Patterns of disease on admission to children's wards and changes during a COVID-19 outbreak in KwaZulu-Natal Province, South Africa

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Background. Major causes of under-5 child deaths in South Africa (SA) are well recognised, and child mortality rates are falling. The focus of child health is therefore shifting from survival to disease prevention and thriving, but local data on the non-fatal disease burden are limited. Furthermore, COVID-19 has affected children's health and wellbeing, both directly and indirectly.
Objectives. To describe the pattern of disease on admission of children at different levels of care, and assess whether this has been affected by COVID-19.
Methods. Retrospective reviews of children's admission and discharge registers were conducted for all general hospitals in iLembe and uMgungundlovu districts in KwaZulu-Natal Province, SA, from January 2018 to September 2020. The Global Burden of Disease framework was adapted to create a data capture sheet with four broad diagnostic categories and 37 specific cause categories. Monthly admission numbers were recorded per cause category, and basic descriptive analysis was completed in Microsoft Excel.
Results. Overall, 36 288 admissions were recorded across 18 hospital wards, 32.0% at district, 49.8% at regional and 18.2% at tertiary level. Communicable diseases, perinatal conditions and nutritional deficiencies (CPNs) accounted for 37.4% of admissions, non-communicable diseases (NCDs) for 43.5% and injuries for 17.1%. The distribution of broad diagnostic categories varied across levels of care, with CPNs being more common at district level and NCDs more common at regional and tertiary levels. Unintentional injuries represented the most common cause category (16.6%), ahead of lower respiratory tract infections (16.1%), neurological conditions (13.6%) and diarrhoeal disease (8.4%). The start of the local COVID-19 outbreak coincided with a 43.1% decline in the mean number of monthly admissions. Admissions due to neonatal conditions and intentional injuries remained constant during the COVID-19 outbreak, while those due to other disease groups (particularly respiratory infections) declined.
Conclusions. Our study confirms previous concerns around a high burden of childhood injuries in our context. Continued efforts are needed to prevent and treat traditional neonatal and childhood illnesses. Concurrently, the management of NCDs should be prioritised, and evidence-based strategies are sorely needed to address the high injury burden in SA.

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Reducing preventable diseases, disabilities and deaths in children remains an important and challenging endeavour[1-4] that requires ongoing insight into the burden of childhood disease. Major causes of under-5 deaths in South Africa (SA) include neonatal and congenital conditions, communicable diseases, nutritional deficiencies and injuries.[3,4] As mortality rates fall, the focus of child health is expanding beyond survival to include morbidity and the optimal functioning of all children, including those with disability and long-term health conditions. Current data on the non-fatal burden of disease (morbidity) are sparse for SA children, as routine indicators have focused on mortality.[2]

The Global Burden of Disease (GBD) collaboration evaluates causes of morbidity and mortality across all age groups at global, regional and national levels, where morbidity is expressed as years lived with disability and disability-adjusted life years (DALYs), the latter indicating the burden of disease that the health system needs to manage.[5] Recent (2019) GBD data identified neonatal and congenital conditions, communicable diseases, nutritional deficiencies, non-communicable diseases (NCDs) and injuries as the dominant causes of DALYs in children aged <5 years.[5,6] GBD estimates for SA are similar to the global data, with a relatively higher contribution of HIV/AIDS and injuries, particularly transport injuries and those

resulting from violence.[6] Inaccuracies in national-level GBD figures result from limited availability of primary data and the use of regional grouping in the estimates.[5]

A review of paediatric intensive care unit (PICU) admissions in KwaZulu-Natal Province, SA, between 1971 and 1995 reported a shift from vaccine-preventable communicable diseases towards other communicable diseases and neonatal conditions.[7] More recent PICU data from Western Cape Province (2017) list a relatively higher proportion of NCDs such as cardiac and neurological diseases.[8] In other sub-Saharan African settings (Nigeria and Niger), the disease patterns have varied according to the study period and centre, with a dominance of communicable diseases seen primarily in the under-5 population.[9-13] Infectious diseases continue to represent a large proportion of the paediatric disease burden in southern Africa, and seasonal variations are described for the incidence of pneumonia/lower respiratory tract infections (LRTIs) and diarrhoea.[14,15]

Since March 2020, COVID-19 has placed additional burdens on the SA health system. By 21 November 2020, children and adolescents aged ≤19 years, despite comprising 37% of the population, represented 9% of COVID-19 infections and 4% of hospital admissions, with an incidence risk one-sixth of that in adults, and with few severe and fatal outcomes.[16] However, various indirect effects on children's health and wellbeing have arisen from the reduced coverage of child health interventions, the societal COVID-19 containment responses, and reduced economic activity. Indirect effects of the COVID-19 outbreak documented in our setting include reduced attendance for preventive, promotive and therapeutic healthcare services,[17-19] disruptions in health service delivery with a temporary decline in health outcomes,[18,20] reduced access to schooling, school meals and early childhood development (ECD) services,[21,22] reduced household food security with increased child hunger levels,[23] and an increasing prevalence of symptoms of depression in population surveys.[24] The impact of these indirect effects on the pattern of childhood diseases and hospitalisation is unknown.

Objectives

To describe the pattern of disease on admission of children at different levels of care and to assess whether the local COVID-19 outbreak coincided with any changes in the burden of disease.

Methods

Retrospective reviews of children's admission and discharge registers were conducted for all general hospitals (N=8) in two KwaZulu-Natal districts, iLembe and uMgungundlovu: 1 tertiary hospital, 2 regional hospitals and 5 district hospitals. The health districts were purposefully selected to include districts with multiple levels of care, relatively high COVID-19 incidence risk in July 2020 (M P Bapela, B Mhlongo, KwaZulu-Natal Department of Health COVID-19 situational report, 21 July 2020 – unpublished), and one predominantly urban and one predominantly rural setting. uMgungundlovu district (DC22) has large urban areas and a population size ~1.7 times that of the more rural iLembe district (DC29), with 1 184 320 and 715 941 inhabitants in 2019/2020, respectively.[25] All wards, both medical and surgical, admitting children aged 2 weeks - 13 years were included. The registers capture essential information about children on admission and discharge or death, including basic demographics; the reason for admission; their nutritional, immunisation, HIV and tuberculosis (TB) status; the under-5 illness category; and the discharge diagnosis or cause of death.

The framework for the GBD study was adapted to create a data capture sheet to record the primary reasons for children's hospital admissions. This sheet included three broad diagnostic categories: (*i*) communicable diseases, perinatal conditions and nutritional deficiencies (CPNs); (*ii*) NCDs; and (*iii*) injuries; additional categories (social admission and no diagnosis on admission); and underlying conditions (malnutrition, TB and HIV). The three broad diagnostic categories were further disaggregated into 37 specific cause categories. Additionally, the numbers of documented COVID-19 infections and COVID-19-related admissions in children aged <15 years were obtained from the daily hospital surveillance (DATCOV) database for KwaZulu-Natal.

The number of admissions was recorded per specific cause category and per month from January 2018 to September 2020 and captured into one Excel 97-2003 workbook (Microsoft, USA) per hospital. Basic descriptive analysis was conducted in Excel and focused on a comparison of the patterns of primary diagnosis on admission (diagnostic categories and cause categories) by hospital, district and level of care. The absolute numbers and percentages of admissions by broad diagnostic category, specific cause category and underlying condition were compared for the same period in 2018, 2019 and 2020. To assess temporal changes in admissions for broad diagnostic categories and specific cause categories (some of which may display seasonal variation), the means for January - September 2019 and January - September 2020 were compared with the mean for the same 9 months in 2018 with 95% confidence intervals (CIs) generated for the difference in means. To ascertain changes in admissions numbers following the local COVID-19 outbreak, the monthly mean for April - September 2020 was compared with a baseline monthly mean for January 2018 - March 2020. Temporal changes were considered statistically significant at a confidence level of 95% (p<0.05). Quarters were defined as standard calendar quarters, with e.g. quarter 1 representing January - March.

Ethical approval for the study was granted by the uMgungundlovu Health Ethics Review Board (ref. no. UHERB 001/2021).

Results

Admission and discharge registers were obtained from 18 wards including 6 paediatric medical, 3 surgical, 3 PICUs and 6 general children's (mixed medical and surgical) wards. Twelve wards were situated in uMgungundlovu district and 6 in iLembe. Registers could not be retrieved for 1 of the 32 months for 2 district hospital children's wards. One medical ward at the regional level was converted to an adult ward from July 2019 with registers missing for 2 additional months, and consequently had data for only 16 months of the study period. One regional hospital was closed for 2 weeks in May 2020 and one district hospital from mid-August to the end of September 2020 owing to the local COVID-19 outbreak and the associated civil unrest.

Admission numbers

During the study period, 36 288 admissions were recorded, 11 617 (32.0%) at district, 18 058 (49.8%) at regional and 6 613 (18.2%) at tertiary level. Hospitals in uMgungundlovu received 73.5% of the admissions and those in iLembe 26.5% (Table 1).

Apart from a 6.0% increase in the mean number of children admitted to tertiary-level care per month (difference +13; 95% CI 2.8 - 22.3) during January - September 2019 compared with January - September 2018, no significant changes in admission numbers (overall, or per district or level of care) occurred from 2018 to 2019. However, in January - September 2020, a 29.3% decline (difference –356; 95% CI –453.5 - –258.5) in the overall admission number per month was observed compared with January - September 2018. The decline

Table 1. Number of children admitted by district and level of care and percentage of admissions

	2018, *n* (%)	2019, *n* (%)	2020 (Jan - Sep), *n* (%)	Total for period, *n* (%)
Overall admissions	14 220 (100)	14 354 (100)	7 714 (100)	36 288 (100)
iLembe district	3 781 (26.6)	3 952 (27.5)	1 869 (24.2)	9 602 (26.5)
uMgungundlovu district	10 439 (73.4)	10 402 (72.5)	5 845 (75.8)	26 686 (73.5)
District hospitals	4 569 (32.1)	4 540 (31.6)	2 508 (32.5)	11 617 (32.0)
Regional hospitals	7 138 (50.2)	7 155 (49.8)	3 765 (48.8)	18 058 (49.8)
Tertiary hospital	2 513 (17.7)	2 659 (18.5)	1 441 (18.7)	6 613 (18.2)

was significant (p=0.001) across districts and levels of care and was most pronounced during April and May 2020, after the start of the national COVID-19 lockdown (Fig. 1). The proportion of children admitted to district hospitals remained fairly consistent, whereas a slight decrease (from 50.2% to 48.8%) was seen at regional hospitals and an increase (from 17.7% to 18.7%) at the tertiary hospital. Additionally, a temporary shift was seen in April 2020 when regional hospitals received a higher (61.8%) and district hospitals a lower (23.2%) than normal proportion of the admissions.

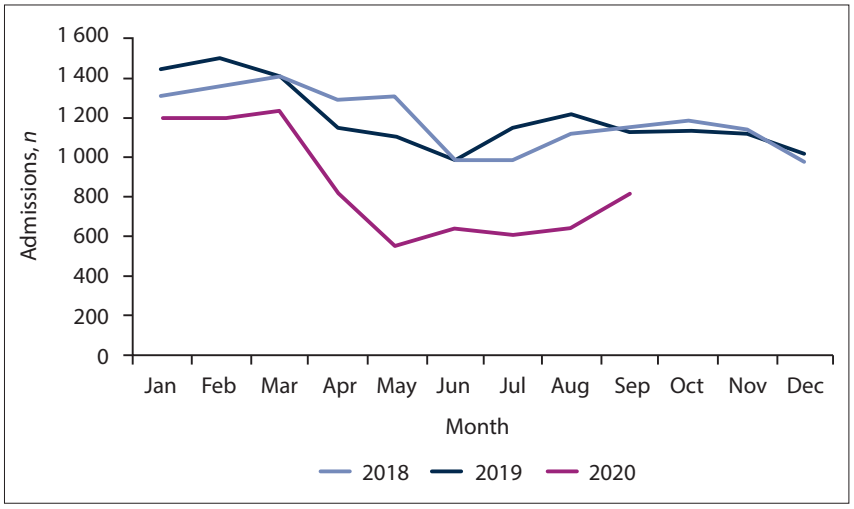

Fig. 1. Total monthly admissions of children in uMgungundlovu and iLembe districts, January 2018 - September 2020.

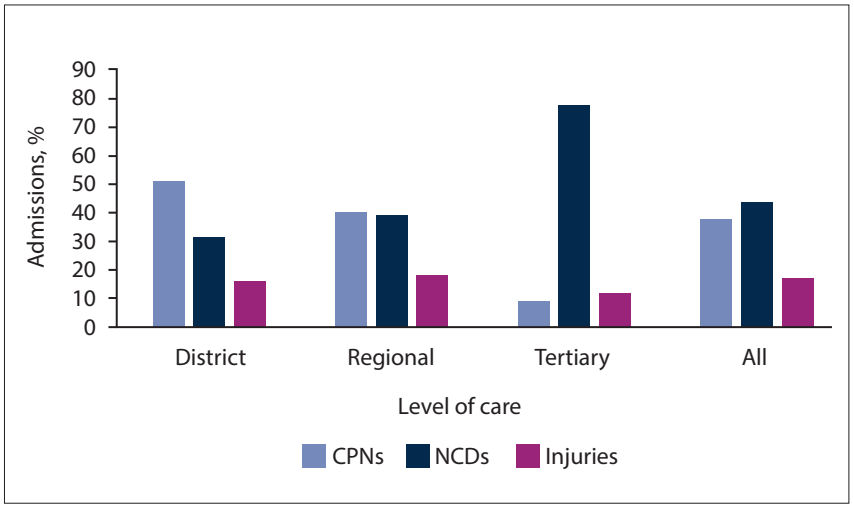

Fig. 2. Distribution of broad diagnostic categories on admission by level of care in uMgungundlovu and iLembe districts, January 2018 - September 2020. (CPNs = communicable diseases, perinatal conditions and nutritional deficiencies; NCDs = non-communicable diseases.)

Diagnoses

Overall for broad diagnostic categories, CPNs accounted for 13 588 (37.4%), NCDs for 15 799 (43.5%), injuries for 6 198 (17.1%) and social/other admissions for 661 (1.8%) of admissions of children. The distribution of broad diagnostic categories varied across levels of care, with CPNs being more common at the district level and NCDs more common at regional and tertiary levels (Fig. 2).

The admission numbers by year, diagnostic category and cause category with temporal changes are presented in Table 2. Between 2018 and 2019, only non-significant changes were observed in overall admission numbers and admissions by broad diagnostic categories, except for a significant decline in injury admissions (difference in monthly admissions –26; 95% CI –47.3 - –3.8). Within the CPN category, nutritional deficiencies demonstrated a significant increase (difference in monthly admissions +6; 95% CI 3.4 - 9.0), and within the NCD category, digestive, genitourinary and musculoskeletal diseases increased, while skin diseases decreased (Table 2). Monthly admission numbers fell significantly during January - September 2020 across broad diagnostic categories and most specific cause categories compared with the same periods in 2018, with exceptions including non-significant changes in neonatal conditions (difference in monthly admissions +2; 95% CI –3.9 - 7.2), non-communicable respiratory conditions, musculoskeletal diseases and intentional injuries.

Temporal trends included a decrease in admissions for all broad diagnostic categories from quarter 2 of 2020, with admissions for CPNs declining more than NCDs and injury admissions (Fig. 3). An annual incidence peak for respiratory infections was observed during quarter 1 in 2018 and 2019, but not in 2020 (Fig. 4), and fewer admissions for respiratory infections and infectious diseases accounted for most of the 2020 reduction in admissions in the CPN category, with admissions for neonatal conditions and nutritional deficiencies remaining relatively stable.

When admission numbers for the entire study period were assessed according to the 37 specific cause categories, the most frequent reasons for admission included

Table 2. Admission numbers by diagnostic category and changes in the means for January - September 2019 and 2020 compared with January - September 2018

Diagnostic category	Broad disease group	2018, *n* (%)	2019, *n* (%)	2020, (Jan - Sep), *n* (%)	Sum for period, *n* (%)	Mean difference Jan - Sep 2019 v. Jan - Sep 2018 (95% CI)	Mean difference Jan - Sep 2020 v. Jan - Sep 2018 (95% CI)
CPNs	Diarrhoeal diseases	1 152 (8.1)	1 261 (8.8)	641 (8.3)	3 054 (8.4)	3 (−16.2 - 22.2)	−29 (−48.0 - −9.6)
	Meningitis/encephalitis	230 (1.6)	232 (1.6)	121 (1.6)	583 (1.6)	0 (−3.8 - 3.8)	−6 (−10.2 - −2.7)
	Other infectious diseases	641 (4.5)	591 (4.1)	323 (4.2)	1 555 (4.3)	−7 (−23.6 - 9.6)	−21 (−37.6 - −4.4)
	Respiratory infectious	2 714 (19.1)	2 837 (19.8)	1 015 (13.2)	6 566 (18.1)	29 (−13.2 - 70.5)	−119 (−160.8 - −77.2)
	Neonatal conditions	353 (2.5)	371 (2.6)	285 (3.7)	1 009 (2.8)	3 (−2.8 - 8.3)	2 (−3.9 - 7.2)
	Nutritional deficiencies	308 (2.2)	339 (2.4)	174 (2.3)	821 (2.3)	6 (3.4 - 9.0)	−7 (−9.3 - −3.8)
	CPNs total	5 398 (38.0)	5 631 (39.2)	2 559 (33.2)	13 588 (37.4)	34 (−36.5 - 103.8)	−180 (−250.3 - −110.0)
NCDs	Endocrine, blood, immune	303 (2.1)	289 (2.0)	152 (2.0)	744 (2.1)	0 (−2.8 - 1.9)	−8 (−10.2 - −5.6)
	Neurological	1 943 (13.7)	1 892 (13.2)	1 082 (14.0)	4 917 (13.3)	0 (−20.0 - 19.3)	−43 (−62.4 - −23.1)
	Cardiovascular	316 (2.2)	289 (2.0)	130 (1.7)	735 (2.0)	−2 (−6.0 - 2.0)	−11 (−15.0 - −7.0)
	Respiratory	258 (1.8)	287 (2.0)	168 (2.2)	713 (2.0)	2 (−1.4 - 4.5)	−2 (−4.6 - 1.2)
	Digestive	912 (6.4)	942 (6.6)	545 (7.1)	2 399 (6.0)	9 (1.4 - 17.1)	−13 (−21.1 - −5.4)
	Genitourinary	431 (3.0)	479 (3.3)	188 (2.4)	1 098 (3.0)	7 (2.6 - 12.0)	−16 (−21.0 - −11.6)
	Skin diseases	642 (4.5)	476 (3.3)	370 (4.8)	1 488 (4.1)	−18 (−24.1 - −11.2)	−16 (−22.8 - −9.9)
	Musculoskeletal	448 (3.2)	649 (4.5)	355 (4.6)	1 452 (4.0)	15 (7.6 - 22.9)	−1 (−8.6 - 6.8)
	Other NCDs	874 (6.1)	946 (6.6)	433 (5.6)	2 253 (6.2)	6 (0.6 - 11.7)	−24 (−29.9 - −18.8)
	NCDs total	6 127 (43.1)	6 249 (43.5)	3 423 (44.4)	15 799 (43.5)	19 (−10.5 - 48.5)	−135 (−164.0 - −105.1)
Injuries	Unintentional injuries	2 307 (16.2)	2 176 (15.2)	1 550 (20.1)	6 033 (16.6)	−24 (−45.0 - −2.6)	−30 (−50.8 - −8.4)
	Intentional injuries	74 (0.5)	43 (0.3)	48 (0.6)	165 (0.5)	−2 (−4.4 - 0.8)	0 (−2.6 - 2.6)
	Injuries total	2 381 (16.7)	2 219 (15.5)	1 598 (20.7)	6 198 (17.1)	−26 (−47.3 - −3.8)	−29 (−51.2 - −7.7)
Social and other		314 (2.2)	214 (1.5)	133 (1.7)	661 (1.8)	−8 (−13.9 - −1.7)	−12 (−18.0 - −5.8)
Total admissions		14 220 (100)	14 354 (100)	7 714 (100)	36 288 (100)	19 (−78.2 - 116.8)	−356 (−453.5 - −258.5)

CI = confidence interval; CPNs = communicable diseases, perinatal conditions and nutritional deficiencies; NCDs = non-communicable diseases.

unintentional injuries (16.6%), LRTIs (16.1%), neurological conditions (13.6%), diarrhoeal disease (8.4%) and digestive diseases (6.6%). Fig. 5 displays the 15 most common cause categories by level of care and overall for childhood admissions.

Comorbidities

Table 3 presents the frequency of comorbidities on admission and their temporal changes, and Table 4 nutrition status by level of care as proportions of the overall admissions.

On admission, HIV status was documented for 91.9% of children, TB status for 92.5% and nutrition status for 77.4%. The number of children with undocumented HIV, TB and nutrition status declined significantly in 2019 and 2020 compared with 2018. Approximately 3.1% of admitted children had confirmed HIV infection, 8.0% were HIV exposed and 80.3% were confirmed HIV uninfected. The number of HIV-infected children fluctuated but did not demonstrate significant temporal changes. The proportion of HIV-exposed children increased gradually from 6.5% in quarter 1 of 2018 to 9.3% in quarter 3 of 2020, with an increase in the monthly admission number that was significant in 2019 (difference +32, 95% CI 16.6 - 47.9) but not in 2020. Approximately 1.3% of admitted children were receiving TB treatment, 7.7% had suspected TB, and in 83.6% TB was not suspected. The proportion on TB treatment also remained stable over time, while the proportion with suspected TB demonstrated a gradual decline from 9.4% in quarter 1 of 2018 to 4.5% in quarter 3 of 2020. The decline in the mean number of children with suspected TB was significant in both 2019 and 2020 (Table 3).

Nutrition status was normal for 69.2% of admitted children and abnormal for 8.2%. It was most frequently abnormal in district hospitals and most frequently documented in iLembe district and at the district and regional levels. A temporal trend was seen towards a decline in the number of children admitted with severe acute malnutrition and moderate acute malnutrition during the study period (Table 3, Fig. 6). The proportion of children admitted with severe acute malnutrition declined from 3.5% in quarter 1 of 2018 to 1.8% in quarter 3 of 2020, and the proportion of children admitted with moderate acute malnutrition declined from 3.1% to 2.3% during the same period. The mean number of admissions declined significantly in 2019 and 2020 for both moderate and

Table 3. Frequency of comorbidities on admission and changes in the means for January - September 2019 and 2020 compared with January - September 2018

Comorbidity	Status	2018, *n* (%)	2019, *n* (%)	2020 (Jan-Sep), *n* (%)	Sum for period, *n* (%)	Mean difference Jan - Sep 2019 v. Jan - Sep 2018 (95% CI)	Mean difference Jan - Sep 2020 v. Jan - Sep 2018 (95% CI)
Nutrition	NAM	9 442 (66.4)	10 400 (72.5)	5 255 (68.1)	25 097 (69.2)	115 (42.9 - 186.2)	−206 (−278.0 - −134.7)
	NAM at risk	143 (1.0)	208 (1.4)	107 (1.4)	458 (1.3)	8 (5.4 - 9.9)	0 (−2.3 - 2.3)
	MAM	514 (3.6)	367 (2.6)	193 (2.5)	1 074 (3.0)	−11 (−15.5 - −6.5)	−21 (−25.1 - −16.0)
	SAM	538 (3.8)	343 (2.4)	210 (2.7)	1 091 (3.0)	−17 (−22.0 - −11.1)	−24 (−29.9 - −19.0)
	SAM with complications	112 (0.8)	189 (1.3)	62 (0.8)	363 (1.0)	8 (6.5 - 10.4)	−3 (−4.5 - −0.6)
	Not documented	3 469 (24.4)	2 845 (19.8)	1 885 (24.4)	8 199 (22.6)	−84 (−131.2 - −36.3)	−102 (−149.6 - −54.6)
HIV	Infected	507 (3.6)	426 (3.0)	190 (2.5)	1 123 (3.1)	−7 (−16.4 - 3.3)	−23 (−32.9 - −13.1)
	Uninfected	11 150 (78.4)	11 709 (81.6)	6 267 (81.2)	29 126 (80.3)	59 (−30.2 - 148.0)	−246 (−335.0 - −156.8)
	Exposed	935 (6.6)	1 224 (8.5)	750 (9.7)	2 909 (8.0)	32 (16.6 - 47.9)	8 (−7.7 - 23.7)
	Unknown	567 (4.0)	356 (2.5)	209 (2.7)	1 132 (3.1)	−18 (−26.0 - −9.7)	−24 (−32.6 - −16.3)
	Not documented	874 (6.1)	639 (4.5)	294 (3.8)	1 807 (5.0)	−27 (−45.7 - −7.8)	−50 (−69.3 - −31.4)
TB	On treatment	183 (1.3)	179 (1.2)	96 (1.2)	458 (1.3)	0 (−4.0 - 3.8)	−5 (−8.4 - −0.7)
	Suspected	1 301 (9.1)	1 035 (7.2)	457 (5.9)	2 793 (7.7)	−20 (−37.1 - −3.3)	−60 (−76.7 - −42.9)
	Not suspected	11 499 (80.9)	12 224 (85.2)	6 608 (85.7)	30 331 (83.6)	67 (−17.6 - 152.2)	−243 (−328.0 - −158.2)
	Not documented	1 240 (8.7)	914 (6.4)	551 (7.1)	2 705 (7.5)	−28 (−47.2 - −9.1)	−49 (−68.2 - −30.1)

NAM = not acutely malnourished; MAM = moderate acute malnutrition; SAM = severe acute malnutrition; TB = tuberculosis.

severe acute malnutrition. However, admissions for severe acute malnutrition with complications demonstrated an upwards trend during 2019 (Table 3, Fig. 6). A similar proportion of admitted children had severe and moderate acute malnutrition recorded as comorbidities in the two districts. However, the occurrence of nutritional deficiencies as the primary cause of admission was three times higher in iLembe compared with uMgungundlovu (4.6% and 1.5% of admissions, respectively).

The COVID-19 outbreak and related changes in admission numbers

The COVID-19 outbreak in SA commenced in early March 2020, with a national lockdown enforced from late March. Paediatric COVID-19 infections and associated admissions remained relatively few until the first epidemic wave occurred from late June to early September. Across both districts during March - September, 1 608 positive tests and 65 COVID-19-related admissions occurred in children and adolescents aged <15 years, with uMgungundlovu district accounting for 61.7% of the positive cases and 76.9% of COVID-19-related admissions (Fig. 7).

During April - September 2020, the mean number of admissions to children's wards declined by 43.1% compared with the mean for January 2018 - March 2020. The reduction in admissions was statistically significant across all facilities, generally occurred earlier in district hospitals (from April 2020) than in regional hospitals (from May 2020), and was larger in district hospitals (47.5%) compared with regional (42.5%) and tertiary (36.7%) hospitals. iLembe experienced a larger decline in admissions than uMgungundlovu (Table 5).

Discussion

Main study findings

Of 36 288 childhood admissions recorded across 18 wards in uMgungundlovu and iLembe districts from January 2018 to September 2020, 49.8% occurred at regional, 32.0% at district and 18.2% at tertiary level. Significant changes in broad diagnostic groups observed from 2018 to 2019 included a decline in injury admissions probably more reflective of the general temporal trends than the 2020 changes that were dominated by a large decline in monthly admission numbers across diagnostic groups associated with the national COVID-19 lockdown before the first epidemic peak (M P Bapela, B Mhlongo, KwaZulu-Natal Department of Health COVID-19 situational report, 23 February 2021 – unpublished). The 2020 drop in admissions disproportionally affected district hospitals compared with other levels of care, and iLembe more than uMgungundlovu. In April and May 2020, iLembe experienced early COVID-19 cluster outbreaks, civil unrest and a 2-week closure of the regional hospital. Additionally, the iLembe district hospital with the largest (84.2%) reduction in admissions was selected as a dedicated COVID-19 facility and from April 2020 received only COVID-19-positive patients, with neighbouring district hospitals absorbing its non-COVID patients. The COVID-19-related disruptions observed in service utilisation and access are consistent with previous SA reports of declines in attendance for child health services, particularly at the hospital level.[17,18,20,26]

In our data set, NCDs accounted for a higher (43.5% v. 37.4%) proportion of admissions compared with CPNs, with CPNs being more common at district level and NCDs more common at regional and tertiary levels. Neurological conditions were the dominant NCD group, also representing the third most common overall specific cause category (13.6% of admissions). The relatively higher burden of NCDs in our data differ from older SA reports, sub-Saharan African reports and the national 2019 GBD estimates, which have stipulated a predominance of CPNs in the disease burden.[6,7,9-13] However, a

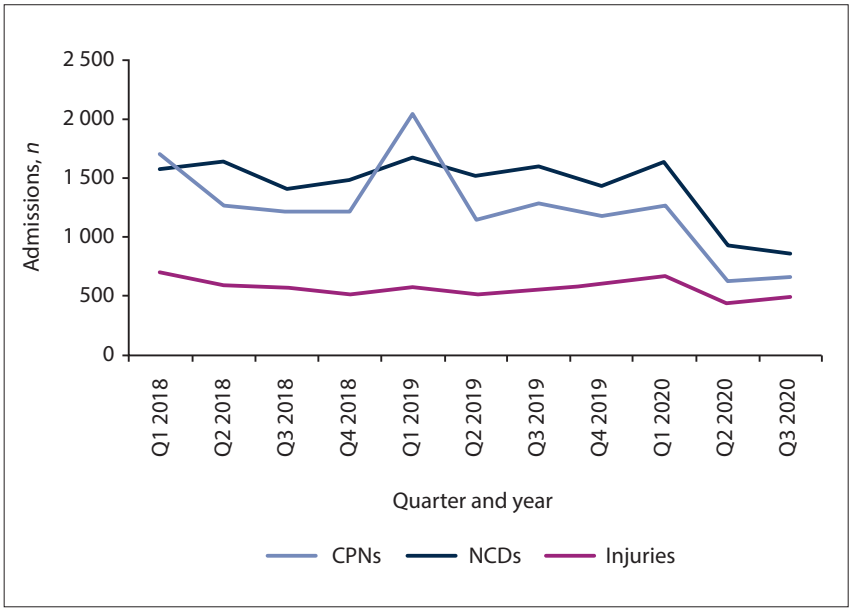

Fig. 3. Number of admissions by broad diagnostic category for CPNs, NCDs and injuries, Q1 2018 - Q3 2020. (CPNs = communicable diseases, perinatal conditions and nutritional deficiencies; NCDs = non-communicable diseases.)

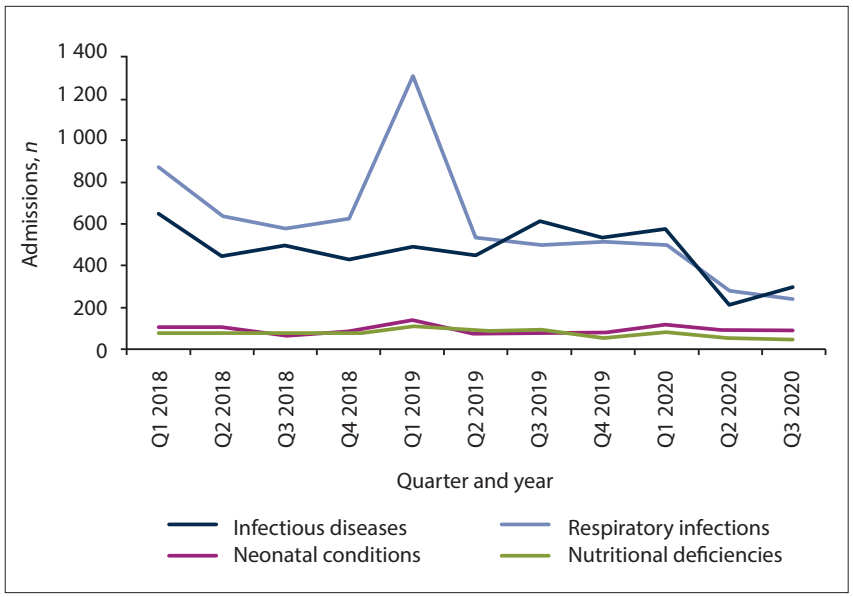

Fig. 4. Number of admissions by sub-category of CPNs, Q1 2018 - Q3 2020. (CPNs = communicable diseases, perinatal conditions and nutritional deficiencies.)

2012 study from Cape Town reported that 65.4% of children admitted to medical and intensive care wards had underlying chronic diseases/NCDs not listed as the primary reason for admission.[27] Additionally, more recent PICU data from Cape Town have documented a higher relative contribution of NCDs and injuries.[8] The conflicting findings regarding the burden of disease may be partly explained by different data sets (e.g. a predominance of medical wards and various levels of care in previous studies) and recording of the acute causes of admission rather than the chronic/underlying cause. However, large-scale COVID-19 infection control measures during 2020 and an ongoing epidemiological transition from nutritional and communicable diseases to NCDs may have contributed.[28,29]

Unintentional injuries represented the overall largest cause category (16.6% of admissions) in our data. Other authors have raised concerns around a high burden of both intentional and non-intentional injuries in our context.[2,30,31] Although we did not disaggregate the injury admissions by mechanism, previous SA studies have identified road traffic accidents, burn injuries, falls, exposure to mechanical forces, foreign body ingestion and drowning as common causes of non-intentional injuries in children.[2,6,30-32]

A temporal trend towards improvement in the documentation of comorbidities was seen. The documentation of nutritional status was inferior to that of HIV and TB status despite 8.3% of children having an abnormal nutritional status compared with 3.1% of children being HIV infected and 1.3% receiving TB treatment. This finding may in part be due to a stronger reinforcement of interventions and reporting in donor-funded HIV and TB programmes. The SA PMTCT programme has reduced the number of new HIV infections in children, and the proportion of admitted children in our data who were HIV infected was roughly

Table 4. Nutrition classifications by level of care and overall for all childhood admissions in iLembe and uMgungundlovu districts, January 2018 - September 2020

Nutrition category	District hospitals,%	Regional hospitals,%	Tertiary hospital, %	All admissions, %
NAM	69.1	72.4	60.5	69.2
NAM at risk	2.2	0.5	1.5	1.3
MAM	4.4	1.9	3.4	3.0
SAM	3.7	2.7	2.5	3.0
SAM with complications	1.2	1.2	0.3	1.0
Nutritional status not documented	19.4	21.3	31.9	22.6

NAM = not acutely malnourished; MAM = moderate acute malnutrition; SAM = severe acute malnutrition.

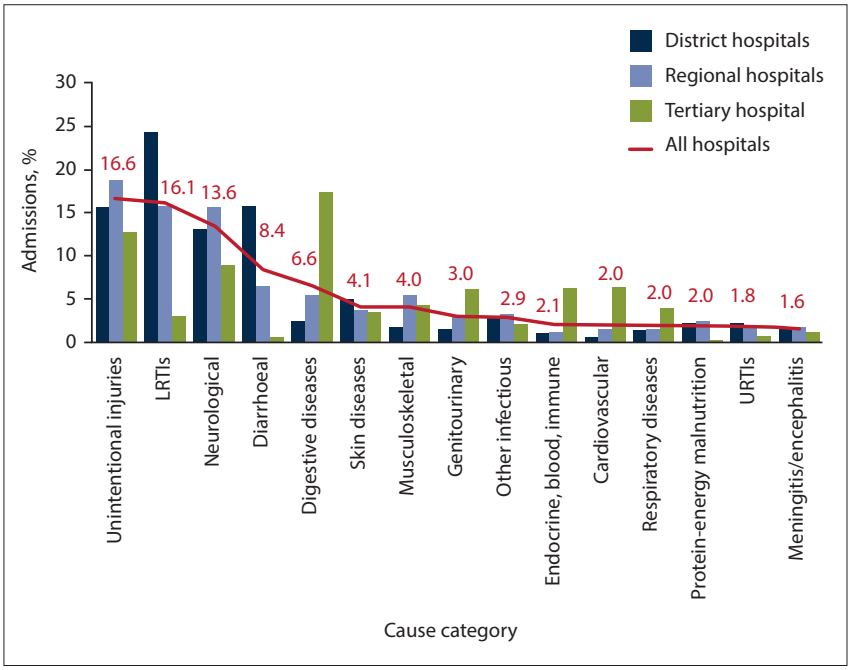

Fig. 5. Frequency of specific cause category by level of care and overall for childhood admissions in iLembe and uMgungundlovu districts, January 2018 - September 2020. (LRTIs = lower respiratory tract infections, URTIs = upper respiratory tract infections.)

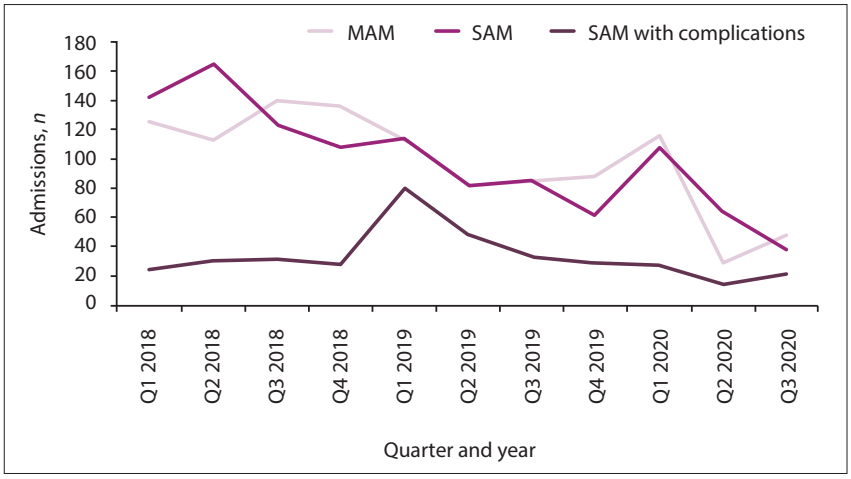

Fig. 6. Nutritional status on admission of children in iLembe and uMgungundlovu districts, January 2018 - September 2020. (MAM = moderate acute malnutrition; SAM = severe acute malnutrition.)

a quarter of that recorded in Cape Town in 2012.[27] Children's nutritional status was most often documented at district hospitals, which treat malnutrition as the primary cause of admission more often than regional and tertiary hospitals. Although the rates of moderate and severe acute malnutrition demonstrated downwards trends, these rates are much too high for an upper middle-income country, speaking to SA's remaining income inequalities. Local variations in socioeconomic status were also highlighted by the three-fold district difference in the occurrence of nutritional deficiencies as the primary cause of admission.

During March - September 2020, uMgungundlovu accounted for 61.7% and iLembe for 38.3% of COVID-19-positive cases in children and adolescents aged <15 years, which is in keeping with the districts' respective population sizes. However, uMgungundlovu received a disproportionately higher share (76.9%) of the COVID-19-related paediatric admissions. In iLembe, COVID-19-infected children were admitted to the dedicated district hospital. As many children live in rural areas, their families may have struggled to access care during the COVID-19-related movement restrictions. In the more urban uMgungundlovu, the majority of paediatric COVID-19 infections were incidental findings due to routine testing on admission for NCDs and injuries. Admissions due to neonatal conditions and intentional injuries remained constant during the COVID-19 outbreak, while those due to other disease groups (particularly respiratory infections) declined. The vulnerability of neonates and young infants to disruptions in access to and quality of health services is well documented.[18,26,33-35]

Study strengths and limitations

Study strengths include a relatively large dataset with an internationally recognised

Table 5. Changes in the mean number of admissions during April - September 2020 compared with the mean for January 2018 - March 2020

District and facility	Level	Mean, Jan 2018 - Mar 2020	Mean, Apr - Sep 2020	Mean difference (95% CI)	Change, %
uMgungundlovu		868.4	539.7	−328.8 (−380.7 - −276.9)	−37.9
Grey's	Tertiary	214.7	135.8	−78.9 (−92.8 - −65.0)	−36.7
Edendale	Regional	380.4	255.3	−125.1 (−162.9 - −87.3)	−32.9
Northdale	District	243.9	134.5	−109.4 (−127.5 - −91.3)	−44.9
Applesbosch	District	29.4	14.0	−15.4 (−20.7 - −10.1)	−52.4
iLembe		324.6	139.5	−185.1 (−223.3 - −146.9)	−57.0
GJGM	Regional	212.6	85.7	−127.0 (−152.7 - −101.2)	−59.7
Montebello	District	32.1	19.7	−12.4 (−18.0 - −6.9)	−38.8
Umphumulo	District	38.9	27.7	−11.2 (−18.5 - −6.9)	−28.8
Untunjambili	District	41.0	6.5	−34.5 (−43.0 - −26.1)	−84.2
All facilities		1 193.1	679.2	−513.9 (−595.5 - −432.3)	−43.1

CI = confidence interval; GJGM = General Justice Gizenga Mpanza Regional Hospital.

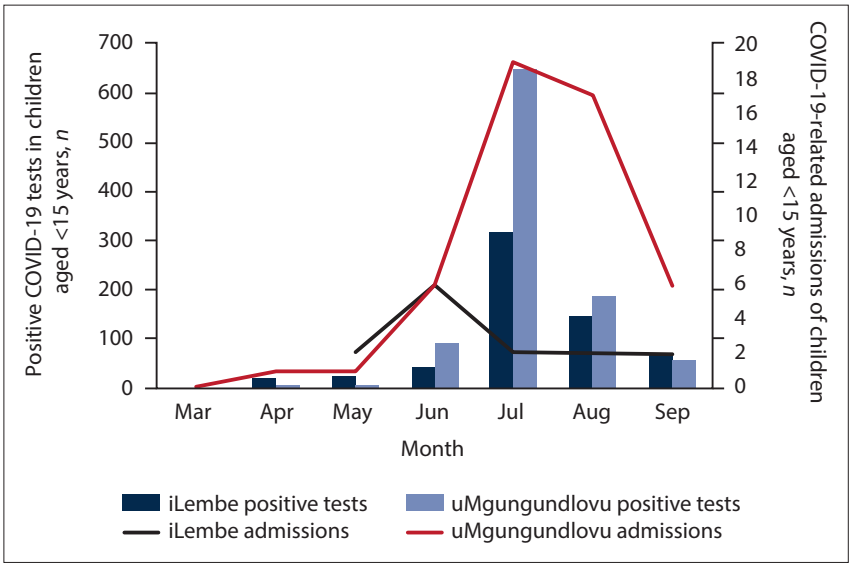

Fig. 7. Number of positive COVID-19 tests and related admissions in children aged <15 years in iLembe and uMgungundlovu districts, March - September 2020.

framework for categorisation of the burden of disease. Our methods could easily be repeated in similar settings, particularly in other KwaZulu-Natal districts, where all paediatric wards keep similar admission and discharge registers. Few previous studies have comprehensively described the non-fatal burden of disease in SA children. Limitations include inability to further disaggregate the admission numbers beyond the cause categories into specific diseases and conditions. Hospital admission numbers would also be an imperfect representation of the pattern of disease in the overall population, as the children admitted would have undergone a preselection process through care-seeking, assessment at and referral from lower levels of care.

Recommendations

Further studies are needed to better describe the burden of disease in children at the population level as well as causes and preferred interventions to effectively prevent childhood injuries in our context. Evidence-based strategies and investments are needed to address the high burden of violence and unintentional injuries, spanning across all levels of prevention (primordial to tertiary) and attending to immediate causes, risk factors and underlying determinants of health.[2,36,37] As major contributors to the non-fatal burden of disease, neurological disorders and other NCDs warrant more attention, as do neonatal and early infant conditions, particularly during times of increased stress on the health system such as the COVID-19 outbreak. Nutrition assessment and management needs reinforcement as an integral part of all child health services.

Conclusions

Although CPNs still account for a large number of childhood admissions, the burden of NCDs is high, with dominating cause categories including neurological, digestive, dermatological and musculoskeletal conditions. In our setting, CPNs are more common at district level and NCDs more common at regional and tertiary levels. Our study confirms previous concerns around a high burden of injuries in our context, and unintentional injuries represented the most common cause category, ahead of LRTIs, neurological conditions and diarrhoeal diseases. Admissions due to neonatal conditions and intentional injuries remained constant during the COVID-19 outbreak, while those due to other disease groups (particularly respiratory infections) declined. Continued efforts are needed to prevent and treat traditional neonatal and childhood illnesses. Concurrently, the management of NCDs should be prioritised and evidence-based strategies are sorely needed to address the high injury burden in SA.

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Author contributions. NHM and CJ conceptualised the article. NHM and KM co-ordinated the data collection with MEM and JvL while YK, NM, NM, TM, TM, YM, ZN, AEP, DP and DR collected the data from hospital registers. KM and KM captured the data, MEM conducted data cleaning and CJ generated the tables and charts. CJ and NHM analysed the data and wrote the article.

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Conflicts of interest. None.

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