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OXFORD

COVID-19 lockdown effect on healthcare utilization and in-hospital mortality in children under 5 years in Cape Town, South Africa: a cross-sectional study

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ABSTRACT

Background: COVID-19 pandemic measures resulted in the de-escalation of non-COVID-19 healthcare provision.

Methods: A retrospective cross-sectional study of routinely collected data was done to investigate the effect of COVID-19 policies on the healthcare utilization and mortality of children younger than 5 years in Eastern Cape Town, South Africa. We compared visits to primary and urgent care facilities, hospitalization, in-hospital deaths, and vaccine uptake from 1 January to 31 December 2020 to similar periods in 2018 and 2019.

Results: During April and May 2020, the most restricted period, visits to primary care facilities declined from 126 049 in 2019 to 77 000 (1.8-fold; $p < 0.05$). This corresponded with a 1.2-fold reduction in the provision of the first dose of measles vaccine at 6 months compared to 2019. Throughout 2020 there was a 4-fold decline in the number of fully immunized children at 1 year of age ($p = 0.84$). Emergency room visits fell by 35.7% in 2020 (16 368) compared to 2019 (25 446). Hospital admissions decreased significantly ($p < 0.01$) in 2020 (9810) compared to 2018 (11 698) and 2019 (10 247). The in-hospital mortality rate increased from 2.3% (96/4163) in 2019 to 3.8% (95/2498) ($p < 0.01$) in Tygerberg Hospital, where 80% (95/119) of deaths were recorded. Twelve of the 119 (10%) deaths occurred in HIV-positive children ($p = <0.01$).

Conclusion: Measures instituted during the COVID-19 pandemic disrupted access to healthcare services for children. This resulted in an immediate, and potential future, indirect effect on child morbidity and mortality in Cape Town.

LAY SUMMARY

During the COVID-19 pandemic in 2020, lockdown policies restricted movement of people and non-COVID-19 healthcare services were de-escalated. In a large district, Metro East, in Cape Town, South Africa, this resulted in a 1.8-fold decline in primary healthcare clinic visits in children less than 5 years of age. Routine immunizations were negatively impacted with a 1.2-fold decline in the uptake of the first dose of measles vaccine at 6 months of age and a 1.4-fold decline in the number of fully immunized children at 1 year of age. Hospital admissions decreased significantly from 10 247 and 11 698 in 2019 and 2018,

respectively, to 9810 admissions in 2020. Although fewer deaths (119) were reported in hospitals in Metro East District, Cape Town, South Africa in 2020, the deaths per number of admissions increased from 2.3% (96/4163) in 2019 to 3.8% (95/2498) in Tygerberg Hospital, where 80% (95/119) of deaths were recorded. Measures instituted during the COVID-19 pandemic in 2020 thus disrupted the access to healthcare services for children. This resulted in an immediate, and potential future, indirect effect on child health and survival in Cape Town.

KEYWORDS: COVID-19, healthcare utilization, children

INTRODUCTION

In March 2020, COVID-19, caused by SARS-COV-2, was declared a global pandemic by the World Health Organization (WHO) [1]. Most countries introduced interventions that enforced social distancing and reduced crowding to reduce the transmission of SARS-COV-2. The South African government legislated and implemented significant movement restrictions, the so-called lockdowns in March 2020 [2]. The lockdowns were stratified in levels of severity from level 1 to 5; Level 5 being the strictest. In level 5, only essential workers were allowed to leave home for work, schools were closed and all private and public gatherings prohibited. The lockdown policy included de-escalation of non-COVID-19 healthcare services with resources redirected to community- and facility-based screening, testing, contact tracing and emergency care for persons with COVID-19; leaving limited capacity to address non-COVID-19 health needs [3].

From the start of the public health restrictions, there was a concern that the impact of the lockdowns on economic and health systems would indirectly cause harm to mother and child health [4] as was seen during the Ebola outbreak from 2013 to 2016 in West Africa where a decrease in utilization of routine services resulted in an increase in maternal and child deaths [5].

Reports of the disruption of routine services caused by the COVID-19 pandemic and lockdown soon emerged globally and from South Africa [6]. South Africa's largest private healthcare provider reported a reduction in hospital admissions, outpatient and emergency departments visits and general practitioner (GP) visits [7]. Reduced paediatric emergency centre visits were reported globally [8]. Missed routine vaccinations were described in both Pakistan [9] and in one province in South Africa [10]. This expanding pool of un-immunized children during lockdown left them susceptible to vaccine-preventable diseases and increased the risk of possible outbreaks, further compounding the pre-COVID-19 sub-optimal performance of immunization programs in Africa [11].

Few studies have reported the impact of the COVID-19 pandemic on the healthcare utilization and outcome of children using the public sector in South Africa. The aim of our study was to investigate the impact of COVID-19 on the health system utilization, hospital admissions and mortality of children <5 years of age in the Eastern District of Cape Town, South Africa.

MATERIALS AND METHODS

We conducted a retrospective cross-sectional study, comparing health utilization data for children younger than 5 years from 1 January to 31 December 2020 in Eastern Cape Town with the same time periods in 2018 and 2019.

Cape Town is divided in two large metros, East and West. The population in Metro East District, Cape Town, South Africa is estimated to be 2 002 508 people, approximately half of the total estimated population in the Cape Metropole. Children and adolescents younger than 14 years represent approximately one quarter of the inhabitants [12]. The public health structure in Metro East District, Cape Town, South Africa consists of four health subdistricts, namely Tygerberg, Northern, Eastern and Khayelitsha. Each subdistrict is served by primary healthcare clinics (PHC) that provide either an 8-hour service on weekdays only, or a 24-hour service, 7 days a week. Children that need hospital referral access one of four district hospitals, Karl Bremer (KBH), Khayelitsha District (KDH), Eerste River (ERH) and Helderberg (HH) for general and specialist care. Secondary and tertiary care are provided by Tygerberg Hospital (TBH). Tygerberg Hospital also serves as a general and specialist centre for the Tygerberg subdistrict. The Eastern subdistrict does not have a PHC centre offering 24-hour service, children from these communities access after-hours care at the emergency centres of either ERH or HH.

Routinely collected health data for all under-5-year-old children presenting to any public healthcare facility in the Metro East District, Cape Town during the study period, and the same time periods in 2018 and 2019, were included. Infants admitted to neonatal services in the hospitals were excluded. Health information data are recorded on the Standard Information Jointly

Assembled by Networked Infrastructure (SINJANI) and the Child Healthcare Problem Identification Programme (Child PIP) databases. Facility-based deaths are recorded and reviewed according to the Child PIP. Aggregated data were obtained from the Western Cape Department of Health in accordance with the Departments' Guidelines on requests for access to patient datasets. Full use of the Child PIP software and database were granted by the Child PIP Executive.

Variables collected for PHC facilities included the number of monthly visits for primary care and vaccination uptake according to the South African Expanded Programme on Immunisation (EPI) schedule (6, 10, 14 weeks; and 6, 9, 12 and 18 months). At hospital level, we used emergency centre visits and paediatric ward admissions. Admissions for acute diarrheal disease (AGE) cases, acute respiratory infections (ARI) and severe acute malnutrition cases (SAM) were recorded. In-hospitable deaths with demographic data, cause of death and modifiable factors, which may have contributed to the child's death, were collected. These factors may be related to the place (home, clinic, referring facility and transit, emergency and admission ward) or responsible persons (clinical personnel, administrators and family/caregivers) involved. In 2020, the ERH inpatient paediatric service was de-escalated and the space re-commissioned for adult SARS-CoV-2 care. Children could still receive urgent care but could not be admitted or followed up; ERH 2020 hospital data were therefore not available. Data for total number of visits to primary care clinics for January, February and March 2018 were not available.

Statistical analysis

Categorical variables were summarized as counts and ratios. Chi square was used to test association between categorical variables with graphs to depict and compare mean ratios of variables with error bars (1 SD error below and above the mean ratio) using 2020 data as reference. The Mann–Kendall trend test was used for detecting monotonic trends of healthcare utilization variables. Statistical significance was set at $p < 0.05$. The study was approved by Human Research Ethics Committee of Stellenbosch University (reference number SN20/09/007_COVID-19) and Provincial Approval from Health Impact Assessment Directorate of the Western Cape Government as custodians of the data (WC_202104_017).

RESULTS

During the level 5 and 4 lockdown periods (April and May) in Metro East District, Cape Town, South Africa,

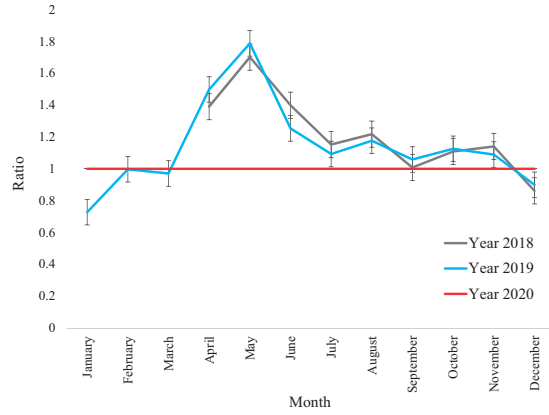

Figure 1. Ratio of under-5-year-old primary healthcare visits comparing 2020[a] with 2019 and 2018 in Metro East District, Cape Town, South Africa. [a]Level 5 lockdown: 27 March–30 April; Level 4 lockdown: 1 May–31 May; Level 3 lockdown: 1 June–17 August; Level 2 lockdown: 18 August–20 September; Level 1 lockdown: 21 September–28 December.

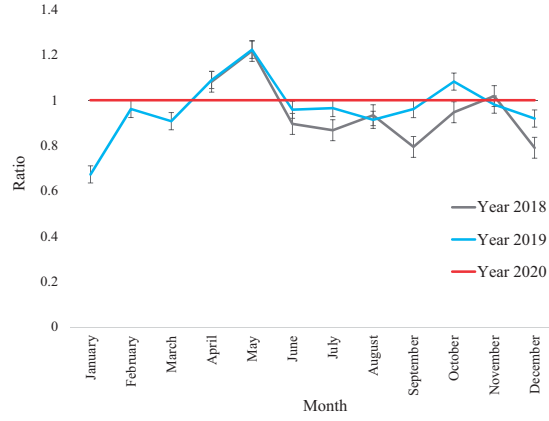

Figure 2. Ratio of first dose of measles vaccine comparing 2020 with 2019 and 2018 in Metro East District, Cape Town, South Africa.

the recorded number of primary healthcare visits for children under-5-year-old were 77 000, a 1.8-fold decline when compared to 126 049 in 2019 and 118 550 in 2018 ($p < 0.05$) (Figure 1). Utilization of primary healthcare services returned to previous levels in September 2020 as lockdown measures were eased.

Through 2020, 22 076 children were fully vaccinated by the age of 1 year. This was similar to the 22 556 in 2019 ($p = 0.84$). There was, however, significant interruption of services. In April 2020, 1789 children had their first dose of measles vaccine at 6 months of age, a

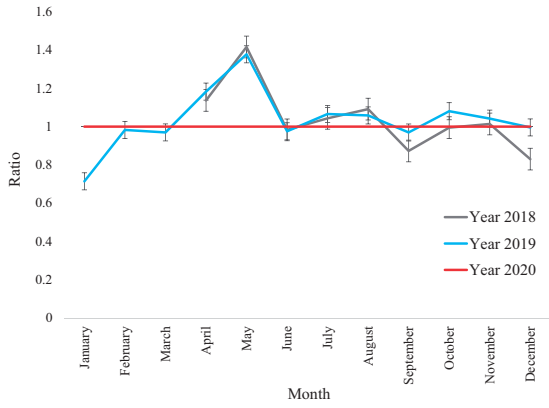

Figure 3. Ratio of fully immunized children at 1 year of age comparing 2020 with 2019 and 2018 in Metro East District, Cape Town, South Africa.

Table 1. Number of urgent care visits and admissions to hospital in 2018, 2019 and 2020

	2018	2019	2020	*p*-value
Emergency centre visits at hospitals, Total (*n*)	21 584	25 446	16 368	1.00
Tygerberg, *n*, (% reduction)[a]	6153	6262	3715 (−40.7)	NA
Khayelitsha, *n*, (% reduction)[a]	4448	5943	4208 (−29.2)	NA
Karl Bremer, *n*, (% reduction)[a]	3260	4240	2506 (−40.9)	NA
Helderberg, *n*, (% reduction)[a]	5224	5879	3640 (−38.1)	NA
Eerste River, *n*, (% reduction)[a]	2499	3122	2299 (−26.4)	NA
Hospital admissions, Total (*n*)	11 485	9875	6601	<0.01
Tygerberg, *n*, (% reduction)[a]	5095	4163	2498 (−40.0)	NA
Khayelitsha, *n*, (% reduction)[a]	3284	2824	1683 (−40.4)	NA
Karl Bremer, *n*, (% reduction)[a]	1574	1661	1393 (−16.1)	NA

Excludes data from January, February and March. NA, not applicable.
[a] Comparing 2020 with 2019 data.

1.2-fold decrease when compared to 1948 children in 2019 and 1935 in 2018 (Figure 2). At the same time, there was a 1.4-fold decline in the number of fully immunized children at the age of 1 year in April of 2020 (1569) when compared to 2019 (1928) and 2018 (1836) (Figure 3). From June to August 2020, the uptake of the first dose of measles vaccine was higher in 2020, 6474, when compared to 5813 in 2018 and 6126 in 2019.

The number of recorded visits to the urgent care at hospitals declined 35.7% from 25 446 in 2019 to 16 368 in 2020 (Table 1). Inpatient admissions to hospital for children younger than 5 years of age were also significantly reduced during the lockdown period from 11 485 in 2018 and 9875 in 2019, to 6601 in 2020 ($p < 0.01$) (Table 1).

The hospital admission burden of disease pattern was different in 2020 compared to previous years (Figure 4). The proportion of admissions due to AGE increased from 12% (1259/10 247) in 2019 to 27% (2675/9810) in 2020, more than the 22% (2141/9810) of admissions due to ARI in 2020. Hospital admissions due to ARI were responsible for 36% (3646/10 247) admissions in 2019 and 35% (4045/11 698) in 2018. It was only after the lockdown measures were lifted that admissions due to respiratory illness were comparable to similar time periods in 2018 and 2019.

The total number of in-hospital deaths per year, with demographic data, is summarized in Table 2. In all three time periods, the majority of deaths occurred at the tertiary centre, TBH. In 2020, it was 80.0% (95/119); compared to 68.0% (96/141) in 2019 and 78.0% (95/122) in 2018. Whilst the actual numbers were similar, and the total number of reported deaths fewer in 2020, the in-hospital mortality rate for TBH increased significantly from 2.3% in 2019 to 3.8% in 2020 ($p < 0.01$). KBH, KDH and HH 2020 in-hospital mortality rates were not significantly different compared to 2018 and 2019.

Infants <1 year of age are disproportionally represented across the three years with the majority of all deaths occurring in this age group. There was a significant difference in the number of deaths in this age group across the three time periods ($p < 0.01$). Amongst the children who died, it was more likely for them to have underlying malnutrition ($p = 0.02$) or HIV disease ($p < 0.01$).

Of all children deaths, 46/119 (38.6%) of children died either on route to hospital or soon after arrival. Most deaths [28/119 (23.5%)] in 2020 occurred within 24 h of presentation to a hospital, with an additional 15.1% (18/119) being dead on arrival (DOA). During 2020, infectious [44/119 (37.0%)] and respiratory causes [29/119 (24.4%)] remained the most common reported categories of death according to Child PIP. During this time period, 9 of the 119 deaths (7.6%) at Tygerberg Hospital were attributed to SARS-CoV-2. The reported modifiable factors were unexpectedly much lower in 2020 [56/119 (47.0%)] compared to 2018 [103/122 (84.4%)] and 2019 [135/141 (95.7%)].

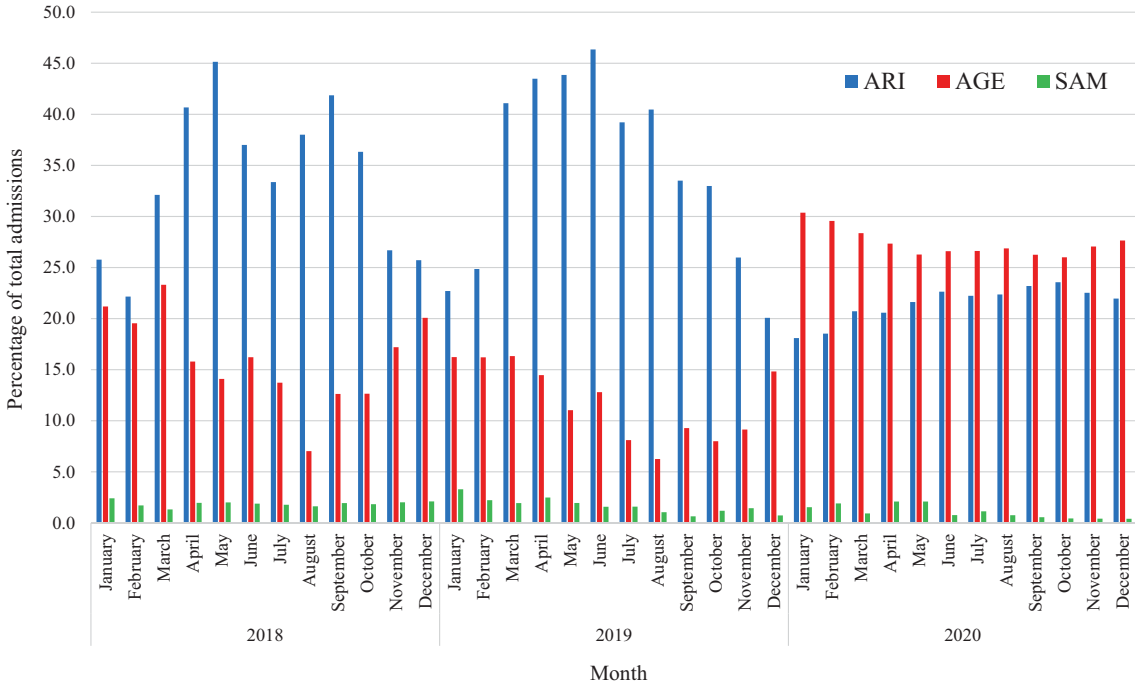

Figure 4. Proportion of total under-5-year-old hospital admissions due to acute respiratory illness (ARI), acute gastroentritis (AGE) and severe acute malnutrition (SAM) across all hospitals in Metro East District, Cape Town, South Africa from 2018–2020.

Table 2. Demographic information of in-hospital deaths in 2018, 2019 and 2020

	2018	2019	2020	*p*-value
Number of in-hospital deaths	122	141	119	NA
Sex; female, *n* (%)	55 (45.0)	66 (46.8)	52 (43.7)	0.88
Age group, *n* (%)				
<1 year	71 (58.2)	106 (75.2)	76 (63.9)	<0.01
1–5 years	48 (39.3)	35 (24.8)	43 (36.1)	
Children with moderate or severe malnutrition, *n* (%)	41 (33.6)	41 (29.1)	47 (39.5)	0.02
Children living with HIV, *n* (%)	3 (2.5)	6 (4.3)	12 (10.0)	<0.01
Timing of death, *n* (%)				
Dead on arrival (DOA)	13 (10.6)	32 (22.7)	18 (15.1)	NA
<1 day of admission	36 (29.5)	30 (21.3)	28 (23.5)	NA
1–3 days of admission	22 (18.0)	30 (21.3)	25 (21.0)	NA
4–7 days of admission	18 (14.8)	10 (7.1)	13 (10.9)	NA
8–14 days of admission	14 (11.5)	13 (9.2)	10 (8.4)	NA
>14 days of admission	19 (15.6)	26 (18.4)	25 (21.0)	NA
Total modifiable factors noted on death audit (%)	103/122 (84.4)	135/141 (95.7)	56/119 (47.0)	NA
In-hospital mortality rate[a] (%)				
Tygerberg Hospital	1.9 (95/5000)	2.3 (96/4163)	3.8 (95/2498)	<0.01
Khayelitsha Hospital	0.5 (16/3268)	1.1 (30/2824)	0.9 (15/1683)	0.03
Karl Bremer Hospital	0.1 (1/1573)	0.1 (1/1661)	0.1 (2/1393)	0.69
Helderberg Hospital	0.65 (10/1522)	1.1 (14/1227)	0.7 (7/1027)	0.32

NA, not applicable.
[a] Total number of deaths/total number of admissions.

DISCUSSION

Our data show that the lockdown measures instituted by the South African government to curtail the spread of SARS-CoV-2 disrupted the access to and provision of routine healthcare services for children. In addition, the epidemiology of admission to hospital for children <5 years of age changed and there was an increase in the in-hospital mortality rate at tertiary level.

The reduction in the utilization of primary healthcare services are similar to the decrease in routine clinical visits of children and young people reported globally. Reductions of up to 68% were reported during periods of lock down elsewhere [13]. Access to primary healthcare services and hospital EC visits returned to pre-pandemic levels as the lockdown measures were eased. This is similar to reports from other areas in the Cape Town Metropole [14]. In contrast, studies from Europe and North America reported a sustained decrease in the number of paediatric emergency visits throughout 2020 [15]. Housing, socio-economic factors, and difficulty in enacting social distancing, may have influenced this behaviour pattern [16]. COVID-19 also altered the patterns of non-urgent emergency centre visits in well-resourced settings [17], but parents and caregivers in lower resourced settings may have fewer options for healthcare engagement, explaining the more rapid return to pre-pandemic patterns of public healthcare utilization.

During the first few months of the pandemic, there was a decrease in the provision of the first measles vaccine at age 6 months, as well as a decrease in the number of fully immunized children at one year of age. These findings are in keeping with a study in England reporting a 19.8% drop in Measles–Mumps–Rubella (MMR) vaccination observed during the COVID-19 pandemic [18]. A study from Saudi Arabia found a 60.9% delay in routine immunization due to fear of getting COVID-19 infection during the pandemic [19]. Because there was an increase in uptake in the latter part of 2020, we could not demonstrate a significant difference from the pre-pandemic period. This may be explained by an intensive immunization catch-up campaign that occurred across the province where measles vaccination was prioritized [20].

We reported a decrease in hospital admissions in 2020 compared to 2019. Similar reports of reduction in hospital admissions were noted globally. For example, a 66.8% reduction in India, 50% in Malta and 66% in Romania [21, 22]. Locally, the reasons for the decline in paediatric admissions may be multifactorial. Elective admissions for surgery and other investigations were cancelled as part of the de-escalation of all emergency services. There was a sharp decline in common seasonal viral infections within the community seen during periods of strict social distancing, and school closures [23] may have played a key role in reducing paediatric illnesses [24]. We could not measure avoidance of hospitals due to fear of COVID-19 transmission. Because fewer children were admitted in 2019 than 2018, we could not show this difference to be statistically significant.

We show that the number of admissions for acute respiratory infections decreased across all the hospitals during the 2020. The relationship between the reduction in admissions and reductions in ARI is also documented for example in Singapore, where there was also a significant decrease, especially in presentations related to acute respiratory and gastrointestinal diseases [25]. It is only after hard lockdown measures were lifted that the number of acute respiratory admissions returned to expected annual levels. This increase in respiratory infections seen were not due to SARS-CoV-2, but other viral infections such as respiratory syncytial virus [26]. Both in absolute numbers and proportions, there was an increase in the number of children admitted with diarrhoea. A review of children with COVID-19 hospitalized at Tygerberg Hospital reported that 19.4% of children hospitalized with PCR-conformed SARS-CoV-2 had diarrhoea as a symptom [27]. Diarrhoea is reported in 2–50% of pediatric and adolescents with COVID-19 [28, 29]. We were not able to review individual patient data to assess testing for COVID-19 in children with diarrhoea.

We did not observe a change in the rate of malnutrition. However, it may have been too early to assess the effect the COVID-19 related unemployment and closure of schools. School closure pressured families to provide food for children who may otherwise have received free school meals [30]. Studies beyond 2020 will be needed to ascertain the real impact of the COVID-19 pandemic on burden of disease in children. According to Statistics South Africa, 23.6% of South Africans in 2020 were affected by moderate to severe food insecurity, while 14.9% experienced severe food insecurity [31].

Studies from the United Kingdom [32] and the United States of America [33] found that overall child mortality rates in 2020 where not higher than before the COVID-19 pandemic. In contrast, we show an increase in the mortality rate at the tertiary hospital. This may be due to a variety of reasons. The simplest explanation is that because there were no non-urgent admissions, children with severe disease are over-represented

in the denominator. Non-urgent or chronic conditions may have been exacerbated by a lack of treatment or surgical interventions. The increase of deaths associated with HIV infection and malnutrition in our study could be due to poor access to chronic care and primary care. Economic hardship combined with disrupted routine child health interventions such as growth monitoring and access to nutrition support programs may have contributed to the deaths. Other considerations include delayed health seeking behaviour due to the fear of contracting COVID-19, not recognizing the early danger signs as well as a lack of transport during the lockdown. It is not clear whether mortality could also be attributed to the disruption in the hospital services once hospitalized as we were not able to assess whether delays in receiving services, once admitted, contributed to poor outcomes.

An increase in reported modifiable factors as part of the Child PiP death audits [34] were expected in this study; instead, a decrease was seen. It is unlikely that this significant decline in modifiable factors is a true reflection of the modifiable factors. It is more likely that this represents a failure of the entrenched death review mechanisms, as departmental and hospital routines remained disrupted for prolonged periods of time. Mortality remains the most severe of all outcomes—this study could not assess other potential morbidities, these include an increased duration of hospital stay, the requirement of a higher level of care, and ongoing disability despite survival. These have all been shown to be associated with delays in access to and delivery of healthcare during COVID-19 lockdowns [35].

Limitations of the study

This is a retrospective analysis of secondary data. Incomplete or inaccurate data capturing could have influenced the findings of this study. Although the study included data on all children who accessed the healthcare service during the pandemic, out-of-hospital deaths were not included. An analysis of out of facility deaths would have given a more complete picture of the impact of COVID-19 lockdown measures on the mortality of children.

CONCLUSION

Lockdown policies resulted in a marked decrease in the utilization of preventative and curative healthcare services for children and an increase in the in-hospital mortality rate. This resulted in an immediate, and potential future, indirect effect on child morbidity. Higher in-hospitality mortality rates in 2020 not related to COVID-19 disease further points to the indirect impact of COVID-19 on the mortality of children.

Healthcare policies such as the COVID-19 pandemic measures, may have indirect and negative effects on child health outcomes as shown in this study. Further studies will be needed to investigate the long-term effect of the COVID-19 pandemic and lockdown measures on child morbidity and mortality, especially severe acute malnutrition and chronic illnesses such as TB and HIV. A more in-depth study of modifiable factors for both in-hospital deaths and referral pathways are needed to understand the factors driving child deaths in the Metro East District of Cape Town, South Africa. Data on out-of-hospital deaths were not available for this study. This was unfortunate and should be included in a follow-up study to better understand the overall impact of the COVID-19 pandemic and lockdown measures on child mortality.

AUTHOR CONTRIBUTIONS

Noradin Elmi (Conceptualization [equal], Data curation [equal], Methodology [equal], Project administration [equal], Writing—original draft [equal], Writing—review & editing [equal]), Liezl Smit (Conceptualization [equal], Data curation [equal], Investigation [equal], Methodology [equal], Project administration [equal], Supervision [equal], Validation [equal], Visualization [equal], Writing—review & editing [equal]), Thandi Wessels (Conceptualization [equal], Data curation [equal], Investigation [equal], Methodology [equal], Supervision [equal], Writing—review & editing [equal]), Moleen Zunza (Data curation [equal], Formal analysis [equal], Methodology [equal], Validation [equal], Writing—review & editing [equal])

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