Impact of the COVID pandemic on the pattern and outcome of admissions in a paediatric emergency unit in Sokoto, Nigeria from 2019 to 2021

Abstract

Background: The COVID pandemic had widespread impact on the world population, especially on health-care. This ranged from direct effects of the infection on populace, in addition to changing pattern of morbidity and mortality, children inclusive.

Objectives: To compare the pattern and outcome of admissions during the COVID pandemic period (2020 – 2021) to the preceeding year (2019) in the emergency Paediatric unit (EPU) of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto.

Materials and Methods: This was a retrospective study. The admission records of children aged > 1 month to 15 years were retrieved, relevant information extracted, entered into a study proforma and analysed with SPSS version 24.

Results: Total admissions were 3741. The 1st pandemic year (2020) had the lowest (1116, 29.8%) while 1406 (37.6%) and 1219 (32.6%) patients were admitted in 2019 and 2021.

The lowest admission was between March and June 2020 coinciding with the lockdown, highest was in August 2020 when restrictions had been lifted. The topmost admissions yearly were malaria, acute respiratory infections and acute gastroenteritis. The trend showed that all cases reduced in the pandemic years (2020-2021) but respiratory infections increased. Mortality was highest in 2020 (p=0.001). Malaria was the highest cause of mortality for the 3 years, however, mortality rate from sepsis, cardiac and respiratory diseases rose sharply in the pandemic years. Three confirmed cases of COVID were seen with 1 mortality.

Conclusion: Admission rates reduced during the pandemic year in 2020 however, with increased rate of mortality. There was increase rate of sepsis, cardiac and respiratory mortality following the pandemic.

Keywords: Pattern, Admissions, COVID, Emergency, Paediatrics, Sokoto

Introduction

The COVID pandemic had widespread impact on the world population and especially on health-care. This ranged from direct effects of the infection on populace, health workers inclusive.[1] Also impacted were ability to attend health facilities due to lock down as well as changing disease pattern due to reduced access to care and increased morbidities from respiratory illnesses.[2]

The COVID pandemic was declared by World Health Organisation (WHO) as a Public Health Emergency of International Concern (PHEIC) on 30th January 2020 and a pandemic on 11th March 2020.[3] Lock down was prescribed to limit the spread also in March 2020. Lockdown implies large scale physical distancing measures and movement restrictions which slows infection transmission by limiting contact between people.[4] The 1st case in Nigeria was in 27th February 2020 while lock down was enforced in March 2020.[5] This led to shut down of businesses, livelihoods, schools and all income generating activities.[4] It also impacted immensely the health care system as sick individuals could not access life-saving interventions and medications.[6] Those with chronic disease could not also assess follow up and drug supply. Supply chain of essential commodities and drugs broke down.[4] This caused widespread suffering and led to spread of disease and depression due to the confinement which caused potential or actual increase in the burden of disease especially on vulnerable children.[7]

Children being at the receiving end of health care at parents' expense especially in low resource countries may have been negatively impacted during that period, despite not being at increased risk of the COVID infection.[8] This is a retrospective review over 3 years including 1-year pre and 1st and 2nd pandemic years to assess the pattern of admissions and outcome in an emergency unit of a tertiary health facility.

Materials and Methods

Study area:

Sokoto State is located in the dry Sahel region and is surrounded by sandy Savannah. Sokoto town lies between latitude 10º and 14ºN, and longitude 3º3¹ and 7º7¹ east of the Equator[9] with an annual average temperature of 28.3ºC, which rises as high as 45°C during the hottest months.

The study was carried out at the Emergency Paediatric Unit (EPU) of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto which is a tertiary health facility as part of a study on the pattern and outcome of admissions in the EPU.

Study design: This was a retrospective study conducted over a 3-year period (1st January 2019 to 31st December 2021)

Study subjects: Comprised all children aged 1 month to 15 years admitted into the EPU during the study period.

Exclusion criteria: Those who were brought in dead and those who were given treatment without full admission.

Procedure of recruitment

The details of children admitted during the 3-year period were accessed from the admission register in the unit which is usually updated by the health information officers every morning. The information extracted included socio-demographic characteristics, diagnosis and outcome. Age was categorized using standard paediatric age group classification into infants aged > 1 month to 12 months, age 1 years to 5 years, 6 years to 10 years and 10 years to 15 years. The different diagnoses were categorized into Malaria (Uncomplicated and Complicated), Acute respiratory infections (Pneumonia, Pharyngotonsillitis, Bronchiolitis), Gastroenteritis, Sepsis including Meningitis, Vaccine preventable infections (Tuberculosis, Measles, Tetanus, Pertussis, Diphtheria), Sickle cell disease amongst others. These were captured according to the pre-pandemic, 1st and 2nd pandemic years. Outcome of mortality was also captured according to month and year of admission.

Data entry and analysis

Data were entered into an ODK software and subsequently moved into IBM SPSS statistical software version 24 for analysis. Univariate analysis (mean, standard deviation) was done for the

continuous variables such as age while frequency tables, charts and proportions were used for the categorical variables such as gender, type of diagnosis, year and month of admission. Bivariate analysis (chi square or Fisher's Exact test) was used to compare outcomes of different diagnosis in the pandemic vs the pre and post pandemic period while Anova was used to compare the mean age between those periods. A p-value of <0.05 was considered statistically significant.

Results

Demographic profile

The highest number of admissions per year was in 2019 (1406; 37.6%) while lowest was in the 1st pandemic year of 2020 (1116, 29.8%). This represented a 20.6% decrease in admissions in the year 2020 from the pre-pandemic year of 2019. The admission rate increased slightly by 13.3% in 2021 relative to the year 2020.

Males accounted for 57% and the proportion of males admitted increased in the 1st and 2nd year of the pandemic which was significant ($\chi^2 = 14.9$, p=0.001). Most of the patients admitted throughout the 3 years were aged 1 to 5 years followed by infantile age group. The trend of infant admissions increased from pre pandemic to pandemic years while the proportion aged 1 to 5 years had a decreasing rate of admission. Those aged 5 to 10 years were also increased in the 1st pandemic year. This relationship to age was statistically significant ($\chi^2 = 17.5$, p=0.008). These findings are detailed in Table 1.

Normality of age distribution was checked by Kolmogorov-Sminorv test, and the results suggested it was not normally distributed (p<0.05). Their median age was similar across the three years (Table 1).

Table 1: **Demographic profile of admitted children in the pre-pandemic & pandemic years**

Parameter	**2019 Pre-pandemic year**	**2020 Pandemic year 1**	**2021 Pandemic year 2**	**Total (n=3741)**	**Test statistic & p-value**
Gender					
Male	751 (53.4)	639 (57.3)	742 (60.9)	2132 (57.0)	$\chi^2 = 14.9$
Female	655 (46.6)	477 (42.7)	477 (39.1)	1609 (43.0)	p = 0.001
Age range					
1- 12months	323 (23.0)	259 (23.2)	341 (28.0)	923 (24.7)	$\chi^2 = 17.5$

1.1 – 5 years	643 (45.7)	497 (44.5)	488 (40.0)	1628 (43.5)	p = 0.008
5.1 - 10 years	251 (17.9)	229 (20.5)	226 (18.5)	706 (18.9)	
10.1 – 15 years	189 (13.4)	131 (11.7)	164 (13.5)	484 (12.9)	
Total	**1406 (37.6)**	**1116 (29.8)**	**1219 (32.6)**	**3741 (100.0)**	
% change from previous year		-20.6%	+9.2%		
Median age (IQR) years	2.0 (1.0, 6.0)	2.2 (1.0, 6.0)	2.0 (0.8, 6.0)		

Monthly trend of admissions over the 3-year period

The chart in figure 1 shows the monthly trend of admission from the pre-pandemic to the pandemic period. The lowest number of admissions was during the lockdown period from March to May 2020 and there was a surge in admissions by August 2020 and another surge in February 2021. In the pre-pandemic year, a surge was seen in July and September 2019.

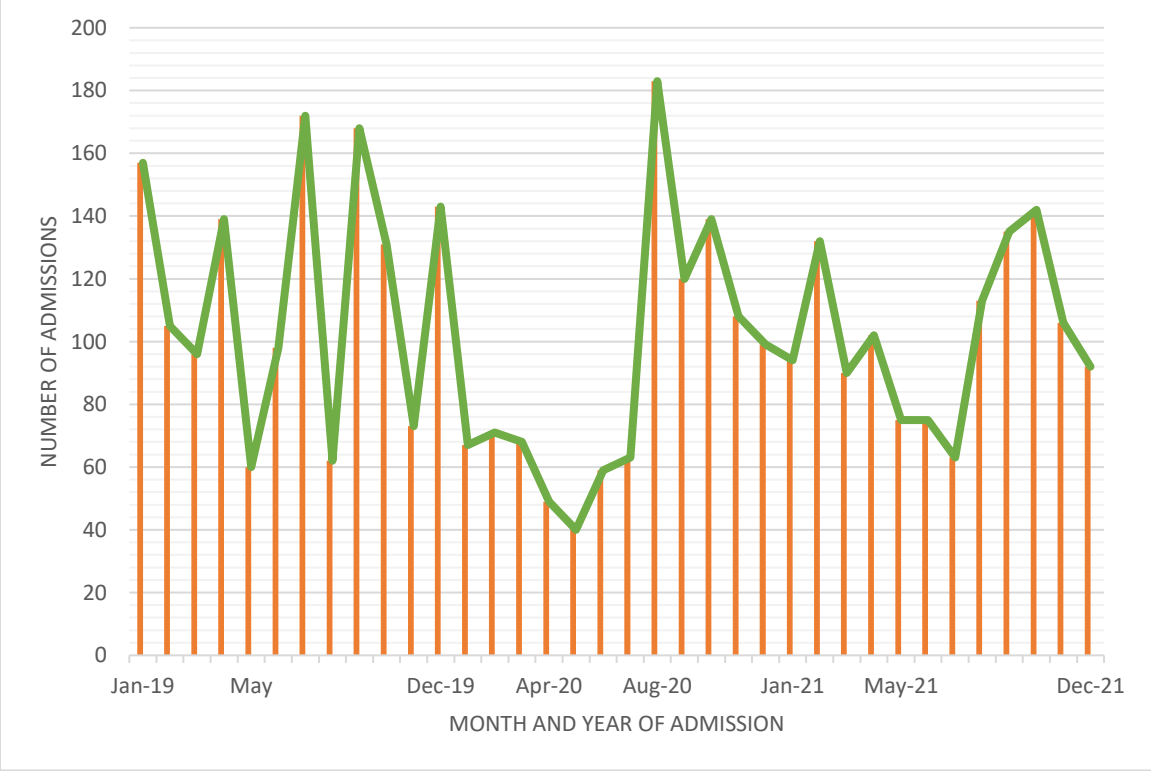

Fig 1: Monthly distribution (January2019 to December 2021)

Case distribution by diagnoses

The most frequent diagnosis was malaria (787, 21%) followed by acute respiratory infections (661, 17.7%), acute gastroenteritis (398; 10.8%), sepsis (370; 9.9%) sickle cell disease (SCD) (368; 9.8%), febrile convulsions (254; 6.8%), severe acute malnutrition (SAM) (250;6.7%), genitourinary tract/renal disorders (175; 4.7%), vaccine preventable infections (119; 3.2%), cardiac diseases (114; 3.0%) and neurological diseases (44; 1.2%). Other diagnoses constituted 201; 5.4% as in Table 2.

Table 2: Distribution of cases by diagnosis in three years (2019 – 2021)

Diagnoses	Frequency (%)
Malaria (complicated & uncomplicated)	787 (21.0)
Acute respiratory infections (Pneumonia, pharyngotonsillitis, bronchiolitis etc)	661 (17.7)
Acute gastroenteritis	398 (10.8)
Sepsis	370 (9.9)
Sickle cell disease	368 (9.8)
Febrile convulsions*	254 (68.2)
Severe acute malnutrition	250 (6.7)
Genitourinary tract disorders including urinary tract infection	175 (4 7)
Vaccine preventable diseases (Tuberculosis, measles, tetanus, Diphtheria, pertussis)	119 (3.2)
Cardiac diseases (congenital and acquired)	114 (3.0)
Neurological disease	44 (1.2)
Others#	201 (5.4)
Total	**3741 (100.0)**

Febrile convulsions causes: Malaria, Acute pharyngitis, UTI, Diarrhoea disease
 # Others include: Malignancies, accidental ingestions, bone and joint infections, COVID, etc

Trend of different diagnoses through the pre-pandemic to pandemic period

The columns in Figure 2 shows the admission rate of all morbidities reduced in year 2020 likewise in the year 2021. However, an increase was seen for acute respiratory infections in 2021. An increase was also seen for gastroenteritis, sepsis and SCD.

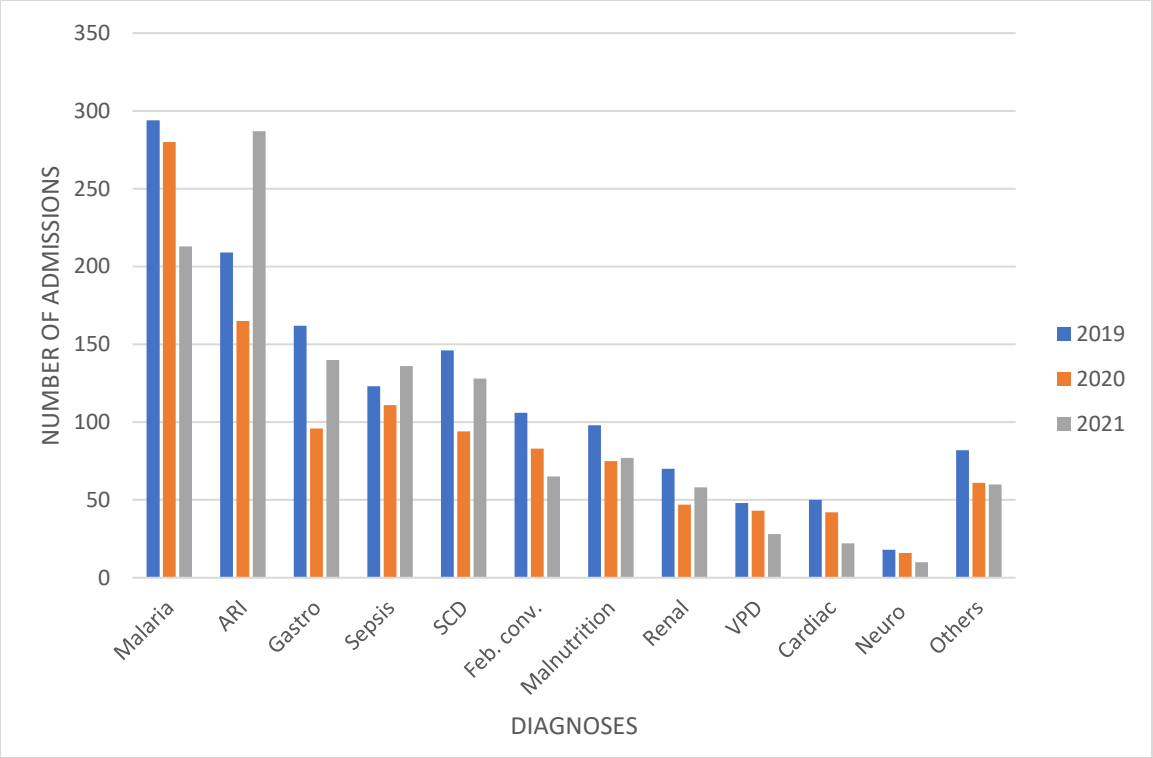

Figure 2: Trend in pattern of admissions by diagnoses

Trend of mortality from January 2019 to December 2021

Figure 3 shows mortality was highest in the pandemic year of 2020 from April to June and fell gradually in the 2nd pandemic year.

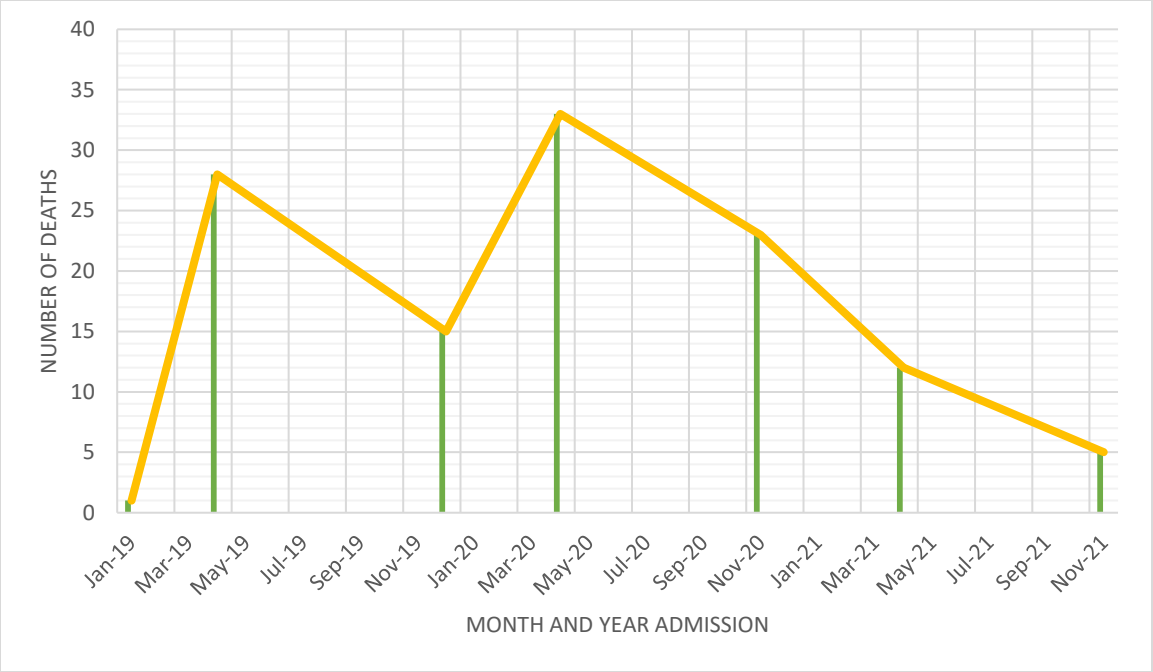

Figure 3: Outcome of mortality from January 2019 to January 2021.

Proportionate mortality by year

The highest mortality rate was in the 1st pandemic year (2020) at 14.4% vs 12.6% in 2019 and 9.4% in 2021 which was statistically significant ($\chi^2 = 14.7$, $p = 0.001$) as seen in Table 3.

Mortality rate of different conditions in the pre-pandemic and pandemic years

The highest cause of mortality in the pre-pandemic year was malaria (23.2%) followed by severe malnutrition (15.8%) then sepsis (14.1%). While in 2020, malaria still predominated (27.3%) but followed by sepsis (15.5%) and cardiac diseases (12.4%). In 2021, malaria (21.1%) was still top followed by sepsis (19.3%) then acute respiratory infections (12.3%). The trend of mortality rates for the different conditions shows that mortality from malaria, sepsis, respiratory infections and cardiac disease all rose in the year 2020. The percentage increase in cardiac deaths from 2019 to 2020 was 82.4% which was the highest. Mortality from malnutrition and diarrhoeal disease reduced during the year 2020 compared to 2019. Mortality rates from respiratory infections, sepsis and sickle cell disease increased steadily from the 2019, 2020 to 2021. Mortality rate from malaria, cardiac disease and vaccine preventable disease rose sharply in 2020 but reduced in 2021. These figures are shown in Table 3.

Table 3: Top causes of mortality per year (2019-2021)

	Mortality rate (% of total mortalities per year)			Total mortality in 3 years
Diagnoses	**2019**	**2020**	**2021**	
Malaria (complicated & uncomplicated)	23.2	27.3	21.1	24.1
Acute respiratory infections (Pneumonia, pharyngotonsillitis, bronchiolitis etc)	9.0	9.9	12.3	10.2
Acute gastroenteritis	5.1	3.1	3.5	4.0
Sepsis	14.1	15.5	19.3	15.9
Sickle cell disease	1.1	1.9	2.6	1.8
Febrile convulsions	4.0	5.0	1.8	3.8
Severe acute malnutrition	15.8	8.7	11.4	12.2
Genitourinary tract disorders including urinary tract infection	5.6	1.2	7.0	4.4
Vaccine preventable diseases (Tuberculosis, measles, tetanus, Diphtheria, pertussis)	8.5	10.6	5.3	8.4
Cardiac diseases (congenital and acquired)	6.8	12.4	7.9	9.1
Neurological disease	0.6	0.6	0.9	0.7
Others#	6.2	3.7	7.0	5.5
Total	**12.6**	**14.4**	**9.4**	**12.1**
$(X^2 = 14.7, p = 0.001$				

#: Malignancies, accidental ingestions, bone and joint infections, COVID, etc

COVID cases seen during the pandemic years 2020 - 2021

Three cases of COVID were confirmed during the period. There were 2 males and 1 female. One male was aged four years and the other two cases were aged 12 years. Two cases were seen in June and September 2020 while one was seen in February 2021. The 2 adolescents survived while the younger child died after a day on admission.

Discussion

The study looked at the pattern and outcome of emergency unit admissions a year before the pandemic and compared these to the year when the pandemic was active from 2020 to 2021.

The number of cases admitted in the pandemic year of 2020 was lower than the pre-pandemic year. This was similar to other Nigerian studies. Shehu[10] from Jos, North-central Nigeria reported a 22.8% drop in the rate of admissions compared to the pre COVID period while Ndu[11] from Enugu,

South-eastern Nigeria reported a 40.6% reduction. A lesser figure was reported by Yahere[12] from Port Harcourt of 6.6%. Similar findings were reported in other studies outside the country as Bharat[13] in India, Kostoupoulou[14] from Greece and Anand[15] all observed reduction in all cases in the pandemic year. Reasons for this drop were obvious ranging from the imposed lockdown which was necessary to reduce the transmission of the infection.[4, 16] There was also a lot of fear of visiting health care facilities due to the rapid transmission and mortality associated with the disease.[13] The number of admissions were at their lowest in April to July which also corresponded to about week 10 to 30 of the pandemic. Miron had similar pattern with week 10 having the lowest number and week 32 having the highest number of admissions in the year 2020.[17] The spike in admissions corresponded to the month of August which was when restrictions to movement was much less.

More males were admitted during the pandemic years as shown in this study. Increased proportion of males admitted during that pandemic year was also observed by Bharat.[13] Possible reasons could be due to higher vulnerability of male children to infection due to genetically imposed single X chromosome which serves as protection for females who have double X that encodes for immunological activity.[18] However, Gills[16] data showed proportionately more females were admitted during the 1st pandemic year compared to the pre-pandemic period, but only some months within 2020 were studied by them and not the whole year.

It was also observed in this study that higher proportion of infants were admitted during both pandemic years. Etoori[19] observed in their study that infants with chronic health problems were more likely to be admitted during the pandemic period however the specific diagnosis for infants were not assessed in this study. The proportion of those aged 1 to 5 years who were admitted also reduced in the 1st and 2nd year of the pandemic as opposed to infants whose proportion increased progressively while those above 6-10 years had increased number admitted during the 1st year of the pandemic. Sodani[20] had similar findings in New Delhi. The increase in infants' admission was attributed to lack of access to postnatal visits and immunizations leading to increased incidence of infections while those above 5 years had injuries and accidental poisoning as the cause of the increased rate of their admissions. This may also be due to increased transmission of infections due to unusual overcrowding at home due to the lockdown whereas their age range actually should be in school at that particular time. Ndu's[11] data from Enugu, Nigeria also showed an increased proportion of age 6 to 10 years in the pandemic vs pre-pandemic year.

The most frequent diagnosis cumulatively for the 3 years was malaria followed by acute respiratory infections then gastroenteritis and sepsis. This mirrors the pattern of admissions seen in the emergency unit in a previous study in the centre.[21] de Jorna[22] in France however found acute infectious disease to be more frequent during the pandemic period in his study.

The trend through the years showed that the frequency of all the diagnosis reduced from year 2019 till 2021 including malaria. The drop was more in the year 2020 followed by further fall or similar levels in 2021. Only acute respiratory infections, gastroenteritis and sepsis were all increased in the 2nd year of the pandemic 2021 compared to 2020, however, the highest increase was for respiratory infections which also exceeded the pre-pandemic levels in 2019. Anand[15] got similar findings which showed acute respiratory infections decreased during the 1st pandemic year and increased during the 2nd year, but was still lower than the pre-COVID-19 period unlike in this study where it was higher. The reduced rate of infectious diseases in the 2020 has been attributed to increase rate of hygienic measures imposed.[1, 15] However, the spike the following year for respiratory infections, sepsis and gastroenteritis could also reflect the decreased utilization of preventive measures.

There was an increase in the mortality rate during the pandemic year 2020 despite the lower number of admissions compared to 2019 and 2021. Possible reasons are not limited to disruptions to health care access, reduced vaccination rates, economic hardship and food insecurity.[23] Large-scale studies on burden of child mortality during and after the pandemic have shown that excess mortality not attributed to COVID infection occurred in the year 2020.[23, 24] However, Odd[25] in England reported reduction in mortality of children likewise Anand[25] in India did not report increase in mortality during the pandemic compared to pre-pandemic period.

The top cause of mortality through the 3 years was malaria. This is not unexpected given that malaria is the topmost cause of admissions and already has a high burden of deaths in this endemic region. However, in the 1st pandemic year, the mortality rate increased possibly due to delay in treatment and late presentation due to hardship imposed by generalised disruptions of financial activities. Some drugs were also not readily accessible. Orish[26] from Ghana had similar findings of reduction in malaria diagnoses in their study however, there was increase in mortality especially from cerebral malaria. The data showed mortality rate from cardiac causes had the highest rate of increase by more than 80% in 2020 and slightly dropped the following year. Recent reviews in the

United States have posited a puzzling finding of excessive cardiovascular mortality from COVID which made it the topmost associated cause of death in adults studied.[27, 28] Also, a review on cardiac changes in children with COVID reported that high-risk groups especially with pre-existing heart disease.[29] Most of the cardiac patients in this report who died had pre-existing cardiac diagnoses possibly supporting new onset complications in them. An acute cardiac decompensation caused by severe inflammatory state after the infection (multisystem inflammatory syndrome in children -MISC) could be responsible.[30, 31] However, not all admitted children were tested for COVID as done in other countries with resources.[32]

Mortality rates from respiratory infections and sepsis also increased steadily supporting increased burden of infectious diseases after the pandemic.[33] However, mortality from malnutrition and diarrhoea disease reduced in the 1st pandemic year but increased subsequently. Reasons for reduction in diarrhoea could be due to hygiene measures being constantly being communicated. Interaction of diarrhoea and malnutrition which may also reflect on the reduced burden of malnutrition. Also, possible fear of hospital visits with non-respiratory illness during COVID pandemic wave could account for this pattern. On the other hand, fear of COVID could have made those with respiratory infections to present more. Increased use of diagnostic point of care tests may be helpful to determine such patterns moving forward.

Only three cases of COVID were diagnosed though higher numbers of adults were confirmed and admitted in the same facility. Two of the three were adolescents and the younger child died. This supports findings that COVID infection burden was less in children compared to adults with excess mortality in younger ages.[34]

Conclusion

This study revealed a decline in admissions through the COVID pandemic with increased rates of mortality in the pandemic year. Infections especially respiratory increased in the 2nd year of the pandemic. Death from respiratory causes, cardiac diseases and sepsis increased during and after the pandemic.

Recommendation

More focused studies on pattern of diseases presenting to the emergency paediatric unit and documentation of trends to ascertain true causes of morbidity and mortality per time period to help prepare for management during outbreaks and pandemics likewise any form of disaster.

Limitations

Being a retrospective study, some data may be missing or not correctly recorded.

Disclaimer (Artificial intelligence)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

I. **Author's contributions**

KOI conceptualized the study and wrote the first draft. AA contributed to the concept, manuscript writing and review. Both authors conducted the literature searches, data collection, read and approved the final draft.

II. We declare no potential conflicts of interest in this research work.

III. No external source of funding was used for this project except authors personal funds

IV. **Ethical approval:** This was sought and approved by the ethics and research committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto

V. **Acknowledgements:**

We acknowledge Miss Habibat Abdulrasheed, who assisted at the data collection stage.

REFERENCES

1. Haileamlak A. The impact of COVID-19 on health and health systems. Ethiopian journal of health sciences. 2021;31(6):1073-4.10.4314/ejhs.v31i6.1

2. The Lancet Respiratory M. Patterns of respiratory infections after COVID-19. The Lancet Respiratory Medicine. 2024;12(1):1.10.1016/S2213-2600(23)00472-1

3. Cucinotta D, Vanelli M. WHO Declares COVID-19 a Pandemic. Acta bio-medica : Atenei Parmensis. 2020;91(1):157-60.10.23750/abm.v91i1.9397

4. Onyeaka H, Anumudu CK, Al-Sharify ZT, Egele-Godswill E, Mbaegbu P. COVID-19 pandemic: A review of the global lockdown and its far-reaching effects. Science progress. 2021;104(2):368504211019854.10.1177/00368504211019854

5. Wikipedia contributors. (2024, March 5). COVID-19 pandemic in Nigeria. In Wikipedia, The Free Encyclopedia. Retrieved 21:52, May 22, 2024, from https://en.wikipedia.org/w/index.php?title=COVID-19_pandemic_in_Nigeria&oldid=1212040431.

6. Amusan L, Agunyai SC. The COVID-19 pandemic and the crisis of lockdowns in Nigeria: The household food security perspective. 2021. 2021;9(1).10.4102/apsdpr.v9i1.484

7. Magklara K, Kyriakopoulos M. The impact of the COVID-19 pandemic on children and young people. Psychiatrike = Psychiatriki. 2023;34(4):265-8.10.22365/jpsych.2023.024

8. Du W, Yu J, Wang H, Zhang X, Zhang S, Li Q, et al. Clinical characteristics of COVID-19 in children compared with adults in Shandong Province, China. Infection. 2020;48(3):445-52.10.1007/s15010-020-01427-2

9. National Population Commission. 2006 National Census: Federal Republic of Nigeria Official Gazette, 2007; 94(24):196.

10. Shehu M, Ihekaike M, O. Jimoh A, Shehu H, Mava Y, E. Eseigbe E, M. Yakubu A. Impact of COVID-19 on Admission into the Department of Paediatric Bingham University Teaching Hospital (BHUTH) Jos. J. Adv. Med. Med. Res. [Internet]. 2022 Apr. 11 [cited 2024 Jun. 20];34(7):85-91. Available from: https://www.journaljammr.com/index.php/JAMMR/article/view/4437.

11. Ndu I, Asinobi I, Nduagubam O. Admission Patterns in the Children's Emergency Room of Enugu State University Teaching Hospital, during the COVID-19 Pandemic. Journal of Advances in Medicine and Medical Research. 2021;33:86-92.10.9734/JAMMR/2021/v33i1931082

12. Yarhere I, Oragui O. Reduced Admissions in the Children's Emergency Room during Coronavirus-19 Pandemic in the University of Port Harcourt Teaching Hospital, Nigeria. Nigerian Journal of Medicine 2022;31(4):378-82

13. Choudhary B, Sharma D, Gupta MK, Singh K, Choudhary Y. Pattern of pediatric emergency visits during lockdown -Impact of COVID-19 pandemic in Jodhpur City, India. Journal of family medicine and primary care. 2022;11(6):2377-80.10.4103/jfmpc.jfmpc_135_21

14. Kostopoulou E, Gkentzi D, Papasotiriou M, Fouzas S, Tagalaki A, Varvarigou A, et al. The impact of COVID-19 on paediatric emergency department visits. A one-year retrospective study. Pediatric research. 2022;91(5):1257-62.10.1038/s41390-021-01815-w

15. Anand V, Vinitha AO, Joseph S, Sankar VH, Yadev IP.Comparing the Clinical Spectrum of Paediatric In-patients in pre-COVID-19, during COVID-19 and post-COVID-19 Pandemic Periods in a Tertiary Level Teaching CentreJ Clin of Diagn Res.2024; 18(1):SC12-SC16.

16. Gill PJ, Mahant S, Hall M, Berry JG. Reasons for Admissions to US Children's Hospitals During the COVID-19 Pandemic. JAMA. 2021;325(16):1676-9.10.1001/jama.2021.4382 %J JAMA

17. Miron VD, Gunșahin D, Filimon C, Bar G, Craiu M. Pediatric Emergencies and Hospital Admissions in the First Six Months of the COVID-19 Pandemic in a Tertiary Children's Hospital in Romania. 2022;9(4):513

18. Cheng MI, Li JH, Riggan L, Chen B, Tafti RY, Chin S, et al. The X-linked epigenetic regulator UTX controls NK cell-intrinsic sex differences. Nature Immunology. 2023;24(5):780-91.10.1038/s41590-023-01463-8

19. Etoori, David; Harron, Katie; Louise Mc Grath_Lone; Blackburn, Ruth; Gilbert, Ruth. 1400 Trends in hospital admissions for clinically vulnerable infants in England during the COVID-19 lockdown. Archives of Disease in Childhood; London Vol. 106, Iss. Suppl 1, (Oct 2021): A355-A355. .

20. Sodani R, Gupta S, Sharma AG. Influence of lockdown during the COVID-19 pandemic on use of pediatric emergency health services: A retrospective observational study from a Tertiary Care Hospital in New Delhi. Indian journal of public health. 2023;67(2):309-12.10.4103/ijph.ijph_1007_22

21. Isezuo KO, Onankpa BO, Adamu A, Jiya FB, Amodu-Sanni M, et al. (2020) Socio-Demographic Factors Associated with Late Presentation and Outcome of Febrile Children Admitted in a Tertiary Facility in North-Western Nigeria: A Comparative Study. Int J Pediatr Res 6:063.

22. de Jorna C, Liber M, Khalifi SE, Neggia G, Martinot A, Dubos F. Changes in pediatric emergency department visits during a COVID-19 lockdown period: An exhaustive single-center analysis. Archives de Pédiatrie. 2022;29(8):604-9.https://doi.org/10.1016/j.arcped.2022.08.003

23. Wagner Z, Heft-Neal S, Wang Z, Jing R, Bendavid E. Infant and Neonatal Mortality During the Covid-19 Pandemic: An Interrupted Time Series Analysis From Five Low- and Middle-Income Countries. medRxiv [Preprint]. 2023 Aug 8:2023.08.03.23293619. doi: 10.1101/2023.08.03.23293619. PMID: 37609306; PMCID: PMC10441505.

24. Alabi, Q.K., Oyedeji, A.S., Kayode, O.O. et al. Impact of COVID-19 pandemic on mother and child health in Sub-Saharan Africa – a review. Pediatr Res 94, 1278–1283 (2023). https://doi.org/10.1038/s41390-023-02651-w.

25. Odd D, Stoianova S, Williams T, Sleap V, Blair P, Fleming P, et al. Child mortality in England during the COVID-19 pandemic. Archives of Disease in Childhood. 2021;107:archdischild-2020.10.1136/archdischild-2020-320899

26. Orish VN, Akake K, Lokpo SY, Kwadzokpui PK, Amegan-Aho KH, Mac-Ankrah L, Boakye-Yiadom E, Ibrahim J, Kwofie TB. Evaluating the impact of COVID-19 pandemic on complicated malaria admissions and outcomes in the paediatric Ho Teaching Hospital of the Volta Region of Ghana. PLOS Glob Public Health. 2022 Sep 15;2(9):e0000509. doi: 10.1371/journal.pgph.0000509. PMID: 36962505; PMCID: PMC10021415.

27. Han L, Zhao S, Li S, Gu S, Deng X, Yang L, et al. Excess cardiovascular mortality across multiple COVID-19 waves in the United States from March 2020 to March 2022. Nature Cardiovascular Research. 2023;2(3):322-33.10.1038/s44161-023-00220-2

28. Gale J. A Spike in Heart Disease Deaths Since Covid Is Puzzling Scientists. https://www.bloomberg.com/news/articles/2024-02-26/covid-made-heart-disease-deadlier-puzzling-scientists (Accessed 25/5/24).

29. Vasichkina E, Alekseeva D, Karev V, Podyacheva E, Kudryavtsev I, Glushkova A, et al. Cardiac Involvement in Children Affected by COVID-19: Clinical Features and Diagnosis. Diagnostics (Basel, Switzerland). 2022;13(1).10.3390/diagnostics13010120

30. Belhadjer Z, Méot M, Bajolle F, Khraiche D, Legendre A, Abakka S, et al. Acute Heart Failure in Multisystem Inflammatory Syndrome in Children in the Context of Global SARS-CoV-2 Pandemic. 2020;142(5):429-36.doi:10.1161/CIRCULATIONAHA.120.048360

31. Ehwerhemuepha L, Roth B, Patel AK, Heutlinger O, Heffernan C, Arrieta AC, et al. Association of Congenital and Acquired Cardiovascular Conditions With COVID-19 Severity Among Pediatric Patients in the US. JAMA Network Open. 2022;5(5):e2211967-e.10.1001/jamanetworkopen.2022.11967 %J JAMA Network Open

32. Mekaoui N, Razine R, Bassat Q, Benjelloun B, Karboubi L. The Effect of COVID-19 on Paediatric Emergencies and Admissions in Morocco: Cannot See the Forest for the Trees? Journal of tropical pediatrics. 2020;67.10.1093/tropej/fmaa046

33. Remien KA, Amarin JZ, Horvat CM, et al. Admissions for Bronchiolitis at Children's Hospitals Before and During the COVID-19 Pandemic. JAMA Netw Open. 2023;6(10):e2339884. doi:10.1001/jamanetworkopen.2023.39884.

34. Ze B, Chen B, Ji X, Zhou W. Risk factors for death among children and young people hospitalized with COVID-19: a literature review. Pediatric Medicine 2022;7:9.