of the COVID-19 pandemic, Zimbabwe imposed stern restrictions and measures to facilitate social distancing and healthy preparedness (Mackworth-Young et al., 2021). Measures that were imposed include the closure of all non-essential businesses and the requirement for citizens to remain in their households. Due to the under-resourced healthcare system in Zimbabwe, the restrictions presented acute challenges to people requiring medical attention, especially considering that they were used to consulting face-to-face, connecting with other patients, and getting their medication directly from hospitals. The collateral damage caused by COVID-19 in the country is extensive, as the weakened health system struggles to manage the intertwined threats of health-care worker strikes and COVID-19 (Mackworth-Young et al., 2021). Numerous research has been conducted on COVID-19, particularly on its impact on education, health, tourism, and the financial sectors (Al-Quteimat, 2020; Tadesse, 2020; Kaushal, 2021; Dube, 2022). Radio broadcast, online consultations and meetings have been extensively used to facilitate business in these sectors during the COVID-19 pandemic (Maphosa, 2021). The healthcare providers were not spared and had to act quickly and carefully at same time the patients responded positively. This has driven many of them to use online technologies to access health services during the COVID-19 pandemic. Online technologies facilitate learning, shopping, collaboration and research (Urokova, 2020). However, little is known about the implications and impact of these online technologies in facilitating access to health services. In the health sector, online health technologies provide a place for users to seek health information, share their experiences with others, communicate anonymously without social stigma, and have enabled them to conduct social interactions and exchange social support conveniently (Yusof et al., 2021). Previous research has put less focus on determining the effects of virtual communities in supporting healthcare access during the COVID-19 pandemic in sub-Saharan Africa. Exploring this role is important in understanding the implications and impact of virtual communities when accessing health services during pandemics. It is also vital in analysing the various roles of virtual health communities and assessing the gap in the supporting literature.

Globally, healthcare providers are the primary source of health information for patients. However, the rapid advancement of cutting-edge technology has led to the wide availability of health information. Whether virtual or physical (real world) community, human beings desire to belong to a community of some sort by nature or necessity (Allen et al., 2021). Human beings are social animals, and almost all sociological thinkers agree that there is a close relationship between the individual and society (Bliuc et al., 2019). Since informal and formal support networks were less available as a result of the COVID-19 pandemic, people's well-being and quality of life suffered (Subotic et al., 2020). The rise of social virtual platforms has led to the development of virtual health communities (VHCs), and this has, in turn, triggered the creation of forums or groups where people can search for health issues and share health-related information.

A virtual health community (VHC) is a collection of people who live in different areas, often in small clusters and occasionally working alone, who communicate via electronic means, particularly the Internet (Tella, 2014). They are self-selecting groups of people who engage in long-term computer-mediated interactions around similar interests or goals, regulated by agreed rules and values, and meeting both individual and group needs (Pentina et al., 2008). Many people will engage in virtual healthcare communities because they need less time and effort. They have been shown to have a direct effect on people's health by reducing stress, improving social support, promoting proactive behaviour and empowering patients by providing more information and eventually improving their social well-being (Liu & Chan, 2011). Examples of communities include online market platforms, auction sites, bulletin boards, list servers, social networking sites (SNSs), blogs, gaming and shared interest sites.

With an increased dependency on Internet-connected devices, classical communities may soon be partially replaced by virtual communities. People are now turning to virtual communities for dating advice, religious guidance, and mechanical and medical diagnosis, to mention a few (Greenaway et al., 2016). Health virtual communities provide patients with health advice and emotional support about the disease they are suffering from. According to world Internet usage and population statistics made in the first quarter of 2021, there were 5,098,463,772 estimated Internet users worldwide in December 2020, and of this number, 634,863,323 were estimated to be in Africa (Argaez, 2021). Social media applications such as Facebook, WhatsApp, Instagram, WeChat, LinkedIn, and Qzone have a very wide global reach and massive user base (Kasemsap, 2019). The top 10 most popular social media apps have more than 5 billion users worldwide (Walsh, 2021). This shows that people are becoming more connected than ever before, creating an opportunity for patients to collaborate and share their experiences. One result of these technological changes has been the patient's ability to access health services through peer-generated health information (PGHI) as well as virtual consultations with health professionals (Rupert et al., 2016). Numerous researchers around the world have looked at the use of virtual communities for health care and the volunteering of doctors online in VHC (Yusof et al., 2021). However, there is a dearth of such explorations in Zimbabwe.

Zimbabwe had 8,400,000 Internet users in December 2020, a rise from 6,796,314 in March 2019. According to the Postal and Telecommunications Regulatory Authority of Zimbabwe (POTRAZ) report of December 2020, Zimbabwe's Internet penetration rate had reached 59.9%, signalling a 3.2% increase in the number of Internet users from the 56.7% recorded in the third quarter of 2020 (POTRAZ, 2021). This chapter seeks to explore the Zimbabwean community and discover how much virtual health communities have been embraced in the country. It also looks at their impact on those in virtual communities in the period of crisis and pandemics such as COVID-19.

The study offers many practical implications and contributions to the literature on proliferation and the impact on those already in VHCs. First, it is useful to the health providers in Zimbabwe and sub-Saharan Africa as a whole during and after the pandemic as they need to incorporate virtual communities in their services. Data generated on these websites/platforms can inform medical professionals and research diseases and treatment alternatives. For example, having websites and applications that allow members to interact with each other and having specialists raise awareness of some sicknesses that may be common. Second, it promotes researchers interested in health informatics, health technologies and data security to obtain basic current statistics of virtual communities' knowledge and usage in Zimbabwe. Third, this study contributes to theories of social identity, VHCs and individual commitment. To the general populace, it raises awareness of the existence of virtual communities and establishes the depth of their knowledge of these communities. It also seeks to assert the number of people who make use of the communities to access affirmative and cognitive information. Fourth, the interaction between users in VHSCs sends Internet traffic to the website/platforms, which can be a helpful medium for platform management and third-party corporations to conduct targeted marketing. The last contribution is that it suggests sound recommendations to policymakers on Internet accessibility and availability (gap), especially in rural areas. Internet service providers (ISPs) should make the Internet affordable and also raise awareness among Zimbabwean people of the importance of virtual communities in the health sector. This chapter is essential to the e-Health field, particularly the relationship between virtual health communities and patients. It also adds to the ongoing conversation about ways in which the former assists the latter in accessing health services during and post-pandemic.

The chapter is set out as follows: Sect. 8.2 reviews the related work and Sect. 8.3 explains the theoretical framework that supports the research. In Sect. 8.4, the research design is explained, followed by Sect. 8.5, which offers a discussion of the findings. Section 8.6 provides the recommendations and concludes by offering directions for future research.

8.2 Literature Review

The emergence of the COVID-19 pandemic shook the entire world, necessitating social distancing measures and a change in business practices (Cho & Hong, 2021; Subotic et al., 2020; Barrows & Goldstein, 2021). To adapt to the new standard, online communities, virtual education, distance learning, virtual care, virtual communities of practice, virtual support communities and e-marketing were all coined as new ways of doing business. According to Bliuc et al. (2019), VHCs can be used to strengthen socio-political ideologies. The impact of VHCs in the real world has been extensively studied; for example, VHCs affect interpersonal associations, personal empowerment and recovery capital in communities of support (Bliuc et al., 2019; Barak et al., 2008; Best et al., 2018). It is estimated that 84% of Internet users in the United States (nearly 100 million people) are members of virtual societies, which include professional associations, hobby clubs, political organisations, and entertainment communities, with 18% going online to find peers with similar health concerns (Johansson et al., 2021).

According to Ravoire et al. (2017), 86% of French people in 2015 reported that they would connect with other patients if they were to develop a disease, and 68% reported consulting the Internet to find medical information. The existing literature on reference group influence in health typically addresses face-to-face direct membership groups where interaction takes place on a regular basis and socially distant (aspiration) groups that do not readily provide an opportunity for interaction. The majority of research on the impact of virtual communities as health reference groups focuses on challenges and gender differences, among other things, without considering the group's impact (Liao & Chou, 2012; De Valck et al., 2009). VHCs have a strong potential for the health sector due to their growing impact and expanding membership, and thus deserve consideration. Such characteristics of online groups as open, non-discriminatory involvement, the possibility of anonymity and low visibility allow members to feel part of the community, airing their problems and getting help.

About 26.6% of Internet users in the world have adopted VHCs, as witnessed by Haodf and Dxy which are popular among users in China (Zhou, 2020). In China and Finland, smoking cessation online health communities have been established to assist people who want to quit smoking (Li, 2020). Coronavirus VHCs have been established in several nations, such as https://www.inspire.com/groups/covid-19/, in response to the COVID-19 pandemic, with the goal of examining a variety of health concerns, including symptoms, 'testing', risk factors, treatment, and prevention (Manga & Wang, 2021). In South Africa, factors that influence readiness to disclose personal health information in VHCs, such as the role of social capital, gratitude, and indebtedness, in explaining levels of willingness to reciprocate, were explored (Mpinganjira, 2019a, b). There are a number of VHCs of patients in the healthcare sector that allow interaction between patients and health practitioners, such as Cancerforum (www.darmkrebs.de), Morbus Cron (www.dccv.de), Colitis Ulcerosa Patients (www.mayoclinic.or) and Communities of Tinnitus (www.

tinnitus.de), among others (Dannecker & Lechner, 2004). Previous research has focused on knowledge sharing, emotional support, and informational assistance in VHCs, but it has paid less attention to the role of VHCs in helping those who use them (Liang, 2011; Yan, 2016).

VHCs build social relations and a place where patients feel at home and in the right ‘neighbourhood’. Typically, a friendly culture and a friendly atmosphere where patients feel that their sorrows are well understood are important to community members. They allow patients to identify self-care activities, identify treatment options, prepare for clinical visits and prepare for treatment. VHCs stimulate the creation of peer-generated health information (PGHI). PGHI provided an alternative source for patients seeking treatment options rather than emotional support as postulated by other authors. Their findings conclude that PGHI in virtual communities facilitates shared decision making with healthcare providers (Bender et al., 2011). VHCs provide patients with a platform to gather information, explore options as well as share experiences. They stated that social media provides access to improved access to healthcare information to a wide range of patients (Syed-Abdul et al., 2016). Theories describing the role of virtual communities in assisting patients, which are: searching for information; and second, providing patients with emotional support. They also proved that some individuals join virtual communities to provide support to peers as they have experienced an event before or they have knowledge related to a specific health topic (Bugshan et al., 2014).

Healthcare educators are a part and parcel of a virtual healthcare community. It is the role of the virtual community to provide a platform for health educators to assist patients online and improve the quality of information generated by patients online, including virtual consultations (Almunawar & Anshari, 2014). The virtual health community plays a pivotal role in providing patients an opportunity to produce and consume health-related virtual content. They suggested a typology of three main types of users, which are non-engagers, prosumers, and tacit consumers. VHCs can help patients gather information about diseases recently diagnosed, especially those that require ongoing treatment, and can be used to reduce the utilisation of traditional health services, thus improving patients’ acceptance and responsibility (Fergie et al., 2016). The following types of groups were identified: Support groups, Informant groups, Self-Help groups, Advocacy and Awareness groups and Fund collecting groups. These groups form communities that help patients access knowledge about the treatment and diagnosis of diseases, as well as generate such information for others and get emotional support (Almunawar & Anshari, 2014).

8.3 Theoretical Framework

This study adds on a growing corpus of literature that has used the concepts of social identity to foster theory and practice in a number of fields of applied research (Haslam et al., 2012; Jetten et al., 2014). According to Virta and Tähtinen (2011), social identity is the structure and function of the socially constructed self. That is, the theory addresses individuals and their identity in connection with other individuals and groups of individuals. Social identity theory says that people classify themselves and others into various social groups, for example, organisational membership, association with religion, gender, and age groups. Social groupings serve two functions. It segments and organises social settings, gives an individual a systematic way of defining others, and allows the individual to locate or define himself or herself in the social setup (Virta & Tähtinen, 2011). Furthermore, self-concept consists of self-identity, including distinctive attributes such as bodily features, interests, psychological traits, and capacity. Social identity entails important group classifications. Social identification is a sense of belonging and a feeling of oneness with some human aggregate (Ashforth & Mael, 2004).

According to an African proverb (Jetten et al., 2017), ‘It takes a society to bring up a child’. First, this implies that social groupings play an important role in determining the significant outcomes in the lives of individuals, especially those related to health and well-being. Rearing a child is a continuous process that occurs throughout the life of an individual and the person is not detachable from the larger community and groups around them but is influenced and developed in strong and deep ways by them (Ferguson & Mckeown, 2016). In this sense, every person’s wellbeing is intimately tied to the circumstances of community life. Second, society has a clear obligation to provide for a child’s welfare, according to this aphorism. That is, if people’s health is primarily determined by the societies and groups in which they live, then responsibility for their health does not rest solely with one person, but also with their groups, culture, and society (Jetten et al., 2017). Individuals can be enriched and strengthened by community memberships, which provide them with self-esteem, belonging, value, a sense of purpose, power, and effectiveness in life (Cruwys et al., 2014; Greenaway et al., 2016; Jetten et al., 2015). The wellbeing of the body and mind of people is strongly conditioned by social factors influencing their social identity (Jetten et al., 2017). Group membership affects health and well-being to the extent that it gives meaning, support, and agency to individuals, impacting health positively and constituting a social cure. However, social identities can become a curse, threatening and actually damaging the health and well-being of group membership if not aligned with these supportive psychological opportunities, or if social identity is questioned in other ways (for example, group membership is devalued or stigmatised) (Jetten et al., 2017).

There are types of relationships that emanate from social groups, for instance, episodic relationships (Umberson & Karas Montez, 2010). It is a relationship that emanates from a need for a service or something between a service provider and a patient for a certain time period, and when it is done, the relationship is then terminated. For example, in the health sector, episodic treatment relationships are to find a cure for a problem that one has and therefore to end the relationship as soon as they find advice or cure for the problem (Virta & Tähtinen, 2011).

8.4 Research Methodology

The study adopted a quantitative methodology to explore and present the impact of virtual health communities on those accessing health services in Masvingo province. An online survey approach was used to gain an overall picture, and a more fine-grained analysis was achieved through online questionnaires and interviews in both urban and rural settings to assert how much knowledge people have about virtual communities, to what extent they make use of these communities, the implications and impact in supporting those accessing VHC. These tools can be administered to a large number of respondents, provide them enough time to respond to the questions and reduce costs. The survey was primarily used to collect data needed so as to answer the research question and hypothesis that are to be tested.

The selection of rural and urban participants was purposefully done to ensure that the findings were inclusive and valid to draw conclusions for both populations. A total of 400 people took part in the survey between March 2020 and January 2021, with 342 valid and usable responses. Of the 342 respondents, it was noted that 87.2% were from urban areas and 12.8% were from rural areas. We included several attention-trapping questions in the instruments to avoid random responses and haphazard questions. Insufficient replies were eliminated, and responses that failed the response quality questions were dropped. We confined the respondents' locations to Masvingo province and asked a screening question regarding their knowledge of VHCs at the start of the study. Respondents who had never used VHC before were stopped from participating in the poll. The sample was selected from different local health and popular social media groups in Zimbabwe such as WhatsApp, Facebook and Twitter. Six categories of age groups were chosen, which included 19 years and younger, 20–29 years, 30–39 years, 40–49 years, 50–64 years, and 65 years and above. The research brought to light the percentage of females versus male, rural versus urban, employed versus unemployed, the literate versus illiterate as well as different age groups in relation to VHCs.

In addition to the intensive literature review of related work, data was collected through online questionnaires and interviews. We restricted the respondents' location to Masvingo province and used a screening question at the beginning of the questionnaire to ask if they knew about VHCs. During the online interviewing process, the following variables were considered in this research: employment (whether one is employed or not), level of education, information and communication technology (ICT) literacy, and Internet usage. The lowest level of education considered in this study is the Ordinary level, followed by the Advanced level/diploma, the Degree level, and the Postgraduate level. ICT literacy was considered by whether one had trained in any computer course of some sort or how well they could use a computer. Of course, the highest literacy rate was found in urban areas, as they have more access to technological gadgets. Internet usage was measured by measuring Wi-Fi usage, use of data bundles on mobile devices, the use of wired networks, and WIMAX. Table 8.1 is the summary of the demographic information in our final dataset.

Table 8.1 Masvingo province urban and rural statistics

Variable	Component	Urban (%)	Rural (%)
Employment	Employed	39.6	5.1
	Unemployed	47.6	7.7
Gender	Male	27.8	3.4
	Female	59.4	9.4
Age	19 years or younger	7.7	1.7
	20–29	30.6	2.4
	30–39	32.8	5.1
	40–49	7.1	1.6
	50–64	4.9	1.4
	Above 65 years	4.1	0.6
Education	Completed high school	36.2	6.4
	Completed diploma	18.5	3.3
	Completed degree	31.7	3
	Completed postgraduate	0.8	0.1
ICT literacy	Basic user	41.2	7.2
	Medium user	38.4	4.8
	Advanced user	7.6	0.8
Internet usage	Daily	44.7	2.9
	Weekly	32.2	3.2
	Monthly	10.3	6.7

Source: Authors

From the sample used in the interview process, 44.7% were employed and from these, 39.6% were urban dwellers while 5.1% stayed in rural areas. 55.3% were unemployed, and this figure was 47.6% urban residents and 7.7% rural area residents. As shown in Table 10.1, more females were eager to participate (68.8%) and there were fewer responses from the rural areas. In the age category, there were more responses from the age categories of 30–39 (37.9%). The lowest number of responses were recorded in the retirement age group, i.e. 65 and above (4.7%). Most of the interviewees had completed high school when the interviews were done, while less than 1% had finished postgraduate studies. This consisted of approximately 48.4% of basic users as far as ICT literacy is concerned. Internet usage is quite low in rural areas, as shown in Table 8.1. However, it is quite high in urban areas.

8.5 Findings and Discussion

The results from Fig. 8.1 show that the 30–39 age group are very familiar with VHCs with the highest percentage of 32.6% and which shows that they find them very beneficial.

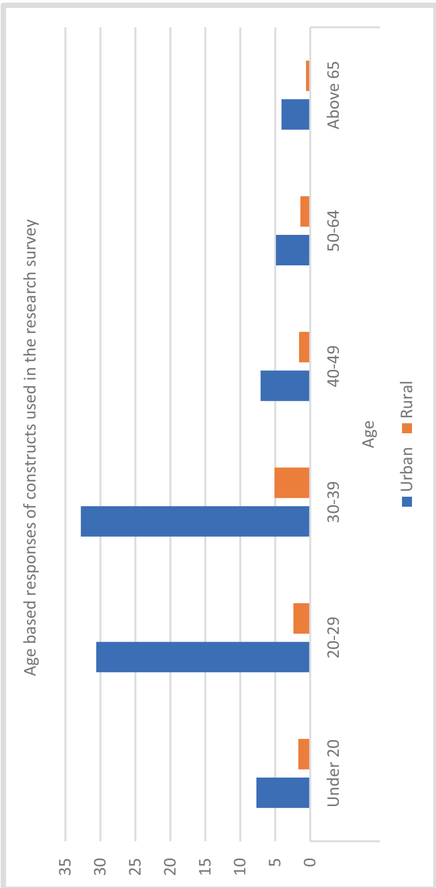

Fig. 8.1 Age-based responses of constructs used in the research survey. (Source: Authors)

Ages 20–29 and 40–49 were also quite familiar with the existence of VHCs. These ages also seem to use them for healthcare assistance or to gain information, because people tend to be busier at such ages, hence, they will not visit hospitals easily. However, most of them prefer to visit the hospital for actual treatment, but they are really keen on gaining knowledge from virtual health communities. The 65-year-old and above age group is not well versed in VHCs, and a huge number of them prefer to visit their doctors and consult traditional healers.

The results, according to Fig. 8.2, shows that females are more engaged in virtual health communities as compared to males. Most females are the major contributors in virtual health discussions since almost 37% participate more in the groups. At younger and middle ages, women tend to participate more than men, yet at later stages in life, they tend to have the same participation levels as shown in Fig. 8.1. The reason females participate more in virtual health communities is because of maternal instincts, or because they enjoy social places more than males, and also because of demographic indicators that show females as a percentage of the population versus males (Mirzaei & Esmaeilzadeh, 2021).

According to Fig. 8.3, the results show that people in urban areas are more engaged in healthcare gamification and use the Internet more frequently than those in rural areas. This can be attributed to poor network connection or signal, electricity, and money to purchase Internet bundles in rural areas. Access and availability to the Internet, having time, devices, and literacy level are some of the factors that contribute to more Internet users in urban areas than in rural areas. These factors contributed to the proliferation of health virtual communities in urban areas compared to rural areas.

The research brought to light the percentage of females versus males, rural versus urban, employed versus unemployed, the literate versus illiterate as well as different age groups in relation to virtual communities. Some age groups prefer to enquire about the VHCs first before visiting the hospital, while others will only check them after they have been treated (Naveh & Bronstein, 2019). Also, respondent's decision to switch between online and offline medical services is based on information they consume from VHCs (Manga & Wang, 2021). The age group from

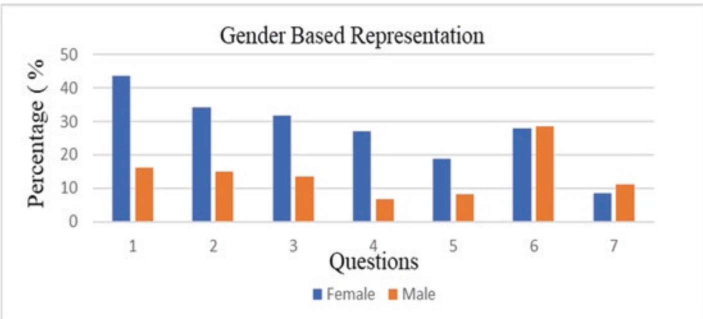

Fig. 8.2 Gender-based representation of construct used in the research survey. (Source: Authors)

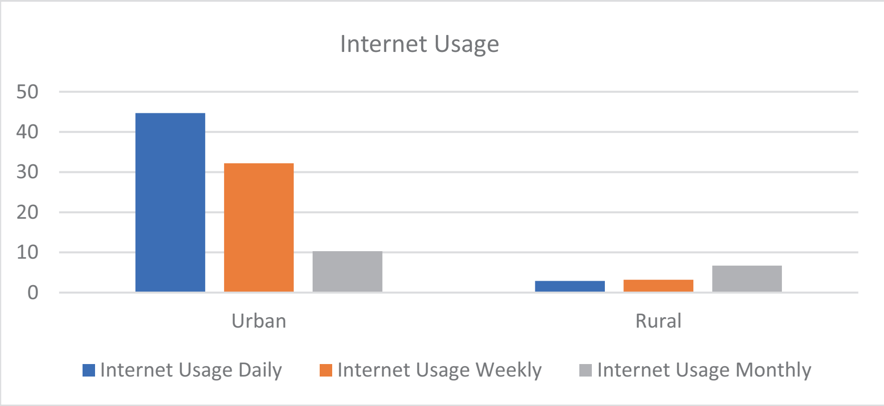

Fig. 8.3 Internet usage representation of construct used in the research survey. (Source: Authors)

30 to 39 had more responses meaning that they have access, trust, and share health related information and females showed that they are generally more active in the virtual communities. The elderly also seemed to trust visiting doctors more than virtual communities. Also, cultural beliefs have a greater impact on the proliferation of virtual health communities (Mirzaei & Esmaeilzadeh, 2021). In urban areas, people are less inclined to these beliefs and use virtual communities to seek and exchange medical information for treatment, whilst in rural areas, they believe in traditional healers and religion and do not consult or use virtual health communities. Health status was also found to contribute to the proliferation of virtual health communities. Some people are shy and not willing to share and seek information on virtual health communities because they are afraid of being exposed to the community, which is more prevalent in rural areas than in urban areas. The results show that the impact of seeking and sharing information among participants in virtual health communities is not the same for healthy and unhealthy users due to different healthcare needs. Overall observation has proved that Zimbabwean society has embraced virtual communities in healthcare.

8.5.1 Implications and Impact of VHCs

In addition to our findings, this study revealed the following implications and impact of VHCs during the COVID-19 pandemic. VHCs make it possible to acquire valuable data for healthcare providers, individual users, regulatory bodies, and researchers on patients' behaviour, such as experiences, differences and similarities, habits, and well-being, which cannot be observed using other methods. The (VHCs) are also very flexible and not dependent on the operator as they are available 24/7. VHC also provides social and emotional support to patients, which is difficult to get if you are seeing a doctor. The issue of anonymity allows both patients to pose questions in a way they would not necessarily use with their doctors. Patients can also educate (increase health literacy) themselves on specific diseases or information that does not necessarily pertain to their diseases, allowing them to become expert laymen (Ravoire et al., 2017). There is also a feeling of empowerment among members due to the ability to share and also educate other members within the community. There is an improvement in the self-care efficacy of VHC members as they seek others' personal experiences and knowledge (Mirzaei & Esmaeilzadeh, 2021). Members who were previously unreachable or difficult to reach by health practitioners can now be reached through VHCs (White, 2001). During the COVID-19 pandemic, VHCs provided support and health information at a low cost, eliminating the need for documents and money for face-to-face consultations (Mpinganjira, 2019a, b; White, 2001). Members of VHCs need to have adequate ICT literacy skills and be effective online communicators, hence promoting their growth. However, these virtual health communities have their own disadvantages. First, the issue of anonymity discredits the veracity of this declarative data. Second, due to anonymity, there is a lack of medical confirmation. Also, there is the issue of language barriers if the community is multilingual. There are also ethical and regulatory issues such as security, anonymity and confidentiality of the data provided by patients. There is also the problem of identity deception and trolling, where members of a group falsely share the group's common interest or concern, and also make false pretences that will negatively affect trust among members of the community.

8.5.2 Limitations of the Study

Because of the COVID-19 restrictions, the participants of this study were restricted to online questionnaires and interviews, which may have influenced the results. Also, the research is limited only to the respondents drawn from Masvingo province, Zimbabwe. Therefore, the results may not be generalised to all users of virtual health communities in other parts of Zimbabwe and Southern African countries. Recommendations are that in future studies, researchers could consider having samples from a broader geographical region, including most parts of the country as well as Southern African countries with more developed technical infrastructures and Internet networks than Zimbabwe. These are some of the issues to do with the use of virtual health communities that led to the following suggestions and recommendations.

8.6 Conclusions and Recommendations

This research focused on determining the implications and impact of VHCs in accessing healthcare services during and post COVID-19 pandemic. Research has proven that patients do turn to VHCs for both cognitive and affective information. Zimbabwean society has also embraced the wave of these communities in both rural and urban areas during the COVID-19 pandemic. Based on the results of this research, urban dwellers in Zimbabwe know and make use of virtual communities, compared to the people in rural areas. Women proved to be part of VHCs (68.8%) and more reliant on them for advice on symptoms that they may be experiencing, illnesses they may be diagnosed with, or even for emotional support. The study showed that there were benefits for most of the participants in terms of being part of a virtual health community, as illustrated by the statistics in Table 8.1, for example, reducing loneliness. There were some drawbacks, however, and the reluctance of some participants to fully immerse themselves in health communities meant that they used multiple sites without any affiliation to a particular community. Those already using virtual communities are generally optimistic about the help they receive and find it helpful to connect with people with similar experiences in particular, but those who have had negative experiences have indicated that they no longer have any trust in the communities but continue to use them with caution by not giving away too much personal information. In future research, we will concentrate on sentiment analysis of responses provided by the users as testimonies in support of the suggested remedies for diseases. This will help us in getting an overall perception of the usage of virtual health communities using user responses. Also, there is a need to consider drawing samples from a broader geographical region with more developed technical infrastructures and Internet networks, and the role of culture in creating patient engagement in VHCs.

There is a need to list and describe available resources that can be used as virtual health communities, as some of them are not authentic. Service providers must create a trustworthy atmosphere for users that fosters a sense of belonging to the VHCs. Based on the findings of this study, it is recommended that citizens and stakeholders in the health industry must embrace VHCs. To do this, we recommend that policymakers increase access to the Internet, especially in rural areas, and also work with Internet service providers through POTRAZ to make data affordable in the country so that people can use these virtual health communities. There is also a need to increase platforms that support different languages through creating glossaries and language lexicons used by patients and aligning them with reference terminology. On the issue of ethics, there is a need to protect patients' data through the use of best practices that should guide researchers.

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Part III
COVID-19 Restrictive Measures and Related Impacts

Chapter 9
Decongesting Global Cities as Part of Health Reform in the Era of COVID-19: Impacts and Implications for Zimbabwe

Isaac Nyambiya and Lawrence Sawunyama

Abstract Since the year 2000, eight major disease outbreaks, including COVID-19 involving zoonosis of viruses, have occurred. Increasing population density, high mobility and economic activity make cities hotspots for the spread of infectious diseases. COVID-19 has exposed the vulnerability of nations regardless of the development index. This paper reviews and analyses the literature on the effect of population density on the morbidity and mortality of COVID-19 since the outbreak of COVID-19. Literature reveals that 7 months into COVID-19, 95% of the infections came from urban centres around the world (Mizutori and Sharif, OPINION: COVID-19 demonstrates urgent need for cities to prepare for pandemics. *UN-Habitat*. https://news.trust.org/item/20200615120207-y321f, 2020). This could be because of a skewed economic model in which 55% of the world's population resides in cities which occupy 1–3% of the landmass while concentrating 85% of the world's economic activity. Cities are a constant magnet for huge numbers of people, making the chances of spreading disease relatively high. Current studies reveal a significant correlation between population density and the number of infections. The paper recommends a health reform plan centred on decongesting cities and a systematic reorganisation of settlement patterns, recognising efficient social distancing to limit illicit human-wildlife interactions. This should ensure less vulnerability to disease pathogens while guaranteeing environmental, food security, and good health for all.

Keywords Decongestion; health reform · SARS-CoV-2 · Cities · Zoonosis

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9.1 Introduction

The COVID-19 pandemic has to date infected about 562 million people (17 July 2022) (John Hopkins University, 2022) and killed nearly 15 million (World Health Organization, 2022). Scientists admit to the unprecedented nature of the spread of COVID-19 (Jefferson et al., 2020). Within a few months of the outbreak, questions were already being asked about the role population density has on the spread of the pandemic (Carozzi et al., 2020). Seven months into the pandemic, it was also observed that 95% of cases emanated from the urban centres (Mizutori & Sharif, 2020). Notably, 55% of the world's population now resides in cities which occupy up to 3% of the entire land mass (Lucertini & Musco, 2020). As such cities which concentrate 85% of economic activity have become global hotspots of all kinds of pollution including pandemic diseases (Landrigan et al., 2017).

Population density is one of the major variables which determine the duration of impact of a pandemic (Reyes et al., 2013). Density has historically always been contentious when referencing the spread of infectious airborne diseases because of the dichotomy of thought among scholars. Modelling studies published early into the pandemic suggested how population density affects the basic reproduction number, R_o, through the number of contacts in crowded areas (Joacim Rocklöv & Sjödin, 2021). This is reflected in the raft of protocols of social distancing measures which have been implemented globally to reduce human contact since the outbreak (Yin et al., 2021).

At least 4.5 billion of the world's population were put on lockdown by decrees from various governments acting in concert (Cresswell et al., 2020; Sheikh et al., 2020). A study of 49 countries has shown that lockdowns effectively reduce the spread of the COVID-19 (Atalan, 2020). A physical separating distance of at least 1 meter is associated with lower transmission of SARS-CoV-2 with better protection accorded when the distance is increased (Chu et al., 2020).

However, being able to social distance is also a function of population density (Wong & Li, 2020). The built environment is known to promote crowding (Sharifi & Khavarian-Garmsir, 2020) which leads to more contacts between persons and hence the spreading of infectious diseases. The debate on the role of cities spreading of COVID-19 as they attract large numbers of residents has meant that some have questioned the sustainability of the sanitation particularly so, the dense model for development. Both sides have weighed in on the 'compact versus sprawl' debates (Sahasranaman & Jensen, 2021). This paper uses an integrative and semi-systematic literature review approach with the aim of analysing the current correlation between COVID-19 infections and mortality as a function of population density.

9.2 Literature Review

9.2.1 Cities and Outbreaks of Pandemics in the Twenty-First Century

The rate at which disease outbreaks are happening has been alarming in the past few years, while crowded cities have acted as chambers for global spread. In the twenty-first century alone, the world has experienced at least eight major disease outbreaks beginning with SARS of 2002 (Cherry & Krogstad, 2004; LeDu & Barry, 2004). Coronavirus are known to undergo a zoonotic spill over into secondary hosts such as civet cats for SARS-CoV-1 (Parashar & Anderson, 2004; Widagdo et al., 2017), dromedary camels for MERS (Sharif-Yakan & Kanj, 2014), (Ji, 2020) and pangolins for SARS-CoV-2 (Liao et al., 2020) (T. Zhang et al., 2020). A 22.8% incidence of MERS-CoV in camels is regarded as an occupational hazard (Ji, 2020). Figure 9.1 shows some of the outbreaks which have happened with increasing frequency and severity during the past 20 years. Table 9.1 also provides more detail on the epidemiology of these infectious diseases of the past 20 years.

Concomitantly with the outbreak of polio (Akil & Ahmad, 2016; Okiror et al., 2021), Ebola Virus Disease (EVD) spread globally from West Africa with a case fatality rate of more than 40% (Cenciarelli et al., 2015; Gatherer, 2014). The African bats have been implicated as primary hosts in the spread of Ebola (Letko et al., 2020). Before the emergency of COVID-19 in December 2019, the world had been grappling with containing another Ebola epidemic which started in West Africa (see Fig. 9.1) and spread to a host of countries in the West (Kalenga et al., 2019; Rugarabamu et al., 2020). Most of the diseases have had their epicentres in urban areas.

Despite the outbreaks occurring in distant countries, the spread of these diseases to become global epidemics and pandemics has been facilitated by global connectivity and population density associated with some jurisdictions especially the mega cities of the world.

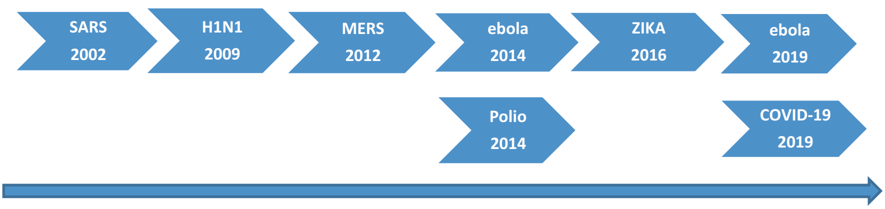

Fig. 9.1 The trajectory, frequency and prevalence of major disease outbreaks since 2000. (Source: Authors)

Table 9.1 Statistics relating to the pandemics of the twenty-first century

Year	Disease outbreak	Causative agent	Duration	Total infections	Total deaths	Estimated CFR (%)	Number of countries affected	Reference
2002	SARS	SARS-CoV-1	2002–2004	8000–8422	774–916	9.7–11.0%	29 on five continents	Peiris et al. (2014), Chan-Yeung et al. (2003), Lam et al. (2003)
2009	H1N1	H1N1pdm09	2009–2010	18,449 (lab confirmed); 700 million-1.4 billion (estimated)	284,500	0.16–4.48%	214	CIDRAP Dawood et al. (2012), Monamele et al. (2019), WHO (2010), Nishiura et al. (2009)
2012	MERS	MERS-CoV	2012–2021	2583	889	34.4%	27	WHO (2021), Alyami et al. (2020)
2014	Ebola Virus Disease (EVD)	Ebola virus	2014–2016	28,652	11,325	39.5%	7	WHO (2021)
2014	Polio	Wild Poliovirus (WPV), cVDPV	2014–2016	359	ND	(5–10%)-theoretical	9	Hagan et al. (2015)
2016	ZIKA	Zikavirus	2016–2019	84,276	51	0.06%	84	Bhargavi et al. (2020), Cardona-Osipin et al. (2019)
2019	Ebola Virus Disease (EVD)	Ebola virus	2019–2020	3462	2267	65.4% (as of 25 March 2020)	2	WHO (2021), Barbiero (2020)
2019	COVID-19	SARS-CoV-2	2019-ongoing	448,028,910	6,008,426	1.3%	224	John Hopkins dashboard (as of 8 March 2022)

Source: Authors' compilation

9.2.2 COVID-19 and the City Connection

Many cities with large population densities have particularly borne the brunt of COVID-19 and there is a tacit realisation of the need to reconfigure the way the city is designed (Sharifi & Khavarian-Garmsir, 2020). Authors such as Hazarie et al. (2021) have posited the existence of a strong interaction between mobility and population density and spread of infectious diseases. An indictment of the city has always been that in extraordinary circumstances such as pandemics, there is the so-called (urban) death penalty associated with urban development (Martínez & Short, 2021).

While the conclusion of population density as driver of infection may be considered intuitive (Federgruen & Naha, 2021), empirical studies have demonstrated that under forced circumstances, population densities are 'quite pathogenic' (Levy & Herzog, 1974). A countrywide study conducted in the USA concluded that counties with larger population densities produced greater reproductive numbers (R_o) hence greater rates of transmission of COVID-19 and as such larger infection cases. Evidence from other studies in the USA reached similar conclusions suggesting a 0.14 increase of R_o with every unit log increase in population density. There are further arguments by the researchers that the value of R_o was not mediated by transportation (Sy et al., 2021) which contradicts the observations in New York (Hamidi et al., 2020; Hamidi & Hamidi, 2021). The evidence of density as a persistent predictor of COVID-19 severity and death appears overwhelming from most of the studies conducted in the USA (Desmet & Wacziarg, 2021)

A study conducted in Brazil revealed that initially smaller cities were impacted more by COVID-19 infections. However, this trend called an urban advantage is reversed in the long term with major cities showing that a 1% increase in the susceptible population being associated with 0.14% increase in infections (Ribeiro et al., 2020). With some of the largest population densities, the difficulty to contain the virus has been compromised by the prevalence of slum urban development with as many as 205,415 people /km^2 in Bangladesh (Islam & Kibria, 2020). Further studies of environmental factors in Bangladesh also reveal a positive correlation between the number of cases and the population density (Alam, 2021). Research done in Malaysia showed that districts with greater population densities were more affected by the COVID-19 pandemic (Ganasegeran et al., 2021). In India where large population densities are realised through very close contact between individuals in public spaces also gave positive correlations between population density and infections (Bhadra et al., 2021). Concerns were expressed at the beginning of the pandemic for cities such as Manila which are known to have very high densities as much as 71,263 persons/km^2 (Salva et al., 2021). Moderate positive correlations have been observed in some Indian cities contrary to the information released by John Hopkins University (Bhadra et al., 2021).

Researchers investigating the effect of household size among other parameters have observed a positive correlation between the size of the household and the rate of infection (Federgruen & Naha, 2021). While one Italian study showed that

COVID-19 exhibited more severity in households with single occupancies for people aged more than 80 years (53.1% of the 25 million Italian families in Italy are composed of less than two people) (Liotta et al., 2020), other research done in Italy showed a positive correlation between population density as a function of the number of infections and deaths further indicating how the proximity of household exacerbates the spread of COVID-19 (Ilardi et al., 2021). An IZA Institute of Labour Economics report often quoted in the debate on population density versus COVID-19 spread categorically finds no evidence that greater population density is linked with more COVID-19 cases and deaths (Carozzi et al., 2020). This demonstrates the divergent views and positions among scholars, and as such the need for further investigation into population density as risk factor of COVID-19.

On the other hand, a largely rural community (Diop et al., 2020) and a younger population in Africa (Chitungo et al., 2020) are some of the reasons proffered for the lesser number of infections and mortalities in Africa compared to West. The United Nations has thus far realised and deplored the roles cities have played in the spread of the COVID-19 pandemic especially as they have been heavily impacted on by the outbreak (UN-Habitat, 2021). There is also a realisation of the need for reconfiguration of the settlement patterns especially in urban centres to a model which provides social and economic equity (Sharifi & Khavarian-Garmsir, 2020).

9.3 Methodology

In this paper, we mostly surveyed literature which has been published since the outbreak of COVID-19 and how the spread of the disease has been influenced by population density. A combination of integrative and semi-systematic literature review approach (Snyder, 2019) is used to search for literature and provide an overhead review and qualitative analysis of information available regarding the influence of population density versus COVID-19 infections and fatalities. A continuous search of literature was done on databases such as PubMed, Google Scholar using search criteria using words such as 'COVID-19 and population density'. Other literature relating to similar infectious diseases such as, SARS, H1N1, Ebola, polio and ZIKA was also consulted. A number of 'cause and effect' or correlation models used by various authors globally were identified. Fifteen studies which provide various models showing the correlation between population densities against the total number of infections and in some cases the number of fatalities due to COVID-19 were selected within the last 2 years of published data. A compilation was done of the model used, the place or cities studied, the correlation coefficients obtained and the time limits within which the study was considered and conducted. Table 9.2 shows the different models which have been used to arrive at the correlation between population density and the number of infections and fatalities around the world.

Table 9.2 Models for predicting the effect of population and population density in the spread of COVID-19

Model used	Place/City	R^2 (infections)	R^2 (mortality)	Date of consideration	Reference
Linear regression	India	0.58 (10 September 2020)	0.64 (10 September 2020)	10 September 2020	Bhadra et al. (2021)
		0.67 (5 July 2020)	0.57 (5 July 2020)	5 July 2020	
Multiple regression models	2814 US counties	0.447 ($F = 219.437$, $p < 0.001$)	0.391 ($F = 174.656$, $p < 0.001$)	1 May 2020	Zhang and Schwartz (2020)
Simple linear regression	50 states andthree US territories	0.55	ND.	Not stated in the paper but estimated here to be between 1 January 2020 and 8 July 2020 (a month before submission)	Yin et al. (2021)
	17 cities in Hubei province, China	0.62	ND: positively associated with the disease mortality.		
Quantile regression	Global study across 84 countries	Population density initially (Week 10) had a strong positive influence at the mean, and at the 25th, 50th, and 75th quantiles that waned with time.		Six (6)-week period: from 10th week (ending March 4th) until the 15th week of 2020 (ending 8 April 2020)	Sigler et al. (2021)
Simple linear regression	Malaysia countrywide ecological survey	($r = 0.912$; 95% CI 0.911, 0.913; $p < 0.001$)	ND	22 January 2021 and 4 February 2021	Ganasegeran et al. (2021)
Multiple linear regression, Pearson correlation	All 64 Bangladesh districts	$r = 0.876$, $p < 0.001$	ND	Data obtained on 18 September 2020	Alam (2021)
		($r = 0.802$, $p < 0.001$)	ND		
Spatial regression models	USA counties	Population density alone 76% in the spatial models	ND	March to late May 2020	Wong and Li (2020)
Spatial lag models	New York counties	Population density not significant with rate of infection after controlling for crowding	ND	1 April and 25 May 2020	Hamidi and Hamidi (2021)

(continued)

Table 9.2 (continued)

Model used	Place/City	R^2 (infections)	R^2 (mortality)	Date of consideration	Reference
SIRD 1 epidemiological model	USA	$R^2 = 0.88$	$R^2 = 0.74$	15 March to 30 November 2020: Density is a persistently important determinant of disease severity across space	Desmet and Wacziarg (2021)
Ordinary Least Squares (OLS); Negative BinomialRegression (NBR) model	South Korea	Only net population density strongly associated with the number of cases (coefficient = 29.38 for the OLS model and coefficient = 0.31 for the NBR model)	ND	20 January 2020 until 17 September 202 Density plays an important role in the proliferation of theCOVID-19 outbreak in South Korea	Jo et al. (2021)
Extreme boundsanalysis (EBA) and variable addition tests (VAT)	172 countries	Bmin = 0.28 Bmax = 0.56 Population density considered robust when there is not sign change from one variable to another when considering infections rather than deaths. As such robustness is 100%	Bmin = −0.01 Bmax = 0.003 A change in sign of the B coefficient interpreted to mean no significant correlation and as such the robustness is 0%	From disease outbreak up to 11 May 2020	Moosa and Khatatbeh (2021)

Nonparametric Spearman's correlation analysis	Italy	$r_{rho} = 0.67$ PD & number of cases at $p = 0.0001$	$r_{rho} = 0.69$, PD & deaths at $p = 0.0001$	From outbreak to 1 April 2020	Ilardi et al. (2021)
Spearman's rank correlation coefficient	Sergipe state, Northeast Brazil	$r_s = 0.326$, CI 95%0.106–0.514, $p = 0.005$; effect size = weak) 5% significance level	($r_s = 0.518$, CI 95% 0.329–0.666, $p < 0.001$; effect size = moderate) 5% significance level	From outbreak to l January 2021	Martins-Filho (2021)
Regression model (not specified)	Three majorcities in Turkey	Population weighted density vs. number of cases $r = 0.97$ with p – value <0.0001	ND	April 2020	Baser (2021)
Spearman's correlation coefficients	Eight cities in Bangladesh	$r_s = 0.712$ of a city	$r_s = 0.678$	07 March 2020 to 14August 2020	Sharif and Dey (2021)

Source: Authors' compilation

9.4 Results

Researchers have used various tests of goodness of fit and statistical significance to assess the validity of the claims of population density as a function of morbidity and mortality. These models range from the simple standard linear regression, and the Quantile regression which is an extension of linear regression method. Others have applied multiple linear regression and cluster analysis to derive Pearson coefficients to measure levels of correlation or association. The other models captured in Table 9.2 are spatial regression models, spatial lag models, the Susceptible-Infected-Recovered-Deceased (SIRD) epidemiological model, the Ordinary Least Squares (OLS), and Negative Binomial Regression (NBR) models, Extreme Bounds Analysis (EBA), Variable Addition Tests (VAT), nonparametric Spearman's correlation and negative binomial regression (NBR). Each of these models have been used to calculate the corresponding correlation coefficient or another size effect parameter such as extreme values coefficients (β) to measure the effectiveness of population density in influencing the COVID-19 epidemiology. Other methods used including econometric methodologies such as random-effects models and Hausman–Taylor models (Kaicker et al., 2020) and the Generalised Linear Model (GLM) combined with the Geographically Weighted Regression (GWR). It is not the scope of this paper to exhaust all the models which have been utilised but highlight how several tools have been utilised to measure the size effect of population density on COVID-19 severity. The heterogeneity of the models makes it difficult for comparisons to be made between the various models. However, what is clear is that from most (about 80%) of the models which have been sampled for this paper, a statistically significant correlation has been established between population density and with the number of infections.

What is also clear is that a number of researchers have predicted that population density including other parameters such as the total country population, the age of the population and family sizes living within the same households correlate strongly with the quick diffusion of COVID-19 within countries (Sigler et al., 2021). In Malaysia, the strongest correlation was observed in the central region of the country, being greater in urbanised districts and cities (Ganasegeran et al., 2021). A study in the Gauteng region of South Africa assessed that the 'ward' areas which have more than average risk to COVID-19 and more than average population density were in the so-called townships with denser settlements patterns (Maree & Ballard, 2020).

In studying the disparate jurisdictions, researchers chose a variety of approaches which include the investigation of many countries grouped together such as the 172 country study by Moosa and Khatatbeh (2021) or the 84 country quantile regression analysis by Sigler et al. (2021). An analysis of data from 140 countries undertaken by Murányi et al. (2021) between 18 April and 4 July 2020 quantitatively reveals very high infection rates as a function of population density after ranking the 140 countries into four categories according to infection rates of very high, high, medium, and low (Murányi et al., 2021).

Comparative and quantitative studies have also been undertaken at country level across the world with a view to recommending the best possible options for in-country containment of COVID-19. In most cases of the literature surveyed, the data reveals a higher severity of the pandemic associated with high population densities. For instance, while studies undertaken in India by Bhadra et al. (2021) reveal a moderate correlation between population density and the number of infections and mortalities ($r = 0.58$ for infections; $r = 0.64$ for mortality) for the four major states in India, the authors are careful to mention that the worst effects of the pandemic have been experienced in the megacities of the four states (Bhadra et al., 2021). These studies in India have been corroborated by other researchers who have reached similar conclusions on the spread of COVID-19 in that country (Sengupta et al., 2021; Tamrakar et al., 2021). In the three states of Maharashtra, Jharkhand and Meghalaya, a large association between urban population density as a function of daily and cumulative severity ratios was established (Kaicker et al., 2020).

Multiple linear regression analysis on 2814 US counties done by Zhang and Schwartz (2020) characterises metropolitan cities in the USA as hotspots for COVID-19, although counterintuitively some smaller cities and counties have been similarly affected. This has been attributed to a more aged population found in some of smaller cities. In the US eastern states, a positive association between population density and transmission or fatalities between the 1 March and 16 November 2020 was observed. In this study, New York City leads in the figures (Lee et al., 2021).

A comparison of 18 cities in the Hubei province of China and 50 states and counties in US arrived at an $r = 0.55$ for the Chinese cities compared to $r = 0.62$ for the US when applying simple regression analysis. The assessment and conclusion from this study is that of a positive association between population density and morbidity (Yin et al., 2021). However, the level of analysis seems not as robust to include other parameters such as connectivity, crowdedness, household sizes which could have influenced the spread of the disease. Spatial regression models have predicted correlations as high as 84% for infections in the United States (Wong & Li, 2020). However, Hamidi and Hamidi (2021) have projected contrary results for New York regardless of the large population densities experienced in the city. A globalised world with increased mobility and connectivity between points of interests (POI) has been used to explain the apparent heterogeneity of the associations between density and vulnerability to COVID-19 especially in more developed countries such as the USA (Hazarie et al., 2021). For cities in South Korea which have similar development indices as the United States, connectivity has a greater impact in the spread of COVID-19 (Jo et al., 2021). This is understandable as travelling has the effect of bringing people into more contact with each other and hence increasing the probability of infection to a susceptible population. Despite the mathematical rigor associated with this conclusion, in our opinion this does not override the intuitive effect of population density on the spread of communicable diseases.

A study conducted in Oman using GLM combined with the GWR yielded an adjusted $R^2 = 78.77\%$ between COVID-19 infection and the population density variable. Other parameters such as the number of households, and spatial interactions have also been used as proxies for population density giving greater effect to the impact of population as a measure of close interaction between individuals during a pandemic leading to infection (Al Kindi et al., 2021).

For the 265,000 cases reported by the end of the August 2020 in Turkey, 60% of these were recorded in Istanbul the capital city with a very strong correlation (r = 0.97) between population density and number of infections (Baser, 2021). Interestingly within a similar timeframe, 60% of infections were also recorded in Dhaka the capital of Bangladesh which has a population density of about 46,997 persons/km^2 (compare New York = 34,338.5 persons/km^2 (Lee et al., 2021)). In this study, the largest correlation was detected between the population density and number of infections (Sharif & Dey, 2021). Alam also finds a strong positive correlation between population density and infection accounting for 60% countrywide variability in Bangladesh, and similar a strong correlation between COVID-19 and prevalence of urban centres (Alam, 2021). Similarly a Z-score analysis performed for the regions of the Philippines yielded the second highest correlation for population density against COVID-19 infections (0.93) and deaths (0.92) after the number of ICU beds at the regional level (Talabis et al., 2021).

The situation in South Korea, however, offers an interesting middle of the ground position in which both population density and connectivity (both leading to crowdedness) have been observed to be positively correlated to the number of infections in the country. However, there is a greater emphasis on the effect of connectivity rather than density as predictor of the number of infections (Jo et al., 2021).

9.5 Discussion

There is a clear existential crisis of novel infections and pandemics happening with increasing rapidity and severity. Coupled with the benefits of globalisation these airborne infections are spreading around the world once they have been triggered from a single location. Research has revealed that infectious diseases such as measles and COVID-19 spread more quickly in densely populations areas (Tarwater & Martin, 2001).

The cases of the cruise ships have been investigated over long periods of times as the environments within these confined spaces offer unintended but conducive conditions for disease causation and spread and study (Carling et al., 2009; Kak, 2007). The Diamond Princess cruise ship provided valuable opportunity and information for epidemiologists to analyse the dynamics of COVID-19 (Russell et al., 2020) revealing basic reproduction numbers which were four times higher on the crowded ship than was found in Wuhan (J. Rocklöv et al., 2020). While some studies in countries such as Italy seem to suggests that social connectedness is negatively correlated with spread of COVID-19 (Liotta et al., 2020), high population densities have been observed to catalyse the spread of COVID-19 (Joacim Rocklöv & Sjödin, 2020). A study conducted in China suggests that population density is not a factor in the spread of COVID-19 under strict lockdown conditions (Sun et al., 2020), but observations from Brazilian cities have confirmed a positive correlation between population density with number of cases (Pequeno et al., 2020). Among other reasons, the high population densities in the cities Sao Paolo and Rio de Janeiro are blamed for the higher number of infections of COVID-19 compared to other states in Brazil (Baqui et al., 2020). The increase of infections with population density has been corroborated by other studies within Brazil controlling for metrological factors such as rain, radiation, humidity and radiation (Pequeno et al., 2020). Apparently the number of infections are reduced by lockdowns conditions where there is a greater number of symptomatic cases as observed in an Indian analysis of the spread of the pandemic in its states (Sardar et al., 2020). Observations carried out in US cities from 14 March through 19 March 2020 have also realised that the worse attack rate of COVID-19 is to be expected in cities with larger population sizes (Stier et al., 2020). Regardless of social distance, measures such as lockdowns are more effective where the population density is low among other parameters (Verhagen et al., 2020). In the UK, hospital capacities have been found to be highest along the Cardiff coast, a place with higher levels of population density in the UK (Verhagen et al., 2020).

Unsanitary conditions emanating from over-crowdedness which induce breeding conditions for pathogens (Amoo et al., 2020) and a high concentration of germs in confined places such as experienced in the Cook County jail in Chicago are examples of how adversely the spread of any infectious disease can be exacerbated by lack of social distance (Reinhart & Chen, 2020). Rural Africa is characterised as sparsely populated, and along with a young population, with fewer comorbidities; this seems to have contributed to a far a smaller number of infections (Oleribe et al., 2021; Wamai et al., 2021) (Diop et al., 2020).

Hamidi et al. have recommended denser urban development as the basis for inducing lower death rates in case of infectious outbreak of disease (Hamidi et al., 2020). This is counter-intuitive to the principles of epidemiology of airborne infections. Unless this is accompanied by the concomitant and commensurate health facilities and adequate infrastructure, a denser model of development becomes a very dangerous proposition especially for countries in the global south. This is because the larger populations residing in the countryside with a better natural phenomenon of social distancing through sparse populations may be encouraged into city dwelling.

Arguments which dismiss the role of population density in large cities appear to have forgotten the importance of this geographical and demographic factor in the spread of infectious diseases (Nathan, 2021). The positions taken by researchers as to whether infectious pandemics spread as function of compactness (dense) or sprawling urban appear to be driven by vested interests amongst scholars of urban planning, with each camp favouring its own theories ahead of intuition and objectivity. Conclusions arrived for compact development in relation to COVID-19 are derived from a persuasion which argues that there is significant reduction in trips to POIs such as grocery stores, pharmacies and transit points during lockdown periods (Hamidi & Zandiatashbar, 2021). As such this would curtail the spread of disease. The data is used to definitively recommend the continued adoption of compact model of development in the face of ever-increasing infections airborne infections

(Hamidi et al., 2020). Based on the findings in New York, the question remains to be answered as to whether the significant effect of POIs in the greater proportion of the spread of infections can be positively correlated with bigger population sizes within smaller geographical spaces and hence with an effective population density.

The disparity between the United States, which has a comparatively lower population size and densities, compared to China and yet the US has recorded the largest infections and mortalities to date points to other socio-economic factors between the two countries other than demographic parameters. A greater prevalence of co-morbidities in North America and a larger proportion of an older population has been used to explain the higher cases and fatalities in North America and other western countries (Badawi & Vasileva, 2021). On the other hand, China has implemented a rapid response 'zero COVID' policy which is not very popular in the western nations for its seeming harsh stringency (Mallapaty, 2022) and possible violation of individual rights of citizens (Watkins, 2020). However, the Chinese policy has been viewed as success model despite the misgivings (AlTakarli, 2020).

Population size and population density which lead to crowdedness are positively correlated to COVID-19 morbidity and mortality. The effects of these are exacerbated by the 'benefits' of globalisation such as better connectivity which unfortunately guarantees the importation of viral infections and their variants from one distant place to another. However, the detrimental effects of higher population densities can be mediated by better health facilities, infrastructure and rapid response governance policies which ensure better chances of survival for a populace. Considering the inequitable distribution of land and the attendant rapid spread of COVID-19 in the urban centres, this paper proposes a calculated and unemotive policy of decongestion of cities as part of a first principles approach to the health reform agenda.

9.6 Conclusion

This paper sought to establish the role of population density on the spread and severity of COVID-19 by surveying the literature which has been published for the last 2 years. Disparate models have been used by researchers around the world to arrive at several conclusions ranging from positive association to high correlations. In most cases, population density has a significant effect on the proliferation of COVID-19. Two main scenarios emerge as follows: (1) High population densities found in conjunction with inadequate health (and connectivity) infrastructure means population density is found to be significantly positively correlated with more infections and may be deaths. This has been the experience in less developed countries such as Bangladesh, India and the Philippines. This represents the classic scenario in which population density is generally expected to influence the spread of infectious diseases; (2) On the other hand, developed countries with larger metropolitan and better connectivity facilities establishments appear to reverse the effect of population density on the spread of infectious disease. The effect of population density seems to be transferred to crowdedness as encouraged by mobility. As such this becomes a proxy for population density. A typical example is that of North Korea which revealed a similar phenomenon to New York where great neural networks are associated with higher infections and mortality. This situation could be mediated by better medical facilities which help in reducing the impact of COVID-19. However, even the best medical facilities can be overwhelmed as has already been experienced during COVID-19.

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Chapter 10
Deciphering Synergies and Trade-Offs Between COVID-19 Measures and the Progress Towards SDG 15-Life on Land in Zimbabwe

David Chikodzi and Lazarus Chapungu

Abstract Despite the crucial role of the restrictive measures meant to curb the spread of the COVID-19 pandemic, little is known about the impacts of these measures on the attainment of Sustainable Development Goal 15. The study examined the synergies and trade-offs that occurred when the implemented COVID-19 measures interacted with SDG 15 in Zimbabwe. The study used a semi-quantitative approach to develop a matrix that was then used to quantify the extent of trade-offs and synergies. The matrix scored the relationships between implemented COVID-19 measures and developed indicators to determine if there was a trade-off or a synergy. The findings show that although there were some observed synergies between COVID-19 measures and progress towards SDG 15 in Zimbabwe, most of the outcomes showed negative impacts and trade-offs. Hence to a large extent, the COVID-19 pandemic had negative impacts on the conservation of biodiversity in Zimbabwe. It is recommended that government and its development partners do more to fund the conservation of the environment during and after the pandemic to ensure that the country attains SDG 15.

Keywords COVID-19 restrictions · SDG 15 · Synergies · Trade-offs · Zimbabwe

10.1 Introduction

In 2015, 193 countries committed to implementing the 17 United Nations Sustainable Development Goals (SDGs) and the 169 targets under the 2030 Agenda for Sustainable Development (United Nations, 2015). However, in 2020, the emergence

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and rapid spread of COVID-19 disrupted and, in some cases, reversed the gains made towards achieving Agenda 2030. According to the United Nations High Level Political Forum (2020), although there was notable traction, the world was not on track to achieving most of the SDG targets by 2030 even without the COVID-19 pandemic. This was more so for the countries in the global south (Chikodzi et al., 2020; Zhou & Moinuddin, 2021). To encourage the scaling-up of action on SDG implementation, the United Nations in 2020 promulgated the 'Decade of Action' on SDG delivery (Van Tulder et al., 2021). However, as a direct impact of the coronavirus, progress towards the attainment of SDGs has either been slowed down or in some countries or regions, completely reversed (Shulla, 2021). Although the African continent did not encounter severe pressure on its health system compared to other continents during the peak of the pandemic, most of its governments were forced to implement restrictive measures meant to curb the rapid spread of the coronavirus (Attah, 2021).

Recent reports suggest that COVID-19 is likely to impede the progress of SDG 15, which aims to ensure the protection, restoration and sustainable utilisation of terrestrial ecosystems (United Nations, 2015). In the African context, due to the unexpected emergency brought by the COVID-19 pandemic, most countries shifted their development priorities (Lindsey et al., 2020). Ecosystem protection was in most cases not prioritised and funds were being diverted toward dealing with the emergent health crisis (Ndlovu et al., 2021). Shifts in the development trajectory due to the pandemic to a large extent undermined the protection of biodiversity and ecosystems (Shulla et al., 2021; Mudzengi et al., 2022). Due to the strong interlinkages between SDGs, the reversal in the progress towards implementing SDG 15 can lead to a corresponding decline in the achievement of other related goals either in the long or short-term (Griggs et al., 2017).

Synergies and trade-offs have also been observed between implemented COVID-19 control measures and progress towards the achievement of SDGs across the world (Nhamo et al., 2020; Zhou & Moinuddin, 2021). Luukkanen et al. (2012) define synergy as the interaction of two or more forces which creates enhanced combined effects. In this study, synergies occur when the implementation of COVID-19 restrictive measures enhances progress towards the achievement of SDG 15. A trade-off involves decision-making were one quality/quantity has to decline in retain for gains in other aspects (Nilsson et al., 2017). Trade-offs occur when the successful implementation of COVID-19 restrictive measures limits the achievement of SDG 15. For post-COVID-19 recovery and building resilience towards future shocks, there is a need for in-depth assessments of the consequences of the pandemic on the implementation of SDGs (Krellenberg & Koch, 2021). The conscious management of synergies and trade-offs is a critical component in the design SDG sensitive pandemic response measures (Zhou & Moinuddin, 2021). This chapter aims to decipher the synergies and trade-offs that occurred between the COVID-19 measures implemented in Zimbabwe and the progress towards achieving SDG 15. Understanding the interactions of COVID-19 restrictive measures and the progress towards achievement of SDG 15 in Zimbabwe can help develop informed and consistent policy actions. It will also help in improving our understanding of how measures crafted to manage a crisis can come at a cost to development progress.

10.2 Literature Background

It is of utmost importance to understand the impacts of COVID-19 on the attainment of SDGs (Zhou & Moinuddin, 2021). Using the SDG framework provides a consistent framework through which multiple local, national and international challenges can be addressed (UNSTATS, 2021). The impacts of COVID-19 on the successful implementation of SDG 15 by 2030 are still not clear but are generally noted in the literature to be potentially severe, long-lasting and difficult to assess (Corlett et al., 2020; Ju, 2020; United Nations, 2021). The total and partial lockdown measures instituted by most countries came at significant economic costs, especially for the relatively poor countries of the global south. These measures triggered serious economic crises which saw the levels of poverty increasing globally for the first time in more than 30 years (UNSTATS, 2021). Almost all sectors of the economy were impacted leading to job losses, reduced business operations and capital flows (Chikodzi et al., 2022). Ju (2020) observes that the pandemic brought tension and authoritarian manoeuvres at a global level through shutting of borders, and restrictions on the movement of people and goods yet it required collaboration at all spatial scales to combat the virus.

One of the most undermined SDGs due to the COVID-19 pandemic is goal number 15 which principally seeks to conserve biodiversity and terrestrial ecosystems. Box 10.1 shows selected targets set for achieving SDG 15. Some of the targets such as 15.1; 15.2, 15.5 and 15.8 have already been missed at a global level and their allocated timeline lapsed in 2020 when the world was at the peak of the COVID-19 pandemic.

Box 10.1. SDG 15 Targets

- 15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services.
- 15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and significantly increase afforestation.
- 15.3 By 2030, combat desertification, restore degraded lands, such as land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.
- 15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.

(continued)

Box 10.1 (continued)

- 15.5 Take urgent action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.
- 15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products.
- 15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems.
- 15.a Mobilize and significantly increase financial resources for conservation and sustainable utilization of biodiversity and ecosystems.

Source: UNSTATS (2021)

For most countries in southern Africa, conservation is left to finance itself due to budgetary constraints (Ndlovu et al., 2021). Biodiversity and ecosystem conservation through wildlife, forestry and wetland related tourism revenue provides the much-needed revenue to sustain itself (Lindsey et al., 2020). Both consumptive and non-consumptive tourists' activities such as photographic safaris, trophy hunting, fishing, mountain hiking, boating and whitewater rafting are important drawcards to local and international tourists and normally occur within designated protected areas (Tairo, 2020; Snyman et al., 2021). This, therefore, implies that anything which reduces tourist arrivals to these countries is a direct threat to the conservation and achievement of SDG 15 (Van der Merwe et al., 2021). The impact of tourism revenues also motivates governments to justify protecting biodiversity and ecosystems. It brings in the much-needed foreign currency, contributes to poverty alleviation at local scales, diversifies local economies and provides income to state natural resource management agencies (Lindsey et al., 2020).

At the margins of these protected areas drawing huge numbers of tourists are usually poor and vulnerable communities. Forests, wildlife and wetlands in these areas act as safety nets during periods of crisis. Most poor rural people look to forests to provide subsistence during times of crisis (Galvani et al., 2016) and turn to negative coping mechanisms such as poaching for subsistence (Ndlovu et al., 2021). In Africa, 90% of the population still uses wood energy for heating and cooking, while about two-thirds rely on forests to support their livelihoods (Ebrahim & Weng, 2016; Kung'u et al., 2021). At a global level, up to 1 billion people illegally consume game meat and many more practice destructive wetland-related agriculture (Kung'u et al., 2021; Attah, 2021). The rate at which these resources are exploited usually increases when shocks such as droughts and economic recessions occur (Lindsey et al., 2020).

Although quantifiable data is still lacking, the COVID-19 induced restrictions have had serious ramifications on SDG 15 by impacting mobility and economic activities. Lockdowns reduced tourist arrivals around the world leading to limited financial flows for conservation (Miller-Rushing et al., 2021). In some cases, reduced funding led to a corresponding reduced capacity for enforcement and subsequently increased unsustainable harvesting of resources. This came as a result of reduced livelihood opportunities and disruption of conservation benefit sharing programmes with local communities (Schwartz et al., 2020; Thurstan et al., 2021; Kideghesho et al., 2021). In the global south countries, donor funds to support conservation efforts were either reduced or diverted to support priority sectors such as health (Lindsey et al., 2020; Thurstan et al., 2021).

The pandemic disturbed the occurrence of key local and international conferences on conservation around the world, especially in 2020 and 2021 (Corlett et al., 2020). This deprived ecologists and conservation practitioners a chance to craft innovative ways of reducing the impacts of COVID-19 on the sector and reduced sharing of conservation related issues (Corlett et al., 2020; Ndlovu et al., 2021). The pandemic also led to the cancellations of training, research, education and awareness programs directed at improving conservation (Cheval et al., 2020). On a positive note, some protected areas had improved habitats and sightings of animals in areas they had not been spotted in a very long time (Lindsey et al., 2020). Breeding of some animal species was also observed to have improved in some areas due to limited human disturbances. In some protected areas, significantly fewer incidences of wildlife killed on the roads due to reduced traffic and visitors were observed (Smith et al., 2021).

10.3 Materials and Methods

The study focused on the impacts of COVID-19 related measures on the progress towards attaining SDG 15 in Zimbabwe for the period from April 2020 to March 2022. A semi-quantitative analysis was performed to analyse the interactions between measures put in place to curb the rapid spread of COVID-19 and SDG 15. The semi-quantitative analysis followed a seven-point scale scoring system which was adopted from Nilsson et al. (2017). Like many other methods used to analyse the interaction of SDGs, the study relied on expert opinions to analyse the synergies and trade-offs (Fader et al., 2018). The scale of scores used in the study ranged from −3 to 3 as shown in Table 1. A positive (+) 3 (indivisible) represents the highest level of synergy where a COVID-19 measure is linked inextricably with the achievement of progress towards SDG 15. On the other side, a negative (−) 3 (cancelling) is associated with measures that when implemented would make it almost impossible to achieve the targets of SDG 15 in Zimbabwe (Table 10.1).

Official Government of Zimbabwe pronouncements, declarations and reports were used to derive the implemented COVID-19 measures. These include daily reports from the Ministry of Health and Child Care, statutory instruments, government regulations and media pronouncements. Since COVID-19 was still an ongoing phenomenon and details of impacts on SDG 15 were still not well known at the time

Table 10.1 Interaction, scores and descriptions used in the study analysis

Interaction	Descriptions	Score
Indivisible	Is the most robust form of synergy where an implemented measure is inextricably related to the achievement of SDG 15	3
Reinforcing	Measure directly produces a situation conducive to the attainment of SDG 15	2
Enabling	Pursuit of the measure enables the achievement of SDG 15	1
Consistent	A neutral relationship in which an implemented COVID-19 measure does not meaningfully interact with SDG 15	0
Constraining	A mild type of negative interaction occurs when the implementation of measure constraints slightly attainment of SDG 15	-1
Counteracting	The pursuit of the COVID-19 measure counteracts the implementation of SDG 15	−2
Cancelling	This is the most negative interaction in which implementation of a measure reverses the progress towards SDG 15 or makes it impossible to implement	−3

Source: Authors, data adopted from Nilsson et al. (2017)

of writing, a combination of expert opinions derived from in-depth interviews with key informants from conservation organisations and a review of relevant literature was used to guide the scoring process. Twenty-three (23) experts were consulted in the research. Interviewees were drawn from the Zimbabwe National Water Authority, the Environmental Management Agency, Rural District Councils with CAMPFIRE projects, Zimparks and the Forestry Commission. During interviews, implemented COVID-19 measures were highlighted and experts explained how the measures interacted with SDG 15 implementation in Zimbabwe. In the end, they gave a score for each measure as highlighted in Table 1. Selection of relevant literature was done based on the time of publication and themes addressed. Literature had to be published between April 2020 and March 2022 to be considered. Themes relevant for inclusion were COVID-19 and its effects on conservation, wetlands, forestry, wildlife and biodiversity in Zimbabwe. Not all interactions of COVID-19 measures and goal 15 could fit precisely into the seven scale semi-quantitative scoring system used; however, most could be adequately placed within the range provided by the scale.

10.4 Findings

Table 10.2 summarises the interactions of COVID-19 measures and SDG 15 implementation/ implications in Zimbabwe as derived from key informants and literature. Most of the respondents viewed the scale and depth of interactions between SDG 15 and COVID-19 measures as being largely unclear and evolving at the time of data collection. However, most viewed the COVID-19 control measures to be largely having negative implications on conservation efforts as shown by the negative scores they gave (Table 10.2). The biggest impact of these restrictive measures was the wiping away of tourism revenue from which most protected areas such as

Table 10.2 Interaction scores of COVID-19 measures and SDG 15 in Zimbabwe

COVID-19 measure	Key interaction with SDG 15	Score
Banning of gatherings of more than 100 people	A reduced movement of tourists into national and private parks, protected forests and wetlands Reduced animal and environmental disturbanceReduced community conservation awareness campaigns	1
Closure of national borders	Stopped the movement of international tourists and conservation scientists Stopped trophy hunting Elicit trade in endangered plant and animal species reduced	−2
Total lockdown	Closed parks, forestry and wetland areas to visitors, hence no conservation fees (the primary source of funding for the conservation) Reduced fish, and animal disturbances in their habitats Stopped community conservation and awareness programs Minimised conservation infrastructure repairs Curtailed the maintenance of park water points and firebreaks Solvency of conservation organisations is threatened	−2
Partial lockdown	Limit to visitors the parks, hence reducing income and conservation spending Increased poaching and harvest of forest resources	−1
Closure of government schools and universities	Stoppage of educational tours and research into conservation Environmental education related to natural resources is compromised	−1
Curfews	Reduced visitors to parks and forest areas Increased poaching was observed Human-wildlife conflict mitigation reduced	−2
Reduced business operating hours	Local economic recessions impacting on ability to visit parks Economic hardships reduced donations for conservation Reduced national budgets and private money available to fund conservation	−2
Compulsory testing & quarantine of visitors and returnees	Fear of travelling by international tourists reduces arrivals	−3
Severely restricted transport service	Reduced both local and international tourist movement Game capture and translocations stopped Use of drones to aid detection of illicit activities and increase patrol coverage	−2
Closure of many non-essential business operations	Stopped community extension services related to conservation Reduced and sometimes stopped community-based enforcement of conservation laws Courts reduced operations, hence prosecution of offenders took the time or stopped Conservation research stopped Increased competition between biodiversity and alternative land uses which degrade biodiversity Economic crisis led rural communities to unsustainable extraction of natural resources to support livelihoods	−3
Closure of domestic travel	Reduced domestic tourist arrivals	−2
Availability of COVID-19 vaccines	Opened-up local and international travel The reduced spread of the virus	1

Source: Authors

national parks, safari and forestry areas derive their greatest share of the revenue. The stoppage of construction and industrial activities during the hard lockdowns also starved funds to state environmental protection agencies such as the Environmental Management Agency and the Forestry Commission. These organisations rely on licensing fees and fines from these shut industries to fund conservation and environmental protection work.

In Zimbabwe conservation efforts are self-funded and the state does not provide any grants for such activities. For the Zimbabwe Parks and Wildlife Management Authority, 80% of the funds it uses for conservation are derived from tourism revenue with the rest coming from donor aid (Lindsey et al., 2020; Ndlovu et al., 2021). Similarly, private game reserves and some Rural District Councils (RDCs) rely on hunter and tourist revenue to sustain their efforts toward conservation. In addition, hunters and tourists provide extra eyes on the rangelands and are key in the fight against poaching (Mudzengi et al., 2022). All these benefits melted away during the COVID-19 pandemic due to the restrictive measures put in place.

The loss of employment due to the closure of non-essential industries during the peak of the COVID-19 pandemic led to the adoption of negative coping mechanisms by communities surrounding national parks, forestry areas and wetlands. There were notable increases in wildlife poaching, illegal harvesting of forestries such as tree cutting, wetland cultivation, fish poaching, protected area encroachment and artisanal mining to support livelihoods. Galvani et al. (2016) observed that during tough periods such as economic meltdowns and drought, families tend to rely heavily on natural resources for their livelihoods. Community reliance on natural resources has been noted to be one of the biggest threats to biodiversity in Zimbabwe. Similar patterns of ecosystem degradation have been observed in Botswana and Kenya during the pandemic. The deterioration of ecosystems in some places were attributed to gaps in ranger deployment frequency by the responsible authorities as a response to constrained operational budgets that came as a direct result of reduced income (Lindsey et al., 2020; Maron, 2020). Due to hardships during the hard lockdown, the nature of most environmental crimes in Zimbabwe became localised, subsistence in nature and mostly perpetrated by vulnerable social groups. The situation was made worse by the fact that Zimbabwean courts were partially shutdown in an effort to decongest the working environment and environmental crimes were not being prioritised during their limited operations.

Open space eco-tourism activities such as those done in parks, forest areas and dams were part of the first group of activities allowed to reopen after the easing of some of the COVID-19 restrictions in Zimbabwe. This is because the open spaces allowed social distances hence considered low risk. However, continued movement restrictions and threats of mandatory quarantines had negative impacts on tourist arrivals and revenue available for conservation. Sustained losses especially by the private players in conservation may result in them further scaling down on their conservation duties or outright shutdown. This may lead to land use conversion to destructive land uses such as crop farming or cattle ranching which out-rightly impacts biodiversity (Van der Merwe et al., 2021). Conservation organisations also struggled to pay and maintain their staff complement due to the drying of funding as tourism was constrained and some funders redirected funds towards the COVID-19 medical emergency. Loss of experienced workforce will likely impact on the success of conservation efforts in both the short and long-term hence handicapping progress towards SDG 15.

In addition to their expected conservation duties, conservation organisations had to deal with additional costs related to implementing COVID-19 safety protocols, reduced capacity levels and sometimes staff absence due to the need for physical distancing measures at workplaces (Miller-Rushing et al., 2021). This has led to the postponement of important but less urgent tasks that are key to the success of conservation efforts. Tasks that were put on hold or significantly scaled-down include research projects, community extension activities, environmental education, responding to problem animals, human-wildlife conflict and sharing of benefits from conservation. The pandemic also impaired networks and collaborations of conservation partners which in the past would help solve issues related to achieving SDG 15. This is because adopted measures prohibited non-essential travel and gatherings (Lindsey et al., 2020). During the pandemic, infrastructure development community outreach projects and human-wildlife conflict interventions at the Gonarezhou National Park in Zimbabwe were temporarily stopped.

Community-based conservation projects were also gravely impacted by the instituted COVID-19 measures. Loss of revenue from tourism and hunting increased the opportunity costs of ecosystem protection and the risk of land conversion to other land uses (Attah, 2021). In the Mahenye community of south-eastern Zimbabwe, COVID-19 control measures resulted in reduced income streams for the community and an increase in poaching incidences. Environmental crimes increased when people returned to the community from urban areas, prisons and the diaspora. This was combined with a significant decline in enforcement patrols (Mudzengi et al., 2022).

The impacts of COVID-19 restriction on invasive alien species are still not clear. Clearing and removal of these species is usually done manually and through the use of chemicals. Removal of invasive alien species was greatly reduced during the pandemic. This is mainly because the process is labour intensive and would attract gatherings which were prohibited by instituted lockdown measures. This will most likely result in the densification and further propagation of invasive alien species in the country. The most widespread invasive alien species in Zimbabwe are *lantana camara, eichhornia crassipes, acacia mearnsii, opuntia fulgida and vernonanthura polyanthes* and *salvinia molesta* (Mujaju et al., 2021). Landscape pollution was also highlighted as a major impact of the COVID-19 lockdowns on the urban ecosystems. This was a result of reduced waste collection as residence struggled to pay rates and the stoppage of wastes recycling since it was not an essential sector. People engaging in waste separation and recovery at municipal dump sites were asked to stop their activities during the lockdowns leading to the accumulation of mostly waste that is not bio-degradable in the environment.

However, there were some notable positive impacts of COVID-19 restrictions on terrestrial ecosystems in Zimbabwe. There were notable reductions in industrial water pollution in heavy industry areas, wildlife benefitted from reduced stress as a result of reduced human and vehicle populations especially in the usually congested national parks areas such as Hwange, Victoria Falls and Zambezi. Although subsistence poaching increased, movement restrictions due to lockdowns may have curbed illegal international trade in wildlife products. There was also an increase in the use of technology in biodiversity conservation during the pandemic. This included the use of drones, camera traps and satellite remote sensing for surveillance and near real-time capture of data on terrestrial ecosystems to support decision-making in the sector. Most of these positive ecosystem outcomes are, however, most likely going to be temporary and easily reversed when imposed restrictions are lifted. The widespread availability of the COVID-19 vaccine has led to the opening up of the country to both domestic and international tourism. This will likely lead to improvements in conservation practices that are in sync with achieving SDG 15 due to increased available funding.

10.5 Conclusion

The majority of the impacts of COVID-19 on the attainment of SDG 15 in Zimbabwe are still anecdotal. There still exist many unknowns and observed initial effects are constantly changing depending on the restriction regime. Lockdowns and related restrictions on the movement of people into and within the county have had a negative impact on tourism which is a major funder of conservation activities in Zimbabwe. This has affected the revenue and operations of conservation organisations both in the public and private sectors. Conservation-related activities such as ecological monitoring, law enforcement, research, community extension and conservation programmes, ecological restoration and administration which were already underfunded before the pandemic further suffered as a result of restriction measures meant to control the spread of the disease. There were notable increases in subsistence poaching, forest encroachment, tree cutting, wetland overuse and artisanal mining in protected areas. However, the environment benefited from less congestion and pollution as a result of restrictive measures put in place during the pandemic. In the light of the results, it can be concluded that the implemented restrictive measures in Zimbabwe created more trade-offs with SDG 15 compared to synergies. It is recommended that post-pandemic recovery and resilience building be informed by sustainability as guided and advocated for in the SDG framework. The inter-related nature of SDGs means that shocks on SDG 15 will likely impact on the success of related SDGs. The over reliance of SDG 15 implementation on tourism has been shown by the pandemic to be unsustainable hence the need to diversify revenue streams. There is also a need to build capacity for crisis management by conservation organisations in Zimbabwe. The government of Zimbabwe and its development partners need to do more to fund ecosystem conservation to counter the negative impacts brought by COVID-19.

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Chapter 11
The Impact of COVID-19 on Economic Development in Zimbabwe: Implications on the Health Delivery System

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Abstract The COVID-19 pandemic has had far-reaching impacts on economies worldwide, and Zimbabwe is not an exception. The economic impacts have had implications for the health delivery systems. Examining the impact of the COVID-19 pandemic on economic development and, therefore, on the health delivery system in Zimbabwe is uncontestably fundamental to inform and adapt the responses of government and other stakeholders to recover from the crisis. This study assesses the impact of COVID-19 on selected economic metrics such as the production of goods and services, inflation, and unemployment in Zimbabwe. It deduces the implications of the economic impacts on the health delivery system. The document analysis approach was adopted as the primary strategy for inquiry. Data on the trends of cases and related variables were obtained from interactive digital platforms such as the ZimStats website. It has emerged from the study that the COVID-19 pandemic has led to an increase in inflation, increased unemployment, a decrease in the growth rate of GDP and the creation of a burden on the health delivery system of Zimbabwe. It is concluded from this study that COVID-19 has profound negative impacts on the economic development and the health delivery system of Zimbabwe.

Keywords COVID-19 · Pandemic · Development · Mortality · Vulnerability and production

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11.1 Introduction

Pandemics are not a new phenomenon in this world. Some of the widespread pandemics are the cholera pandemic (1831–1832) that diffused from Asia to Europe, the influenza pandemic (1889 and 1918) and the H1N1 Swine Flu pandemic (2009–2010). The COVID-19 pandemic is currently ravaging the world. The pandemic has spread swiftly across the globe immediately after the first confirmed case in Wuhan, China, in December 2019 (WHO, 2020). The pandemic has had a substantial negative impact on economic development worldwide. It led to slow fiscal growth and a humanitarian crisis that affected economic sectors worldwide. The World Bank (2021) posits that the world economy is estimated to have constricted by about 4.3% in 2020, and output remained more than 5% below pre-pandemic projections in 2021. The COVID-19 contagion has, therefore, led to reduced global economic productivity.

The Zimbabwean economy has not been spared the economic and humanitarian crises induced by the pandemic. The shocks have exacerbated the stresses that the Zimbabwean economy has been facing over the years, especially after 2000. The economic effects have directly and indirectly affected the health delivery system as reflected by drug shortages, lack of Personal Protective Equipment, slow deliveries of materials and medicines, pressure on the few available medical infrastructures and long queues of patients at health facilities. The post-2000 economic challenges include negative Gross Domestic Product growth, inflation, constriction of foreign earnings, drying up of foreign direct and portfolio investments, increase in unemployment and a deterioration in international relations with Western nations (Bond & Manyanya, 2002; Ferreira, 2004; Balint & Mashinya, 2006; Chiutsi et al., 2011; Mudzengi & Chiutsi, 2014). The COVID-19 contagion shocks are worsening the economic turmoil in the country.

Given the profound impacts of the COVID-19 pandemic on livelihoods, it becomes imperative to assess the impacts of the contagion on economic development in Zimbabwe. The objectives of the current study are to analyse the current COVID-19 situation in Zimbabwe, assess the impact of COVID-19 on unemployment, analyse the impact of COVID-19 on Zimbabwe's GDP, examine the impact of COVID-19 on inflation in Zimbabwe and assess the impact of COVID-19 on the health delivery system of the country. It was hoped that the research would inform and adapt the responses of policymakers and other stakeholders to recover from the COVID-19 crisis to ensure that the contagion does not disrupt the implementation of Vision 2030, which seeks to attain an upper-middle-income economy status for Zimbabwe.

11.2 Literature Review

Numerous scholars (Jribi et al., 2020; Nicola et al., 2020; Yamin, 2020) concur that the COVID-19 pandemic has negatively impacted countries' socio-economic development globally. The slowdown in the world economy has severely impacted the working class, causing a loss in employment in all countries (ILO, 2020b). Losing employment and income pushes more individuals and families below the poverty line (United Nations (U.N.), 2020). As more individuals become relegated to the unemployment category, the levels of per capita incomes drop. Sumner et al. (2020) estimated the impact of COVID-19 on per capita household income and concluded that COVID-19 has led to an increase in the population below the poverty datum line in many countries worldwide. Indeed such a scenario constitutes an obstacle to attaining the goal of eliminating poverty by 2030. In keeping with Sumner et al. (2020) observations, Buheji et al. (2020) observed that the pandemic is a 'new source' of poverty that hurts the economic development of global economies. Generally, therefore, COVID-19 has affected the Gross Domestic Product (GDP) and, more particularly, incomes per capita in countries worldwide. Persistent lockdowns, related economic activity disruptions, travel constraints, and other COVID-19 containment measures have severely impacted workers and businesses (ILO, 2020a, b). The economic well-being of billions of people was directly affected by the pandemic because many people across the world depend on the informal economy. Globally, informal workers constitute about 61% of the workforce (ILO, 2020a, b). Such people do not have formal employment and rely on incomes from daily activities for survival. The COVID-19 pandemic and its associated negative economic impact had numerous implications on the global health delivery system. The vulnerability of public health systems across the globe cannot be overemphasised.

In general, funding for essential public health functions is causing severe challenges and is dwindling (Huberi, 2021). Health facilities are overwhelmed by COVID-19 patients, leading to human resources shortages (Huberi, 2021). COVID-19 pandemic has interrupted routine healthcare services (World Health Organization, 2020), with medical personnel getting infected, leading to their deaths, while others resigned due to fear of contracting the virus. Further, the COVID-19 contagion has hurt people's physical and mental health (World Health Organization, 2020). The COVID-19 pandemic has also led to health authorities emphasising more on the containment of the epidemic, thereby giving less attention to other diseases such as the Human Immuno-Deficiency Virus (HIV), tuberculosis and malaria. The COVID-19 pandemic has interrupted routine healthcare services (World Health Organization, 2020), with medical personnel getting infected, leading to their deaths, while others resigned due to fear of contracting the virus.

Further, the COVID-19 contagion has hurt people's physical and mental health (World Health Organization, 2020). The COVID-19 pandemic has also led to health authorities emphasising more on the containment of the epidemic, thereby giving less attention to other diseases such as the Human Immuno-Deficiency Virus (HIV), tuberculosis and malaria. The COVID-19 contagion has also led to increased hunger, and malnutrition incidences as resources are diverted from supporting agricultural activities into trying to contain the epidemic (Mudzengi et al., 2021). Hunger and malnutrition could lead to people being lethargic and more prone to other illnesses, leading to poor health outcomes. Huge budgets are being committed to trying to contain the COVID-19 pandemic through vaccination and monitoring the epidemic through ongoing epidemiological surveillance, strategic testing, conducting outbreak investigation and contact tracing (World Health Organization, 2020).

The African continent has generally recorded lower infection rates of COVID-19 compared to Europe and North American continents (WHO, 2020). It can be argued that the lower pandemic infection rates in Africa can be attributed to the continent's predominantly youthful population age structure since, generally, people who have easily succumbed to the pandemic are those over the age of 65 with other underlying morbidities. The World Economic Forum (2020) notes that 3% of the population in Sub-Saharan Africa is above 65 years, much lower than, for example, that of China, which stands at 11% and 23% of Italy. The spatial spread of the pandemic has also not been homogeneous across Africa. As of 24 April 2020, South Africa had the most significant number of COVID-19 confirmed cases at 3953 and death cases of 75, but on the other hand, Comoros and Lesotho had not recorded any confirmed cases of COVID-19 during that time (WHO, 2020). The lower infection rates did not mean that the continent was spared from the negative ramifications of the pandemic. With heavy dependence on agriculture, Africa is experiencing severe food shortages, some of which are COVID-19 induced (Lindsey et al. (2020). Lindsey et al. (2020) further note that due to the crises associated with the COVID-19 pandemic in Africa, local food insecurity and poverty have increased as governments invest more in health and less in agriculture and other economic sectors. The COVID-19 contagion also disrupted food production and distribution. This was especially so during the first phases of the pandemic when most economic activities closed as governments and companies instructed workers to stay at home (Nicola et al., 2020). Health facilities in Africa generally lack the essential resources for the containment of COVID 19, such as masks, sanitisers, diagnostic testing kits and equipped (Faln, 2021).

Zimbabwe's economic development has been negatively affected by the shocks emanating from the COVID-19 pandemic. The first COVID-19 case in Zimbabwe was reported on 21 March 2020 in the resort town of Victoria Falls, and by 31 March, more and more people were testing positive, with one reported death (Zimbabwe Peace Project, 2021). As the pandemic worsened in Zimbabwe, the living standards of people suffered. Incomes were directly affected since millions of people in Zimbabwe depend on self-employment or the informal sector. Zimbabwe has the biggest informal economy in Africa, 60.6% (IMF, 2018). Informal traders generally live from hand to mouth, and when lockdown and other related containment measures were introduced, the traders were not prepared for that. This implies that COVID-19 severely impacted the millions of Zimbabweans who depended on the informal sector and whose sources of income and livelihoods were disrupted by the pandemic and related containment measures.

The pandemic and the related negative economic impacts severely impacted Zimbabwe's healthcare delivery system. The onset of COVID-19 in Zimbabwe against a background of declining health services and a deteriorating epidemiological profile characterised by a dual burden of both communicable and non-communicable diseases. Even before the pandemic, the healthcare system of Zimbabwe was characterised by a malfunctioning infrastructure, a shortage of equipment, including personal protective equipment, a shortage of drugs and poorly paid healthcare professionals (Kavenga et al., 2021). In addition, Kavenga et al. (2021) note that striking the healthcare professionals demanding higher salaries and better conditions of service during the initial phase of COVID-19 reduced the ability of the system to manage the cases of the pandemic timeously, delaying the setup of isolation and treatment facilities.

11.3 Materials and Methods

11.3.1 Study Area

Zimbabwe is a land-locked country in Southern Africa (Fig. 11.1). South Africa borders it to the south, Zambia to the northwest, Mozambique to the northeast, Botswana to the Caprivi Strip of Namibia to the southwest. Harare is the capital city of the country. The country has 61 administrative districts and ten provinces. The provinces have, on average, about seven administrative districts each. These administrative districts, such as provinces, show significant variation in terms of area, population health characteristics and levels of economic development. Zimbabwe's health delivery system is generally fragile, and the provision of health services in the country is highly unequal. Urban areas in Zimbabwe tend to have better healthcare services than their rural counterparts (Chazireni, 2015). The COVID-19 pandemic has become an additional challenge to the matrix of problems the country's health delivery system faces. As of 20 March 2022, 224,452 confirmed cumulative cases of COVID-19 and 5429 COVID-19-related deaths (Hannah et al., 2022). During the onset of the pandemic, the cases fatality rate for the country was high, but it has now stabilised to a cocktail of the pandemic containment measures put in place by the government.

Zimbabwe has been periodically facing many challenges, including economic challenges, droughts and cyclones (Mudzengi & Chiutsi, 2014). Currently, there is a great shock caused by the COVID-19 pandemic.

11.3.2 Data Collection

To analyse the impact of COVID-19 on the economic development of Zimbabwe, it was necessary to examine the impact of COVID-19 on the macroeconomic indicators of the development and health delivery system of Zimbabwe. The macroeconomic indicators considered in this study were unemployment, inflation and GDP. Such variables were selected based on data availability, and the variables constitute the core of indicators of economic development. Data on the cumulative cases of COVID-19 in Zimbabwe were extracted from published data by the

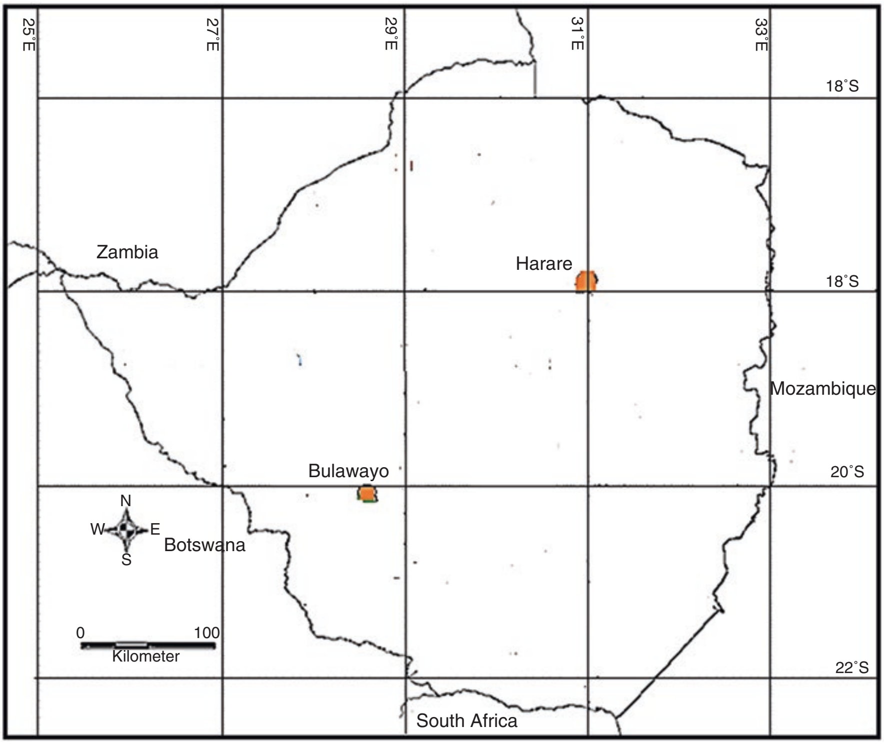

Fig. 11.1 Map of Zimbabwe. (Source: Authors, 2022)

Ministry of Health and Child Care website. On the other hand, data on macroeconomic variables were extracted from the published Zimbabwe Statistical Agency (ZIMSTAT) website and the Take-profit organisation website. The data collected on macroeconomic variables included data on unemployment, inflation and economic growth rate and particularly on Gross domestic product.

11.3.3 Data Analysis

Data analysis in this study involves the examination of the impact of COVID-19 on economic development and the health delivery system of Zimbabwe. Macroeconomic variables determine economic development. Macroeconomic variables (e.g. economic output, unemployment and employment, and inflation) play a vital role in the economic development of any country (Sharma et al., 2011). A comparative confirmatory analyses approach was used to examine the impact of COVID-19 on various macroeconomic variables (unemployment, inflation and GDP) was used to examine how COVID-19 affected economic development and the health delivery system of Zimbabwe. Minitab 17 Statistical software (2010 Version) was used to perform the analysis of data. Graphs were used to depict the temporal variation in the cumulative cases of COVID-19 and the temporal variation in the macroeconomics of unemployment, inflation and GDP changes. After the graphical presentations, there is an interpretation and discussion of the Results. Emphasis is made in the discussion on how the pandemic has impacted economic development and the health delivery system of Zimbabwe.

11.4 Results and Discussion

Zimbabwe experienced an increase in cumulative cases of COVID-19 since the beginning of the pandemic in the country (Fig. 11.2). The cumulative cases of COVID-19 rose from below 1000 on 15 February 2020 to 214,540 on 11 January 2022 (Fig. 11.2). During the same period, there were also increases in total coronavirus deaths. Initially, the growth rate in cumulative cases of COVID-19 and total coronavirus death was meagre. However, the rates are currently high, as depicted by the gradient of the curves in Fig. 11.2. The large numbers of COVID-19 cases and the associated deaths in Zimbabwe have led to numerous negative impacts on the economy of Zimbabwe. As the total number of COVID-19 rose, as depicted in Fig. 11.2, there were numerous implications for the health delivery system. Inevitably, such increased cases imply greater demand on health workers, more Personal Protective Equipment for the workers, more medicine being needed and other health resources.

Unemployment is a macroeconomic variable in the economic development of Zimbabwe. There is no standard definition for unemployment. In broad terms, unemployment denotes a condition where anyone looking for a job and is available to work but fails to get one may be considered unemployed for the period (Adesina,

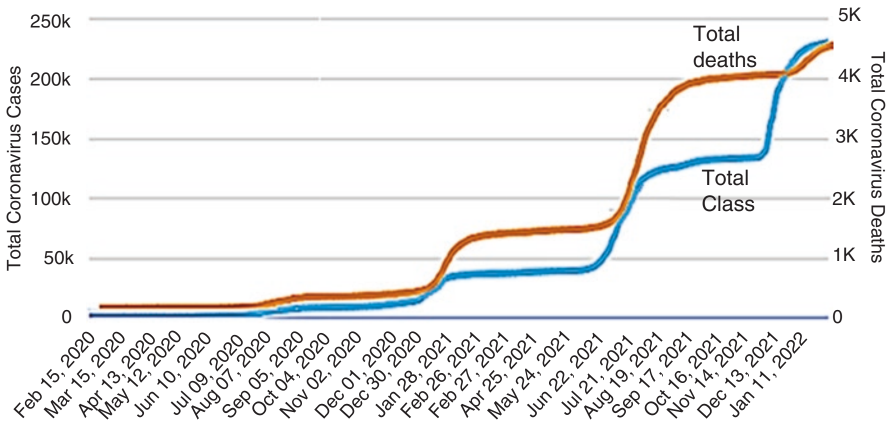

Fig. 11.2 Total COVID-19 cases and deaths. (Source: Authors, field data, 2022)

2013). Numerous countries use definitions that suit their local priorities. According to ZIMSTAT (2021), the unemployed people would exclude those that are self-employed, such as those in the informal sector and those in subsistence farming. This is why the unemployment rates for Zimbabwe, depicted in Fig. 11.3, are generally low values. For the current study, there is no problem since the intention is to analyse the temporal variation of the unemployment rates since all rates were calculated using the same criterion.

There are numerous causes of unemployment; Friedman (2013) attributes unemployment to changing jobs within an economy (time lag between leaving a job and getting a new job), downturns in the economy and technological change where machines replace human labour. Entirely attributing unemployment to COVID-19 is unjust. It can be argued in this study that while there are numerous causes of unemployment, COVID-19 has exacerbated the influence of other factors leading to higher levels of unemployment in Zimbabwe. As shown in Fig. 11.3, prior to the onset of COVID-19, unemployment was falling during the period from 2018 to 2019. Unemployment remained constant from 2019 to 2020. From 2020 onwards, after the onset of COVID-19, the gradient of the unemployment curve was steep, which means that there was a sharp increase in unemployment. This means that increase in cumulative cases of COVID-19 was associated with increased unemployment, as depicted in Figs. 11.2 and 11.3. This means that as the cumulative cases of COVID 19 increased, unemployment also increased.

Inflation is a continuous increase in the general price level of goods and services. The Consumer Price Index (CPI) is customarily used to measure inflation by tracking the changes in the prices consumers pay for a basket of goods and services over time. When inflation increases, it is a sign that the country is not experiencing economic development. As shown in Fig. 11.4, inflation starts to increase from mid-2020 to 2022. During the same period (2020 to 2022), the incidences and

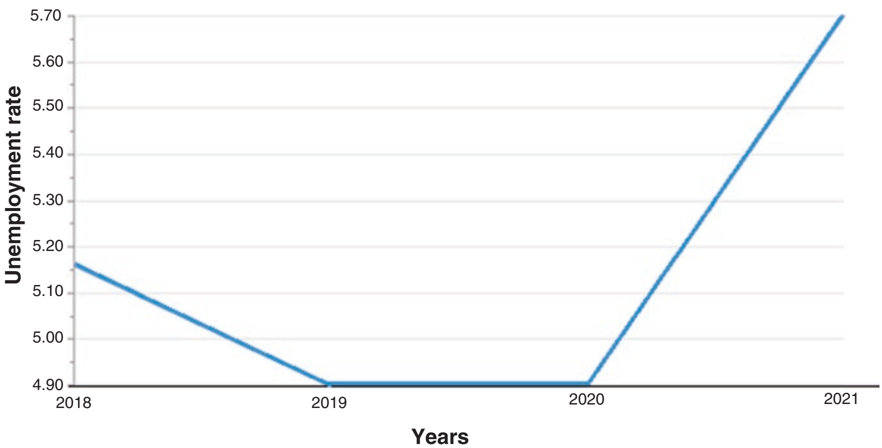

Fig. 11.3 Unemployment in Zimbabwe from 2018 to 2021. (Source: Authors, data from Take-profit org. Unemployment data)

prevalence rates of COVID-19 increased. Before the onset of COVID-19, the inflation rate (measured by Consumer Price Index (CPI)) was meagre, at 130 index points in 2018 and 290 index points in 2019. After the onset of COVID-19, the inflation rate (CPI) rose continuously from 290 index points in 2019 to 4190 index points in 2022 (shown in Fig. 11.4).

GDP represents the total value of final goods and services produced in a country over some time. The use of GDP as an indicator of economic development in development discourse is not unique to this study. Numerous scholars (Kuznets, 1934; Marcuss & Kane, 2007; McCulla & Smith, 2007) acknowledge that GDP is an indicator of a country's overall economic performance of a country. Gross Domestic Product (GDP) is thus an essential indicator of the economic performance of Zimbabwe.

Several factors affect GDP growth, and these include the openness of the economy (Baldwin, 2004), foreign direct investment (Falki, 2009), foreign aid (Fatima, 2014), inflation (Qayyum, 2006), and education expenditures (Sylwester, 2000). This implies that COVID-19 is not the only determinant. What is interesting in this study is that the increase in the COVID-19 pandemic was associated with a decrease in DGP growth. It is, therefore, reasonable to argue that COVID-19 has negatively impacted GDP growth in Zimbabwe.

As depicted in Fig. 11.5, before the onset of COVID-19, GDP was increasing, reaching a maximum in 2019. After the onset of the pandemic (in 2020 and 2021), there was a decline in the GDP, and this is the period when COVID-19 was affecting the country.

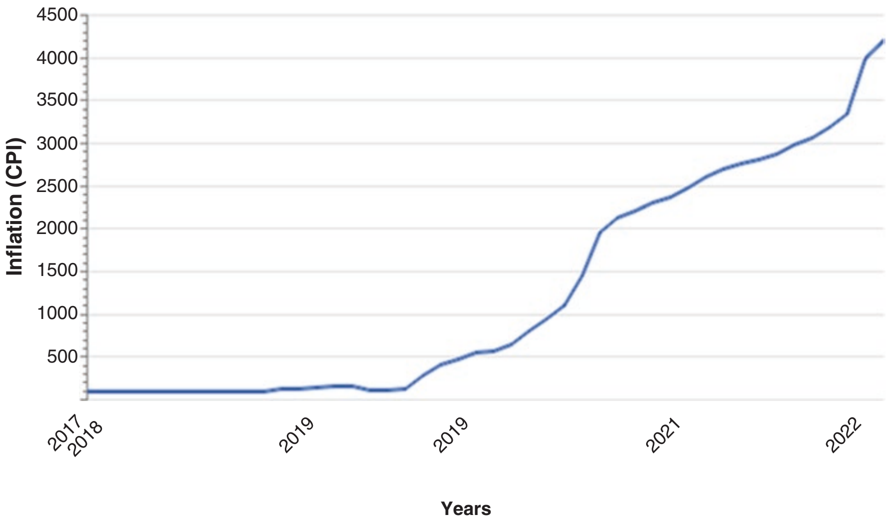

Fig. 11.4 Inflation measured by Consumer Price Index. (Source: Authors, data from Take-profit org. Inflation data)

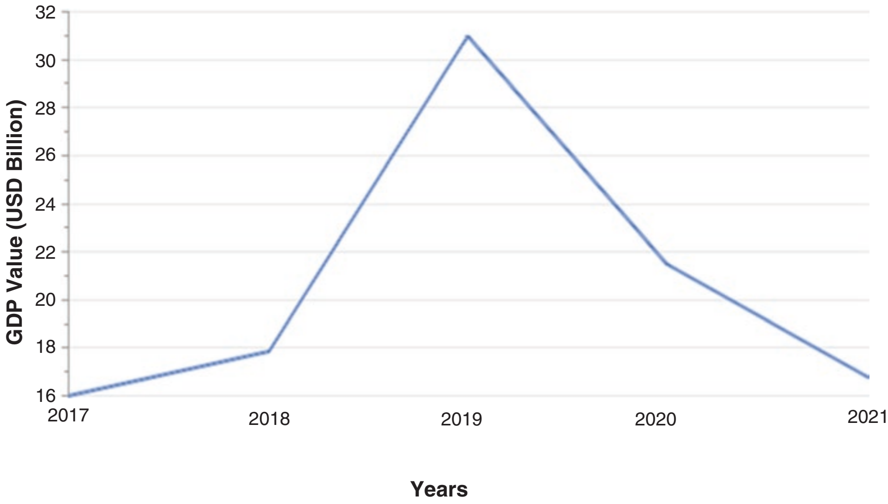

Fig. 11.5 Gross Domestic Product (GDP) of Zimbabwe from 2017 to 2021. (Source: Authors, data from Take-profit org)

11.5 Discussion

Numerous macroeconomic variables serve as indicators of a country's economic development level. The macroeconomic variables are inflation, GDP or Gross National Product, Balance of Payments and unemployment. In this chapter, unemployment, GDP and inflation were used to demonstrate how they varied with the incidence and prevalence of COVID-19. The linkage between each macroeconomic variable with COVID-19 was determined to assess the impact of COVID-19 on the overall economic development and the health delivery system of Zimbabwe.

Numerous scholars (Paul & Moser, 2009; Jin et al., 1995; Stuckler & Basu, 2013; Parvathamma, 2020) have demonstrated a strong and consistent association between unemployment and various adverse health outcomes. An increase in unemployment was associated with an increase in cumulative cases of COVID-19 (Figs. 11.2 and 11.3). This means that as cumulative cases of COVID-19 increased, the unemployment rate also increased. A high unemployment rate is a sign that a country's economic performance is poor. It can be argued that with continued lockdowns, some firms eventually failed to meet the fixed costs of the firms (costs which are mandatory irrespective of whether there is production or no production) and eventually, such firms had to close operations leading to unemployment. COVID-19 also led to morbidities and mortalities, lowering the firms' production processes. Overall, the economic development of Zimbabwe has been negatively affected. The high morbidities and lower economic development levels imply that the health delivery system was negatively impacted. Health facilities have a more significant number of patients to take care of, often against the background of limited resources.

Inflation is another macroeconomic variable which can serve as an indicator of the level of development of a country. As depicted in Fig. 11.4, the pre-COVID era experienced price stability, but after the onset of the pandemic, market volatility ensued with a large-scale increase in inflation. As shown in Figs. 11.2 and 11.4, inflation has a positive relationship with COVID-19. This means that as cumulative cases of COVID-19 increased, the inflation rate also increased. A high inflation rate is a sign that a country's economic performance is poor. It can be argued that with continued lockdowns accompanied by higher morbidities, particularly among workers, production processes in the economic sectors of the economy Zimbabwe declines to lead to lower outputs. Once there are fewer commodities (goods and services), prices inevitably go up. Such a phenomenon is often called demand-pull. When the value of demand is greater than the value of supply, the inflationary gap or demand-pull inflation arises (Tatoninchi, 2011). This implies that when a country's gap between aggregate demand and aggregate supply is significant, there is more rapid inflation. In other words, consumer demand outpaces the available supply of many types of consumer goods. Prices rise beyond the reach of many people, which negatively impacts the socio-economic well-being of the people. Overall, the economic development of Zimbabwe has been negatively affected by such inflationary pressures.

The GDP negatively affected COVID-19 (Figs. 11.2 and 11.5). This means that as cumulative cases of COVID-19 increased, GDP decreased. Low GDP is a sign that a country's economic performance is poor. The Organisation of Economic Cooperation and Development (2020) observes that measures put in place to reduce the diffusion of COVID-19, such as lockdowns, short working hours, mobility restrictions, stay-at-home mandates and distancing restrictions, have led to a decline in output and GDP. In Zimbabwe, the continued lockdowns and higher morbidities and mortalities among the population, social distancing restrictions mandated by the governments and reduced working hours have led to a decline in production in the economic sectors of the economy country hence, lower outputs and GDP. ILO Monitor (2021) also observes that COVID-19 has impacted the world of work badly regarding reduced working hours and employment losses. Reduced working hours imply fewer production processes and hence lower GDP. COVID-19 also led to reduced revenue from the tourism sector of Zimbabwe, partly leading to a lower GDP level. As the number of cumulative cases of COVID-19 rises and with the enactment of specific mandatory measures such as social distancing, lockdowns, work from home, stay at home, quarantine, and curbing of crowding, pressure is created to suppress the growth of the tourism industry (Gretzel et al., 2020; Sigala, 2020). During the pre-COVID-19 era, tourist arrivals in Zimbabwe rose from 2,498,400 in 2018 to 2,579,974 in 2019; after the onset of COVID-19, tourist arrivals dropped over the years to 639,356 in 2021 (ZMoECCTHI, 2021). Overall, the economic development of Zimbabwe has been negatively affected by COVID-19.

The impacts of COVID-19 on macroeconomic parameters of economic development have implications on the health delivery system of Zimbabwe as it precipitates failure to counter the rapid diffusion of the pandemic effectively. The implication of failure to counter the rapid diffusion of the pandemic is that the more significant part of the population remains susceptible to COVID-19 infection, which imposes a burden on the country's health delivery system. The rapid diffusion of the pandemic has led to an increase in levels of hospitalisations in the population. Such a scenario is highly worrisome in Zimbabwe, given that the country's health system is already struggling with drug, material, personnel and bed shortages. In addition to such challenges, the health system in Zimbabwe has a disgruntled workforce which is on strike from time to time. COVID-19 has led to job losses in Zimbabwe. Job losses have led to negative ramifications on the health of the unemployed people, and such a scenario strains the country's already weak health delivery system. Numerous scholars (Bambra, 2010; Dooley et al., 1996; Mathers & Schofield, 1998; Burgard et al., 2007) have established the link between unemployment and poor health. Such a health burden stains and weakens the country's health delivery system. The decline in GDP due to the pandemic has led to severe ramifications for the health delivery system of Zimbabwe. When the level of GDP decreases, health expenditures decrease too, and the health delivery system of Zimbabwe usually declines. Inflation implies that the cost of accessing health services increases. It is against the background that the Zimbabwean health system heavily relies on the Out-Of-Pocket system as a source of funding for health delivery, as indicated by Makochekanwa and Mapani (2016).

11.6 Conclusion

The COVID-19 pandemic has caused unprecedented economic turmoil and severe humanitarian crisis in countries worldwide, and Zimbabwe is not spared from the problem. Numerous macroeconomic variables have been negatively impacted by COVID-19. It is, therefore, imperative that the impact of COVID-19 on economic development in Zimbabwe and, therefore, on the health delivery system of the country needs to be assessed. Based on the analysis of temporal variations in the cumulative cases of COVID-19 in Zimbabwe, and temporal changes in unemployment, inflation and Gross Domestic Product in the country, it emerged that the disease has linkages with the macroeconomic variables. Overall, economic development and the health delivery system of Zimbabwe have been severely affected by the emergence of COVID-19. There is a positive relationship between COVID-19 and unemployment, but on the other hand, there is a negative relationship between COVID-19 and Inflation as well as GDP values. COVID-19 has significantly constrained economic activities in Zimbabwe, resulting in higher levels of unemployment, higher levels of inflation as measured by the consumer price index, lower Gross Domestic Product and higher imports. Amid a lower level of economic development and proliferation of COVID-19 cases, there were negative implications for the country's health delivery system.

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Part IV
Vaccine Uptake and Diplomacy

Chapter 12
COVID-19 Vaccination Hesitancy: Interrogating the Trends, Dynamics and Implications for the Health Delivery System in Zimbabwe

Lazarus Chapungu and David Chikodzi

Abstract The proliferation of the COVID-19 pandemic has seen a cocktail of measures being implemented across the globe in an effort to stop its spread as well as its impacts. Vaccination has been considered one of the most effective public health strategies to protect against the infectious disease. However, its effectiveness has been largely compromised by vaccine hesitancy across the globe. The government driven COVID-19 vaccination programme in Zimbabwe has seen variable responses from the citizens, with some indicating unwillingness to be vaccinated. As of 6 June 2022, only 31% of the eligible population had been fully vaccinated despite the ready availability of different types of vaccines. The reasons for vaccine hesitancy remains veiled in obscurity yet vaccination is key to stopping the spread of the pandemic. The question is, why is the rate of vaccination still low when the vaccines are available? This study explores the vaccination trends since the onset of the COVID-19 pandemic and assesses the factors influencing the specific trends and implications on the country's health delivery system. It interrogates the possible causes and consequences of COVID-19 vaccination apathy, hesitancy and neutrality. A mix of methodological approaches is employed, including empirical data collection using a pre-designed data collection tool, systematic literature review following the PRISMA model and use of secondary data sources from interactive science websites. Results indicate low vaccine uptake. Lack of information about the vaccines, the government strategy, misinformation, religious and cultural orientation, medical conditions, and lived experiences were the key factors influencing vaccination apathy, hesitancy and neutrality. The study concludes that the appropriate use of all available information platforms to inform and educate citizens is key in implementing government programmes in addressing global pandemics.

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Keywords Vaccine hesitancy · Vaccination neutrality · Vaccination apathy · Zimbabwe · COVID-19

12.1 Introduction

The severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) has wreaked havoc across the world, causing the corona virus disease 2019 (COVID-19) which has affected about 534 million people and killed approximately 6.3 million as of 9 June 2022 (Ritchie et al., 2020). Several other direct and indirect effects of the pandemic were felt by virtually every sector of the world economy, including tourism, agriculture, environment and manufacturing, among others (Adelodun et al., 2021; Jiang et al., 2021). In Southern Africa, the pandemic further constrained the already struggling health sector riddled by deprived medical infrastructure and poor health outcomes with consequences of high mortality rates driven by HIV and AIDS, tuberculosis and non-communicable disease burden (Vearey et al., 2021).

To address the effects of COVID-19, both direct and indirect, the World Health Organization (WHO) drafted a cocktail of measures, which included social and physical distancing, frequent handwashing, face mask wearing, disinfection of public places, covering coughs and sneezes and quarantining the infected persons (Studdert and Hall, 2020; Von Tigerstrom and Wilson, 2020). In addition to the various methods approved to contain the proliferation of the pandemic, COVID-19 vaccines were developed to provide immunity to the masses against the virus (King et al., 2021; Dzinamarira et al., 2021). This was considered a colossal step towards the complete eradication of the global disease and revert back to normalcy (Haque and Pant, 2022). Since 1900s, vaccination has been recognised as the best method to address global health challenges associated with pandemics and epidemics (Cascini et al., 2021). It has significantly contributed to the obliteration of smallpox and slow down the onslaught of tetanus, measles, poliomyelitis, diphtheria and a plethora of other infectious diseases (Dzinamarira et al., 2021). For the COVID-19 pandemic, various vaccines were developed and administered to populations across the world, including Johnson and Johnson, Moderna, Oxford AstraZeneca, Pfizer, Sinopharm, Sinovac, Sputnik V, Covaxin, Sputnik light, Medigen, and Soberana2, among others (WHO, 2022).

Initially, the vaccines were scarce and only accessible to the wealthy countries and individuals who could afford to travel for a vaccine (Biru, 2021). However, the entry of several players into the development and distribution of COVID 19 vaccines saw an increased availability across the world. For example, the COVAX facility was focused on promoting equitable distribution of vaccines in low and middle income countries (Nhamo et al., 2021). By 15 January 2022, the facility had distributed 1 billion doses, assisting a significant fraction of the global population (WHO, 2022). However, despite these efforts, a number of countries in the developing regions still face logistical challenges related to the distribution and administration of COVID-19 vaccines. Most of the challenges are related to internal factors and the general perceptions on the vaccines (Cordina et al., 2021).

In fact, most countries have received more doses than they have administered. WHO (2022) reports that more than 1 billion eligible people in low-income countries were still not vaccinated as of 22 May 2022. Globally, merely 57 countries had inoculated 70% of their population. All of these countries are high-income. In Africa, as of 13 June 2022, only 23.7% of the population had received at least one dose and 18% had been fully vaccinated (WHO, 2022). This slow progress in vaccination is indicative of the fact that despite the global successes in eradicating infectious diseases through administering vaccines, a significant fraction of the global populace remains either oblivious or concerned about the efficacy, safety and the need for vaccines. This has bred the phenomenon of vaccine hesitancy among a large number of the global population.

In view of the global health significance of vaccination programs at the backdrop of a vaccine apathetic, neutral and hesitant populace, the need to unpack the trends, dynamics and factors of vaccine hesitancy cannot be overemphasised. In Zimbabwe, as of 13 June 2022, enough doses (22,397,800 (108%)) of COVID-19 vaccines had been received but only 48% (10,796,053) of the vaccines had been administered and only 30% of the population had been fully inoculated. This presents a clear case of slow vaccination progress which might have been precipitated by vaccine hesitancy. The evidence of vaccine hesitancy has already been highlighted in a number of studies (Dzinamarira et al., 2021; Murewanhema et al., 2022; Mundagowa et al., 2021). Mundagowa et al. (2021) pointed out some of the factors contributing to vaccine hesitancy. However, the study did not reflect on the implications on the health delivery system within the country. More so, only a few factors were determined. Dzinamarira et al. (2021) explored the threat of vaccine hesitancy in Zimbabwe and underscore the need for information provision to enable clear understanding of the vaccines and encourage participation in the vaccination program. However, the trends, dynamics and implications of vaccine hesitancy on health delivery system still remains veiled in obscurity. In addition, Murewanhema et al. (2022) did a narrative review of the strengths, weaknesses, opportunities and threats of the vaccination programme and pointed the need for the government to address vaccine hesitancy. However, the study did not provide the practical steps towards dealing with the problem of vaccine hesitancy.

Given this background, and the existence of information gaps, it remains difficult to design an effective framework for addressing the problem of vaccine hesitancy. This chapter interrogates the trends, dynamics and implications on the health delivery system of vaccine hesitancy, apathy and neutrality with a view to contribute to the knowledge for designing an effective framework for improving participation in vaccination programs that aim to address global pandemics such as COVID-19.

12.2 Literature Review

12.2.1 Vaccine Development and Distribution

Vaccine development is not a new concept, it dates back to the seventeenth century (Greenwood 2014). Several vaccines have been developed to deal with infectious diseases, especially among the infants. In a bid to slow down and obliterate the proliferation of the COVID-19 pandemic, the World Health Organisation (WHO) authorised vaccines for emergency use in December 2020 (Murewanhema et al., 2022). The vaccines were developed in the developed countries and by March 2021, more than 1 billion doses were developed. Nhamo et al. (2021) report that by 15 July 2020, 24 COVID-19 candidate vaccines were already on clinical evaluation while 140 were at pre-clinical evaluation stage. Most of these developments were taking place in high income countries whist Africa and other developing regions were lagging behind in terms of vaccine development (Otu et al., 2021). Inoculation also began in the developed countries and the vaccines were initially not easily accessible to countries in Africa and other developing regions (Nhamo et al., 2021; Hlongwa et al., 2022; Mutombo et al., 2022).

Developed countries adopted a number of strategies to ensure that their populations were vaccinated ahead of other regions, with massive ordering of pre-developed millions of doses of COVID-19 vaccines (Otu et al., 2021). By April 2021, more than 87% of the COVID-19 vaccines global stocks were amassed by high-income countries (Otu et al., 2021) However, the WHO-led COVAX facility was put in place to ensure that other vaccine non-producing countries also receive the vaccines. More so, other developed countries later on embarked on a programme to support developing countries through bilateral and multi-lateral agreements. For example, Asia secured the commitment of India, Australia, Japan and the USA to receive more than a billion doses by the end of 2022 (Otu et al., 2021). Africa has now embarked on a massive vaccination drive through the COVAX facility as well as bilateral agreements with vaccine producing countries. For example, Zimbabwe secured most of its COVID-19 vaccines from China (Kouamou et al., 2021; Murewanhema et al., 2022), while 18% of the total doses received were received through the COVAX facility (WHO, 2022).

Not only were the vaccines inaccessible, but also information about the vaccines was very limited among the developing countries. In the absence of well communicated scientific information, infodemic took centre stage with the dominance of the social media in the dissemination of information related to the COVID-19 pandemic. In some cases, anti-vaccine movements dominated the social media sending wrong negative messages concerning the COVID-19 vaccines and reducing vaccination willingness among the global citizens (Lu and Sun, 2022). In Zimbabwe, the first delivery of vaccine doses arrived from China on 15 February 2021 as a donation (Dzinamarira et al., 2021). Receiving a donation in times when there was a global scramble for vaccine doses raised a lot of social media questions which exacerbated negative perceptions about the vaccines, and this could have contributed to the increase in vaccine hesitancy.

12.2.2 Vaccine Hesitancy: An Overview

The concept of vaccination as the panacea for dealing with global health challenges dates back to 1796 during the days of Edward Jenner who contributed significantly to the pioneering of the approach to address the challenge of smallpox (Greenwood, 2014). Vaccination has generally been regarded as the most effective way to deal with deadly pandemics worldwide (King et al., 2021; Sina-Odunsi, 2021). Diseases that have been commonly found in countries across the globe have been eliminated due to vaccination. For example globally, a significant number of children suffered from illnesses due to diseases but after vaccination, the infectious diseases have been completely eradicated (Marzo et al., 2022; Cordina et al., 2021). There are specific success stories in Canada and other developed countries where cases of measles, smallpox, diphtheria, polio, and pertussis among children were completely eradicated as a result of vaccination (Heywood et al., 2016). In the context of a pandemic like COVID-19, an adequate number of individuals must be vaccinated to achieve herd immunity (Morales et al., 2022; Corcoran et al., 2021; Hlongwa et al., 2022). This would prevent transmission of the virus among individuals. However, if herd immunity is not achieved, infection and reinfection will take place resulting in failure to eradicate the pandemic. One of the key factors that has potential to influence failure to achieve herd immunity is vaccine hesitancy (Morales et al., 2022; Hlongwa et al., 2022). The recent outbreaks of rubella, pertussis, and mumps, among other infectious diseases have been associated with under-vaccinated communities (Dzinamarira et al., 2021), influenced by vaccine hesitancy, among other factors. Vaccine hesitancy is defined as the delay in recognition of the authenticity and acceptability of a vaccine in spite of its availability (Burger et al., 2022; Lu and Sun, 2022; Morales et al., 2022).

The management of routine infant vaccines is now very high among developing countries as well as the developed world (Greenwood, 2014). The vaccines have become acceptable in most communities around the world except in those communities where religious beliefs dominate all other practices. However, the story is different with the proliferation of the COVID 19 pandemic, which requires vaccination of adults who can make a choice not to be vaccinated. Signs of vaccine hesitancy in Africa are reflected in the statistics on the received versus the administered doses. Most countries have now received more doses than they have administered, with others having received enough doses to inoculate more than 70% of the population but they are still way below 50% (WHO, 2022). In Zimbabwe, for example, about 30% of the population has been fully vaccinated as of 14 June 2022 yet the country has received enough doses to vaccinate more than 70% of the population (WHO, 2022). A survey by CompariSure in South Africa shows that 52% of South Africans indicated unwillingness to take the COVID-19 vaccines citing fear of needles, religion and the government's approach as impediments to vaccination (Dzinamarira et al., 2021).

12.2.3 The Drivers of Vaccine Hesitancy in Zimbabwe

Mutombo et al. (2022) argue that the underlying cause of vaccine hesitancy in Africa is the lack of knowledge on the effectiveness of vaccination as a strategy to address public health concerns. In Zimbabwe, this proved to be true as the greater part of the population seemed hesitant to take the COVID-19 vaccines in the early stages of the vaccination programme. As of June 2022, more than a year after the roll-out of the vaccination programme, only about 31% of the population was fully vaccinated (WHO, 2022). This is despite the fact that the country has received enough doses for all people to be vaccinated. The key drivers of vaccine hesitancy in Zimbabwe are related mainly to the lack of scientific information on the effectiveness and safety of the COVID-19 vaccines (Mundagowa et al., 2022). The information provided by the Ministry of health and Child Care (MoHCC) as well as the WHO was distorted by social media platform information supplied by the anti-vaccine movement. A lot of conspiracy theories and mythical stories were put across, instilling fear and doubt among the greater part of the population. Otherwise, initial studies had observed greater willingness by the populace to receive the vaccine (Dzinamarira et al., 2021; Mundagowa et al., 2021) but this trend might have been affected by misinformation and infodemic through social media.

Some of the stories make reference to the 'historical, structural and other systemic dynamics that underpin vaccine matters in Africa in general (Mundagowa et al., 2022:320). There are historical, colonial research distortions in the medical field that might be contributing to vaccine hesitancy. In addition, from the onset of the vaccination programme, there was lack of trust in the government's ability to ensure the effectiveness of the vaccines (Dzinamarira et al., 2021; McAbee et al., 2021). The lack of trust partly emanates from weak regulation and quality control of the imported vaccines.

Conspiracy theories that were propagated at the beginning of the vaccination programme have had a long term impact on decision making by individuals (Dzinamarira et al., 2021). Even at the time of writing, there are still some religious sects who hold that vaccination against COVID-19 is unacceptable. McAbee et al. (2021) in a study conducted in the Eastern Highlands of Zimbabwe reported that the level of education contributes to the intention to vaccinate against COVID-19. In their study, respondents with at least secondary level education had higher chances of getting vaccinated compared to those without formal education.

There is an observation that, although various factors are working together to influence vaccine apathy, neutrality and hesitancy in Zimbabwe, the vaccine landscape remains dynamic and the trends are likely to shift with time (McAbee et al., 2021). For example, as people gain more knowledge about COVID-19 vaccines, their willingness to be vaccinated can be enhanced. Government policies and strategies also play a pivotal role in determining the trends and dynamics of vaccine hesitancy, for example, imposed restrictions on unvaccinated individuals have been a driving force behind voluntary vaccination (Kouamou et al., 2021; Murewanhema et al., 2022).

12.3 Materials and Methods

12.3.1 Study Area

The study was conducted in Zimbabwe, a landlocked southern African country lying in the tropics. The country is located on a plateau whose elevation drops northwards in the Zambezi valley. The country recorded its first case of COVID-19 on 20 March 2020 (Makurumidze 2020). Since then, the number of daily cases has been fluctuating across the country. While the study covered all the provinces using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework for analysis, empirical data was collected from three randomly selected provinces, namely Mashonaland Central, Matabeleland North and Masvingo (Fig. 12.1).

12.3.2 Research Design and Data Collection

The mixed methods research design was adopted for data collection and analysis. In this design, a combination of the literature analysis following the PRISMA guidelines (Fig. 12.2) and questionnaire surveys was used. The PRISMA approach was selected based on its wider applicability and comprehensiveness (Janjua et al., 2021). The word schemes used included ‘Vaccine hesitancy AND Zimbabwe’ or ‘COVID-19 vaccination and Zimbabwe’. Four major e-databases (Scopus, Web of Science, PubMed, and ScienceDirect) were considered to achieve a multidisciplinary scope of the literature.

As shown in Fig. 12.2, the qualitative synthesis included 28 studies while 11 research articles that were explicitly referring to COVID-19 vaccine hesitancy in Zimbabwe were included in the quantitative synthesis.

In addition to literature analysis, a questionnaire was administered through a blended data acquisition approach which involved online as well as face-to-face surveys. The online survey on google forms was distributed to individuals known to the researchers, most (approximately 65%) of whom were university students and staff members. The recipients of the survey were asked to share the survey with their contacts and their contacts will do the same until contact saturation was achieved. Self-administered face-to-face surveys were conducted in four conveniently selected provinces, namely Harare, Mashonaland Central, Masvingo, and Matabeleland

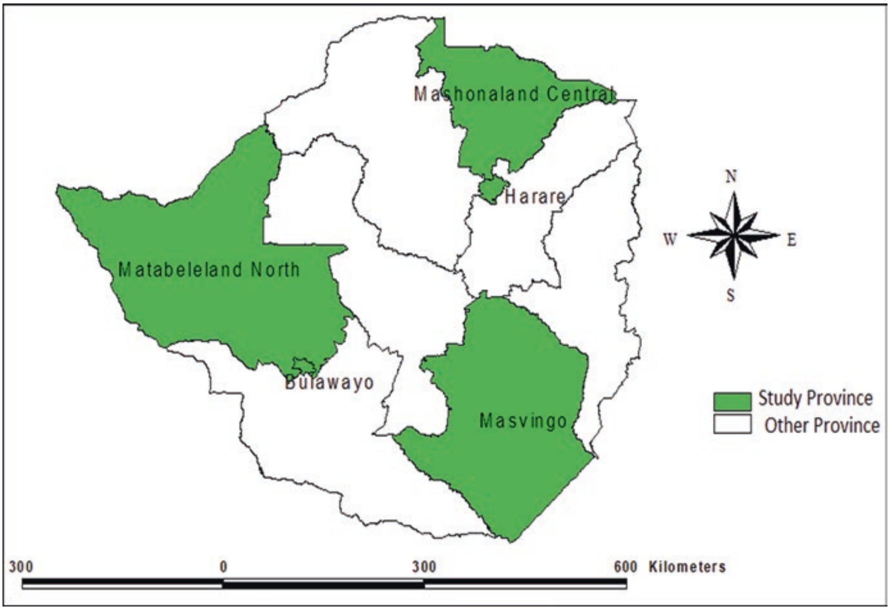


Fig. 12.1 Map of study area. (Source: Authors)

North. Most of the face-to-face surveys were conducted in residential suburbs by research assistants who were familiar with the areas. The survey comprised questions focused on understanding the demographic profile, historical vaccination behaviour, COVID-19 vaccination status, the factors influencing the status and the general perceptions on COVID-19 vaccines. A total of 361 online and 102 face-to-face (Masvingo- 49, Harare- 35, Matabeleland North- 7 and Mashonaland Central-11) surveys were completed.

Included in the survey were distinct choice tasks predetermined to examine vaccine acceptance or refusal based on vaccine characteristics such as efficacy, location of vaccine developer (USA, the EU or China), place of vaccine administration and risk of serious side effects. Analysis of the responses was designed in a way that disentangles absolute vaccine refusal from vaccine hesitancy.

12.4 Results and Discussion

12.4.1 Evidence of Vaccine Hesitancy

The results show that about 54% of the sampled population was partially vaccinated while 33% was not vaccinated. About 13% was fully vaccinated (Fig. 12.3).

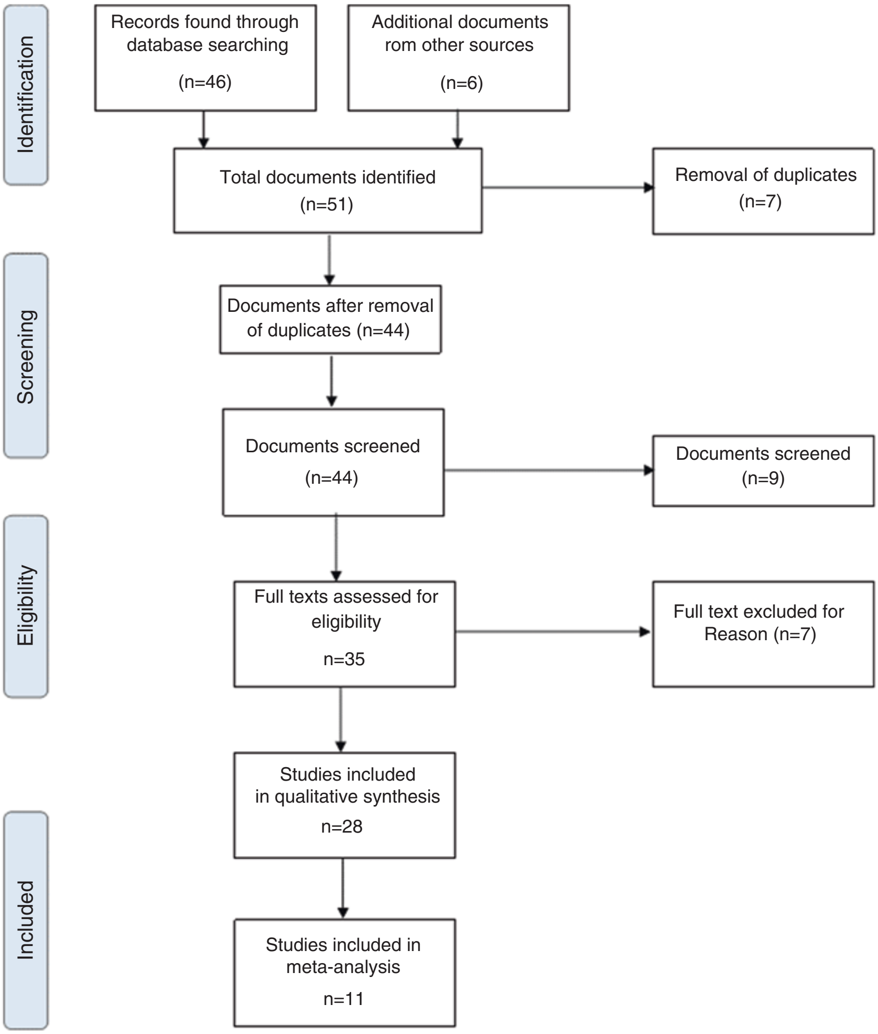
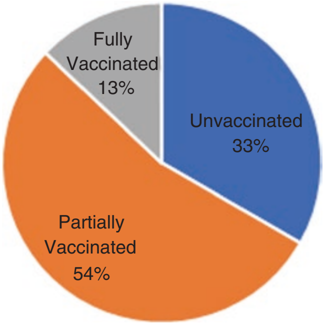


Fig. 12.2 The PRISMA approach used in the study. (Source: Authors)

As shown in Fig. 12.3, the rate of vaccination is slow, with only 13% of the sampled population fully vaccinated. Most of the 33% unvaccinated respondents indicated lack of willingness to be vaccinated now and in the foreseen future. They cited a plethora of reasons, including, lack of trust in the source of the vaccines, lack of trust in the national government and policymakers, general fear of the resultant effects of the vaccine and religious commitments, among other influencing conditions. The greatest percentage (54%) of the respondents were partially vaccinated with 83.78% of them indicating unwillingness to get the second dose of the vaccine. The reasons for unwillingness to get the second dose included medical conditions,

Fig. 12.3 Vaccination rate of the sampled population. (Source: Authors, field data)



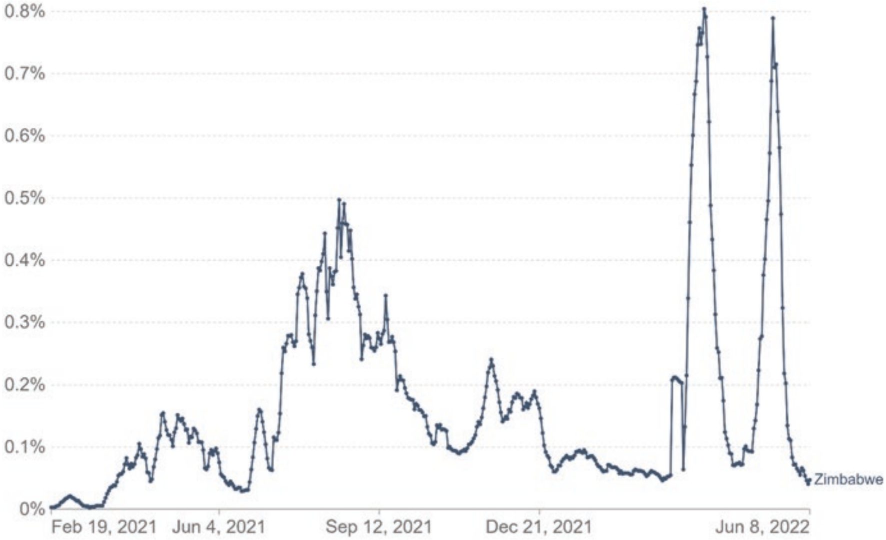


Fig. 12.4 Zimbabwe share of population with at least one dose of COVID-19 vaccine. (Source: Our World in Data, 2022)

experiences from the first dose, fear induced by misinformation, and lack of access to the second dose, among other factors. The remaining 16.22% of the partially vaccinated respondents indicated that they may get vaccinated if certain conditions change, for example, completion of the breastfeeding phase, improvement of medical condition and access to the vaccine, among others.

The vaccination trends and dynamics portrayed by the results of this survey seem to depict the situation at the national level where the rate of vaccination has plummeted to very low levels despite the fact that the doses are now readily available for the whole population to be vaccinated. At national level, vaccination has been fluctuating from time to time and appears to follow the trend of COVID-19 waves. An increase in the number of COVID-19 cases was associated with an increase in the rate of vaccination. Figure 12.4 shows the vaccination trend in Zimbabwe.

Figure 12.4 displays the share of total population with a minimum of a dose of the vaccine. As shown, the vaccination rate for Zimbabwe has not been consistent, progressing in a fluctuating trend. Several factors explain the lack of consistency, including, availability of the vaccines, awareness campaigns, and infodemic, among other factors. However, key informant interviews and document analysis revealed that vaccine hesitancy also contributed to the waves in acceptance, mainly regulated by the transfer of information among the population. The dominance of social media in the information supply and distribution matrix distorted the scientific information about COVID-19 vaccines and promoted conspiracy theories generated through anti-vaccine crusades by individuals and leaders from a diversity of belief, professional and ideological orientations.

The results also show gender disparities on vaccine hesitancy. Vaccine hesitancy is significantly high in male respondents compared to their female counterparts. Figure 12.5 shows gender based categories for the vaccinated, partially vaccinated as well as fully vaccinated individuals from the study's sampled population. As shown in Fig. 12.5, about 55.5% of the unvaccinated eligible individuals were males while only 27.7% were females. The remaining 16.7% preferred not to identify with a specific gender. Also shown in Fig. 12.5 is that more females (about 62.1%) were partially vaccinated whereas only 27.9% of their male counterparts were partially vaccinated. The remaining unidentified gender had only 10.3% indicating that they are partially vaccinated. In addition, male respondents proved to be more vaccine hesitant as they had the least number of the fully vaccinated individuals while females had close to 30% of the sampled population vaccinated. Of interest is the

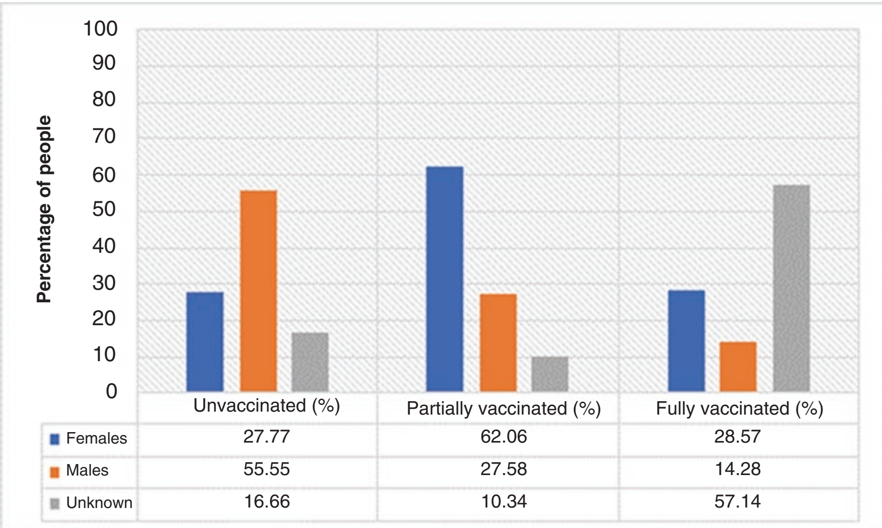


Fig. 12.5 Vaccination hesitancy depicted by vaccination rate according to gender categories. (Source: Authors, field data)

fact that the unidentified gender category had the highest percentage (57.14%) of people who were fully vaccinated.

The picture depicted by the overall results is that males were more hesitant to take COVID-19 vaccines than females.

12.4.2 Likelihood of Vaccination

Results from the questionnaire survey indicate that most of the respondents have little likelihood of getting vaccinated now and in the foreseen future. The low vaccination appetite was highest among male respondents compared to the female respondents as shown in Fig. 12.6.

As shown in Fig. 12.6, only 1.8% of the unvaccinated male participants indicated willingness to be vaccinated while only 3% of the unvaccinated female respondents indicated willingness to be vaccinated. Those whose gender remained anonymous had 1% probability of getting vaccinated now or in the foreseen future. Overall, the study shows that there is 1.93% probability of an unvaccinated individual to get a COVID-19 vaccine. Thus, these results presence a picture showing very low COVID-19 vaccine appetite, an indication of vaccine apathy, and hesitancy. In addition, the probability of those who have received the first dose, going for the second dose is very low. The results show that, of the respondents who participated in this study, about 3.6% of the partially vaccinated population is still willing to take a second dose while for females, about 8% are still willing to receive the COVID-19

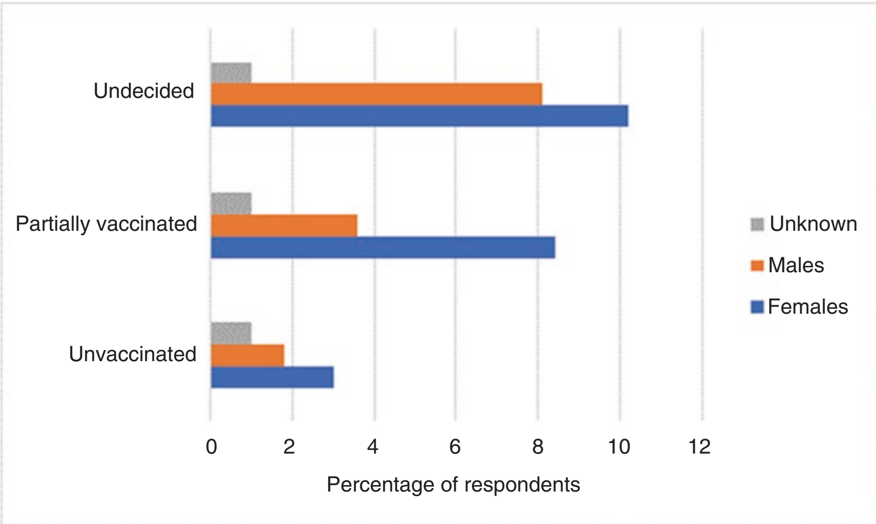


Fig. 12.6 Likelihood of vaccination among the unvaccinated and partially vaccinated respondents. (Source: Authors, field data)

second dose. Only 1% of the unidentified gender have indicated willingness to get the second dose. Overall, about 4.2% of the sampled population indicated willingness to be vaccinated for the second time.

This study observed that 'vaccine neutrality' exists among the population. This is a concept adopted by this study to refer to people who have 'mixed feelings' about the COVID-19 vaccines. They are neither willing nor unwilling to take the vaccine. In other words, vaccine neutrality describes those individuals with no ideological, professional or religious position on COVID-19 vaccines or those who take a long time to make a decision concerning vaccination. In this study, females are dominating vaccine neutrality, with 10.2% indicating that they have not yet decided whether to take the vaccine or not. About 8.1% of the male respondents who were unvaccinated indicated that they are not yet decided while only 1% of those who did not indicate their gender reported that they are not decided yet.

12.4.3 Determinants of Vaccine Hesitancy

The results point to the existence of a superfluity of intrapersonal, interpersonal, and institutional dynamics that contribute to COVID-19 vaccine apathy, hesitancy and neutrality. Table 12.1 shows the factors that influence COVID-19 vaccine hesitancy.

As shown in Table 12.1, lack of confidence in the source of vaccines was cited by 32.7% of the females who participated in the study as one of the causes of vaccine hesitancy. About 76.8% of males indicated that they also do not have confidence in the source of the vaccines while other 8.3% who did not indicate their gender feel the same. The study inquired whether the respondents know the source of the vaccines. All the participants indicated that they know where the vaccines came from, and they do not have confidence in the source country. Some respondents indicated that they do not have trust in the government since there were no mechanisms to check the authenticity and quality of the vaccines being given to the people. About 43.2% of the male respondents cited their lack of trust in the government's COVID-19 vaccination programme whist 21.4 female respondents and 4.1% of the

Table 12.1 Factors influencing vaccine hesitancy

	Percentage of respondents		
Factor	Females	Males	Unknown
Lack of confidence in the source	32.7	76.8	8.3
Lack of trust in the government	21.4	43.2	4.1
Medical condition	63.4	18.1	0
Religious beliefs	11.5	16.9	0
Just feel unsafe	21.3	46.5	0
Pregnancy	6.5	0	0
Still undecided	10.2	8.1	1

Source: Authors

uncategorised participants share the same sentiments. Most of the women (63%) who were not vaccinated reported that they had medical conditions they think would worsen or result in health deterioration after taking the vaccine. Only 18% of the male respondents claimed that their health condition was the major impediment to COVID-19 vaccination. Religious beliefs, pregnancy and breast feeding, and indecision were some of the factors that were cited as contributing to the problem of COVID-19 vaccine hesitancy in Zimbabwe.

This study observed that lack of information about the COVID-19 vaccines contributed significant high levels of vaccine hesitancy. This is indicated by the huge number of respondents indicating that they are not sure about specific pharmaceutical aspects of the vaccines. Table 12.2 shows the responses that were given to specific aspects related to the COVID-19 vaccines.

As shown in Table 12.2, about 44% of the respondents indicated that they are not sure about the safety of COVID-19 vaccines. However, about 26% confirmed that they agree that the vaccines are safe, 6% strongly agree while 12% disagree. Lack of knowledge about the vaccines is also reflected in the responses provided when they were asked whether the vaccines are effective in building immunity against the virus. About 56% indicated that they are not sure while 18.8% completely disagree that the vaccines are effective. Only 22% agree while 2.1% strongly agree. Furthermore, the high percentage of people indicating lack of knowledge on other aspects of the COVID-19 is indicative of the fact that people still lack information and there is need for the dissemination of pharmaceutical information and related information among the people to address the problem of vaccine hesitancy. However, the study noted that there are some people who were not sure but still went on to get vaccinated. Thus there is an interplay of several factors in determining the final decision of individuals to get vaccinated or not.

It emerged from this study that information sources played a pivotal role in determining the perceptions of respondents on COVID-19 vaccines. Various information channels, both formal and informal, disseminated information related the COVID-19 vaccines. Some of the information is related to the effectiveness of the vaccines, the authenticity of the manufacturers, the trends in vaccine production, the acquisition of the vaccines by the national government, experiences with the vaccines, reported cases of side effects, theories by the anti-vaccine movement, alternative remedies besides the conventional pharmaceutical measures, and several other religious interpretations of the vaccination programme. Such information determined how people perceived the vaccines. Informal information channels such as the social media,

Table 12.2 Perceptions about specific aspects related to COVID-19

Statement	Agree	Disagree	Not sure	Strongly agree
COVID-19 vaccines are safe	26.0	12.0	44.0	6.0
COVID-19 vaccines are effective	22.9	18.8	56.3	2.1
COVID-19 vaccines have dangerous health effects	29.2	20.8	39.6	10.4
All people must vaccinate	20.8	31.3	31.3	16.7

Source: Authors

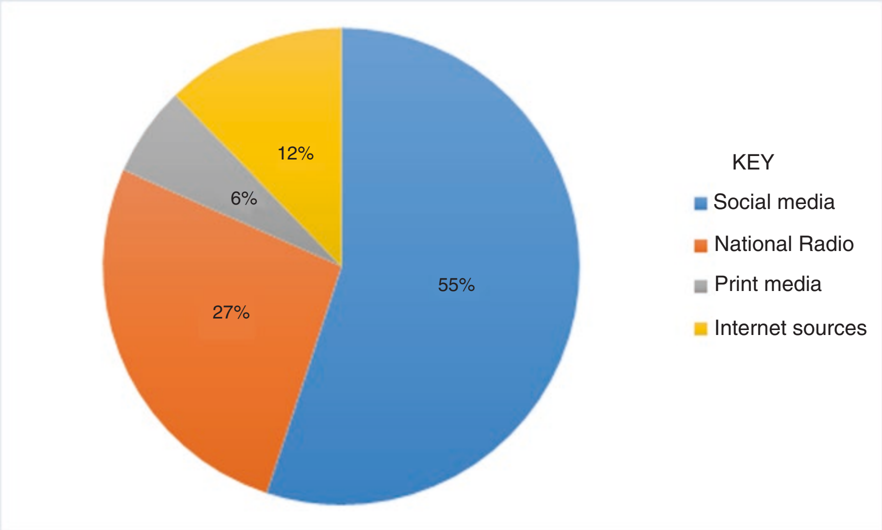


Fig. 12.7 Sources of vaccine information among respondents. (Source: Authors, field data)

specifically WhatsApp and Facebook platforms, perpetuated infodemic which has precipitated lack of trust in the vaccines and exacerbated vaccination apathy, neutrality and hesitancy. The dominance of social media platforms in information dissemination implies that anti-vaccine information is reaching out to the people more than regulated pro-vaccines information. Figure 12.7 shows the information channels through which respondents receive information on COVID-19 vaccines.

As shown in Fig. 12.7, most (55%) of the respondents have access to social media platforms and that is their main source of COVID-19 information, including vaccines and vaccination dynamics updates. Social media information in not properly regulated and has facilitated the propagation of anti-vaccine information which has misinformed several people, leading to decisions against vaccination. The national radio stations are the second most important source of information, but only 27% of the respondents indicated that they obtain COVID-19 related information from this channel. Internet sources and print media are accessed by 12% and 6% of the people, respectively.

12.5 Discussion

This study sought to understand the trends and dynamics of COVID-19 vaccine hesitancy in Zimbabwe and its implications for the country's health delivery system. Results indicate that COVID-19 vaccination hesitancy is a reality and a challenge to the government initiated vaccination drive. The findings confirm earlier observations by Kouamou et al. (2021) and Murewanhema et al. (2022) that vaccine hesitancy exists in Zimbabwe and may pose a challenge in the processes of fighting the COVID-19 pandemic. However, a study conducted by Dzinamarira et al. (2021) at the beginning of the vaccination process was optimistic that vaccine hesitancy was not going to be a major challenge to as the respondents in the study for both South Africa and Zimbabwe indicated high intentions of being vaccinated. However, considering the COVID-19 vaccination rate of 31%, as of June 2022, more than a year after the rolling out of the vaccination programme, vaccination hesitancy could be significantly high and contributing to low vaccine uptake. Thus, although several factors contribute to the low vaccination uptake in Zimbabwe, this study has shown that vaccine hesitancy contributes quite significantly.

The vaccine hesitancy trajectory has implications on the health delivery system of the country as it precipitates failure to achieve herd immunity. The implication of failure to achieve herd immunity is that the greater part of the population remains susceptible to SARS-CoV-2 infection, which imposes a burden on health provision value chains. Lack of immunity against the pandemic will likely increase hospitalisations. This is against the backdrop of a struggling health delivery system which has been experiencing bed shortages. In addition to bed shortages, the health system in Zimbabwe has several other challenges including disgruntled workforce which is on strike from time to time, shortages of medicines and other medical facilities have also been reported. Thus vaccine hesitancy will only exacerbate the tribulations of an already weak health delivery system.

This study has shown that there is a plethora of factors influencing vaccine hesitancy such as lack of trust at various levels including the source of the vaccines, the processes involved and the government itself. McAbee et al. (2021) also asserted that vaccine hesitancy is addressed by improved confidence in the safety and effectiveness of the health delivery system and trust in policymakers and all systems including the sources of vaccines and approval processes. Lack of trust will jeopardise the vaccination programme and consequently the health delivery system. In this study, most of the unvaccinated people indicated that they doubted the safety of the vaccines and they are not very confident about their sources and approval processes. If there is hope to address this challenge, the need to restore confidence in the whole vaccine supply and administration value chain cannot be overemphasised. Mutombo et al. (2022) argue that the lack of trust is compounded by the historical, colonial therapeutic and vaccine research manipulation in Africa.

This study has also shown that there is a plethora of other factors contributing to vaccine hesitancy, including lack of information, medical conditions, and religiosity. Conspiracy theories and religious myths shared on social media platforms by the anti-vaccine movement 'kingpins' have exacerbated unwillingness to get a vaccine dose among people. This has already been observed by other studies (Pullan and Dey, 2021; Mundagowa et al., 2021; Ransing et al., 2022). Thus, to date, there are still religious sects and philosophies that stand against COVID-19 vaccination although they cannot publicly claim so because of the government's stand to reprimand the anti-vaccine regime.

It has been noted that a significant number of individuals who received the first dose indicated unwillingness to get the second one citing safety issues. This could be explained by the fact that some of the people who received the first dose experienced some side effects and others are reported to have died as their medical conditions further deteriorated after taking the vaccine. Such cases instil fear among the population and exacerbate the problem of vaccine hesitancy.

The major implication of all the challenges associated with vaccine hesitancy is the failure by the health delivery system, now and in the future, to deal with health effects associated with lack of immunity of the greater population to known viral infections. There is need to devise strategies to improve uptake of recommend vaccines and other pharmaceutical therapies in the aftermath of a global disease outbreak.

12.6 Conclusions and Recommendations

This study explored the trends and dynamics of vaccine hesitancy in Zimbabwe and deduced the implications for the health delivery system. It emerged that the rate of COVID-19 vaccination in Zimbabwe has been fluctuating over time but generally, it has been slow. While a plethora of factors could be working together the slow down the vaccination process, this study established that vaccine hesitancy is significantly contributing. The study revealed that COVID-19 vaccine hesitancy has been high among males compared to their female counterparts. The driving forces behind vaccine hesitancy include lack of trust at various levels along the supply and administration value chains of the vaccines, fear for safety, medical conditions, and procrastinated decision making at individual level, among other factors. Information dissemination channels have been observed to be key in determining vaccination hesitancy as they conveyed messages that either encourage or discourage participation in the vaccination programme. The dominance of the social media as a source of vaccination information has largely created negativity among the populace, resulting in diminished vaccine appetite. The proliferation of vaccine hesitancy in Zimbabwe has negative implications for the health delivery system. Failure to achieve herd immunity due to lack of vaccination renders the entire population susceptible to viral infection. This creates further challenges for the health delivery systems, which is already incapacitated, in terms of its dexterity to contain possible outbursts of viral infections of pandemic proportions now and in the future.

The study recommends a massive community engagement and education approach to vaccination, involving local leadership and all key stakeholders. There is need to first demystify COVID-19 vaccines and clarify on the short and long term consequences of not achieving herd immunity. The frequent use of social media to disseminate positive information about vaccination can be adopted as a strategy to counteract the negative information it spews.

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Chapter 13
The Complexities of Public Health Communication on COVID-19 Vaccination in the Social Media Era: Implications on Zimbabwe's Health System

Elizabeth Farisai Hove

Abstract Social media platforms intend to engage the public in an interactive manner. They are often used as a mechanism by the public to share current information and engage in multi-way conversations and interactions. This chapter defines and discusses social media engagements on COVID-19 vaccination. It examines different chats on selected WhatsApp groups about the COVID-19 vaccination pros and cons and deliberates on the latent risks, benefits, and challenges of embracing the social media platform such as WhatsApp on public health communication. It also investigates how social media platforms have the potential to promote or undermine public health communication campaigns on the COVID-19 vaccination drive and consequently Zimbabwe's health system. The period under study was from March 2020–December 2021. Virtual ethnography was undertaken of messages from two WhatsApp groups. Group 1 consisted of 257 participants, while group two consisted of 34. The researcher is also a member of these groups and thus was a participant observer. It emerged from the findings that negative religious discourse, lack of trust in government or fear of political manipulation, suspicion of commercial gain and vaccine safety are the some of the complexities behind vaccine hesitancy. These have been amplified by social media and thus social media has the potential to derail or hamper efforts to curb the spread of the virus. The Government of Zimbabwe needs to step up public health messages and awareness campaigns so that these messages do not drown in the infodemic or sea of misinformation and disinformation. Tapping into social media can thus reverse complacency and vaccine hesitancy. It can provide a rich research ground for health communication specialists. Social media can also be used to gauge public opinion on the issue of vaccination. The questions and issues surrounding the pandemic can be used as indicators on how to

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redirect messages to the public. Social media has emerged as a networked public space in which due to the anonymity offered, important matters can be discussed without fear and ignoring this space can be detrimental to any government during this pandemic.

Keywords COVID-19 · Vaccination · Social media · Public health · Communication campaign

13.1 Introduction

The role of the media in the coronavirus 2 (SARS-CoV-2) COVID-19 global health crisis has been put under a microscope; concerns being raised particularly about social media. In the past media platforms were mainly composed of traditional sources such as radio, television, and newspaper. Running public health campaigns was relatively easy as messages would be carried on such platforms. The coming of the Internet ushered in convergent and multiple platforms. The proliferation of social media platforms further complicated the communication landscape. According to the World Health Organization (WHO), it has become an 'infodemic' as there is an overabundance of information and mostly misleading information on the virus and social media can amplify these harmful messages (www.who.int). The lack of a cure to the novel corona virus resulted in all sorts of cures being suggested, some of them detrimental to human health. Thus, the Ministry of Health and Child Care (MOHCC) in conjunction with the World Health Organization and other partners in the health sector sat out to try and educate the public on COVID-19. Public Campaigns centred around non-pharmaceutical interventions (NPIs) with the public being encouraged to observe certain norms such as avoid public gatherings, stay at home, sanitise, wear face masks and practice social distancing to curb the spread of the virus. Besides the above measures they also encouraged vaccination. Vaccination was welcomed by most but also met with resistance.

Zimbabwe received the first consignment of the Sinopharm vaccine from China on 15 February 2021 amid mixed reactions from the public. The goal was to reach herd immunity of 60%, which is ten million people vaccinated by the end of 2021 (www.xinhuanet.com, 2021). Public health campaigns were mounted in the media to encourage Zimbabweans to get their 'jab'. Public health communication has had to contend with obstacles such as vaccine hesitancy. Vaccine hesitancy and or vaccination misinformation has the potential to reverse the gains the Zimbabwe health system has made. A report from the World Health Organization (WHO) in 2019 lists vaccine hesitancy is one of the top ten threats to global health, 'Vaccine hesitancy – the reluctance or refusal to vaccinate despite the availability of vaccines- threatens to reverse progress made in tackling vaccine-preventable diseases' (www.who.int, 2020). This has been witnessed before in outbreaks of Ebola in 2014 and the Zika virus in 2016 (Singh et al., 2020). Although the reasons for this are complex, a report from the Centre for Countering Digital hate in 2020 (www.conterhate.co.uk, 2020) uncovered that social media has given mileage to the ‘anti-vax’ movement which in turn contributed to vaccine hesitancy. Among some of the reasons for vaccine hesitancy is lack of transparency by governments in the procurement and distribution of these vaccines (Maketo & Mutizwa, 2021), Religiosity/religious practices (Obi-Ani et al., 2020; Dzinamarira et al., 2021), vaccine safety (Mcbee et al., 2021). It is these complexities raised or amplified by social media that could hamper the vaccination drive.

To explain how social media has become an area of concern would require looking at the situation, context or environment that resulted as a result of the COVID-19 pandemic. Globally a number of countries imposed various levels of lockdowns which resulted in restricted movement of people in accordance with WHO guidelines. On 20 March 2020, a total lockdown was first announced in Zimbabwe, and this was subsequently extended on 19 April 2020 for another 14 days. The lockdown saw the country introducing measures that included the banning of all social gatherings with only funerals exempted but limited to less than 50 people (www.herald.co.zw, 2020). This was only the beginning because in January 2021, Zimbabwe experienced a second wave of COVID-19 infections and in July 2021, a third wave. These lockdowns necessitated a major shift to online platforms of communication particularly the use of social media. What made these platforms appealing when physical interaction was discouraged during the lockdown periods include the following:

- Availability and access to high-speed Internet and mobile technology
- Content was more decentralised and less hierarchical, multiple production and distribution points
- Relatively high frequency of content exposure
- Usually directly accessible to the public free of charge
- Message typically came out very quickly, sometimes instantaneously (Chibita & Ugangu, 2017 p. 235)

Social media sites also allowed users to generate online groups with whom they shared information, ideas and personal messages (Chibita & Ugangu, 2017). To add on social media did not require physical contact to stay in touch with friends and family, and thus it was the above factors that separated social media from traditional media such as radio, television and newspapers. Examples of popular social media platforms include Facebook, Twitter, LinkedIn, Pinterest, Google+, YouTube, Instagram, Flickr and WhatsApp.

In Zimbabwe social media platforms are accessible due to the mobile phone industry which can be closely tied with the rise in the use of the Internet in Zimbabwe in 2008. The industry is currently dominated by three cellular networks namely Econet, Netone and Telecel (potraz.gov.zw). And the number of mobile subscribers has increased since then. As of December 2020, Zimbabwe had 8,400,000 Internet users and Internet penetration was at 55.7% (internetworldstats.com, 2022). The popularity of WhatsApp and Twitter is that it has come in to fill the void that traditional/mainstream media was not able to fill due to tight regulation, in terms of distributing alternative views in issues and polices (Thomas, 2020) and thus is a formidable contender as a source of news as opposed to mainstream media. It is against this background that this chapter focuses on WhatsApp. However, it has to be noted that social media platforms are not for everyone in Zimbabwe, there is a digital divide due to economic barriers such as acquiring a smartphone and the prohibitive cost of data required to access the Internet.

Although it has given a voice to the subaltern, social media as 'parallel market of information' is fraught with misinformation, disinformation and outright fake news. It should not be dismissed but closely studied as it represents a 'networked public sphere', a 'digitised counter hegemonic space' that could inform and possibly enrich public health campaigns (Moyo, 2009; Moyo, 2011; Mutsvairo et al., 2014). The chapter's main objective therefore is to investigate how social media platforms particularly WhatsApp have the potential to enhance or undermine public health communication campaigns/interventions on the COVID-19 vaccination drive in Zimbabwe. The study sought to address the following questions: What are the messages/conversations about vaccination on WhatsApp? What are the complexities that are revealed through these messages? What are the possible implications of such messages on the health care system in Zimbabwe?

13.2 Literature Review and Conceptual Framework

13.2.1 Public Health Campaigns and Anti-Vaccination ('Anti-Vax') Campaigns

Public health campaigns are part of health communication. They involve the study and use of communication strategies to inform and influence individual and community health decisions (Healthy People Report, 2010). Among these strategies are public health messages and campaigns and these are to educate, change and encourage healthy behaviour among members of the public. Campaigns have traditionally been mounted on billboards, radio, television, newspapers and pamphlets to deliver health messages and as highlighted by Randolph and Viswanath (2004) 'Mass media campaigns, because of their wide reach, appeal and cost-effectiveness, have been major tools in health promotion and disease prevention. They are uniformly considered to be powerful tools capable of promoting healthy social change' (2004:43). The environment for communicating about health has however changed significantly and has become challenging due to multiple and convergent platforms and an audience that demands quality health information (Healthy People Report, 2010).

Research however shows that these multiple platforms can better reach various segments of the audience in contexts that are relevant to them (Healthy People Report, 2010). Thus, the multiplicity of platforms can thus be a blessing or a curse for health communication professionals. A curse in the sense that there is a lot of inaccurate information on the Internet which can lead to the public making poor uniformed decisions about their health (Healthy People Report, 2010). Besides the misleading information social media has given a platform to the ‘Anti-vax’ (Anti-vaccination) campaign. The anti-vax movement poses a huge threat to global public health in the era of COVID-19 but yet raise important issues pertaining to safety and effectiveness of the vaccines (Armitage, 2021). To address these issues, governments should provide transparent, timeous and accessible public health messaging to the public (Armitage, 2021).

Social media has hampered effective response by health departments and governments and has become the major driver of fake news, false heath information and conspiracies, particularly WhatsApp, Twitter, YouTube Facebook and Instagram (Cindelli et al., 2020; Allington et al., 2020; Lima et al., 2020; Singh et al., 2020). The impact of social media has become a concern in the management of vital health information. Cindelli et al. (2020) in their comparative analysis of social media platforms, Twitter, Instagram, YouTube, Reddit and Gab looked at the dangers of misinformation through social media platform. This has been termed an infodemic and this infodemic has made it difficult to manage the spread of the pandemic. On the positive they also concluded that, ‘Social media is extremely important to fight this contagious disease, not only to get information and be updated about it but also to understand how it spreads, how people interact, and how we can respond to it’ (2020 p. 2). Thus making it a vital tool in the fight against the virus.

A study by Allington et al. (2020) focused on how conspiracy beliefs compromised health-protective behaviour by studying social media as sources of health messages by respondents from the age of 16–75 years in the UK through online questionnaires. They looked specifically at three conspiracy beliefs: ‘The virus that causes COVID-19 was created in a laboratory’. Second, the ‘symptoms of COVID-19 seem to be connected to 5G mobile network radiation’ and third ‘The COVID-19 pandemic was planned by certain pharmaceutical corporations and government agencies’ (2020 p. 1765). Their results revealed a positive relationship between COVID-19 conspiracy beliefs and the use of social media as a source of information. Thus they conclude that ‘unregulated social media can present a health risk (2020). All three studies suggest that conspiracy beliefs act to inhibit health-protective behaviours and that social media act as a vector for such beliefs’ (2020 p. 1768). In a health crisis such as COVID-19 this has meant life or death and increased anxiety in society.

As to why COVID-19 is prone to false information on social media, Jaiswal et al. (2020) highlight ‘Much of the evidence needed to fully inform clinical and public health responses is not yet available, making COVID-19 uniquely vulnerable to a proliferation of disinformation, misinformation and medical mistrust, including what are often called “conspiracy beliefs”’ (Jaiswal et al., 2020 p. 1). They further define the terms disinformation, misinformation and mistrust and call for an understanding of the origin of these to carry out successful public health campaigns,

> *Disinformation (strategically and deliberately spread false information), misinformation (false information, not necessarily with intent to mislead), and mistrust (more than the lack of trust; suspicion of ill-intent) are multi-faceted phenomena, heterogeneous underlying motivating factors… understanding the etymologies of disinformation, misinformation, and medical mistrust must be an important component of the public health response to COVID-19* (Jaiswal et al., 2020 p. 1).

Understanding the dynamics of social media can thus be used to address issues of race and xenophobia like in the United States where people of colour (including Asians and Black people) were blamed for the virus. Understanding this phenomenon can further assist to dispel state sanctioned disinformation (Jaiswal et al., 2020 p. 1).

To add credibility to this disinformation and misinformation**,** Lima et al. (2020) add that 'These messages and texts always start the same way: they feature a physician, nurse, surgeon or other authority figure who shares advice – such as holding your breath as a COVID-19 confirmation test, or taking vitamins to decrease the possibility of infection' (2020 p. 2). The major source of all this being social media, thus people are overwhelmed by information and do not know which sources to trust, hence the need to evaluate the contribution of social media during the COVID-19 pandemic and regulate it. They however point out that regulating social media platforms is difficult and where possible it has been done inconsistently and thus curtailing the spread of these conspiracies is near impossible (Lima et al., 2020). In their observation from Nigeria Obi-Ani, Anikwenze, and Isiani (2020), highlight the advantages and disadvantages of social media and the role that social media played in spreading information during the COVID-19 pandemic. The qualitative study looked at social media platforms such as Facebook, Twitter, WhatsApp, blogs, online newspapers and YouTube where the contestations about the pandemic were prevalent. In their findings, they uncover that religious practices contributed to the fake messages on social media. They concluded that 'these platforms have been abused as people hide under its anonymity to spread fake messages and instigate panic amongst members of the general public' (2020 p. 1).

These findings however remind us of the importance of social media during times of crisis as highlighted by Singh et al. (2020). Their study centred on the amount of conversation on the social media platform Twitter. They conclude that social media platforms can be used as a surveillance approach to understanding how people are impacted by the virus and the influence of social media platforms on public health and behavioural changes. To further understand the influence of social media**,** Al-Dmour, Masa'deh, Salman, Abuhashesh, and Al-Dmour et al. (2020) examined the influence of social media platforms on public health protection against the COVID-19 pandemic. This study sampled 2555 social media users in Jordan and revealed that the use of social media platforms had a significant positive influence on public health protection against COVID-19 as a pandemic. They concluded that 'the use of social media platforms can positively influence awareness of public health behavioural changes and public protection against COVID-19. Public health authorities may use social media platforms as useful tools to increase public health awareness through the dissemination of brief messages to targeted populations'

(2020 p. 12). This chapter therefore seeks to add on to this body of knowledge by examining how social media platforms can potentially enhance or hinder public health communication in Zimbabwe.

13.2.2 The Networked Public Sphere and the 'Parallel Market of information'

Digitally networked technologies have transformed the communication industry. 'This change is technological (with social media platforms enabling new forms of publishing, receiving and discussing stories) as well as cultural, with idiosyncratic conversations emerging on these platforms' (Mutsvairo et al., 2014 p. 4). This digitally networked space has been called a digitally networked public sphere (Mutsvairo et al., 2014). The public sphere concept originated in the writings of Jurgen Habermas in the 1960s. Habermas (in Cladwell, 2017 p. 162) argues that the public sphere 'may be conceived as a space where private people come together as public and discuss matters of common concern'. It can also be defined as 'the space where citizens converge for the purpose of deliberating over matters of public importance, and where they can form public opinion, being an aggregate of their opinion' (Cladwell, 2017). Traditional media was central in this public space or sphere and thus the coming in of new media or digitally networked technologies was seen as bringing hope for democracy as the platform enabled citizen participation. And indeed it has allowed citizen participation and discussion of important social issues as the COVID-19 pandemic. As Goldstein and Rotich (in Mutsvairo et al., 2014) assert, 'Digitally networked technologies enable ordinary citizens, to become their "own broadcasters" and reach large numbers of people in unprecedented ways at trivial cost' (2014 p. 5). However this networked public sphere represents more of a public space rather than a public sphere as these discussions do not influence democratic processes (Bosch, 2017; Cladwell, 2017).

Yet, this does not dismiss these spaces as according to Caldwell, 'Successful instances of cyber-activism have demonstrated only too poignantly the power of the Internet and social media, which governments and corporates ignore to their peril' (2017 p. 162). Controlling or regulating this space has thus become a challenge for governments in this COVID-19 pandemic as it has emerged as a 'parallel market of information' (Chuma, 2008; Moyo, 2009). The concept arose during the March 2008 elections in Zimbabwe, when the government withheld election results, and this resulted in a lot of speculation about the outcome of the elections and gave alternative communication platforms an opportunity to fuel false information (Moyo, 2009). Similarly the gap in information about COVID-19 opened up or fuelled a parallel market or black market of information, disinformation, misinformation and medical mistrust thus, 'in a situation where information flows were restricted and the mainstream media were unable to fulfil the citizen's informational needs, the parallel market of information became the dominant source of a mix of information and disinformation' (Moyo, 2009 p. 553). Furthermore these platforms can provide counter hegemonic spaces, counter narratives to reports in mainstream media yet the downside is they can promote violence and misinformation (Moyo, 2011). In the subject under study, the COVID-19 pandemic can be a threat to or a positive influence on the public mental and physical health.

13.3 Methodology

The study focuses on the period March 2020 to December 2021 during which time the country had experienced three waves of the virus and vaccination. This qualitative study employs virtual ethnography which is defined as an 'academic research method for explaining how people make sense of the internet' (Hine, 2000). 'Virtual ethnography draws on a range of qualitative methods including direct observation, participant observation and sometimes content analysis' (Fourie in Bosch, 2017 p. 62). 'Virtual ethnographies in much the same way as traditional ethnography centres around communities; studies communities and cultures created online' (2017 p. 62). Thus 'the internet is approached, in much the same way as communities can be co-constructed, in much the same way as communities were created in the pre-digital age' (2017 p. 63). 'The major point of departure here being that a researcher can explore the social spaces of the internet from his/her desk with focus on technological mediated interactions in online communities' (Bosch, 2017 p. 64). Virtual ethnography was carried out to study two WhatsApp chat groups, which the researcher is a member. Data was gathered from these two different personal chat groups on WhatsApp. The researcher was immersed in these WhatsApp chat groups as a participant observer. The two groups or rather sites of study consisted of:

Group 1 – Neighbours group: this group consists of neighbours in the area and has 257 participants. This online community is composed mainly of Zimbabweans living locally in Masvingo and Zimbabweans living in the diaspora who have properties in this specific local neighbourhood. Data from this divergent group consisted mainly of messages marked 'forwarded' or 'forwarded many times' on COVID-19. This implied these messages which were being passed from group to group and from unverified sources.

Group 2 – Work group: This online community is composed of professionals mainly university employees and has 34 participants. Messages from this group was mostly from sources such as newspapers and online news sites. The differences in the group could possibly account for the messages. Group 2 is largely dominated by academics and thus understood the implications of passing on unverified information. This however requires further study.

Data extracted from these WhatsApp groups was purposively sampled. For WhatsApp, the researcher mainly looked at messages on or related to COVID-19 and COVID-19 vaccination. Content and discourse analysis of the messages was carried out and the data was presented thematically. The messages were divided along the following themes that emerged:

(a) Religiosity specifically religious discourse on vaccines
(b) The main motive behind the virus and vaccines is commercial purpose/gain
(c) Mistrust or suspicion of political manipulation by the government
(d) General mistrust of vaccines—vaccine safety

The weakness or limitations of virtual ethnography however relates to the validity and reliability of such information (Bosch, 2017 p. 62). To compensate for this, the researcher employed online document analysis of documents from organisations such as the World Health Organization, Ministry of Health and Child Care in Zimbabwe. To address ethical concerns related to informed consent and privacy of participants and anonymity of research subjects, the researcher did not cite any names to information found on WhatsApp.

13.4 Findings and Discussion

13.4.1 Messages and Complexities to Public Health Communication

13.4.1.1 Religiosity Specifically Religious Discourse on Vaccines

Data gathered revealed that narratives centred on religious beliefs and the end of the world due to the COVID-19 pandemic dominated the messages from Group 1. The coronavirus pandemic was a sign of the times as revealed in Mathew 25 in the Bible and thus the world needed to repent and be saved. Messages on vaccination warned that the vaccine contained toxins and being vaccinated was tantamount to receiving the mark of the beast and the Anti-Christ mentioned in the Bible in Revelations. The Anti-Christ could possibly be Bill Gates who is funding and driving the vaccination agenda as shown below**:**

> ***Information from Credible Source About the Lockdown Due to COVID-19***
>
> *The objective of the group (a group called ID2020) is to bring the NWO (New World Order) to reality by the use of vaccines. How? The group has successfully produced & launched the ID2020- a vaccine so to speak but not a vaccine in reality…It contains the vaccine alright but the main aim is the DIGITAL IDENTITY it gives to everyone that receives it. This digital identity enables you to be able to track a man like you would track a phone. Bill Gates is also working with the ID2020 group to produce this nano chip that is called the ID2020 project which when inserted into your skin (they have proposed already-right hand& forehead just as scripture predicts) makes you traceable- you can do money transfers from your hand, (not a phone), make calls with your hand (not a phone)* etc. *this is the mark of the Beast. Governments will now much more than ever be able to manipulate man beyond what they are doing now with the media filled with all sorts of concocted lies*
>
> *Please take note that the Book of Revelations 13* vs. *16–18 identifies the Antichrist as the man that will spearhead the implanting of the Mark of the Beast (RFID chip) on human beings. Bill Gates is the chief proponent of implanting the chip on human beings.*

> *This is why everyone must reject the Coronavirus vaccines and the RFID Chip which is the Mark of the Beast. For according to the Book of Revelations 14:19–11, anyone who receives the Mark of the Beast is doomed forever, as they will not enter the Kingdom of God* (WhatsApp Group 1; accessed on 4 May 2020).

Thus, anyone who chose to be vaccinated would be doomed to hell. This messages on WhatsApp were passed from group to group as it was marked 'forwarded many times'. To add authenticity, it claimed to be from credible source and thus it ought to be trusted and taken seriously. These messages can become a formidable threat to the vaccination drive. To try and repair the damage one of the Christian leaders had to later retract his earlier statements on vaccination. He claimed that he had been misquoted and was therefore encouraging his followers to be vaccinated (YouTube, Hot263, 28 July 2021). One influential government official, the spokesperson and permanent secretary in the Ministry of Information came out clearly blaming religious leaders for deaths due to COVID-19, 'I am going to be blunt (as usual). Men of cloth are responsible for a number of deaths among the unvaccinated' (Twitter; accessed on 28 July 2021).

Zimbabwe has a large Christian community about 87.4% (www.indexmundi.com 2015est.) and thus religious leaders are considered opinion leaders. Christian leaders are thus influential in important social and political issues in Zimbabwe. Some Christian leaders thus made bold statements against the virus and vaccination, declaring divine immunity for their followers, vowing not to be vaccinated and encouraging their followers to follow suit as one pastor declared, 'Don't think what is happening right now has to do with the virus. It's not a virus. The world has chosen to be deceived. As they have been deceived many times before,' 'This is basically a group of people serving a devilish cause trying to checkmate humanity to hell' (Kukurigo News WhatsApp Updates, 9 April, 2020). These Christian leaders found a voice on social media platforms such as WhatsApp and Twitter. Such messages as from the study by Obi-Ani et al. (2020) can 'significantly influence the spread of false preventative measures of the Coronavirus disease' (2020 p. 7).

To confirm the above and in anticipation as it were of resistance from religious groups, the government of Zimbabwe also issued a statutory instrument that explicitly mentioned that those gathering for religious gatherings or gatherings for the purpose of worship were to be vaccinated as the definition for 'gathering' shown in the Statutory Instrument (S.I.) 234 of 2021 under the Public Health (COVID-19 Prevention, Containment and Treatment):

> *'Vaccine mandate*
>
> *2 HH. (1) In this section –*
>
> *"gathering" means a gathering of more than two persons for a purpose specified in section 5 (1) (j), (gatherings at a place of worship for the purpose of worship) which are subjected to a vaccine mandate*
>
> *(2) For the avoidance of doubt, this section does not apply to gatherings of two or more persons for a purpose specified in section 5(1) other than gatherings referred to in paragraph (j) of that provision (gatherings at a place of worship for the purpose of worship)'* (S.I. 234 of 2021 Public Health (COVID-19 Prevention Containment and Treatment) Regulations (National Lockdown) (No. 2) (Amendment) Order, 2021 (No. 35)

Religious gatherings were clearly seen as hotspots of the infodemic and thus needed to be controlled. What the above also revealed was that the social media space as a place of discussing matters of importance proved that it could influence national policies and discussions as shown in the above instrument.

13.4.1.2 The Main Motive Behind the Virus and Vaccines Is Commercial Purpose/Gain

Due to very little information about the virus, conspiracy theories also dominated social media. When the virus broke out in 2019 in Wuhan, many viewed the virus as a biological weapon manufactured in some lab in China specifically in Wuhan which was the epicentre of the virus in 2020. Social media speculation was rife, and the virus became known as the 'Chinese virus' or 'Wuhan virus' with influential leaders such as Donald Trump giving legitimacy to this disinformation by calling it the 'Chinese virus' (Jaiswal et al., 2020 p. 9). The virus was something human-made and the main suspects or culprits being the World Health Organization (WHO), major pharmaceutical organisations in league with major conglomerates led by billionaires such as Bill Gates to create a new world order (WhatsApp; 18 July 2021). Data gathered revealed that there was a belief that the virus and vaccines were manufactured for commercial gain/ profit as shown below a WhatsApp message which circulated:

> ***The Snakes Are Coming Out***
>
> *'The Chinese biological laboratory in Wuhan is owned by GlaxoSmithKline, which (accidentally) owns Pfizer!' The one who makes the vaccine against the virus which (accidentally) started at the Wuhan Biological Lab and which was (accidentally funded by Dr. Fauci) who promotes the vaccine!"*
>
> *"Black Rock" is also (coincidentally) a major shareholder of MICROSOFT, owned by Bill Gates, who coincidenatally is a shareholder of Pfizer (which remember sells a miracle vaccine) and (coincidentally) is now the first sponsor of WHO! Now you understand how a dead bat sold in a wet market in China has infected the WHOLE PLANET! Now you know pass it on until the whole world knows'* (WhatsApp Group 1; accessed on 18 July 2021).

The simplicity of social media is that at little cost, messages such as these can be forwarded and forwarded so many times 'until the whole world knows' and unlike mainstream media there is no verification of facts hence the infodemic label. Such conspiracy theories were passed on from group to group dismissing the vaccine as mere marketing gimmick meant to enrich phamaceutical companies and Bill Gates. The call was to discredit vaccination and encourage all who received the message to refuse vaccinaton. The source of these messages as alluded to earlier was the ani-vax movement (Counterhate.com). As espoused by Allington et al. (2020) such can pose a health risk as their studies suggested that 'conspiracy beliefs act to inhibit health-protective behaviours and that social media act as a vector for such beliefs' (2020 p. 1768).

13.4.1.3 Mistrust or Suspicion of Political Manipulation by the Government

Data gathered also revealed that the vaccination drive was viewed as harbouring a hidden political agenda, why specifically vaccines from China; Sinopharm and not vaccines from Western countries? A general mistrust of the Zimbabwean government and its dealings with the Chinese prevails in Zimbabwe as there is a belief that the relationship is exploitative and non- beneficial (Mano, 2016; Maketo & Mutizwa, 2021). This sentiment was echoed in the messages on the selected groups. And the discourse on these vaccines revealed this. This message was from group and was from a local newspaper.

> ***ALARMING: 50 Mberengwa rural teachers have reportedly been admitted in Munene Mission Hospital with breathing problems***
>
> *Interestingly, all the cases are of teachers who were allegedly 'coerced' by Government to receive both 'shots' (1st and 2nd Jabs) of the controversial Chinese Sinopharm Vaccine donated to Zimbabwe by the Chinese Communist Party.*
>
> *Frightening enough the head of Government Vaccination program was quoted 'Live and direct' admitting that the Government was using its citizens as Guinea pigs to Chinese Experimental vaccines…* (WhatsApp Group 2; accessed on 18 July 2021).

The messages above revealed that it was the vaccine not the idea of vaccination that people were against. Any other vaccine would be welcome not the Chinese brands. Vaccine diplomacy was feared, the Chinese and other developed countries were using vaccines to further political hegemony (Maketo & Mutizwa, 2021 p. 65). This was essentially an anti-vaccination drive as the prevalent vaccine in Zimbabwe was Sinopharm from China. However, it was not only China that donated vaccines, other donated vaccines were Sputnik from Russia and Covaxin from India. As of July 2021, the donations from the three nations are shown in Table 13.1:

The exact statistics on how many had been vaccinated by either Sinopharm or the other vaccines were not available but statistics from the Ministry of Health and Child Care (MOHCC) daily updates as of 8 December 2021 show that about 3,907,860 had received the first dose whilst 2,926,141 had received the second dose (MoHCCZ, 2021).

This further revealed that the targeted herd immunity of ten million by the end of 2021 was still a long way from being realised. Even when political leaders offered to get the jab/ vaccine first messages circulated that they were not being injected with the vaccines but something else as pointed out by one prominent Christian

Table 13.1 COVID-19 vaccine sources for Zimbabwe as of July 2021

Country	Vaccine type	Donated vaccines
China	Sinopharm	500,000
Russia	Sputnik	125,000
India	Covaxin	35,000

Source: Maketo and Mutizwa (2021)

leader in a video that circulated on social media (WhatsApp; 5 March 2021). Furthermore it was viewed as a campaign move by political leaders to gain popularity with voters in the upcoming 2023 general elections, as shown from these tweets:

> *COVID-19 has been a god-send for ZANU PF. Zimbabwe is rejecting vaccines because of where they come from rather than what they can do. Also ZANU PF is looking for political capital in the vaccination drive. Sad.* (Twitter; accessed on 20 July 2021)

This potentially could have deterred and caused vaccine hesitancy in the public as it was dismissed as a political stunt by the ruling party. It was even revealed by WhatsApp that the government was refusing to authorise the use of Ivermectin, a new drug for COVID-19 in favour of vaccination to allow the Chinese government to 'experiment' on Zimbabwean citizens. '…the head of Government Vaccination Program was quoted "Live and Direct"' admitting that government was using its citizens as Guinea pigs to Chinese experimental vaccines' (WhatsApp Group 2; accessed on 18 July 2021).

13.4.1.4 General Mistrust of Vaccines – Vaccine Safety

Debates have also emerged on the issues of whether vaccination does work. Do vaccines really work? Are they effective? What are the unforeseen health effects? Are they safe? What causes other people to die soon after taking the vaccine? What causes blood clotting after taking some of these vaccines? And how long does immunity last? Data from WhatsApp showed that this debate was on-going as there were voices pushing that vaccination saves lives while other voices are dismissing it. The following WhatsApp messages revealed some deep seated fears on vaccination:

> ***HEALTH WORKER STROKES, DIES AFTER RECEIVING CHINESE VACCINE***
>
> *A Gutu health worker at Mutema Health Care Centre has reportedly died in Harare days after being vaccinated with the Chinese Sinopharm COVID-19 vaccine* (www.tellZim; 3 March 2021 on WhatsApp Group 2).

Reports on social media that people died after being vaccinated such as the above mentioned health worker further stirred fears and anxieties. The issue on the safety of COVID-19 vaccines dominated and continues to dominate social media. To give credence to these fears were reports from allegedly prominent and influential persons such as Nobel Prize winner Luc Montagnier, Robert F. Kennedy Jr. (both have named as anti-vaxxers: Counterhate.com), like the messages below:

> ***All vaccinated people will die within two years***
>
> *Nobel Prize winner Luc Montagnier has confirmed that there is no chance of survival for people who have received any form of vaccine.*
>
> *They will all die from antibody dependent enhancement. Nothing more can be said.*
>
> *The history books will show that, because it is the vaccination that is creating variants* (WhatsApp Group 1; accessed on 18 July 2021).
>
> ***Breaking News: US Supreme Court has cancelled Universal vaccination***

> *Bill Gates, US Chief Infectious Disease Specialist Fauci, and Big Pharma have lost a lawsuit in the US Supreme court, falling to prove that all their vaccines over the past 32 years have been safe for the health of citizens.*
>
> *Robert F. Kennedy Jr: 'The new COVID vaccine should be avoided at all costs'.*
>
> *This is an instrument of genetic influence. Gene weapon! That is, they were going to destroy from earthlings, and the survivors will become GMOs!*
>
> *DAMAGE CAUSED BY VACCINATION WILL BE GENETICALLY IRREVERSIBLE!*
>
> *Vaccination –weapons of genocide of the century* (WhatsApp Group 1; accessed on 18 July 2021).

These messages echoed once again that vaccines were biological weapons meant to wipe out humanity and thus should be avoided. The message by Montagnier was later dismissed as fake news: 'WhatsApp Forward claiming "Vaccinated People Will Die in 2 Years" is untrue' (Health Analytics Asia ha-asia.com, 27 May 2021). To complicate the situation were messages that pointed out that vaccines it seemed were not effective because in some countries COVID-19 infections had actually increased after vaccination. The implications of such mis- and disinformation had the potential to lead to poor, uninformed decisions among members of the public and even cause more COVID-19 related deaths. Thus, such messages as earlier established contributed to misinformation and disinformation on social media and thus one of the leading causes of vaccine hesitancy, a threat to global health (Jaswal et al., 2020; Armitage, 2021).

13.4.2 Implications for Health Delivery

That being established, the messages on WhatsApp were not all negative. Positive messages were also circulated. Of note were messages from the WHO which had health experts explaining vaccination and the advantages of being vaccinated (WhatsApp Group 1; 7 November 2021) the video was a programme entitled 'Science in 5' in which Vismita Gupta –Smith (WHO Communications Director) and Dr Soumya Swaminathan (WHO Chief Scientist) provided information on vaccination addressing some of the fears raised on the platform. Shutting down the Internet or heavy censorship therefore might not be the answer, rather social media might enrich public health campaigns. Zimbabwe had hoped to achieve herd immunity of 60% by the end of 2021; however, the statistics above show that the country is still a long way to achieve this figure, and this could adversely affect the health system in Zimbabwe. Government needs to step up public health messages and awareness campaigns so that these messages do not drown in the infodemic or sea of misinformation and disinformation. Social media has the potential to derail this goal or hamper efforts to curb the spread of the virus. On the other hand, it can provide a rich research ground for health communication specialists.

Social media platforms such as WhatsApp and Twitter allow debates and discussion on vaccination a gap that traditional media cannot fill. Traditional media is restricted by legislation, especially in Zimbabwe. These narratives are not entertained by mainstream media but can find a space on these alternate platforms. These alternate platforms should thus inform public health campaigns and can be used to address the public's fears and concerns about vaccination.

13.5 Conclusion and Recommendations

This chapter has shown that social media has swayed perceptions about vaccination against COVID-19. Some misleading circulations in these platforms have strong language and are persuasive enough to potentially mount strong resistance by citizens against vaccination. To address this all avenues to distribute authentic information need to be utilised. Social media can also be used to gauge public opinion on the issue of vaccination. The questions and issues raised surrounding the pandemic can be used as indicators on how to redirect messages to the public. Social media is a networked public spaces in which due to the anonymity offered, important matters can be discussed without fear and as pointed out ignoring this space can be detrimental to any government during this pandemic (Caldwell, 2017). As highlighted by Cinelli et al. (2020 p. 9) 'We believe that the understanding of social dynamics behind content consumption is an important subject, since it may help to design more efficient epidemic models accounting for social behaviour and to implement more efficient communication strategies in times of crisis'.

Governments, political, religious leaders and the Ministry of Health and even the World Health Organization can be held to account on these platforms as witnesses can report abuse of human rights anonymously. Social media can counter hegemonic practices and provide counter narratives. Furthermore, this parallel market of information seems to fulfil users' informational needs which mainstream media cannot do, thus by tapping into social media, public health campaigns can be more educative and informative and benefit ordinary people. Government thus needs to educate the public on vaccination and provide more informed and educative health communication to counter misinformation and disinformation. The religious community should also be roped into the vaccination drive as mentioned above they can be influential in their communities. Reliable and authentic public health messages should be 'passed on wildly' on social media platforms. To address the lack of reliable information, governments and health ministries should provide tools to assist the public to get authentic information on the virus and vaccination. COVID-19 applications and official websites can help the public access information about the vaccine and vaccine centres in Zimbabwe. Not everyone is on social media thus more intense awareness campaigns to bridge the digital divide and reach out to rural and marginalised communities in Zimbabwe are needed. There is still room for follow-up research into the COVID-19 virus and efficacy of vaccines.

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Chapter 14
COVID-19 Vaccine Diplomacy: Tracking the Chinese, Indian and Russian Global Pathways and Undertones

David Chikodzi and Godwell Nhamo

Abstract Vaccine diplomacy is a subject of medical diplomacy that has been used for some time. Recently, it has been widely used to address the coronavirus disease 2019 (COVID-19). As global health challenges, particularly pandemics, bite, many countries with the necessary capacity leverage their advancement in developed vaccines to gain diplomatic mileage. However, there has been observed limited documentation of vaccine diplomacy outside the USA and the European Union. Through the tracking of proclamations by the Chinese, Indian and Russian authorities and associated authentic sources, this paper investigates the extent to which COVID-19 vaccine diplomacy took root in the focus countries up to 22 April 2021. Geographical Information Systems (GIS) tools were applied to present the spatial dimensions of COVID-19 vaccine diplomacy. Findings show that several initiatives to deploy COVID-19 vaccines developed in China, India, and Russia took place worldwide. Among the vaccines deployed were China's CoronaVac and Sinopharm, India's Covishield and Russia's Sputnik V. However, the vaccine diplomacy was not free of incidences as debates on efficacy, effectiveness, and safety played out. While acknowledging that COVID-19 vaccine diplomacy from the study countries was solid, the paper recommends that vaccine recipient countries remain open-minded regarding the ultimate purpose of the seemingly 'ethical' and global solidarity drive, making COVID-19 a genuinely global public good.

Keywords COVID-19 · Vaccine diplomacy · Developing countries · Geopolitics

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14.1 Introduction

The notion of vaccine diplomacy or cooperation between and among nations has been addressed over the years, with Hotez (2010, 2014a, 2014b, 2017, 2021) being one of the leading authorities in this space. Vaccine diplomacy includes the use of vaccines as a public diplomacy tool. The discourse around vaccine diplomacy and medical diplomacy at large centres on the use of vaccines to improve a country's image and improve relations between and among countries and other key and influential actors of interest. Following the COVID-19 pandemic in March 2020, the concept of pandemic diplomacy also emerged (Dodds et al., 2020).

As the world continues to battle with COVID-19, there has been a visible movement in the spaces of vaccine diplomacy, with China, India and Russia among the key actors (Saha & Chakrabarti, 2021). This has been taking place against the odds of vaccine nationalism and regionalism, as highlighted earlier (Hotez, 2021). As of 5 December 2021, data from the Johns Hopkins University dashboard revealed that (Johns Hopkins University, 2021) from the global total of about 265.44 million infections, India had 34.63 million, compared to Russia, which had about 9.63 million infections, while China had about 111,671 COVID-19 infections. As for deaths, India had sadly lost 470,900 lives out of the global total of about 5.25 million. Russia followed with 275,824 deaths, and China had 4849 deaths. These figures remain a challenge, as one death is one too many. Given the gloomy global picture regarding both COVID-19 infections and deaths, it is inevitable that vaccines be shared widely across the globe. However, in analysing the geopolitics of COVID-19 diplomacy, one needs to engender the understanding that human and viral agencies remain entangled (Chan et al., 2020).

Given the preceding, this chapter locates itself in the space of COVID-19 vaccine diplomacy. The chapter restricts its focus to three countries: China, India and Russia. These countries were selected because they are the only BRICS countries that successfully developed vaccines. The research question raised is: what form does the COVID-19 vaccine diplomacy from China, India and Russia take, and which countries were early targets? To address the set question, the objective to map the extent and nature of COVID-19 vaccine diplomacy from China, India and Russia is stipulated. The following section presents the literature informing COVID-19 vaccine diplomacy.

14.2 Literature Review

Hotez (2010) discusses the concept of peacebuilding through vaccine diplomacy. The author's argument centres on the United States of America (USA) President Barack Obama's visit to Indonesia, where he sought to establish scientific ties. The oral polio vaccine is mentioned as an example of vaccine diplomacy that has promoted peace in times of crisis, including breaking down ideological differences between and among countries and regions. Cooperation in vaccines research and development (R&D) was viewed as presenting the potential for promoting foreign relations between the USA and Islamic nations. Hotez (2010) further observes that when the USA and Soviet Union entered a protracted Cold War after the 1957 Sputnik launch, the two countries agreed on scientific and medical collaboration, leading to the development of the oral polio vaccine (Hotez, 2014a). The polio vaccine eventually eradicated polio globally by 2008, apart from in a few Islamic states, including Pakistan (Shakeel et al., 2019). Vaccine diplomacy may not be the panacea for growing tensions between some nations but remains a vehicle for promoting joint humanitarian efforts (Hotez, 2017).

Hotez (2014a) reveals that vaccine diplomacy relies on the use or delivery of vaccines presenting innovative opportunities for countries to propel their broader foreign policies and diplomatic ties. The USA used this effectively to penetrate Latin America (Hotez, 2014b. However, central to vaccine diplomacy is its potential as a humanitarian intervention, and in the case of the COVID-19 pandemic, the drive to have vaccines as a global public good through the eradication of vaccine nationalism (Nhamo et al., 2021). Hotez (2014a) further acknowledges that from 2000, vaccines became key integral elements in assisting the attainment of the Millennium Development Goals (MDGs). As such, following the launch of the Global Alliance for Vaccines and Immunisations (GAVI), the Vaccines Alliance, many low and middle-income countries gained access to much-needed vaccines. Vaccine diplomacy also involves critical stakeholders, including the World Health Organisation (WHO), the Bill and Melinda Gates Foundation and manufacturing companies (Shakeel et al., 2019).

Shakeel et al. (2019) identify vaccine diplomacy as one of the missing elements toward polio eradication in Pakistan. The available statistics show polio cases increased from 198 in 2011 to 306 in 2014 (Ibid.). Although efforts remain in place to eradicate polio, 16 cases were confirmed in 2016 and 8 more in 2018. To eradicate polio in the country, vaccine diplomacy that involves coordinating multiple actors and areas of leadership, advocacy, policy and global governance is needed. Aspects to be addressed include, among others, the following (Shakeel et al., 2019: 4):

- Increasing national access to and ensuring the safety of the vaccine supply chain
- Improving water and sanitation in affected areas
- Enhancing environmental surveillance
- Mobilising community and religious leaders
- Assisting Internally Displaced Persons
- Effective vaccine health promotion and communication activities

The highlighted elements remain relevant even under the COVID-19 pandemic. However, as indicated earlier, vaccine diplomacy may not be separated from commerce and business (Cohen, 2020). Large volumes of COVID-19 and other vaccines are traded across the globe. Although there have been initial ‘donations’ moving forward into the future, where COVID-19 vaccines require annual boosting, the vaccine trade will take centre stage (de Paula, 2021). From the onset, in May 2020, China made it clear to the WHO that its vaccines were a global public good, and this was followed up by the country joining the COVID-19 Vaccines Global Access (COVAX) Facility in October 2020 (Cohen, 2020). COVAX is an initiative spearheaded by the WHO, Coalition for Epidemic Preparedness Innovations (CEPI), and GAVI, the Vaccine Alliance, to ensure that 92 low and middle-income countries get safe and effective vaccines (Nhamo et al., 2021).

With the talk surrounding COVID-19 vaccine passports having grown so much, diplomatic ties remain challenged, including the possibilities of certain countries accepting certain vaccines compared to others. Given the ongoing tensions between the USA and China, there was an instance where China would only accept those vaccinated with vaccines developed by its companies into its borders (Davidson, 2021). This triggered retaliation, and other countries and business entities with close ties to the USA insisted that their residents get COVID-19 vaccines developed from the USA and Europe (Nardelli & Dendribnou, 2021). Hence, sandwiched between vaccine diplomacy are undertones regarding the best vaccine and from which country or region such vaccines originate. Inevitably, there are social and ethical dilemmas associated with vaccine diplomacy (Vanderslott & Marks, 2020). Other undertones include whether there has been full disclosure of vaccine safety and efficacy data. Undertones cover the cost of the vaccines and associated infrastructure to administer the vaccines, as well as endorsement regimes across the world, which include the WHO and significant national regulatory authorisations such as the U.S. Food and Drug Administration (FDA) and European Medical Agency (EMA).

Shameem and Mohammed (2020) argue that the development of the COVID-19 pandemic vaccines has emerged as a global vaccine competition. In their view, the key competitors were China, Germany, India, Russia, the United Kingdom, and the USA. These countries host COVID-19 development companies that are state-backed and stand-alone private entities. Under President Donald Trump's regime ('Operation Warp Speed'), many private companies involved in COVID-19 vaccines development and deployment received state financial aid. These companies included Pfizer, Johnson & Johnson (J&J), and Moderna (Dyer, 2020; Roubein, 2020). The Oxford-AstraZeneca COVID-19 vaccine initiative also got solid financial backing from the United Kingdom government (Safi, 2021). Companies whose majority stake is owned by governments include those from China (CanSino, Sinovac and Sinopharm), India (the Serum Institute of India, Indian Council of Medical Research, the National Institute of Virology, and Bharat Biotech) and Russia (Gamaleya Research Institute). Hence, COVID-19 vaccine diplomacy is embedded within the influence of governments as key players.

The following section deals with the methodological underpinnings of this chapter. The chapter mainly draws from event study, document and critical discourse analysis, and the application of the Geographical Information Systems (GIS) used for mapping.

14.3 Materials and Methods

The focus countries of this study are presented in Fig. 14.1. To generate and analyse data, the paper utilised the mixed methods approach that included textual analysis, which was used by Chen (2020), who looked at China's vaccine gambit. Document and critical discourse analysis, a method widely applied by Nhamo et al. (2021) and Nhamo et al. (2021), who looked at COVID-19 vaccines development discord in the BRICS forum, as well as COVID-19 vaccines and treatments nationalism, was also applied. The primary methods were supplemented by elements borrowed from event studies and announcements, drawing from work by Giorgino et al. (2017) and Hayward (2018). Some of the key events and announcements tracked were government proclamations of their plans to join the COVAX, announcements on COVID-19 vaccines donations and missions that accompanied the consignments. In addition, weekly, the COVID-19 Vaccine Tracker website (https://covid19.trackvaccines.org/vaccines/) was checked for new proclamations in terms of vaccine authorisations by national jurisdictions. Responses by other countries to the COVID-19 vaccine diplomacy endeavours from the study countries, especially the USA's criticisms of China (Dodds et al., 2020), were also part of the events informing this work.

To map the spread of the COVID-19 vaccine diplomacy spatially, GIS was employed as widely used by Nhamo et al. (2020) in researching the cost of COVID-19 on the global tourism industry. The period covered by this article is marked by the outbreak of COVID-19 as reported by China on 31 December 2019, up to 22 April 2021. The cut-off date was established so that the authors could manage the write-up within the space where there are volumes of new information on COVID-19 diplomacy, presenting a moving target. Since there are several COVID-19 vaccines and vaccine candidates from the focus countries, there was a need to identify which ones to track in the COVID-19 vaccine diplomacy drive. To this end, the vaccines that had been authorised and widely used were identified (Table 14.1).

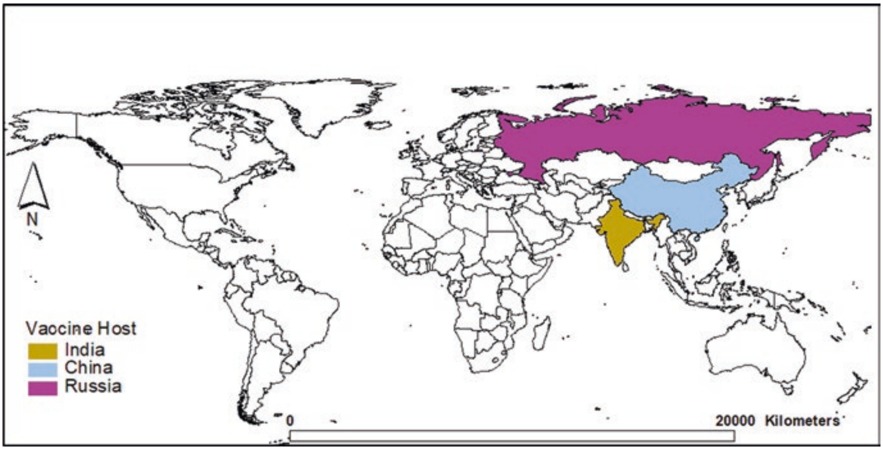

Fig. 14.1 Location of the study area. (Source: Authors)

Table 14.1 COVID-19 vaccines developed and deployed from the focus countries

Country	Vaccine	Manufacturer/Company
China	Ad5 CoronaVac Sinopharm	CanSino Biologics and Institute of Biology at the country's Academy of Military Medical Sciences Sinovac Biotech Sinopharm in partnership with China National Biotec Group
India	Covishield Covaxin	Serum Institute of India, in partnership with AstraZeneca and Oxford University Indian Council of Medical Research, the National Institute of Virology, and Bharat Biotech
Russia	Sputnik V	Gamaleya Research Institute, part of Russia's Ministry of Health

Source: Authors, based on Nhamo et al. (2021)

One may then ask: how were the focus countries selected? This was done purposefully after reviewing existing literature, with the insights from the other work done by the authors that pointed to the need to focus exclusively on COVID-19 vaccine diplomacy. Furthermore, unlike many COVID-19 vaccine R&D and deployments with private companies with a more significant say, initiatives from China, India, and Russia are heavily government-backed. This makes the subject of COVID-19 vaccine diplomacy interesting to readers. The following section presents and discusses the results of the study.

14.4 Presentation and Discussion of Results

This section details the emerging critical findings through data presentation and discussions. The section is divided into three sub-sections focusing on each of the three countries under deliberation. Overall, it emerged that Russia's Sputnik V vaccine had gained the most authorisation.[1] From national regulatory jurisdictions as of 22 April 2021, with 62 authorisations. This was followed by China's Sinopharm, which had 35 authorisations, and India's Covishield, with 33 authorisations. Further details regarding these and other tracked vaccines are presented in the following sub-sections.

14.4.1 COVID-19 Vaccine Diplomacy from China

With continued global pressure following the outbreak of COVID-19 in Wuhan in December 2019, China remains in the spotlight regarding how it presents itself nationally and abroad (Chen, 2020). Suspicion abounds, especially after President

[1] This term is taken to collectively refer to emergency use authorisations, formal approvals and other forms authorising the marketing of the COVID-19 vaccines in a particular country.

Trump embarked on an anti-China and diplomatic offensive, rebranding COVID-19 as the coronavirus (Heisbourg, 2020), with the backing of other countries, including Australia and Japan. Kobierecka and Kobierecki (2021) argue that after China managed to control the COVID-19 outbreak at home, the country went on a 'coronavirus diplomacy' offensive. This form of diplomacy mainly focused on helping other countries that were and are still struggling with COVID-19 infections and deaths due to shortages in medical equipment and medical staff. The vaccine diplomacy spread of the identified Chinese COVID-19 vaccines is shown in Fig. 14.2.

Of the four Chinese COVID-19 vaccines, namely Sinopharm, Sinopharm (Wuhan), Sinovac and CanSino, the Sinopharm vaccine had gained regulatory authorisations in 35 countries as of 22 April 2021. This was followed by Sinovac's vaccine that had been authorised in 22 countries, with CanSino and Sinopharm (Wuhan) vaccines having gained authorisation in five and two countries, respectively.

Against mistrust and noise regarding the Chinese COVID-19 vaccines, the United Arab Emirates (UAE) and Bahrain became the pioneers in granting emergency use authorisation of the Sinopharm vaccine (Cyranoski, 2020; Cohen, 2020). This move significantly boosted China's plans to roll out a number of its vaccines globally. The Sinopharm vaccine was authorised for use in the UAE on 9 December 2020, with Bahrain doing likewise 4 days later on 13 December 2020 (Cyranoski, 2020). The main concern regarding the Sinopharm COVID-19 vaccine was the lack of publicly accessible data on safety and efficacy. However, Sinopharm reported an 86% efficacy in the two-dose vaccine, which included testing 31,000 people in the UAE. As a state-owned company, Sinopharm can produce billions of doses that could be used worldwide. At that time, the Chinese state-run media outlets were reporting orders of the Sinopharm vaccine from over 100 countries while the vaccine was undergoing Phase 3 clinical trials in Egypt, Jordan and Argentina.

In what Cohen et al. (2020) terms 'China's vaccine gambit', the author observes that China's global campaign to test and promote its vaccine candidates were aimed at winning friends and cutting deals, given that the COVID-19 pandemic had its

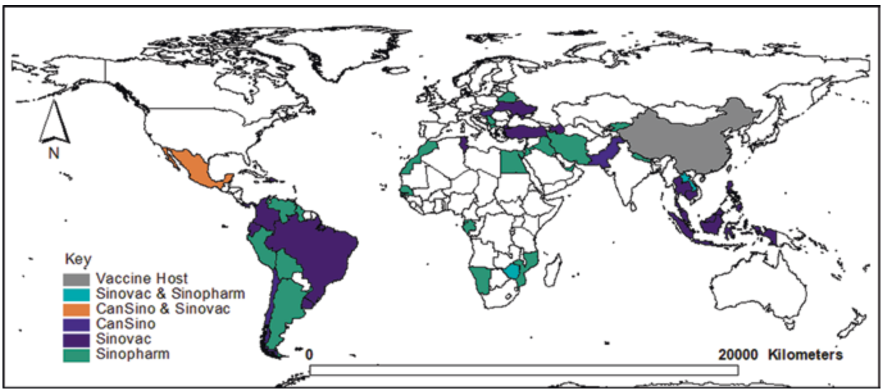

Fig. 14.2 Chinese COVID-19 vaccines diplomacy map. (Source: Authors, data from COVID-19 Vaccine Tracker (2021))

roots in Wuhan, China. From 2 July 2020 to 13 October 2020, four Chinese vaccine candidates (two from Sinopharm working with China National Biotec Group and one from Sinovac and CanSino) were under trial in 14 countries.[2] Cohen et al. (2020) notes the navigation by China of toxic politics in Brazil to have the country declared as one of the vaccine trial sites as a significant diplomatic victory for China. However, while the Chinese COVID-19 vaccines global move can be accepted at face value as a global public good endeavour, the broader strategic goal is to attain hegemonic influence in the bio-economy and leverage public relations and other commercial engagements in the coming decades. For example, China's move into the UAE is associated with the desire to enhance public relations. With the UAE and other collaborating countries having large Muslim populations, such a move was likely to boost perceptions of China's treatment of Uyghur Muslims in the Xinjiang province. Limiting enemies after the COVID-19 pandemic remains on the radar for China (Nhamo, 2021). Cohen et al. (2020) further observes that building goodwill was necessary for promoting China's Belt and Road Initiative (BRI), an idea supported by Rudolf (2021). The BRI is a colossal infrastructure investment programme that spreads over 100 countries and is focused on increasing trade.

Serbia is one of the countries that received COVID-19 assistance from China. After declaring a state of emergency on 15 March 2020, the Serbian President sought help from the European Union (EU), which did not come, and ended up linking up with China (Šantić & Antić, 2020). The first COVID-19 Chinese mission to Serbia included a planeload of humanitarian aid containing supplies, critical medical equipment, and six of China's most eminent epidemiologists. This was just 6 days after the Serbian President had proclaimed a COVID-19 pandemic. Emanating from the publicity of the Chinese assistance to Serbia, the European Commission announced a COVID-19 package for Serbia on 26 March 2020, which included immediate financial aid of €15 million to be used for the transport and purchase of emergency medical equipment and supplies abroad. China could not outdo the European Commission. All this confirms earlier arguments on geopolitical tensions surrounding COVID-19 vaccines diplomacy.

On 21 April 2021, the Chinese Foreign Ministry spokesperson was quoted extending a COVID-19 helping hand to India. This was after the USA had allegedly banned exports of COVID-19 vaccine materials, impacting India's production capacity (O'Connor, 2021). The pledge for assistance was coming against a background of fatal border disputes between the two countries in 2020 (Nhamo, 2021). The hard decision by the USA to ban COVID-19 vaccine material exports came after strong collaboration with India to fight the pandemic under the QUAD initiative in March 2020 (Kutty & Basrur, 2021). The QUAD initiative is discussed further in the following sub-section.

China's COVID-19 vaccine diplomacy has not been free of adverse incidences. Following the death of a trial participant in Brazil, the country suspended the

[2] These countries included Bahrain, Argentina, Brazil, Chile, Egypt, Indonesia, Jordan, Mexico, Morocco, Pakistan, Peru, Russia, Turkey, and the UAE.

Sinovac trial of its CoronaVac vaccine on 9 November 2020 (Cohen, 2020). In a rare undiplomatic Facebook post, Brazilian President Jair Bolsonaro indicated that the vaccine was dangerous, yet the participant's cause of death was later confirmed as emanating from another drug overdose. The Brazilian President had not backed the Sinovac trial initiated by his opponent, the governor of São Paulo. However, in a diplomatic and public relations coup, China signed an agreement with the São Paulo state to supply 46 million vaccines of the CoronaVac at US$90 million. The agreed price was ten times less compared to the Pfizer-BioNTech and Moderna mRNA vaccines originating from the USA and Germany, which were gaining rapid global recognition. There are many more testimonies regarding China's COVID-19 diplomatic move, but the space limits further elaboration.

14.4.2 COVID-19 Vaccine Diplomacy from India

The diplomatic vaccine spread of the two Indian COVID-19 vaccines under study is shown in Fig. 14.3. From a recent publication by Nhamo et al. (2021), initial moves by India in science and COVID-19 diplomacy are highlighted. Saha and Chakrabarti (2021) take the storyline further. The authors view India as the South Asian hegemon. As the COVID-19 vaccine diplomacy took root, India had to look after its immediate neighbours forming part of the Indian sub-continent, namely Bangladesh and Pakistan. As early as May 2020, The Indian Navy Ship Kesari sailed off to deliver essential food supplies and medicines, including hydroxychloroquine, to countries that included Mauritius, Madagascar, Seychelles and Comoros. Other COVID-19-related medical supplies were airlifted to Sri Lanka. India pledged ten million COVID-19 vaccine doses for distribution to its immediate neighbours, including Afghanistan, Bhutan, Bangladesh, Nepal, Sri Lanka, the Maldives, Mauritius, the Seychelles and Myanmar. Indian COVID-19 vaccine diplomacy also

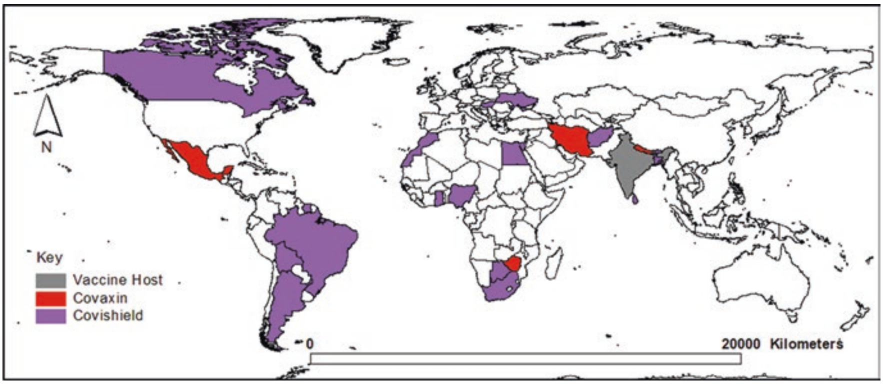

Fig. 14.3 Indian COVID-19 vaccines diplomacy map. (Source: Authors, data from COVID-19 Vaccine Tracker (2021))

featured strongly when it partnered with South Africa to present a proposal to waive specific provisions of the Trade-Related Aspects of Intellectual Property Rights agreement for the prevention, containment and treatment of COVID-19 at the World Trade Organization (Chattu et al., 2021; Nhamo, 2021).

This paper considers two COVID-19 vaccines from India, namely Covishield and Covaxin. The Serum Institute of India's Covishield had been authorised in 33 countries by the data cut-off date for this work. Although Covaxin had not made comparable penetration, it had received authorisations in five other countries excluding India, which included Iran (the Islamic Republic of), Mauritius, Mexico, Nepal and Zimbabwe. Covaxin remains controversial as India's regulatory body authorised it before Phase III results. In a way, the deployment of the vaccine to other countries can be viewed as continued trials under Phase III clinical trials that are not monitored as such. India's COVID-19 vaccine diplomacy for the Covishield reached as far as Canada. Although South Africa was among the countries that received the Covishield early, having bought 1.5 million doses, it had to cancel the planned use of the vaccine as it was discovered to be less effective against the South African COVID-19 variant, the 501.V2 or B.1.351 (Fihlani, 2021). The initial one million doses had to be sold to the African Union, with the outstanding order of half a million doses refunded by the Serum Institute of India.

India's COVID-19 vaccines diplomacy was further elevated through the resuscitation of the Quadrilateral Security Dialogue (QUAD) that involves Australia, India, Japan, and the USA, which is at times alleged to be a kind of Asian North Treaty Atlantic Organisation (Kutty & Basrur, 2021). Although a COVID-19 vaccines development and deployment programme found space in the QUAD, the QUAD had an abortive start in 2007 in its efforts to counter the rise of Chinese influence globally and in Asia. However, China was not mentioned in the inaugural joint statement following the 12 March 2021 QUAD Summit. A statement released by The White House (2021) after the March Summit provides a glimpse of what QUAD strives for. Here is what the heads of governments involved highlighted:

> We bring diverse perspectives and are united in a shared vision for the free and open Indo-Pacific. We strive for a free, open, inclusive, healthy region anchored by democratic values and unconstrained by coercion. We recall that our joint efforts toward this positive vision arose from an international tragedy, the tsunami of 2004. Today, the global devastation wrought by COVID-19, the threat of climate change, and security challenges facing the region summon us with a renewed purpose (The White House, 2021 online).

The White House statement elaborates on matters surrounding their diplomatic engagements and cooperation regarding COVID-19 within the QUAD set-up. The QUAD pledged to join forces, resulting in the expansion of the production of safe, affordable and effective vaccines (The White House, 2021). This would be done to promote equitable access and quicken economic recovery through partnerships with the WHO and COVAX. The mentioning of the WHO and COVAX was critical for the USA after former President Trump had pulled out of the WHO (Hotez, 2021) and withheld support of up to US$500 million (Cohen et al., 2020). The QUAD initiative pledged one billion COVID-19 doses for the Asian-Pacific region (Asian News, 2021). The roles and responsibilities in the deal included India being in charge of the production, the USA providing the needed technology, Japan getting involved in the financing and Australia being responsible for the logistics.

Unfortunately, while India's COVID-19 vaccine diplomacy grew, the country entered a terrible second wave from February to April 2021 (Beaumont, 2021). Among the reasons provided for this second wave is the failure by the government in COVID-19 surveillance, as there had been severe underreporting in January and February. With over 1.3 billion people, India reported a first wave peak of about 100,000 cases per day, that later dropped to 10,000 cases daily. Many believed the country was indeed out of the COVID-19 woods (Biswas, 2021). Pandey and Nazmi (2021) believe that huge religious gatherings, the reopening of most public places and crowded election rallies could have resulted in the surge from the second wave. A new 'double mutant' COVID-19 variant was also reported on 25 March 2021. On Sunday, 18 April 2021, the country reported more than 270,000 daily cases and 1600 deaths; these were new records. Should things continue unchecked, India was expected to hit about 2300 deaths daily by the first week of June 2021 (Biswas, 2021). The projections were likely to become true as on 22 April 2021, the daily infections rose to 314,835, the highest ever recorded since the pandemic outbreak in December 2019 (Pearce et al., 2021). The daily death rate stood at 2104.

Other matters that arose from Indian-based Covishield doses were that they were near their expiry date. The Africa Centre for Disease Control and Prevention – Africa CDC (2021) was forced to make a statement on the donated doses on 21 April 2021. The Africa CDC indicated that it had to seek clarity on the remaining 925,000 Covishield doses it had received in mid-March 2021 for 13 African Union member states. While all recipient countries were informed of the 13 April 2021 expiry date, several member states had not used all the doses by that time. In an unprecedented move, The Serum Institute of India had to formally write to the African CDC approving the 'shelf-life extension' of the donated vaccines to 13 July 2021. This move left more questions than answers associated with COVID-19 vaccines diplomacy. Under normal circumstances, these vaccines were supposed to be discarded, primarily based on national vaccine public health laws and protocols. It was, therefore, not surprising when Malawi and South Sudan indicated they were to destroy the expired vaccines (Oduor, 2021). Malawi received 102,000 doses, of which 16,400 had not been used by the original expiry date, while South Sudan had 60,000 doses it intended to discard.

14.4.3 COVID-19 Vaccine Diplomacy from Russia

Russia's Sputnik V COVID-19 vaccine is one of the vaccines that this paper focuses on. This vaccine was announced in August 2020, less than 6 months after the WHO declared COVID-19 a global pandemic on 11 March 2020. However, President Vladimir Putin's government approving emergency use even before a Phase III clinical trial (Baraniuk, 2021) caused widespread resentment. Approving the two-dose regime Sputnik V before a Phase III trial meant that there remained a black hole of uncertainty in terms of both efficacy and safety matters (Nhamo et al., 2021). This meant that the country had to go on an overdrive of its vaccine diplomacy, including promising reduced and affordable pricing of less than US$10 per dose. The Sputnik V diplomacy got a boost when Phase III results were published in a reputable medical journal, showing efficacy of 91.6% (Jones & Roy, 2021). The R&D, as well as the deployment and marketing of the Sputnik V, is supported financially by the Russian Direct Investment Fund (RDIF), the country's sovereign wealth fund. With over a dozen manufacturing companies across ten national jurisdictions, the RDIF indicated it was capable of manufacturing up to 1.4 billion doses. The Sputnik V diplomatic spread is shown in Fig. 14.4, clearly pointing to a double victory – on the one hand, the science victory, and on the other, the political victory. By 22 April 2021, the Sputnik V vaccine had gained regulatory authorisations in 62 countries worldwide.

Of the tripartite countries under investigation, Russia is the only one in the intersection, having managed to collaborate with both China and India in COVID-19 vaccine development and deployment. However, while soft Russian diplomacy surrounding COVID-19 persisted, it also brought challenges to some countries such as Serbia. Šantić and Antić (2020) argue that Serbia remained placed in the China–Russia–EU triangle. As a country seeking to join the EU, but with strong historical links to Russia and recent emerging economic ties with China, Serbia had to embark on mutually beneficial COVID-19 diplomacy. In the first week of April 2020, Russia dispatched 12 planeloads on a mission to Serbia with COVID-19 relief that included disinfection specialists, ventilators, medical equipment and teams. Similar supplies were sent to Italy. However, the Italian media raised concerns and campaigned to have the Russian aid scrutinised (Dodds et al., 2020). Russia also faced strong opposition to having its Sputnik V vaccine registered by the European Medical Agency (Jones & Roy, 2021). Lastly, while Russia enjoyed good relations with the USA under President Trump's administration, its tensions with President Biden's

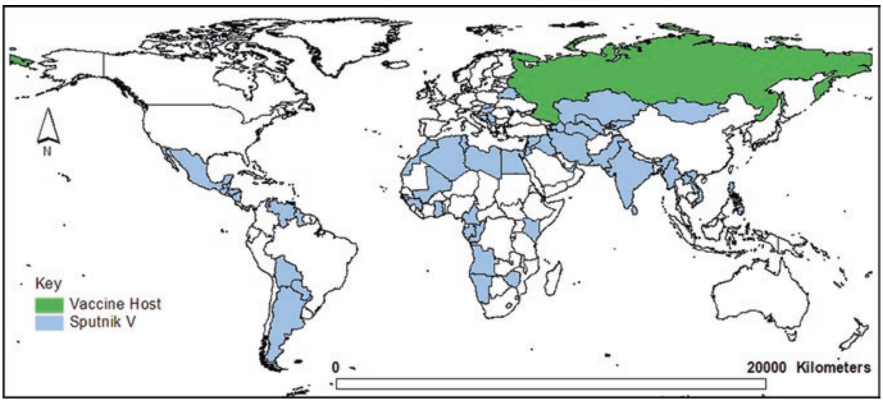

Fig. 14.4 Russian COVID-19 vaccines diplomacy map. (Source: Source: Authors, data from COVID-19 Vaccine Tracker (2021))

administration run high. This emanates from the contested 2016 USA elections in which Russia stood accused of meddling in favour of Trump's party (Abrams, 2018.). It remains to be seen if the Biden administration will reconsider and promote Sputnik V or any other Russian COVID-19 vaccine, for that matter.

14.5 Conclusions

As of 22 April 2021, there were about 102 countries involved in the COVID-19 vaccine diplomacy. From this list, three were the COVID-19 vaccine host countries that are the focus of this paper, namely China, India and Russia. This implies that 99 countries were targeted as part of spreading COVID-19 vaccine diplomacy involving the six vaccines outlined in the methodology chapter (four from China, two from India and one from Russia). Several countries were recipients of vaccines from two of the three host nations, with some 'benefitting' from all three vaccine host countries. Several European countries also got involved in the equation, including Belarus, Bosnia and Herzegovina, Hungary, Montenegro, North Macedonia, Turkey, Serbia and Slovakia.

However, it became clear that while India embarked on a solid COVID-19 vaccine diplomacy pathway, it backfired as many of its citizens were caught up in a nasty second wave that started in February 2021 and looked to be peaking in April 2021. Its COVID-19 vaccines ran out, particularly the Covishield, with some blaming the USA for banning COVID-19 vaccines raw materials. On 22 April 2021, India set a new world record on infections, having reported over 300,000 daily cases. Deaths were also very high, averaging over 2000 daily. Overall, India's vaccine diplomacy did not play out as intended.

Both China and Russia had to be aggressive in their COVID-19 vaccine diplomacy as their vaccines faced a global backlash following opaque R&D and national authorisations. Both countries authorised some of their vaccines only after Phase II clinical trials, leaving a vast black hole in the efficacy tested under Phase III. The only Russian vaccine considered in the paper, Sputnik V, only got global acceptance when its Phase III clinical results were published in the Lancet journal. This resulted in considerable uptake by countries, leading to 62 recorded national regulatory authorisations by 22 April 2021. China also had to embark on aggressive COVID-19 vaccine diplomacy as the source of the COVID-19. Countries including the USA, Australia and Japan were at the forefront in demanding accountability from China. To leverage its COVID-19 vaccine diplomacy, China also joined the COVAX initiative, a partnership between the WHO and GAVI, the Vaccine Alliance aimed at providing subsidised COVID-19 vaccines to 92 low and middle-income countries. China further declared that its vaccines would be global public goods and supplied at reduced prices. However, there remained a considerable chance that some countries could not resist Chinese vaccines as they feared a potential backlash from the global superpower. Overall, China's vaccine witnessed considerable uptake, whether the host countries were 'forced' by circumstances or not, remains another research for the future.

In the process of COVID-19 vaccine diplomacy, the tripartite focus countries also had to collaborate. China networked with Russia, while Russia networked with India. Given the tensions, especially between India and China, India ended up joining a resuscitated QUAD, although China extended a hand to assist during the second Indian wave. The QUAD is a grouping that includes Australia, India, Japan and Japan and was initially conceptualised in 2007 after the Indian Tsunami. However, while acknowledging the incredible work associated with COVID-19 vaccine diplomacy, there is a need for targeted countries to undertake due diligence in terms of unveiling the motives behind these so-called noble acts. The literature is clear that such health diplomacy adventures are intertwined with other exterior motives, including future economic and political gains. It is also important to note that other aspects are associated with global health diplomacy apart from vaccine diplomacy, including access to medicines/treatments, air pollution, migration and health, trade, intellectual property rights and health.

It emerges that the objective, strategies and tactics employed by China, India and Russia in vaccine diplomacy differ and rarely intersect. In most cases, their strategies are competitive and, at times, confrontational (especially in China and India). However, compared to other forms of competition, such as that related to the control of resources, vaccine diplomacy, to a large extent, delivers more benefits than risks to the targeted countries. It offers recipient countries opportunities to diversify their sources of vaccines since none of the three countries demands exclusive supply to them. The risks to vaccine recipient countries will only emerge should competition among these vaccine producers escalate to the level where recipients have to choose whom to cooperate with.

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Part V
Conclusion

Chapter 15
The COVID-19-Health Systems Nexus: Conclusions, Emerging Trends, Key Findings and Policy Implications

David Chikodzi, Lazarus Chapungu, and Kaitano Dube

Abstract The COVID-19 pandemic had serious ramifications on global health systems. The greatest impacts were felt in the global south where health systems were already weak before the pandemic. This chapter highlights the key findings from a book titled the COVID-19-health systems nexus: emerging trends, issues and dynamics in Zimbabwe. Findings show the spatio-temporary dynamics of COVID-19 infections that occurred, institutional settings dealing with public safety, models for pandemic governance, possibilities of implementing of the One Health approach, vaccine hesitancy, vaccine diplomacy, role of communication and social media during pandemics, role virtual health communities during pandemics, synergies and trade-offs between COVID-19 restrictive measures and Sustainable Development Goals and issues of population density and its implication of on the spread and intensity of infections. The chapter the recommends policy interventions to deal with gaps noted in the book chapters and to help build resilience to future pandemics.

Keywords Health systems · COVID-19 · SDGs · Policy

15.1 Introduction and Background

The COVID-19 pandemic has exposed the weaknesses of the global health systems from a preparedness and response perspective. The pandemic grossly overwhelmed even the most sophisticated and well-funded health systems across the world

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(Khetrapal & Bhatia, 2020). Not only were heath systems overwhelmed but were forced by the pandemic to shift priorities and restrict capacity of service offered to society (Tiirinki et al., 2020). Further, the availability of PPE, other medical equipment and material was affected by disruptions on logistics and supply chains during the early days of the pandemic (Ahmed et al., 2020). The disruptive impacts of the pandemic on health systems were mainly due to the scale and speed by which the virus spread which was facilitated by increased global connectivity (Xiao et al., 2021). Although pathogen identification and development of test kits was done relatively fast, testing capabilities were quickly overwhelmed during the pick of the pandemic (Yu et al., 2020).

15.1.1 Access to Health Care and Interaction with SDGs

In most countries, the COVID-19 pandemic had a devastating collateral impact on all aspects of care such as ongoing health programmes, curative services, health services utilisation and access to healthcare (Ahmed et al., 2020). This pattern was consistent in most regions of the world regardless of differences in infections and severity of the contagion. South Africa and Nigeria for example observed decreases in antenatal visits during the pandemic (Sevalie et al., 2021). Pakistan witnessed an over 52.5% drop in vaccinations during the lockdown (Chandir et al., 2020). China observed a significant reduction in healthcare expenditure and utilisation during the peak period of the pandemic (Zhang et al., 2020). The perceived barriers to access of health systems were costs since many had lost their jobs, quality of service, lockdowns which restricted movement, physical distancing measures, limited transport and fear of infection (Chen & Chen, 2020; Sevalie et al., 2021). The most impacted health care practice included deferring or foregoing routine collection of medication, elective surgeries, mental health check-ups and preventive visits (Chen & Chen, 2020). There is therefore a need for increased awareness on the risks of patients defaulting, deferring or forgoing health services. The extent of impacts imposed on health systems by the COVID-19 pandemic varies depending on location, form of healthcare provided and type of facility (Zanin et al., 2020). The impacts also exacerbated the existing inequities in health systems across regions and the globe (Sevalie et al., 2021).

The negative impacts of the COVID-19 pandemic on health systems will have long-lasting effects on the achievement of SDGs especially goal number three (Fenner & Cernev, 2021). SDG 3 endeavours to ensure healthy lives and promotion of well-being for all by 2030. SDG 3 is closely interlinked and draws synergies from other SGDs such as SDG 1 (no poverty), SDG 2 (zero hunger), SDG 4 (quality education), SDG 5 (gender equality), SDG 6 (clean water and sanitation), SDG 13 (climate action), SDG 15 (life on land) and SDG 17 (partnerships for goals) (Fenner & Cernev, 2021). These goals are key in maintaining healthy human and environmental resources on which progress towards other goals can be built from (Naidoo & Fisher, 2020). Progress towards these goals might have been slowed down or in some cases reversed due to the effects of the pandemic (Khetrapal & Bhatia, 2020). The response to the pandemic and post-COVID-19 recovery must be linked to SDGs to be sustainable and leave no one behind (Fenner & Cernev, 2021). The situation created by the pandemic can also be used as an opportunity for transformation and increased efforts towards attaining the SDGs and also redefining of future targets to be achieved (Tonne, 2021; Naidoo & Fisher, 2020).

15.1.2 Impacts on Vulnerable Communities and Management of Health Systems

The effects of the pandemic have disproportionately impacted on the most vulnerable populations within communities. Kashem et al. (2021) shows that ethnicity, lower educational attainment, migrants, refugees, class segregation all have positive correlations with high rates of COVID-19 transmission. These population characteristics influence access to COVID-19 health literacy which is key in reducing exposure and spread of the disease. This brings about the need to consider socioeconomic characteristics of a community before designing intervention measures because success in fighting pandemics is centred on the inclusion of all population segments of society (Orcutt et al., 2020). Rural communities have been noted to generally have lower levels of COVID-19 information assessment skills compared to urban ones hence may not be able to adopt suitable preventive measures (Chen & Chen, 2020). Designing health information to suit the needs of rural communities is an effective strategy of promoting preventive health behaviors against COVID-19 (Zanin et al., 2020; Prusaczyk, 2021).

A decentralised health system has been argued to be the most responsive when dealing with pandemics such as COVID-19 (Tiirinki et al., 2020). A decentralised health system is one which is organised, managed and financed by municipalities/local authorities. A good example will be the Finnish health system. Decentralised public health functions make it possible to easily engage in active public health actions at local level and to design policies and actions that are relevant to local communities. The COVID-19 pandemic is also noted in many countries to have accelerated the development of digital health services and telemedicine as people were either locked down or feared infection during the process of travelling (Xiao et al., 2021). However, the potential increased use of virtual care as substitutes for in-person visits during pandemics still requires more monitoring to assist in developing robust regulatory action (Tiirinki et al., 2020).

15.1.3 Impacts on Africa's Heath System

Africa bears the disproportionate burden of the COVID-19 pandemic due high prevalence of poverty and other diseases (Ataguba, 2020). Most health systems on the continent are funded by the global north which during the COVID-19 pandemic was preoccupied with funding their own health systems due to the shocks imposed by the pandemic (Tarricone & Rognoni, 2020). This reduced donor funding for Africa's health system. There is therefore a need for increased local investment in public health systems on the African continent to build resilience to future shocks related to COVID-19 (Ataguba, 2020). This requires a serious paradigm shift in the way African countries fund their health systems to protect public health. As it stands, health systems are currently under funded, understaffed, stressed and placed at the bottom of political agenda (Bonnet et al., 2019). Increased local funding will also reduce the micro-economic impacts of future pandemics which were shown during the pick periods of the COVID-19 pandemic to be borne by individuals, households, firms, schools, hospitals and also came at the highest cost to livelihoods (Tarricone & Rognoni, 2020).

The next section highlights the key findings from the book which examined trends issues and dynamics of the COVID-19-health systems nexus in Zimbabwe and other parts of the world. The book is divided into five sections each focusing on specific sub-themes of the book. The book starts with an introductory chapter. The chapter introduces the reader to the book focusing on the themes addressed and methods applied. Sections which follow include those that examine health system dynamics in a COVID-19 environment; COVID-19 restrictive measures and related impacts and one that addresses vaccine uptake and diplomacy. The book then concludes with a chapter that addresses the key findings from the book.

15.2 Key Findings

15.2.1 Health system Dynamics in a COVID-19 Environment

The second chapter in the book examines the COVID-19 pandemic spatial patterns and temporal trends in Zimbabwe. Information from this chapter is key in enabling public health authorities and decision makers to prioritise vulnerable areas and to allocate resources where they will have the biggest impact. Findings show that the virus emerged rapidly spread to all the regions of Zimbabwe with the highest cumulative cases occurring in Harare. Other provinces with notable figures were Manicaland, Mashonaland West, Bulawayo and Mashonaland East provinces. Hotspot areas were generally characterised by relatively cooler temperatures, received higher precipitation levels and had higher population densities compared to the rest of the country. The spread of the virus during the observed four waves of infection was consistently from the hotspot areas to the rest of the country. The spatio-temporal distribution pattern of infections reviews that the burden of infection was not evenly distributed across the country and constantly changed from time to time.

The next chapter explored the institutional settings dealing with public safety and health systems during the COVID-19 pandemic in Zimbabwe. This was done in view of building and strengthening the capacity of public health systems to handle to future pandemics. The chapter also builds a framework for integrated public safety planning and development which was found to be lacking in Zimbabwe. It is argued in the chapter that the health and safety systems prevailing in the country had left it ill equipped to manage the spread and impacts of COVID-19. It noted in the chapter that accurate reporting and communication of public safety/health issues will improve understanding of risks and enhances the capacity to offer the correct policy prescriptions to relevant institutions. This will also help in promoting the provision of suitable post-pandemic assessment. Future interventions put in place to manage pandemics must be implemented only if they come with actionable and viable recommendations for public safety and health agencies operating during a pandemic.

Governance was shown to be a key factor in managing pandemics. It is argued in Chap. 4 of the book that a devolved governance model was the best in managing emergences such as COVID-19. This chapter examined the opportunities and constraints brought by devolution as a governance model by investigating its efficacy in curbing the spread and devastating effects of COVID-19 in Zimbabwe. The devolution of power and responsibilities to sub-national tiers of government will ensure the equitable allocation of national resources, and the participation of local communities in the determination of and responses to public health emergencies within their area. The ongoing COVID-19 crisis has presented an opportunity to address the historical underperformance of local tiers of the national government in changing and enhancing the resilience of local communities in fighting their local problems such as those brought by pandemics. It also emerged that devolution's success must be evaluated by its ability to act as a living laboratory of governance, through showcasing and experimenting health policies and responses in one local area, district, province for the benefit of the entire country. However, although devolution gained notable progress in Zimbabwe, it still lacked institutionalisation in supporting the health functions of the local authorities.

The next chapter assessed the prospects and constraints of operationalising the One Health approach in Zimbabwe in response to the current and future pandemics. It is highlighted in the chapter that the on-going COVID-19 pandemic has reinforced the importance of One Health approach in responding to infectious diseases at the human-animal-ecosystem interface. Findings from the study show that Zimbabwe is not currently prioritising the operationalisation of the One Heath approach. To successfully implement the approach, the country needs to build on the existing legal and institutional framework, taking advantage of the available database management systems and geospatial technology opportunities. There was also a need to address challenges of limited capacities in the public and animal health systems, and inadequate water and sanitation.

Some researchers and health experts have advocated for both pharmacological and non-pharmacological preventive interventions to manage the impacts of COVID-19 on society. Countries and regions in the global south which are known to have poor formal health systems, limited resources, and huge populations of low socioeconomic status, relied on indigenous systems as a means of survival during the pandemic. In the book, Chap. 7 examined Zimbabwe's indigenous health practices and lifestyles to check their efficacy in fighting against the spread of the coronavirus. It is shown in the chapter that cultural characteristics must be identified and included in the national COVID-19 measures to establish an effective pandemic control strategy. The research noted that a well thought-out fusion of formal hospital and indigenous techniques performed better in combating the spread of the coronavirus. It was therefore encouraged that countries move beyond pro- and anti-nonnative approaches and propose a health reform based on indigenous practices and lifestyles that can work alone or can be practically and pragmatically blended with World Health Organization approaches of combating the spread of COVID-19.

The last chapter in this section of the book explores the implications and impact of virtual communities in healthcare (VHCs) during the COVID-19 pandemic in Zimbabwe. It looks at how patients adjust to and what still needs to be done to make virtual communities more effective in supporting access to health services during pandemics. Findings show that patients used VHCs for both cognitive and affective information and have been embraced by both rural and urban communities during the COVID-19 pandemic. However, more urban dwellers in Zimbabwe were aware and used VHCs and women were more reliant on them for advice on symptoms, illnesses they may be diagnosed with and for emotional support compared to man. There were some noted drawbacks observed. Some participants were reluctant to fully rely on one VHCs hence used multiple sites without any affiliation to a specific community. Those who were already using virtual communities are generally optimistic about the help they received and found them helpful in connecting with people of similar experiences in particular. Those that have had negative experiences indicated lack of trust in the communities but continued to use them with caution and not giving away too much personal information.

15.2.2 COVID-19 Restrictive Measures and Related Impacts

Population density is one of the major variables which determines the intensity and duration of pandemics. The first chapter of this section analysed the effects of population density on the morbidity and mortality of COVID-19. Findings show that high population densities irrespective of whether they occur in the global north or south were significantly related to high infection rates. However, where there is high population density coinciding with inadequate health infrastructure, then more deaths were likely to occur. The effect of high population density on the intensity of the COVID-19 pandemic can therefore be significantly reduced by advanced infrastructure and medical facilities. However, even the best medical facilities can be overwhelmed as was witnessed several times during the COVID-19 pandemic.

The deliberate management of synergies and trade-offs is a critical action in the design of SDG sensitive pandemic response measures. A chapter in this section analysed the synergies and tradeoffs that occurred when COVID-19 restrictive measures interacted with SDG 15 in Zimbabwe. The findings show that COVID-19 restrictive measures were largely associated with tradeoffs with the targets of SDG 15. Hence to a considerable extent, the COVID-19 pandemic had negative impacts on the conservation of biodiversity. This was mainly because conservation is largely self-funded in Zimbabwe through revenue from tourism which was significantly impacted during lockdowns. Conservation related activities such as ecological monitoring, law enforcement, research, community extension and conservation programmes, ecological restoration and administration could not be executed as a result of imposed restrictive measures. The COVID-19 period saw notable increases in subsistence poaching, forest encroachment, tree cutting, wetland overuse and artisanal mining in protected areas.

The last chapter in this section analysed the impacts of the COVID-19 pandemic on the macro-economy of Zimbabwe specifically looking at production of goods and services, inflation, employment and the health delivery system. Findings highlighted that numerous macro-economic variables were negatively impacted by the COVID-19 infections and control measures. Economic development and Zimbabwe's health delivery system were severely affected by the emergence of COVID-19. There was a positive correlation between COVID-19 infections and unemployment levels and a negative relationship between COVID-19 infections and levels of inflation as well as GDP values. COVID-19 resulted in higher levels of unemployment, higher levels of inflation as measured by the consumer price index, lower Gross Domestic Product and higher imports. All these had negative implications on the health delivery system of the country.

15.2.3 Vaccine Uptake and Diplomacy

Reasons for vaccine hesitancy and apathy remain veiled in obscurity yet vaccination is key to stopping the spread of the pandemic. Questions on why the levels of vaccination remain yet vaccines are available therefore remain relevant. The first chapter in this part of the book explores the vaccination trends since the onset of the COVID-19 pandemic in Zimbabwe and assesses the factors influencing the specific trends. The chapter interrogates the possible causes and consequences of COVID-19 vaccination apathy, hesitancy and neutrality.

The next chapter defined and discussed social media engagements on COVID-19 vaccination. It examined different chats on selected WhatsApp groups about the COVID-19 vaccination pros and cons and deliberates on the latent risks, benefits, and challenges of embracing the social media platform such as WhatsApp in public health communication. The chapter further investigates the potential of social media platforms in promoting or undermining public health communication campaigns on COVID-19 vaccination drive and consequently Zimbabwe's health system. Findings show that negative religious discourse, lack of trust in the government, fear of political manipulation, suspicion of commercial gain and concerns about vaccine safety were some of the complexities behind vaccine hesitancy. These were then amplified on social media; hence, social media had the potential to derail or hamper efforts to curb the spread of the virus. The research concludes that social media had swayed perceptions about vaccination against COVID-19 and was persuasive enough to potentially evoke strong resistance by citizens against vaccination.

The final chapter of this section investigated COVID-19 vaccine diplomacy by three countries namely Russia, India and China. Findings highlight that vaccine diplomacy was very solid and dominated by debates on efficacy, effectiveness and safety. China's vaccines witnessed considerable uptake, whether the host countries were 'forced' by circumstances or not, remains another research for the future, Russia's vaccine was relatively highly rated, India's vaccine diplomacy did not play out as intended because of a serious wave of infection which hit the country and led to vaccine export bans. The chapter recommended vaccine recipient countries to remain open-minded regarding the ultimate purpose of the seemingly 'ethical' and global solidarity drive.

15.3 Policy Implications

In the light of the gaps noted in the book chapters that point to limited funding, poor institutional framework, poor communication, vaccine hesitancy, limited resilience, increased vulnerability and inequalities and poor policies addressing the health systems, the following policy recommendations can assist to fill these gaps.

There is a need for public health systems that are resilient to future pandemics. This starts by building strong public health institutions which are well capacitated financially and technically. Public health institutions must formulate policies that are informed by evidence gathered objectively and subjected to continuous monitoring and evaluation to ensure their relevance. Pandemic preparedness and response plans must be prioritised and coordinated at the highest level of policy making. There is a need to develop, innovate and sometimes adopt advanced public health surveillance technologies and applications to improve the capture and analysis of public health data which is key in informed decisions during deadly crises. Further, there must be regular monitoring of health service utilisation during pandemics to inform and evaluate public health response measures. There is a need for wider cooperation and synchronisation of efforts between state and non-state actors in the health system at all levels of society during pandemics. Crafting of public preventative measure during pandemics must link legislation and regulations to facilitate compliance by the public, and this will also help in crafting preventative policies that are implementable and sensitive to local livelihoods.

There is a need to develop comprehensive holistic national One Health platforms, policies and strategic frameworks necessary for the formulation and implementation of the One Health approach. This will be the basis for accurate quantitative risk management for future epidemics and pandemic through provision in depth understanding of patterns that are dynamic over time and space. The post-pandemic recovery and resilience building should be informed and led by principles of sustainability that aim to address the targets of applicable Sustainable Development Goals.

During pandemic such as COVID-19, there is a need for continuous education and risk communication to the affected communities. This brings the need for regular surveys on public awareness, education campaigns and ability to transform the results to action on issues of public concern. Communication of public health information must be tailor made to suit local community needs to be effective. There is a need to strengthen laboratory testing capabilities at all levels of society and health system. Only widespread testing and diagnosis capability and help directing resources and interventions to where they are most needed will produce the greatest impact.

There was disruption of healthcare provision during the pandemic. Most healthcare facilities witnessed reduced patients visits. There is a need for sustained monitoring of the situation and crafting of targeted interventions to rebuild public trust in healthcare facilities. Further, there is also a need to determine the vulnerable patient groups and disease specific healthcare services were most affected during the pandemic. This will inform strategies and policies to manage such impacts during future pandemics. Just as in times of war, countries significantly increase their spending on defence; similarly, there is thus a need to increase spending on health systems. Increased spending on health will help reduce the disruptive impacts of future pandemics.

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