



The impact of the COVID-19 pandemic on paediatric surgical volumes in Africa: A retrospective observational study



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ABSTRACT

Background: The aim of this study is to investigate the impact that COVID-19 had on the pattern and trend of surgical volumes, urgency and reason for surgery during the first 6 months of the pandemic in sub-Saharan Africa.

Methods: This retrospective facility-based study involved collection of paediatric operation data from operating theatre records across 5 hospitals from 3 countries: Zimbabwe, Zambia and Nigeria over the first half of 2019 and 2020 for comparison. Data concerning diagnosis, procedure, anaesthesia, grade, speciality, NCEPOD classification and indication was collected. The respective dates of enactment of cancellation policies in each country were used to compare changes in weekly median surgical case volume before cancellation using the Wilcoxon Sign-Rank Test.

Results: A total of 1821 procedures were recorded over the study period. Surgical volumes experienced a precipitous drop overall from a median of 100 cases/week to 50 cases/week coinciding with cancellation of surgical electives. Median accumulated weekly procedures before COVID-related cancellation were significantly different from those after cancellation ($p = 0.027$). Emergency surgery fell by 23.3% while electives fell by 78.9% ($P = 0.042$). The most common primary indication for surgery was injury which experienced a 30.5% drop in number of procedures, only exceeded by congenital surgery which dropped 34.7%.

Conclusions: The effects of surgical cancellations during the covid-19 pandemic are particularly devastating in African countries where the unmet need and surgical caseload are high. Continued cancellations that have since occurred will cause similar drops in surgical case volume that these health systems may not have the resilience to recover from.

Level of Evidence: Level II.

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1. Introduction

The COVID-19 pandemic has been very disruptive to surgical health systems around the world. While surgical services in high income countries (HICs) appear to be getting back to business as usual [1,2], the pandemic has left an indelible mark on more vulnerable systems. The unintended collateral effects on surgical services provision in HICs are well worn in the surgical literature and

paint a picture of a transient disruption [3]. The experience of low- and middle-income countries (LMICs) however is not as well characterised [4]. There is a dearth of work describing the effect of COVID-19 on children's surgery in LMICs and Africa has been conspicuous in its absence from published work on paediatric surgery during the pandemic including an early global review on this subject [5]. Guidelines from multiple surgical associations around the world recommended blanket postponement of all elective operations estimated to amount to more than 28 million cancelled procedures globally [3]. Surgical societies in Africa followed suit soon after.

The African continent is central to efforts to scale up surgical care by 2030 that have been put in jeopardy by the current

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health emergency [6]. In addition, the burden is considerable. In Africa, 85% of children require a surgical procedure before their 18th birthday. Surgical volumes are one of the core metrics for evaluation of surgical capacity and will provide key information about the detrimental effects of the interruption and prospects for resuming progress towards Lancet commission goals for 2030. There is an urgent need to look back to count the cost of the interruption, inform resumption of services and learn lessons for potential future pandemics. This study aims to describe the effect of the covid-19 pandemic and surgical rationing policies on surgical volumes for children's surgery in government hospitals in Africa.

2. Methods

This was a retrospective facility-based study performed at 5 hospitals in three countries namely: Zimbabwe, Zambia and Nigeria. Primary ethics approval was obtained from the Sally Mugabe Central Hospital Ethics Committee (HCHC070520/25). Further ethics approvals and permissions were obtained from all sites. This manuscript was prepared in accordance with the STROBE guidelines.

2.1. Setting

The study was conducted in the following countries: Zimbabwe, Nigeria and Tanzania. The participating countries were chosen because the first case of COVID-19 was recorded in these countries around approximately the same time. We chose the health facilities based on their size and catchment areas in their respective countries, as well as their location in major cities with a wide range of paediatric surgical capabilities. All of the hospitals provided mixed adult and paediatric surgical care. All hospitals are central referral hospitals in the government sector, and their respective catchment areas represented 13.3% of the overall national/state population of all three countries (17.3 in Zambia, 12.8% in Lagos state, Nigeria and 14.7% in Zimbabwe).

2.2. Patient population

All patients aged 18 years and below who had a surgical procedure performed in any one of the hospitals were included for analysis. A surgical procedure was defined as "any intervention occurring in a dedicated main hospital operating room involving the incision, excision, manipulation, or suturing of tissue either directly or percutaneously requiring any form of anaesthesia and listed in its recording system" modified from existing definitions by Weiser [7] and Bolkan [8]. Surgical procedures performed in a minor theatre were excluded from the analysis.

2.3. Data collection and variables

Data was collected retrospectively from health facility records for the period from 1st January 2020 to 31st June 2020 and 1st January to 31st June 2019. The following variables were collected as part of the study: date of operation, age, gender, urgency of surgical operation procedure, grade of operation, body region involved and primary indication for surgery (injury, infection, neoplasia or congenital) and categorised according to predefined definitions modified from previously published definitions in similar studies [9,10]. Surgical procedures were coded according to the NOMESCO Classification of Surgical Procedures version 1.16. Data was transcribed from physical theatre registries to Microsoft excel. We used the WHO transmission phases framework to conceptualise the phases of the pandemic in each country [11].

2.4. Statistical analysis

Descriptive statistics were used to present demographic data and surgical case load was plotted using weekly volumes as time-series data. Data are quoted as median (interquartile range IQR) unless otherwise specified. The weekly median surgical case volume before the start of the pandemic (defined by the decision to cancel elective surgery because of the pandemic) was compared to weekly volumes after this date and also compared to corresponding dates the previous year in 2019 using the Mann Whitney U test. Surgical urgency was expressed elective rates (number of elective procedures divided by total number of procedures) and Emergency/elective (Ee) ratios (the number of immediate and urgent surgeries divided by the number of elective surgeries, and multiplying by 100). Data was analysed using the Statistical Package for the Social Sciences (SPSS) version 24 (SPSS Inc., Chicago, IL, USA). For all analyses, $p < 0.05$ was considered statistically significant.

We excluded the first 3 weeks of the year when surgical volumes are still low following the Christmas break when surgical elective activity is postponed in all hospitals concerned. We also removed volumes from volunteer surgical camps because they caused spikes in surgical volumes that represented outliers in the data and did not reflect normal patient flows.

3. Results

1821 surgical procedures were recorded in the study period between 1 January 2020 to 30 June 2020 across all hospitals on 1218 males and 603 females (Table 1). The age of operated patients was 36 (12 – 96) months before COVID which decreased to 23.5 (3 – 72) months after enactment of cancellations. The most commonly operated age group was the 1 month to 4-year age group and the neonatal age group was the only age group where more operations were performed post-COVID as compared to pre-COVID.

Zambia accounted for the largest percentage of surgical volumes, (58.1%) followed by Zimbabwe (30.5%) and Nigeria (11.4%). In the first three weeks of the year surgical volumes remained depressed after the holiday period hiatus and increased from 46 cases in the first week to a steady state of 100 (95 – 106) cases per week

Surgical volumes experienced a precipitous drop overall. Median weekly surgical volumes dropped from a 100 (95 – 106) cases per week before COVID to a 50 (38 – 56) cases per week after COVID (Table 2). This drop was observed in week 13 coinciding with lockdown measures and cancellation of non-essential surgical activity (Fig. 1). Median accumulated weekly procedures before COVID-related cancellation were significantly different from those after cancellation ($p = 0.027$). This trend was not observed in the corresponding period the year before. Median weekly surgical volumes in Zambia dropped from 47 (45 – 55) cases per week to 27 (23.5 – 33.3) cases per week, a drop of 41.5%; in Zimbabwe from 37 (35.5 – 40.2) cases per week to 13 (9 – 17) cases per week a drop of 65.3% and in Nigeria from 10 (8 – 11.3) cases per week to 5 (4 – 6) cases per week (a drop of 50%) (Fig. 2).

The most common primary indication for surgery was congenital anomalies followed by injury which together accounted for more than 50% of all operations performed. These two were also the most affected indications for surgery. Total procedures performed for congenital anomalies and injury dropped by 34.7% and 30.5%, respectively (Fig. 3).

All procedures along the urgency spectrum from elective to immediate were affected. Elective surgery made up 30.0% of all surgical procedures performed before surgical rationing policies were

Table 1
Summary of characteristics of surgical patients (2020).

	Before COVID (absolute numbers)	After COVID (absolute numbers)	All patients (n = 1821)
Median age (months)	36.0	23.5	34.0
Gender			
Male	776	442	1218
Female	363	240	603
Age categories			
0 - 28 days	65	89	154
29 days - <12 months	218	181	399
1 - 4 years	310	155	465
4 - 6 years	153	63	216
6 - 8 years	83	59	142
8 - 10 years	83	41	124
10 - 12 years	69	28	97
12 - 14 years	59	28	87
14 - 16 years	47	23	70
16 - 18 years	52	15	67
Country			
Nigeria (Lagos)	118	90	208
Zambia	653	405	1058
Zimbabwe	368	187	555

Table 2
Weekly median procedures before and after COVID for a selection of operation characteristics.

	Before COVID Weekly median procedures (IQR)	After COVID Weekly median procedures (IQR)
Country		
Zimbabwe	37.5 (35 - 40)	13 (9 - 17)
Zambia	47 (45 - 55)	27.5 (23 - 33)
Nigeria (Lagos)	10 (8 - 11)	5 (4 - 6)
Total	100 (95 - 106)	50 (38 - 55)
Grade of Surgery		
Minor	1 (1 - 3)	1 (1 - 2)
Intermediate	64 (54 - 78)	34 (28 - 41)
Major	18 (15 - 22)	12 (7 - 14)
Urgency of Surgery		
Immediate	32 (25 - 45)	24 (19 - 29)
Urgent	15 (14 - 18)	13 (11 - 17)
Expedited	13 (7 - 15)	7 (4 - 8)
Elective	25 (17 - 29)	3 (2 - 6)

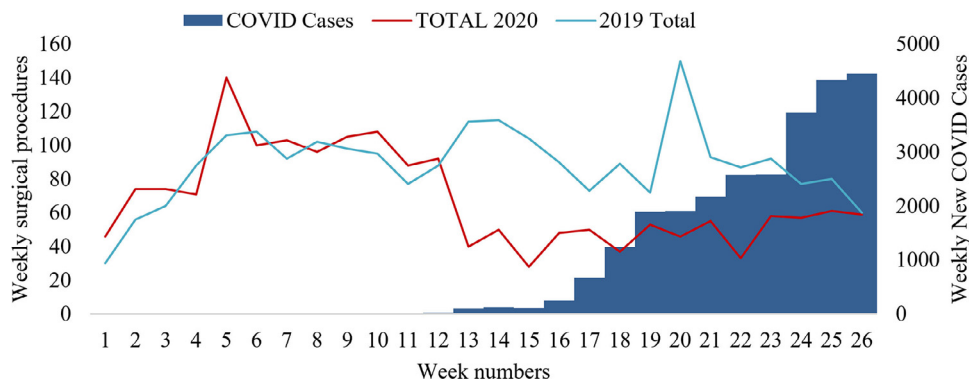


Fig. 1. Total weekly surgical volumes for all hospitals over the study period superimposed with total number of COVID-19 cases across all countries for 2020 and 2019 for comparison.

put in place but dropped to 9.7% of total operations after this date (Table 3) (Fig. 4). When elective rates are compared by country, Zambia’s elective rate was 43.0% pre-COVID and declined to 14.7% post-COVID; Zimbabwe’s elective rate declined from 8.2% to 0% and Nigeria’s rate dropped from 25.4% to 6.6. the corresponding changes in Ee ratio for each country are shown in Table 3.

Using WHO criteria for the four transmission phases of the pandemic [11] it was determined that in all three study sites, cancellation was enacted during transmission phase 2 while in China it was enacted in phase 3 and in the UK and USA during phase 4 (Fig. 5).

4. Discussion

This study evaluated the impact of the COVID-19 pandemic and its associated surgical rationing policies on children’s surgery in 5 hospitals in 3 African countries. We demonstrated a significant drop in paediatric surgical volumes after the beginning of the pandemic in the hospitals studied compared to before the pandemic and compared to the previous year. The drops observed coincided with cancellation of all non-essential surgical activity and persisted for weeks even after resumption of surgical services. Every age group experienced a decrease in total procedures performed ex-

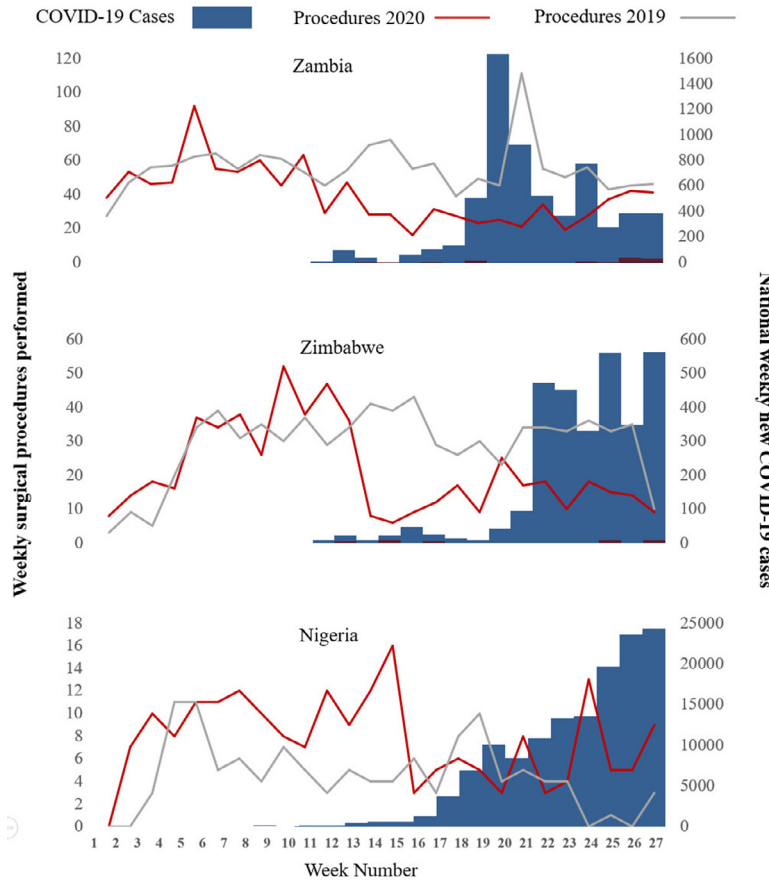


Fig. 2. Per-country surgical volumes over the study period superimposed with total number of COVID-19 cases nationally for 2020 and 2019 for comparison.

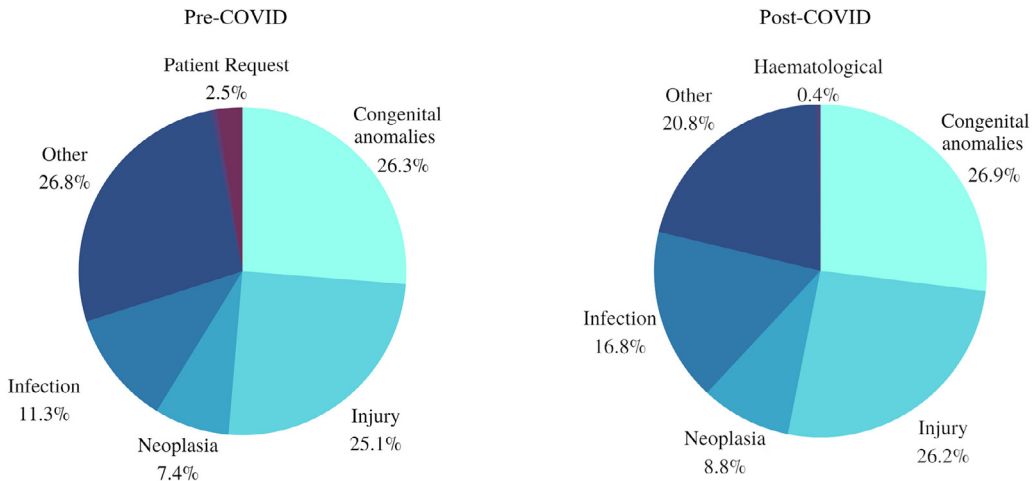


Fig. 3. Changes in primary indication for surgery in the pre-COVID period vs the post-COVID period.

cept the neonatal group who actually experienced an increase during this time. This phenomenon has been noted in prior analyses [4] and is thought to reflect a decision to prioritise neonates who are already in hospital. Decreases in caseload for older age groups may reflect reduced care seeking and reduced access to hospital as a result of travel restrictions and reluctance to leave home. An increase in caseload however may reflect a reduced threshold for surgeons to intervene surgically in children who would otherwise have had non-operative treatment.

Surgery for congenital conditions and injury were the most affected and elective surgery was predictably adversely affected al-

though emergency surgery was not spared. The reduction in injury surgery may be explained by a reduction in the incidence of injury during the pandemic particularly road traffic accidents which has been well described previously [12,13]. In addition, the reduction in transport injuries may be offset by an increased incidence of household injuries particularly burns in the infant age group because of protracted stay-at-home orders [14]. Health care seeking behaviours, transport access, altered referral patterns and hospital admission policies are other possible explanations. Surgery in the elective and expedited category declined by 34.4% and 78.9%, respectively from pre-COVID totals and were the most affected cate-

Table 3

Surgical urgency of recorded procedures before and after COVID by country Ee ratio: Emergency-to-Elective Surgery Ratio; EHR: emergent hernia repair ratio.

	Before COVID (absolute numbers)	After COVID (absolute numbers)	All patients (n = 1821)
Urgency of Surgery			
Immediate	444	335	779
Urgent	199	186	385
Expedited	154	96	250
Elective	341	66	407
Elective rate	30%	9.7%	22.4%
Elective hernias	104	23	127
Emergency hernias	30	32	62
EHR	0.3	1.4	0.5
By country			
Zimbabwe			
Immediate	206	150	356
Urgent	69	28	97
Expedited	63	9	72
Elective	30	0	30
Elective rate	8.2%	0	5.4%
Ee ratio	916.7	–	
Zambia			
Immediate	174	130	304
Urgent	117	138	255
Expedited	80	78	158
Elective	282	59	341
Elective rate	43.2%	14.7%	32.2%
Ee ratio	103.2	454.2	
Nigeria (Lagos)			
Immediate	64	54	118
Urgent	15	19	34
Expedited	9	11	20
Elective	30	6	36
Elective rate	25.4%	6.6%	17.3%
Ee ratio	263	1217	

Surgical Urgency of cases before and after COVID

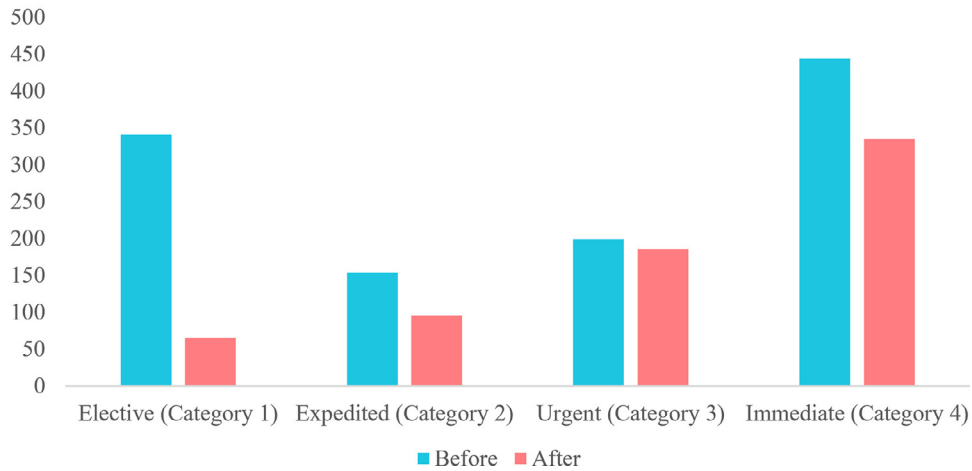


Fig. 4. Change in total procedures performed by surgical urgency using the NCEPOD classification pre-COVID vs post-COVID.

gories. Elective surgery in African countries constitutes only 43% of all procedures in adults [15], while in south Africa they constitute 64.8% of all children’s surgery [9]. In our three countries pre-COVID elective surgery rates ranged from 8.2% to 43.0%. The reason for the unusually low pre-COVID elective surgery rates in Zimbabwe was a protracted health care worker strike in the months before that incapacitated the surgical workforce. The Ee Ratio has been proposed previously as an indicator of access to available surgical care [16]. It reflects a reduction in the need for emergency surgery because of intervention of surgical disease early in its clinical course. Median Ee ratios in sub-Saharan African countries are approximately 62.6 but can be as high as 500 indicating low access to elective surgery [16]. The deterioration of this ratio from the pre-COVID totals (as

high as 1200) may suggest decreasing access to surgery during this time. The emergent hernia repair ratio, increased markedly also suggesting deterioration of access to surgical care.

COVID-19 arrived relatively later in Africa than in other global regions and in each of the three study countries there were approximately 2-month periods in which there were low numbers of cases. Despite this lockdown and surgical cancellations were enacted relatively early in the course of the pandemic in a pre-emptive response to events occurring on other continents around the same time without regard to the transmission phases of the outbreak in each country. A phase-based approach to surgical cancellation rationing based on an evaluation of risk of transmission may be a better approach that minimises the deleterious ef-

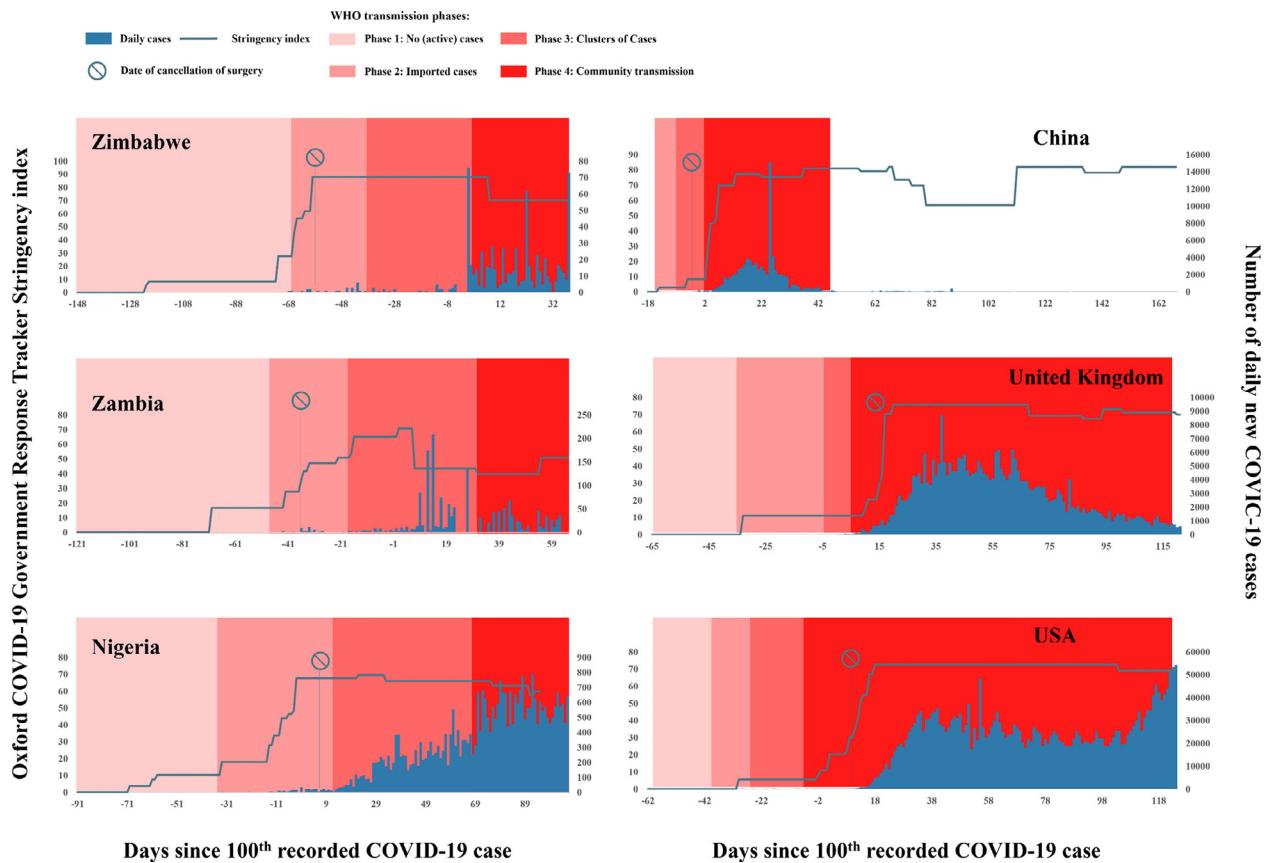


Fig. 5. Showing (A) the African pandemic compared to other continents. Illustrating that the African pandemic started later than all other continents. (B) Stringency index and daily confirmed cases of COVID-19 in selected countries annotated with the date when elective surgery was cancelled. Data for the stringency index was obtained from the Oxford COVID-19 Government Response Tracker (OxCGRT): Hale, Thomas, Sam Webster, Anna Petherick, Toby Phillips, and Beatriz Kira (2020). Oxford COVID-19 Government Response Tracker, Blavatnik School of Government. Data use policy: Creative Commons Attribution CC BY standard.

fects of curtailed surgical activity while reasonably recognising the risks during a pandemic. Indeed, the WHO recommends that public health and safety measures (PHSMs) should be instituted with due regard to the transmission phase of the pandemic in the target countries [11]. The four WHO transmission phases are defined as: phase 1 - no (active) cases, phase 2 - Imported/sporadic cases, phase 3 - clusters of cases and phase 4 - community transmission (CT) [11]. There is minimal to low risk of infection for the general population in transmission phases 1, 2 and 3, and therefore there should be a low requirement for surge capacity and low risk of nosocomial transmission.

This analysis is limited by its retrospective nature, and the attendant biases as well as the inability to collect additional variables of interest or determine cause-and-effect. The sudden change in surgical volumes coincided with the decision to cancel elective surgery but also with various other national, provincial and hospital level actions in response to the pandemic. Therefore, it may be difficult to parse out the effect of elective cancellation from the effect of these other events. However, the fact that the pattern is repeated across 5 hospitals in 3 countries lends credence to the assumption that it was the surgical rationing decisions that led to the changes observed.

5. Conclusions

The effects of surgical cancellations during the covid-19 pandemic are particularly devastating in African countries where the unmet need and surgical caseload are high. Surgical services across

the urgency spectrum and of all grades were adversely affected and countries with pre-existing vulnerability suffered further decline in surgical activity. There is an urgent need to mitigate the effects of the current pandemic and future ones while accelerating expansion of surgical services in children. A staged approach to cancellation using WHO transmission phases may be a useful system that balances competing harms to child health in affected countries. Future research directions should include an evaluation of excess mortality because of untreated surgical disease compared to the potential lives saved from the extra COVID bed capacity during early pandemic phases.

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