Direct and Indirect Health Effects of Lockdown in South Africa

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Abstract

This paper investigates both the potential impact of national lockdown measures on COVID-19 transmission, and other health and non-health indicators in South Africa, based on available data. We present findings relating to both "costs" and "benefits" in health terms of the national lockdown side by side. Cumulative and new daily cases were plotted against changes in regulations. Disease transmission during each lockdown level was estimated using effective reproduction rate as a proxy, calculated using the EpiEstim method. The reproduction number was calculated at national and provincial level. To compare township and suburb living environments, the Cape Town township of Khayelitsha was compared with the southern suburbs of the same city. Indirect health effects were assessed by official reports and releases from government departments and institutes. Crime statistics were retrieved from the South African Police Service and StatsSA. We find that for large parts of the country and parts of the population, stringent lockdown was little or no better than measures already in place for controlling transmission of COVID-19. The net health effect of COVID-19 lockdowns in South Africa cannot yet be assessed because causes of death data have not been made available. Substantial excess deaths relative to previous years were observed, and the majority of these are not accounted for. There is reason to anticipate significant future health consequences of lockdown.

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Direct and Indirect Health Effects of Lockdown in South Africa

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Foreword

On March 11, 2020, the World Health Organization declared COVID-19 a global pandemic. With dire predictions about how the virus could devastate populations and overwhelm health systems, many countries imposed stringent measures to limit spread and the resulting morbidity and mortality. Yet most of these policy approaches focused narrowly on potential impacts for COVID-19, without sufficient attention to how the pandemic and various response measures would have broader indirect impacts across other health needs and health services. While the evidence of disruptions to essential health services was largely anecdotal to begin with, and its health effects mostly modeled, increasingly detailed evidence is beginning to emerge from countries.

Over the past year we partnered with research institutions in Kenya, the Philippines, South Africa, and Uganda to document, from a whole-of-health perspective, what we know about the nature, scale, and scope of the disruptions to essential health services in those countries, and the health effects of such disruptions. This research provides initial insights on the observed near-term indirect health impacts of the pandemic and response measures, relying on the best available data in the months following lockdown measures. However, it is important to recognize the limitations of conducting research during a pandemic and a continuously evolving epidemiological and policy context. We plan to build on these studies as more and better data become available, and as public health responses continue until the pandemic is brought under control.

In this paper, Benjamin Smart, Herkulaas Combrink, Alex Broadbent, and Piet Streicher present findings on the direct and indirect health effects of COVID-19 and its mitigation strategies in South Africa. They show us that for much of the country, the stringent lockdown implemented by the government was little or no better than measures already in place for controlling transmission of COVID-19. And yet, evidence of the collateral health damage of the lockdown is mounting. The authors believe there is reason to anticipate significant future health consequences of the lockdown.

We are hopeful that the findings from this working paper—and the project as a whole—will contribute to our global knowledge about the ongoing and lingering effects of the pandemic, and ways to mitigate these effects. It is not too late for action. Armed with the kind of evidence in this working paper, national governments and global partners must focus their efforts on the most affected, most cost-effective services, and ensure that any lost generations due to the pandemic are minimized.

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Introduction

Many African countries have seen a slow spread of COVID-19 with a late or even no peak. Many also implemented stringent lockdown regulations early on (Haider, et al., 2020). While early stringent lockdowns have been credited the apparently low impact of COVID-19 in South Africa (Meyer, 2020), the spread of cases in South Africa has not varied with variations in lockdown level (Broadbent, et al., 2020) . A recent comparison of regimes in different African countries found considerable differences in the measures actually implemented, and "no obvious pattern" between those measures and the spread of the epidemic (Haider, et al., 2020). The effectiveness of lockdown at slowing the spread of COVID-19 thus remains uncertain in South Africa. The rationale for effectiveness of lockdowns depends on their reducing social contact, but in overcrowded living conditions they may have the opposite effect (Chirisa, et al., 2020). South Africa is a very unequal country (Tregenna & Tsela, 2012) with a very wide range of living conditions in the country.

Given high levels of poverty and food insecurity, lockdowns may also pose serious health risks in the African region, including in South Africa, where approximately half the population lives below the upper bound poverty line (StatsSA, 2019) despite the country's relative wealth. While there are numerous reports of malnutrition and disruption of health services (Headey, et al., 2020), there has not yet been an attempt to quantify the indirect health impact of lockdown.

This paper investigates both the potential impact of national lockdown measures on COVID-19 transmission ("direct effect"), and other health and non-health indicators ("indirect effect") in South Africa, based on available data. We thus present findings relating to both "costs" and "benefits", in health terms, of the national lockdown side by side. We do not, however, seek to estimate the direct or indirect effects of lockdown relative to any counterfactual scenario. Rather, we compare transmission under different lockdown regulations implemented at different times, and transmission in different provinces and environments under the same regulations. As regards indirect effects, we refer to expected health data based on previous years.

South Africa confirmed its first case on 5th March and first local transmission on 15th, when it declared a National State of Disaster. Initially a mitigation strategy was implemented including some restrictions on the sale of alcohol, a ban on gatherings of over 100 people, and a large-scale campaign promoting social distancing and regular hand-washing. On March 18th all schools were closed (sending home 12.4 million learners (Department of Basic Education South Africa, 2018)). By 24th March all the country's 9 provinces had confirmed cases (NDOH, 2020). On March 26th the country entered "Level 5 Lockdown", one of the most stringent globally (bsg.ox.ac.uk, 2020), which was gradually relaxed over a period of many months (see Table 1).

Table 1. Breakdown of South African lockdown levels and subsequent restrictions

Lockdown Level	Date	Most Salient Restrictions
5	26th March 2020 – 30th April 2020	• Only Essential Services • Ban on cigarette and alcohol sales • Non-essential workers to remain in their residences except to obtain essential services • Curfew 8pm-5am
4	1st May 2020 – 31st May 2020	• Essential services with exceptions to more sectors of the economy • Public transport at all times outside of curfew, but with limitations on capacity • Ban on cigarette and alcohol sales • Citizens permitted to exercise between 6am and 9am only • Mask-wearing in public became compulsory
3	1st June 2020 – 17th August 2020	• Further opening of the economy, with restrictions on entertainment and gatherings • All major forms of public transport outside of curfew hours permitted, with restrictions on capacity and hygiene. • No interprovincial travel except for the transportation of goods and exceptional circumstances, e.g. funerals
2	18th August 2020 – 20th September 2020	• All retail permitted • Hotels allowed to re-open for domestic travel • Limited domestic air travel; Car rental services • Interprovincial travel permitted • Curfew relaxed to 10pm-4am daily • Ban on cigarette sales ended on August 17th, 2020
1	20th September -28th December	• All sectors of industry permitted • All restrictions on public transport lifted, with strict hygiene conditions • Interprovincial travel allowed, with restrictions on international travel
Adjusted 3	29th December – 28th February	• Re-instatement of the alcohol ban • Curfew 10pm-5am • Public swimming pools and beaches closed • Social gathering banned • Interprovincial travel allowed
Adjusted 1	28th February -	• All sectors of industry permitted • Curfew midnight-4am • Alcohol sales allowed except during curfew

Source: https://www.gov.za/COVID-19/resources/regulations-and-guidelines-coronavirus-COVID-19

Objectives

The twin objectives of this study were to ascertain, respectively, the direct and indirect health effects of lockdown regulations, to the extent possible given available data. In order to assess the direct effect of lockdown on COVID-19 transmission, we sought to estimate the effective reproductive number at a national level, and to identify salient provincial deviations. We further sought to compare transmission under the same lockdown regulations in different living conditions found within South Africa, specifically townships and suburbs. In order to assess indirect effect we sought to quantify excess deaths during the period of lockdown, and to identify their causes. Given that many negative health impacts would be likely to occur in the future, we also sought to identify sources of potential future negative health outcomes, including those effects lockdown had on crime rates.

Methods

In order to assess effectiveness of lockdown regulations, cumulative and new daily cases were plotted against changes in regulations. Disease transmission during each lockdown level was estimated using effective reproduction rate as a proxy. The COVID-19 data gathering processes were consolidations from official ministerial press releases gathered on the Data Science for Social Impact (DSFSI) research group GitHub repository for South African context (Marivate, et al., 2020; Marivate & Combrink, 2020)

Effective reproductive number was calculated using the EpiEstim method. This method focusses exclusively on expected infection incidence at time *t,* with an infection rate of $R_e(t)\,.\,w_s$. The measurement of w_s is described as the infectivity profile *s* days after the infection took place and is used for the likelihood calculation (Goldstein, et al., 2009; Cori, et al., 2013; Huisman, et al., 2020). The likelihood for an expected infection can be classified as:

$$\Lambda t = \sum_{s=1}^{t} I_{t-s} w_s \qquad (1)$$

This approach to calculation of the effective reproductive number has previously been found to be an effective method in establishing the effective reproductive rate over time, retrospectively (Cori, et al., 2013).

The reproduction number was calculated at national and provincial level. In order to compare township and suburb living environments, the Cape Town township of Khayelitsha was compared with the Southern Suburbs of the same city.

Indirect health effects were assessed by official reports and releases from the National Institute of Communicable Diseases (NICD), COVID-19 healthcare effects, released statistics from the South African Medical Research Council (SAMRC), the National Department of Health (NDOH), and healthcare synthesis reports from the Coronavirus Rapid Mobile Survey National Income Dynamic Study (CRAM-NIDS) (McQuaid, et al., 2020; SAMRC, 2020; NDOH, 2020; NICD, 2020a; Stiegler & Bouchard, 2020; Bulled & Singer, 2020; Spaull, et al., 2020). Additionally, the crime statistics as well as the economic consequences for South Africa were derived from official population-based statistics released quarterly by the South African Police Service (SAPS, 2020) and StatsSA respectively.

Results

National and provincial direct health effects

As of the 15th of March 2021, South Africa had 1,530,033 confirmed COVID-19 cases and 51,421 confirmed COVID-19 deaths, used in the association study (NICD, 2020a). This comprises approximately 2.57% of the total South African population (59.64M) (STATSSA, 2020). Within South Africa, 57.79% of the confirmed COVID-19 cases are female with the majority of cases between the ages of 25 – 49. By far, the majority of cases are isolated in the Gauteng province (32.11%), followed by Kwa-Zulu Natal and the Western Cape, respectively [Table 2] (NICD, 2020a).

The epidemic in South Africa is, at the time of writing, characterised by two waves of infections. The first wave peaked in July 2020, following which the rate of new daily infections continued to drop until October 2020. In November 2020, clinicians in the Nelson Mandela Bay region reported a significant uptick in new cases. This led to the identification of a new variant of the virus, SARS-CoV-2 (501Y.V2), most notable for its significantly higher viral load, and increased transmissibility (Makoni, 2021). This quickly became the dominant strain in the country, leading to a second wave of infections and the re-instatement of stricter lockdown conditions (amended level 3).

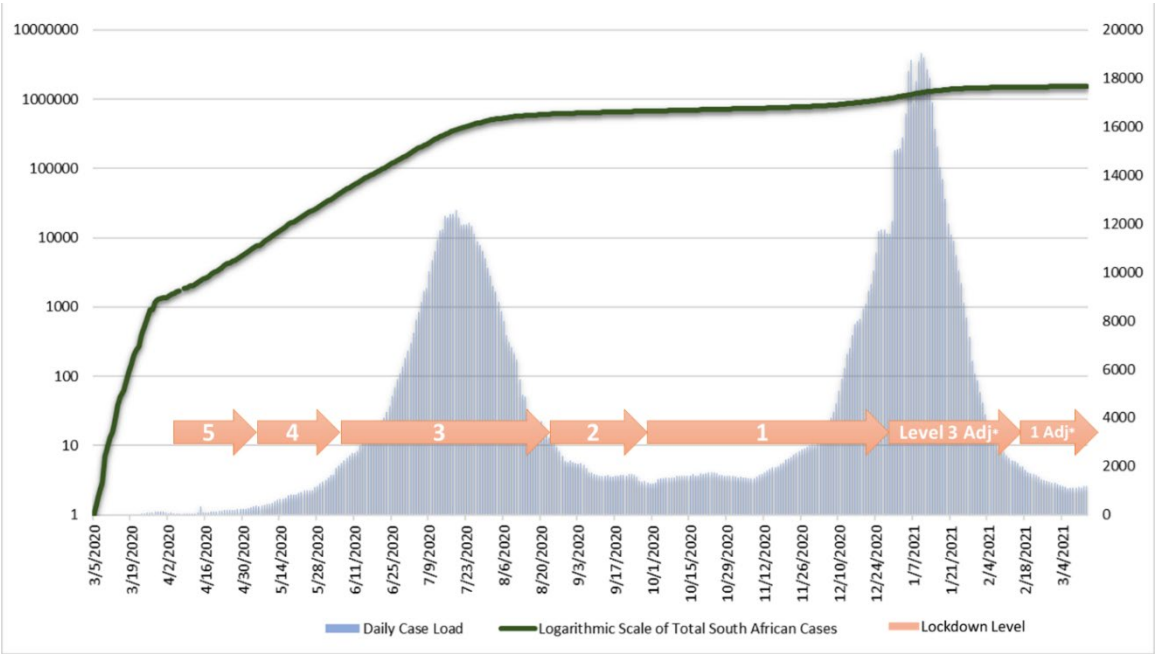
Table 2. South African provincial distribution of cumulative caseload

Place	Number	% of Total Case Load	% of Total Population
EC[1]	194,342	12.70	0.33
KZN[2]	331,977	21.70	0.56
NW[3]	62,199	4.07	0.10
MP[4]	72,938	4.77	0.12
NC[5]	34,931	2.28	0.06
LIM[6]	62,693	4.10	0.11
FS[7]	81,471	5.32	0.14
GP[8]	409,404	26.76	0.69
WC[9]	280,078	18.31	0.47

1 – Eastern Cape Province, 2 – KwaZulu Natal Province, 3 – North Western Province, 4 – Mpumalanga Province, 5 Northern Cape Province, 6 – Limpopo Province, 7 – Free State Province, 8 – Gauteng Province, 9 – Western Cape Province, 10 – Republic of South Africa

Figure 1 shows the number of cases per day and the cumulative COVID-19 cases in South Africa mapped on a logarithmic scale, with arrows indicating when the various stages of lockdown were implemented.

Figure 1. COVID-19 caseload over time



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A more detailed understanding of rate of transmission during different lockdown regimes may be obtained by comparing effective reproductive rate during those periods at provincial and national levels (Table 3).

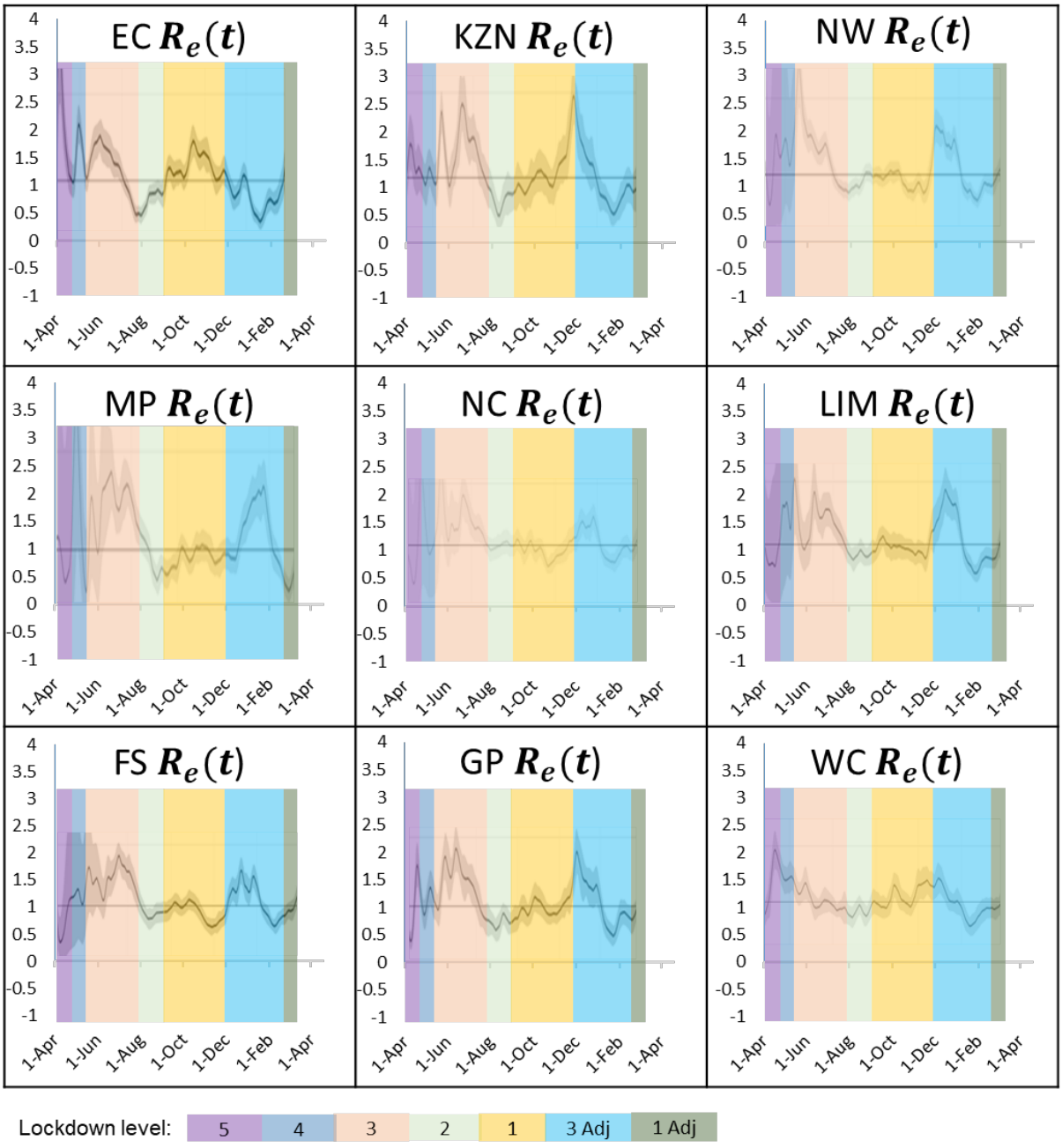
Table 3. Lockdown level associated distribution of effective reproductive rate

Place	Level 5 $R_e(t)$ (CI)	Level 4 $R_e(t)$ (CI)	Level 3 $R_e(t)$ (CI)	Level 2 $R_e(t)$ (CI)
EC[1]	1.8 (0.85 - 3.5)	1.31 (0.95 - 1.76)	1.05 (0.57 - 1.56)	1.00 (0.78 - 1.26)
KZN[2]	1.24 (0.87 - 1.73)	1.32 (0.81 - 1.96)	1.20 (0.52 - 1.95)	0.86 (0.72 - 1.01)
NW[3]	1.28 (0.07 - 2.87)	1.61 (0.13 - 3.02)	1.18 (0.73 - 1.79)	0.97 (0.82 - 1.14)
MP[4]	1.59 (0.77 - 4.67)	1.16 (0.22 - 1.97)	1.25 (0.67 - 2.27)	0.88 (0.68 - 1.13)
NC[5]	1.26 (0 - 5.96)	1.49 (0.13 - 3.69)	1.34 (0.85 - 2.11)	0.99 (0.83 - 1.16)
LIM[6]	1.19 (0.05 - 3.81)	1.43 (0.59 - 3.06)	1.24 (0.71 - 2.22)	0.96 (0.72 - 1.25)
FS[7]	0.84 (0.13 - 2.49)	1.35 (0.83 - 2.52)	1.29 (0.75 - 1.99)	0.98 (0.84 - 1.13)
GP[8]	1.00 (0.4 - 1.79)	1.36 (0.82 - 1.86)	1.23 (0.61 - 1.81)	0.86 (0.72 - 1.03)
WC[9]	1.34 (0.65 - 2.08)	1.31 (1.14 - 1.52)	0.92 (0.71 - 1.13)	0.88 (0.72 - 1.07)
RSA[10]	1.28 (0.42 - 3.21)	1.37 (0.62 - 2.37)	1.19 (0.68 - 1.87)	0.93 (0.76 - 1.13)

1 – Eastern Cape Province, 2 – KwaZulu Natal Province, 3 – North Western Province, 4 – Mpumalanga Province, 5 Northern Cape Province, 6 – Limpopo Province, 7 – Free State Province, 8 – Gauteng Province, 9 – Western Cape Province, 10 – Republic of South Africa

Nationally, there was a slight increase in reproductive rate in Level 4 compared to Level 5, which then decreases at Levels 3 (during wave 1) and, especially, 2. Reproductive number corresponds to the gradient of the cumulative case line in Figure 1, which is fairly straight through Levels 5-3 and then flattens off during Level 2. Against this trend, three provinces saw reductions in reproductive number from Levels 5 to 4 (EC, MP, WC) and one (MP) saw an increase from Levels 4 to 3. Five of the nine provinces (EC, KZN, NW, MP, and WC) had slower transmission under Level 3 than under Level 5, and only one province (FS) saw higher reproductive number at Level 2 compared to Level 5. There were deviations observed between the various South African provinces in terms of $\boldsymbol{R_e(t)}$ (Figure 2). High variations in the confidence intervals (CI) were observed during lockdown levels 5 and 4 for five of the provinces (NW, MP, NC, LIM, and FS). For all these numbers, it is important to bear in mind that the "average" for the lockdown period conceals some variation within that period (see Figure 2).

Figure 2. Reproduction number in each province over time.



Comparing direct health effects in Khyalitsha Township and Cape Town Southern Suburbs

During the first wave, the townships of Khayelitsha, Mitchells Plain and Klipfontein had a marginally higher peak and shorter epidemic curve than the suburban areas under investigation (Southern Suburbs, Northern Suburbs, Western Seaboard) (figure 3). The suburbs had a marginally flatter and longer curve and a marked resurgence starting around 4 October, about 10 days after entering Level 1. The second wave, exacerbated by the appearance of the new, more transmissible variant of the disease, was more prominent in the suburban areas than the first wave, infecting up to three times as many

people daily. Although there was also a second wave in the township areas, this peaked at a similar level to the first wave.

Figure 3. COVID-19 Southern Suburbs, Northern Suburbs, and Western Seaboard caseload

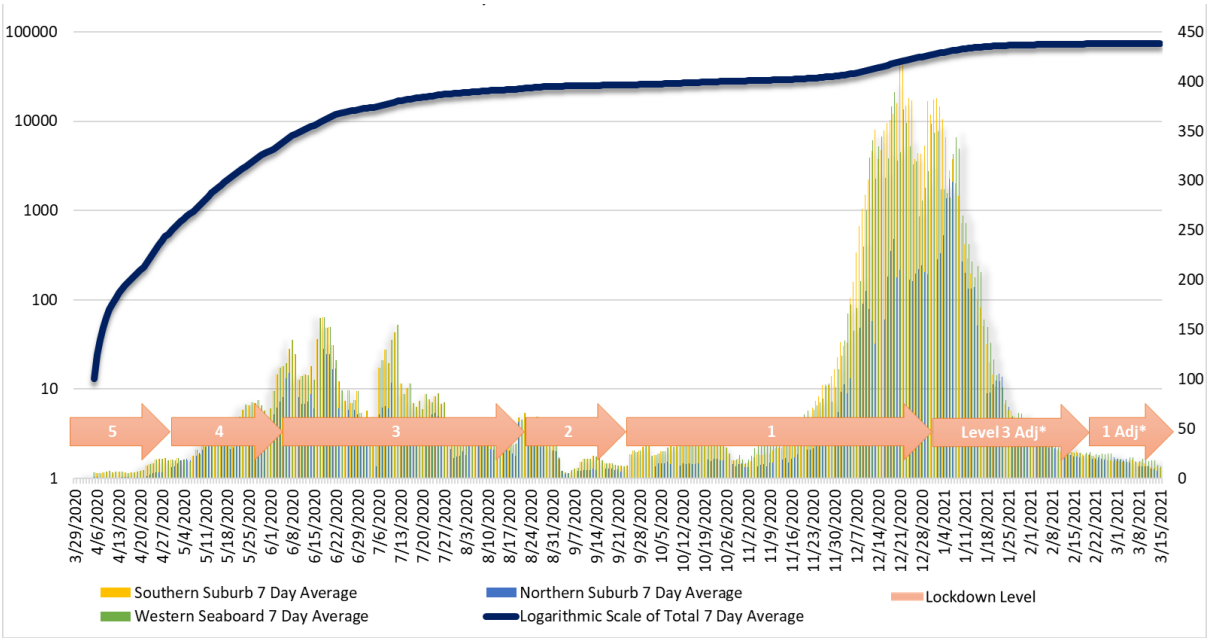
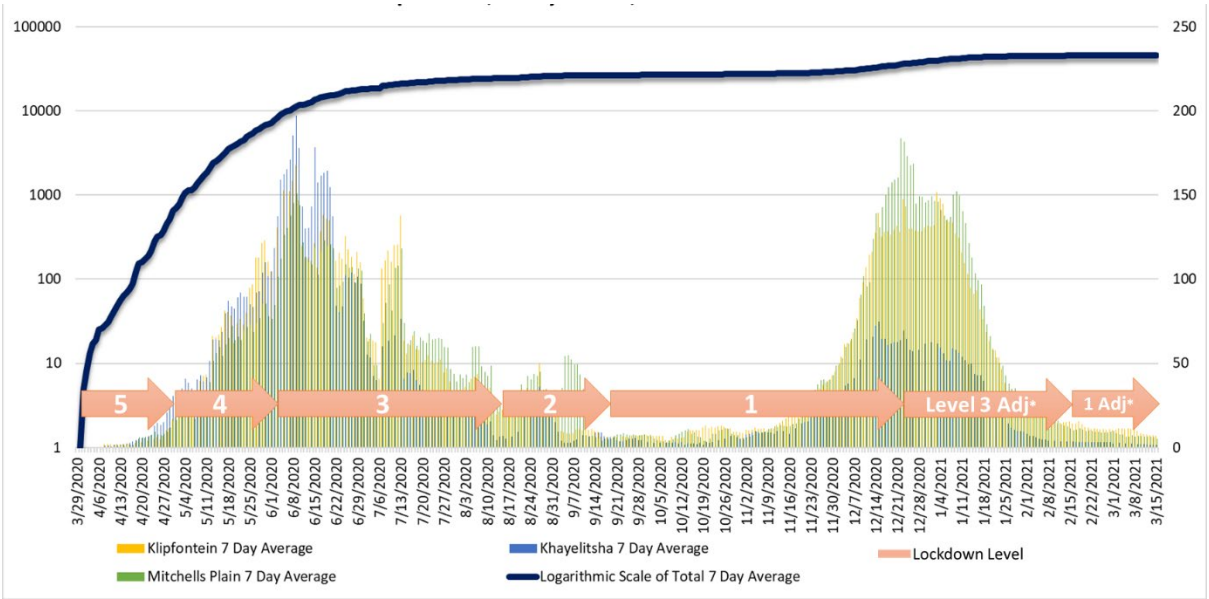


Figure 4. COVID-19 Klipfontein, Khayelitsha, and Mitchells Plain caseload



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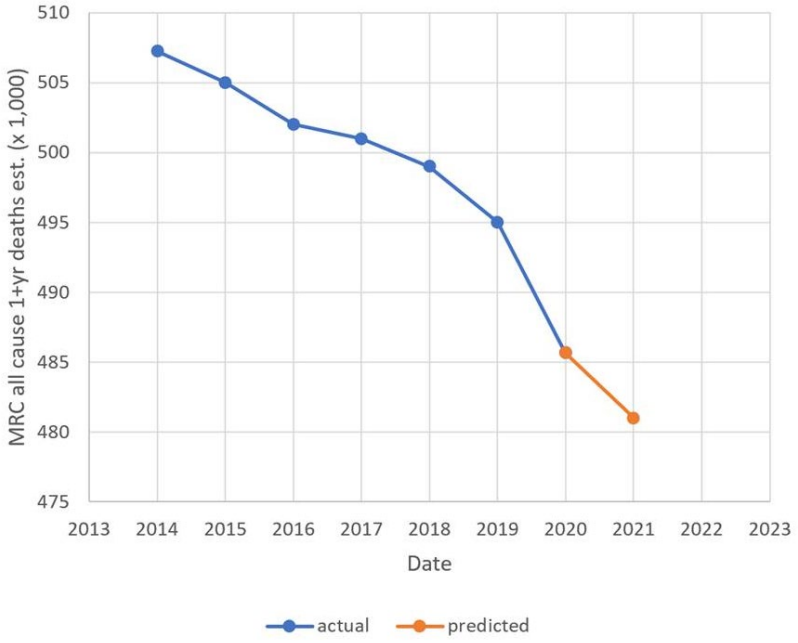
Excess deaths

The South African Medical Research Council (SAMRC) produce a weekly report estimating excess deaths for the week. Excess deaths are estimated by subtracting expected deaths from the total number of deaths recorded in a week. The expected deaths are based on average deaths from the same period in 2018/2019, minus 12-16k deaths to accommodate the existing downward trend.

Figure 5. Decline in MRC actual and predicted deaths – using epi-year estimates adjusted to 52 weeks

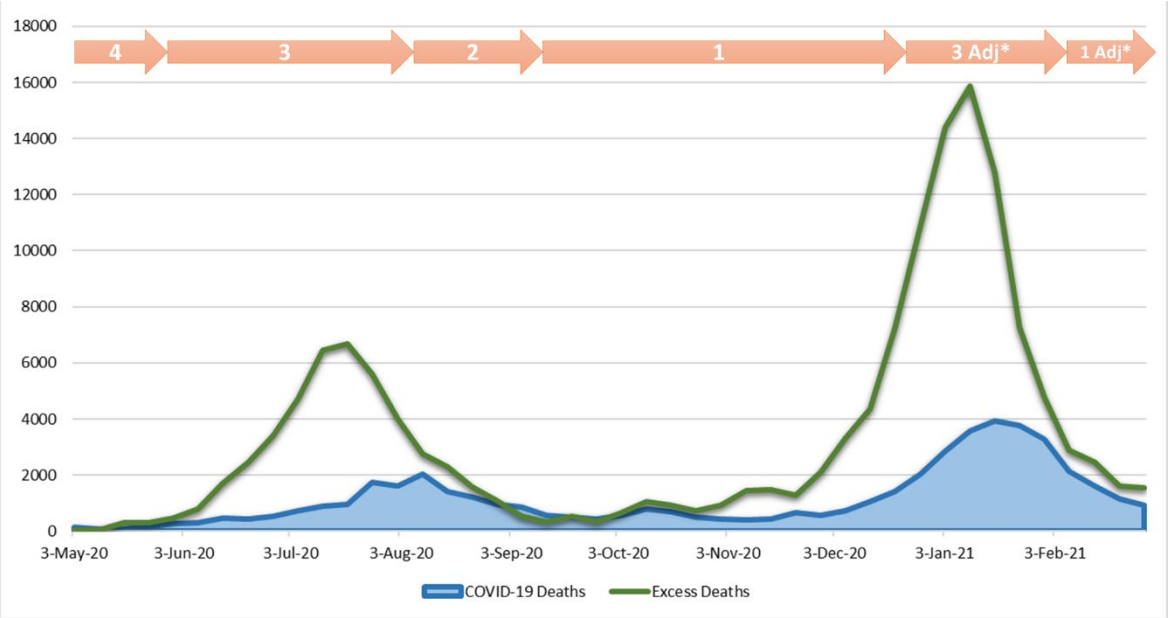


For the period 3 May 2020 6 March 2021, the SAMRC estimate excess deaths at 146,626. By March 15th, COVID-19 deaths recorded were running at 51,326 (NDOH, 2020).

There is a close correlation between the number of excess deaths and recorded COVID-19 deaths, with the former peaking before the latter during the first wave on infections. However, excess deaths are considerably higher than COVID-19 deaths, with 93,300 not recorded as COVID-19. While the National Health Laboratory Service have reported backlogs in test results, they are not of this scale (NHLS, 2020). Despite efforts, we were unable to obtain causes of death data from official sources.

It is critical that both the possibility of missed COVID-19 deaths and non-COVID-19 deaths are considered during this period. Both possibilities point to a potentially large number of deaths outside of hospitals.

Figure 6. South Africa reported deaths



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Leading indicators of future indirect health impact of lockdown

For the period April to June, HIV testing in South Africa dropped 46% from 4,467,057 in 2019 to 2,428,564 in 2020. Performance varied from province to province, with Gauteng, the country's most populous province, experiencing the largest drop of 82% (NDOH, 2020). Although clinics and hospitals remained open during this period, restrictions on movement as a consequence of the lockdown resulted in the cessation of community testing, a primary source of HIV testing in South Africa. The South African government sought to offset the lack of community testing with HIV self-testing, distributed online and through local pharmacies.

The NICD reported an average weekly reduction in TB Xpert testing volume of 48% during level 5 lockdown, with a 33% reduction in positive tests (NICD, 2020b). The Imperial College COVID-19 Response Team project an increase in mortality of 10% and 20% for HIV and TB respectively in the Sub-Saharan region over a five-year period (Hogan, et al., 2020). This amounts of 63,000 deaths from TB (only) over 5 years (WHO, 2019).

National immunisation coverage in April dropped from 82% in 2019 to 61% during lockdown level 5 in 2020. The second dose of the measles vaccine dropped from 77% to 55% coverage from April 2019 to April 2020 (Baleta, 2020). In the uMkhanyakude District of ZwaZulu-Natal Province, South Africa, a >50% drop was observed in health visits for children under 5 at the start of level 5 lockdown, "with a gradual return to pre-lockdown within 3 months after the first lockdown measure" (Siedner, et al., 2020).

A report by Partnership for Evidence-Based Response to COVID-19 (PERC) based on a nationally representative telephone poll, media monitoring, epidemiological data, and other publicly available data sources, found that 38% of households in South Africa requiring medical care had difficulty accessing healthcare visits, and 31% of households

had difficulty accessing medication (PERC, 2020). Although the long-term effect of drops in both vaccination rates and primary health care visits are beyond the scope of this paper, these effects will be significant, and manifest over time.

The Johannesburg NGO 'Doors of Hope' reported a surge in voluntary baby abandonment during the lockdown (AfricaNews, 2020).

PANDA (Pandemics – Data & Analytics) member, Jonathan Witt, reports that he "has never seen so many amputations presenting to our theatre complexes". This trend has been confirmed in Italy, where one study attributes the relative risk of limb-amputation following hospital admission for Diabetic Foot Ulceration of 2.50 in 2020 compared with 2019 to the mandatory lockdown in that country (Caruso, et al., 2020). The data for South Africa is not available, but further research concerning amputations is warranted.

A recent observational study in South Africa's North West Province suggests a significant reduction in both trauma and non-trauma related surgeries during the lockdown period, even when the prevalence of Covid-19 was minimal. The study compares pre-lockdown (3 February-26 March) with lockdown (27 March – 30 April) admission instances and found a 44% reduction in the incidence of non-trauma admissions during lockdown, and a 53% reduction in the incidence of trauma related admissions (Moustakis, et al., 2020).

In KwaZulu-Natal Province, a study demonstrated a 36% decrease in clinic attendance, and 50% reduction in hospital admissions for children under 5 years of age during April-June 2020 (based on data from January 2018 – June 2020). A 'temporary 47% increase in neonatal facility deaths was reported in May 2020 that could potentially be attributed to COVID-19 related disruption and diversion of health resources' (Jensen & McKerrow, 2021).

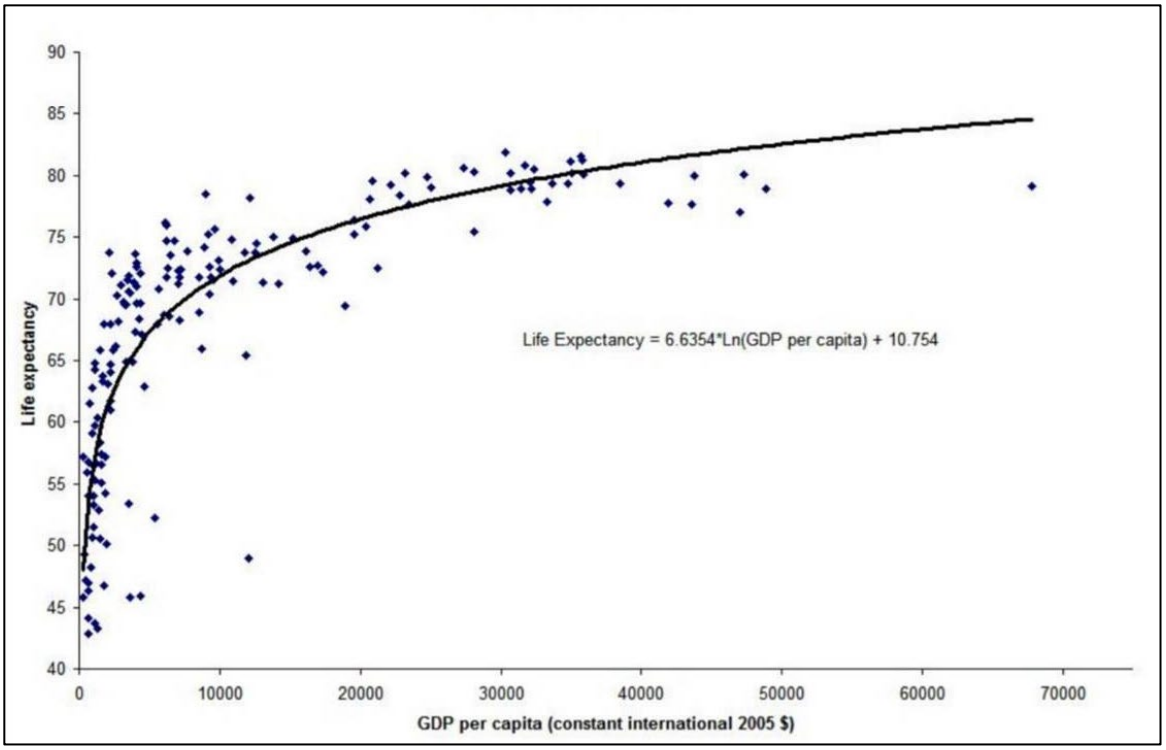
The indirect health effects of lockdown extend to mental health, evidenced by data released by the South African Depression and Anxiety Group. Pre-lockdown, the group received approximately 600 telephone calls per day concerning depression, anxiety and suicidal thoughts. This increased to 1200-1400 during level 5 lockdown (Grobler, 2020).

Health and the economic consequences of lockdown

The economic consequences of lockdown are substantial. As the Preston Curve (figure 7) below demonstrates, these should not be omitted from a discussion of the indirect health consequences of lockdown.

According to StatsSA, South Africa's GDP dropped by 16.4% between the first and second quarter in 2020, leading to an annualised growth rate of -51% (StatsSA, 2020). Based on the reduction of South Africa's annualised GDP from ZAR3,129,488 to ZAR2,617,664 from Q1 to Q2, GDP per capita dropped by USD527 during the lockdown period.

Figure 7. Preston curve (2005)



(Source: PANDA, 2020).

Reduced income lowers life expectancy, especially in SA where many live just above the poverty threshold. If 10% of South Africans fall only 1 socio-economic class, and economic recovery takes 10 years, then SA will lose 14 million life years (YLL) according to standard actuarial tables (PANDA, 2020).The relationship between economic indicators and health outcomes is complex, but it is plausible that substantial drops in income for lower income groups, and movements of large numbers of people below poverty lines, will have negative health outcomes.

The quarterly labour force survey for South Africa estimates that the number of employed persons decreased by 2.2 million. This is the largest known decline since 2008, totalling a net increase in the population by 5.2 million who are not economically active.

According to the NIDS–CRAM Wave 2 report, the poorest 50% of citizens were ten times more likely to lose their jobs than the richest. This is relatively good news for tax revenue, but it comes at a cost. Poorer South Africans working in the informal sector typically have no savings, and when employment opportunities are taken from those living hand-to-mouth, levels of hunger and malnutrition in the population likely increase (Altman, et al., 2010). This projection is vindicated by the NIDS-CRAM Wave 2 report, which indicates a drop of 27% in both adult and child hunger from May/June to July/August, as relaxing lockdown restrictions allowed many South Africans to return to work. The current levels of hunger, however, remain significantly higher than pre-COVID levels. 47% of respondents declared that they had run out of money to buy food in April 2020 (dropping to 37% in June, following the relaxation of some lockdown restrictions) – this is double the figure reported in 2016 (CRAM, 2020).

Crime and police brutality

Within the South African Police Service (SAPS), crime is stratified into seven distinct categories (Table 4). During April – June 2020, most of the crime statistics in South Africa saw a decrease in the percentage of overall crime. There were areas in South Africa that experienced unambiguous disproportions in crime shifts related to the hard lockdown measures that were taken (SAPS, 2020). SAPS stations in Port Shepstone Kwa-Zulu Natal and Temba in Gauteng saw an increase of non-residential burglary by up to 155%, while Park Road Station in the Free State saw a decrease by 46%. With regard to overall stock theft, the SAPS of Carnarvon saw an increase by 600%, whereas stations in Harrismith in the Free State and Maluti in the Eastern Cape saw a decrease by up to 38%. Stations Philippi East in the Western Cape, Atteridgeville in Gauteng and Lentegeur in the Western Cape saw increases in murder by 96.6%, 111.1% and 78.6% respectively. This illustrates that the overall decrease in murder by percentage does not represent the number of cases which was still relatively high (n = 3,466) during April to June, considering the mobility restrictions and different lockdown levels.

Table 4. Crime comparison between 2019 and 2020 for the months of April and June

No	Category	April – June 2019	April – June 2020	% Change
1	Contact crimes - (crimes against the person)	144,267	90,376	-37.4%
2	Category: sexual offences	12 094	7,296	-39.7%
3	Subcategory aggravated robbery	15,185	10,241	-32.6%
4	Contact related crimes	27,167	19,191	-29.4%
5	Property related crime	121,822	86,410	-29.1%
6	Other serious crimes	402,023	266,495	-33.7%
7	Crime detected as a result of police action	67,579	25,093	-62.9%

During lockdown level 5, several cases of police brutality made mainstream media, with some of the early reported police and military related deaths reported in Alexandra in Gauteng. This coincides with an increase in assault in a few areas of the country where police brutality was reported. Common assault rose in both Alexandra in Gauteng and Ikageng in the North West by 20% and 17.7% respectively during lockdown levels 5 and 4 (Mngadi, 2020). However, although the number of common assaults decreased from 36,185 to 25,995, the percentage distribution of common assault cases on a provincial level increased in the contact crime category [Table 5]. A useful reduction in crime-related and alcohol-induced hospital admissions was observed. But the data demonstrate that, on closer inspection, the crime statistics are not to be universally celebrated. A significant increase in non-residential burglaries was observed, further damaging already-struggling businesses.

Table 5. Crime proportion comparison for common assault across all South African provinces

Province	Total contact crime 2019	Total contact crime 2020	Common assault 2019	Common assault 2020
Western Cape	26,490	16,314	32%	35%
Northern Cape	3,926	2,515	25%	30%
North West	8,215	4,848	23%	26%
Mpumalanga	8,337	5,071	22%	27%
Limpopo	8,048	4,851	20%	27%
Kwa-Zulu Natal	23,961	15,764	24%	25%
Gauteng	41,352	25,879	25%	29%
Free State	8,025	5,140	34%	42%
Eastern Cape	15,913	9,994	17%	19%

Discussion

Did lockdown buy South Africa time?

We did not model a counterfactual scenario against which to assess either direct or indirect health effects. Instead, we gathered and analysed information about the actual course of the epidemic in South Africa. While this precludes a formal (and quantitative) estimate of causal effect, it is nonetheless informative, and not silent on causal hypotheses. In particular, the hypothesis that early, stringent lockdown provided South

Africa with "breathing space" by slowing the spread of the disease, relative to the spread that would have occurred had measures existing at the time remained in place, is hard to sustain given our findings.

There are two principal reasons for this. First, South Africa implemented a series of reasonably well-defined "levels" declining from 5 to 1, and then back to adjusted level 3 for the second wave, but transmission does not follow a similar pattern either nationally or in any of the provinces. In all provinces, it is possible to identify a higher-level period with greater effective reproductive number than some lower-level period in the same province. At national level the fastest spread during the first wave of infections was observed during Level 4, a stringent lockdown level. The epidemic trailed off in the middle of Level 3, which cannot be attributed to any change in lockdown regulations and cannot logically be attributed to higher levels of lockdown that had already been eased many weeks previously.

Second, there is also a synchronic contrast between different provinces. With the exception of Mpumalanga, effective reproductive number—which we treat as a proxy for transmission—rose and then fell in roughly the same way. However, the timing of this rise and fall differed from province to province. Lockdown regulations, however, were implemented nationally at the same time. Transmission appears to have sped up and slowed down independently of these changes, making it very hard to argue that they had an effect on transmission, at least one that is detectable at the provincial level. Taking any single one of these provinces, or just the national data, it might be possible to think of ways that lockdown was effective in a way that was proportionate to its stringency, yet other factors distorted the picture. However, to find one such explanation that fits all the data is extremely difficult, and the findings do not naturally suggest one. On the contrary, the natural suggestion is of a disease spreading through different regions in roughly the same way but at different times.

The comparison of a township and suburb provides a clue as to a possible explanation for these findings. In the Southern Suburbs of Cape Town, one sees resurgence starting about 4 October, around 10 days after entering Level 1 (see Figure 3), which eventually led to a much higher rate of daily new infections than during the first wave. The resurgence in Khayelitsha was far less pronounced, however, barely exceeding the peak of the first wave. While there is considerable variation in both regions, this contrast is consistent with differential effectiveness of lockdown between overcrowded and more sparsely inhabited contexts. This is consistent with existing observations of the ineffectiveness of lockdown for slowing transmission in overcrowded conditions (Chirisa, et al., 2020).

The most recent seroprevalence data indicate that townships reached levels (up to 71%) that would have been expected if there were no mitigation measures (Sykes, et al., 2021). The high levels were ascribed to socio-economic status and housing conditions.

It is important to acknowledge that any finding at either national or provincial level in a country as varied as South Africa is likely to be an aggregate of many underlying realities. We do not mean to suggest that lockdowns were entirely ineffective in all of these. A more likely scenario is that social distancing was not significantly increased by lockdown

regulations in large portions of the population, and that these dominate the national picture, representing the majority of the population.

The province of Mpumalanga displays a different pattern, although one that is also hard to square with highly effective lockdown. The establishment of the disease in different densely populated areas at very different times is a possible explanation, as is variation in testing regime. The uncertainty further underscores the importance of contextual factors that may be entirely invisible from a "data" perspective.

Did lockdown have a negative indirect health impact?

Turning to indirect health effects, in the absence of causes of death data, it is impossible to do more than speculate about the causes of the excess deaths that we found. A proportion of COVID-19 deaths may have gone unconfirmed. There have been backlogs of laboratory results (NHLS, 2020). However, it hard to imagine that anything close to the 93,300 additional excess deaths beyond those included in the official COVID-19 count could have gone undetected during a period in which the entire world was focused on such COVID-19 deaths, especially in a country with such an active civil society as South Africa.

On the other hand, there is a clear correlation between COVID-19 mortality and excess mortality, suggesting that there is a relationship between the two. The PERC report suggests that a significant number of people needing emergency care did not go to hospital, or could not access care upon arrival due to an increased load due to Covid-19 (PERC, 2020). This is further supported by the large reduction in both trauma and non-trauma related surgeries performed during the lockdown period in the country's North West Province (Moustakis, et al., 2020), and by the reduction in both clinic and hospital admission for the under 5s in KwaZulu-Natal Province (Jensen & McKerrow, 2021).

Some portion of these deaths may also have been due to malnutrition consequent on loss of livelihood, and other indirect health effects of lockdown, including the lack of access to medication. However, we found no apparent correlation between lockdown levels and excess deaths, consistent with the expectation that the major health effects of lockdown will take some time to show (Hogan, et al., 2020).

Looking ahead, there are clear reasons to anticipate adverse health outcomes. These include:

- Rise in incidence of untreated HIV, due to disrupted treatment and detection programmes;
- Rise in incidence of untreated TB, due to disrupted treatment and detection programmes;
- Elevated risk of outbreak of measles and other diseases due to disrupted vaccination programmes;
- Rise in incidence of malnutrition and associated conditions due to loss of livelihood;

- Rise in incidence of substance abuse due to increasing poverty and unemployment; and
- Rise in incidence of mental health problems due to a wide variety of stressors.
- Rise in amputations, particularly for diabetic patients.
- Rise in voluntary abandonment of babies.

Conclusion

Our findings show that, at least for very large parts of the country and parts of the population, stringent lockdown was little or no better than measures already in place for controlling transmission of COVID-19.

The net health effect of COVID-19 lockdowns in South Africa cannot yet be assessed because causes of death data have not been made available. Substantial excess deaths relative to previous years were observed, and the majority of these are not accounted for by official COVID-19 mortality. There is reason to anticipate significant, but so far unquantified, future health consequences of lockdown.

Limitations

We acknowledge that this approach does not take into consideration the cases that will be retrospectively identified through serological testing. It is impossible at this stage to determine how many COVID-19 cases went undetected due to (a) testing constraints and (b) the high percentage of asymptomatic cases, most of which will have gone undetected and (c) caveats within the public healthcare system that may have an impact on the analysis. Bias in the data may exist due to asymptomatic carriers of active SARS-CoV-2 (Gostic, et al., 2020). In the absence of further information, one can only make rational inferences about the cause of South Africa's excess deaths in 2020, based on the low probability of non-COVID-19 health effects appearing within this short timeframe. In addition to the assumptions made about the spread of the disease, the disease dynamics of COVID-19 were not discussed in this paper.

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