Health and nutritional status of children hospitalized during the COVID-19 pandemic, Bangladesh

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Objective To compare the health and nutrition of children younger than 5 years admitted to hospital during and before the coronavirus disease 2019 (COVID-19) pandemic in Bangladesh.

Methods We collected data from hospital records of children 0–59 months admitted to the Dhaka Hospital of the International Centre for Diarrhoeal Disease Research, Bangladesh in March 2020–February 2021 (COVID-19 period; n = 2552) and March 2019–February 2020 (pre-COVID-19 period; n = 6738). Data collected included sociodemographic, anthropometric, clinical and biochemical characteristics. We compared these data for child admissions in the COVID-19 and pre-COVID-19 periods, including infants 0–11 months born during and before the pandemic and admitted to hospital.

Findings Admissions of children as a percentage of total admissions were lower in March 2020 (2.47%; 63/2552) than March 2019 (8.30%; 559/6738), but increased to 20.61% (526/2552) in February 2021, three times greater than in the pre-COVID-19 period (6.69%; 451/6738). Children admitted during the COVID-19 period were significantly more likely to have dehydration, severe sepsis or septic shock, convulsions, hypernatraemia and raised creatinine than children admitted before the pandemic (P < 0.05). In infants <6 months and those born during the pandemic, stunting and wasting were significantly higher than in infants in the pre-COVID-19 period (P < 0.05). The risk of death was higher in infants <6 months during the pandemic (odds ratio: 1.66; 95% confidence interval: 0.95–2.92).

Conclusion During the pandemic, children presented with more severe illness and poorer nutrition. Efforts are needed to reduce the adverse effects of the pandemic on the health and well-being of children.

Abstracts in العربية, 中文, Français, Русский and Español at the end of each article.

Introduction

The growing global incidence of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has led the World Health Organization (WHO) to acknowledge COVID-19 as a public health emergency.¹ The unprecedented global, social and economic crisis created by the pandemic has brought unpredictable threats to the nutritional status and survival of young children in low- and middle-income countries.² Childhood malnutrition, including wasting, is expected to increase as a result of sudden decreases in household incomes, food insecurity and disruption of the health-care system.³ Before the start of the COVID-19 pandemic, 47 million children younger than 5 years in the world were wasted.³ Estimates suggest that during the first year of the pandemic, a further 6.7 million children will have suffered from wasting and an additional 10,000 children will have died.² The COVID-19 pandemic is predicted to result in a reduction in health service coverage of essential pregnancy and newborn care in 132 low- and middle-income countries.³

Recent research has shown that COVID-19 will continue to disrupt health and economic indicators worldwide, including progress in maternal and child nutrition. Based on the MIRAGRODEP model, a multicountry, multisector world economy equilibrium model, the COVID-19 pandemic will result in a 20% increase in global poverty.⁶ To determine how much the COVID-19 pandemic will affect the health and development of children requires an evidence-based approach.⁷ Currently, we lack evidence on the influence of COVID-19 on morbidity and nutrition in children younger than 5 years, including infants younger than 6 months and children born during the pandemic. These infants not only have the greatest growth velocity and a unique physiology,⁸ but are also vulnerable to a lack of adequate nutrition.⁹ In our hospital we observed that infants admitted to the hospital during the COVID-19 pandemic were sicker than infants admitted before the pandemic.

In this study, we aimed to assess changes in the health and nutritional status of children younger than 5 years and infants younger than 6 months admitted to hospital during the COVID-19 pandemic compared with the health and nutritional status of children of the same age admitted in the pre-COVID-19 period. In addition, we aimed to assess the severity of illness of children who were born and admitted to hospital during the COVID-19 pandemic.

Methods

Study site

The Dhaka Hospital of the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) is the world’s largest diarrhoeal disease treatment facility¹⁰ and provides free treatment to about 200,000 patients annually. This hospital has advanced laboratory facilities capable of performing all types of routinely prescribed diagnostic tests. All units of the hospital were in operation during the COVID-19 pandemic. On admission to the hospital, children are assessed by triage nurses.
for dehydration and co-morbidities. Children without dehydration or co-
morbidities are moved to the outpatient
department, and those with dehydration
but without co-morbidities are shifted to
the short-stay unit. Children with
dehydration and co-morbidities, includ-
ing electrolyte imbalance, enteric fever
or severe malnutrition, are transferred to
inpatient wards, which include the
longer stay unit and the intensive care
unit. The intensive care unit is equipped
with invasive and non-invasive ventila-
tion and other facilities for management
of critically ill patients.

Study design and data collection

This study was a cross-sectional study of
the patient records of children admitted
to the hospital from March 2019–February
2021. We collected data on sociode-
graphic characteristics (age, sex, type
delivery, immunization status and breast-
feeding), anthropometric indices (stunting,
wasting, and severe acute mal-
nutrition), clinical characteristics (acute
diarrhoea, dehydration, fever, convul-
sions, pneumonia, severe pneumonia,
sepsis, severe sepsis or septic shock,
hospital-acquired infection and death)
and biochemical measures (hyperna-
traemia, hyponatraemia, hyperkalaemia,
hypokalaemia and raised creatinine)
of the children.

We assessed nutritional status based
on z-scores, calculated according to
the WHO 2006 growth standards.11 We
defined severe acute malnutrition in
children of 0–59 months as weight-for-
length or -height z-score < −2 standard
deviations (SD) or by the presence of
bilateral pedal oedema, irrespective of
anthropometric indicators. We defined
underweight as weight-for-age z-score
< −2 SD, and stunting as length- or
height-for-age z-score < −2 SD.

We categorized the children into
two time periods: children admitted in
the pre-COVID-19 period (March
2019–February 2020) and children ad-
mitted in the COVID-19 period (March
2020–February 2021). We compared the
characteristics of the children in the
two periods. Fig. 1 shows the numbers
of children in the COVID-19 and pre-
COVID-19 periods by age

Statistical analysis

We report categorical variables as num-
bers and percentages and normally dis-
tributed quantitative variables as mean
and SD. We used the χ² test to com-
pare categorical variables between the
groups. We considered the COVID-19
period as the independent variable and the dependent variables as:
anthropometric indices, acute watery
and/or invasive diarrhoea, dehydration,
fever, convulsions, pneumonia, severe
pneumonia, sepsis, severe sepsis or sept-
tic shock, hospital-acquired infection,
death and abnormal electrolyte status.

We used logistic regression analysis
to assess the strength of associations
between the COVID-19 pandemic and
anthropometric indices, morbidities and
mortality after adjusting for potential
confounders (age and sex), reported as
odds ratios (ORs) and 95% confidence
intervals (CIs). We considered P < 0.05
statistically significant.

We used Stata version 13.0 IC
(StataCorp, College Station, United
States of America) for all analyses.

Ethical considerations

We retrieved data from the electronic
database of patient records of the hos-

titational review board of the
International Centre for Diarrhoeal
Disease Research, Bangladesh approved
the study. We de-identified data for
analysis and publication.

Results

In total, 6738 and 2552 children younger
than 5 years were admitted to inpatient
wards during the pre-COVID-19 and
COVID-19 periods, respectively. From
March to August 2020, the hospital
admission rate was significantly lower
compared with the same time of the year
in 2019. This decrease was due to the
movement restrictions imposed during
this period. From September 2020, with
the removal of movement restrictions,
hospital admissions gradually increased
and in March 2021, admissions were
three times higher than admissions in
March 2019. Fig. 2 shows the monthly
hospital admissions in the pre-COVID-
19 and COVID-19 periods. As data
were collected from hospital records,
information was missing for some vari-
ables. We calculated percentage value on
the basis of available records.

Children

Characteristics of the children younger
than 5 years admitted to hospital during
and before the COVID-19 pandemic are
compared in Table 1. Children ad-
mitted to the hospital in the pandemic
period were significantly younger than
those admitted in the pre-pandemic
period (11.11 months; SD: 8.54 versus
11.59 months; SD: 9.65; P = 0.02). Sig-
ificantly more children admitted in the
COVID-19 period had been delivered
by caesarean section than children born
before the pandemic (48.87%; 887/1815
versus 45.74%; 1875/4099; P = 0.026).

In age- and sex-adjusted logistic
regression analysis, the odds of dehydra-
tion (OR: 1.25; 95% CI: 1.15–1.38), con-
vulsions (OR: 1.74; 95% CI: 1.41–2.16),
sepsis (OR: 2.25; 95% CI: 1.88–2.69),
severe sepsis or septic shock (OR: 1.76;
95% CI: 1.28–2.41), hypernatraemia
(OR: 1.47; 95% CI: 1.19–1.82) and
raised creatinine level (OR: 1.25; 95%
CI: 1.00–1.57) were significantly higher
in children in the COVID-19 period
than children in the pre-COVID-19 period
(Table 2). The odds of severe
acute malnutrition (OR: 0.87; 95% CI:
0.78–0.97), pneumonia (OR: 0.87; 95% CI: 0.77–0.99) and severe pneumonia (OR: 0.79; 95% CI: 0.67–0.93) were significantly lower in the COVID-19 period than the pre-COVID-19 period. The odds of hospital-acquired infection and death were comparable in both periods.

Infants

During the COVID-19 period, 700 infants younger than 6 months were admitted to hospital, which was lower than the 1937 infants admitted in the pre-COVID-19 period (Table 1). Infants in the COVID-19 period were significantly younger than those admitted in the pre-COVID-19 period (3.44 months; SD: 1.48 versus 3.63 months; SD: 1.49; \( P = 0.004 \)). The proportion of infants delivered by caesarean section was comparable between the two periods, 50.36% (279/554) for the COVID-19 period and 49.02% (600/1224) for the pre-COVID-19 period. Breastfeeding and immunization in these young infants were comparable in the pre-COVID-19 period and COVID-19 period.

In age- and sex-adjusted logistic regression analysis, the incidence of wasting (OR: 1.38; 95% CI: 1.11–1.71) and stunting (OR: 1.28; 95% CI: 1.05–1.56) in infants <6 months was higher in the COVID-19 period than the pre-COVID-19 period (Table 2). Infants <6 months admitted to hospital in the COVID-19 period had significantly higher odds of dehydration (OR: 1.54; 95% CI: 1.28–1.84), convulsions (OR: 1.89; 95% CI: 1.29–2.76), sepsis (OR: 2.79; 95% CI: 2.11–3.68), severe sepsis or septic shock (OR: 1.85; 95% CI: 1.15–2.98) and raised creatinine (OR: 1.56; 95% CI: 1.07–2.29) than infants admitted in the pre-COVID-19 period (Table 2). The odds of death were also higher in infants in the COVID-19 period than in the pre-COVID-19 period; although the difference was not statistically significant (OR: 1.66; 95% CI: 0.95–2.92; Table 2).

Infants aged 0–11 months

Of the children under 5 years admitted to hospital, 1195 were born in the COVID-19 period and were aged 0 to 11 months. We compared these infants with 4467 infants of the same age group (0–11 months) admitted in the pre-COVID-19 period (Table 3). Infants 0–11 months admitted during the COVID-19 period were significantly younger at admittance than infants of the same age admitted in the pre-COVID-19 period (5.59 months; SD: 2.80 versus 6.48 months; SD: 2.95; \( P < 0.001 \)). Significantly greater proportions of infants 0–11 months admitted in the COVID-19 period than those admitted in the pre-COVID-19 period were stunted and wasted, dehydrated, had convulsions, had sepsis and severe sepsis, and had hypernatraemia and raised creatinine (\( P < 0.05 \)) (Table 3). In logistic regression analysis, with adjustment for age and sex, infants born during the COVID-19 period compared with those born in the pre-COVID-19 period had higher odds of: dehydration (OR: 1.43; 95% CI: 1.26–1.64), convulsions (OR: 1.74; 95% CI: 1.30–2.34), sepsis

Discussion

Our study findings show that COVID-19 is already affecting the health of children, especially young infants, with a significantly higher percentage of critically ill children being treated at our facility in the COVID-19 period compared with during the pre-COVID-19 period. Moreover, compared to the pre-COVID-19 period, these infants had a higher proportion of deaths, although the difference was not statistically significant.

We found a marked reduction in admission of children between April 2020 and August 2020. After the detection of the first COVID-19 case in Bangladesh, the country imposed a complete stay-at-home order for 2 weeks from 26 March 2020. The stay-at-home order was extended to 30 May 2020, and was then followed by restrictions on movement and limited business hours. Restrictions on movement were officially lifted on 1 September 2020. As a result, admission of children to hospital gradually increased from September 2020 onwards in the COVID-19 period. Admissions of infants in February 2021 were three times higher than in the corresponding pre-COVID-19 period of 2019. An inpatient survey in an Australian paediatric hospital suggested that more than one third of parents delayed medical care visits for their children from fear of COVID-19. Other studies from different parts of the world have also reported such delays.

The COVID-19 pandemic is likely to have affected health-care systems in many ways. The government of Bangladesh is concerned about reduced coverage and quality of maternal and child health services, but little evidence is
available on health service provision, use or adaptation during COVID-19. The most important factors identified for the disruption of the health system are disturbances to the livelihood of people from the stay-at-home order and related restriction measures, and the lack of protection measures for health-care workers. A recent study documented a decline in visits to health facilities for regular antenatal care during April and May 2020 in Bangladesh compared with the same months in 2019. Likewise, visits to family planning clinics and child immunization centres also declined. Our findings on children born during the COVID-19 period also showed lower proportions of immunization in

| Characteristic | Children < 5 years | Infants < 6 months |
|---------------|-------------------|-------------------|
|               | COVID-19 period   | Pre-COVID-19      | COVID-19 period | Pre-COVID-19 period |
|               | (n = 2552)        | period (n = 6738) | (n = 700)       | (n = 1937)         |
| Age in months, mean (SD) | 11.11 (8.54) | 11.59 (9.65) | 3.44 (1.48) | 3.63 (1.49) | 0.004 |
| Sex, female | 957 (37.50) | 2514 (37.31) | 288 (41.14) | 741 (38.26) | 0.179 |
| Delivery by caesarean section | 887/1815 (48.87) | 1875/4099 (45.74) | 279/554 (50.36) | 600/1224 (49.02) | 0.600 |
| Immunization as per EPI schedule | 1712/1903 (89.96) | 4079/4591 (88.85) | 456/577 (79.03) | 1074/1352 (79.44) | 0.839 |
| Exclusively or partially breastfed | 1424/2075 (68.63) | 3418/5181 (65.97) | 372/632 (58.86) | 861/1561 (55.16) | 0.113 |
| Stunting | 1051/2186 (48.08) | 2533/5149 (49.58) | 386/597 (64.66) | 883/1512 (58.40) | < 0.001 |
| Wasting | 863/1933 (44.65) | 1977/4383 (45.11) | 237/486 (48.77) | 482/1173 (41.09) | 0.004 |
| Severe acute malnutrition | 694/2171 (31.97) | 1813/5177 (35.02) | 233/589 (39.56) | 623/1533 (40.64) | 0.650 |
| Acute diarrhoea (watery and/or invasive) | 2477/2552 (96.97) | 6540/6738 (97.06) | 674/700 (96.29) | 1869/1937 (96.49) | 0.803 |
| Some or severe dehydration | 1489/2552 (58.15) | 3499/6657 (52.56) | 466/697 (66.86) | 1073/1901 (56.44) | < 0.001 |
| History of fever | 609/2552 (23.86) | 1595/6738 (23.67) | 141/700 (20.14) | 388/1937 (20.03) | 0.949 |
| Convulsions (during and/or after admission) | 146/2552 (5.72) | 229/6738 (3.4) | 47/700 (6.71) | 72/1937 (3.72) | 0.001 |
| Pneumonia | 376/2552 (14.73) | 1102/6738 (16.36) | 151/700 (21.57) | 409/1937 (21.12) | 0.800 |
| Severe pneumonia | 217/2552 (8.50) | 700/6738 (10.39) | 91/700 (13.00) | 292/1937 (15.07) | 0.182 |
| Sepsis | 233/2552 (9.13) | 287/6738 (4.26) | 112/700 (16.00) | 19/1937 (6.14) | < 0.001 |
| Severe sepsis or septic shock | 65/2552 (2.55) | 98/6738 (1.45) | 30/700 (4.29) | 44/1937 (2.27) | 0.006 |
| Hospital-acquired infection | 41/2552 (1.61) | 125/6738 (1.86) | 21/700 (3.00) | 45/1937 (2.32) | 0.326 |
| Death | 31/2552 (1.21) | 83/6738 (1.23) | 20/700 (2.86) | 33/1937 (1.70) | 0.062 |
| Hypernatraemia | 213/1053 (20.23) | 223/1520 (14.67) | 52/234 (22.22) | 72/389 (18.51) | 0.261 |
| Hyponatraemia | 340/1053 (32.99) | 682/1520 (44.87) | 87/234 (37.18) | 165/389 (42.42) | 0.197 |
| Hyperkalaemia | 89/1053 (8.45) | 139/1520 (9.14) | 50/234 (21.37) | 75/389 (19.28) | 0.529 |
| Hypokalaemia | 249/1053 (23.65) | 407/1520 (26.78) | 62/234 (26.50) | 94/389 (24.16) | 0.515 |
| Raised creatinine | 200/577 (34.66) | 318/1091 (29.15) | 98/169 (57.99) | 144/307 (46.91) | 0.021 |

COVID-19: coronavirus disease 2019; SD: standard deviation; EPI: Expanded Programme on Immunization.

Notes: The COVID-19 period was March 2020–February 2021 and the pre-COVID-19 period was March 2019–February 2020. As data were collected from hospital records, information was missing for some variables. We calculated percentage value on the basis of available records.
the COVID-19 period (85.16%; 786/923 versus 87.05%; 2689/3089), although the difference was not statistically significant.

Due to the effect of movement restrictions in Bangladesh, routine immunizations have been severely disrupted, with parents being reluctant to take their children to health-care facilities for routine care. Despite the continuation of routine immunization in the country, many catch-up drives and vaccine campaigns were suspended and the transport of vaccines to different parts of the country is still challenging. To combat vaccine-preventable diseases, the Directorate-General of Health Services in Bangladesh issued guidelines to continue routine immunization during the COVID-19 pandemic, in line with global and regional advisories from the United Nations Children’s Fund and WHO.  

A study on contextual factors influencing maternal, neonatal and child health care in Bangladesh, Nigeria and South Africa also reported that during the initial period of the pandemic, the use of health facilities for normal deliveries in Bangladesh decreased, which was attributable to more home births. However, we observed a higher proportion of children delivered by caesarean section during the pandemic period than those born during the pre-COVID-19 period, although the difference was not statistically significant. Our analysis also showed that during COVID-19, breastfeeding improved in children younger than 5 years compared with the pre-COVID-19 period. We had no data on the duration of exclusive breastfeeding, but the use of breast-milk substitutes in Bangladesh reportedly increased during COVID-19.  

Health services for children younger than 5 years have declined significantly in Bangladesh due to the COVID-19 pandemic. The use of health services for children of this age group in March 2020 fell by 25% compared with service use in March 2019. Research on the indirect effect of COVID-19 in 118 low- and middle-income countries, based on the worst of three scenarios, suggested that even a minor disruption to health-care services could increase childhood wasting by 10%. Our study supports these findings. Among the young infants, wasting and stunting was significantly higher in the pandemic period and a greater proportion of children born during the pandemic were wasted compared with children in the same age group born in the pre-COVID-19 period.

National nutrition strategies had been implemented in Bangladesh to reduce the rates of maternal and child undernutrition, but problems with coordination resulted in poor delivery of nutrition services. The uptake of maternal and newborn health services decreased by about 19% during the pandemic. Various initiatives have been adopted by the public and private sectors to deal with the adverse effects of the COVID-19 pandemic on the healthcare system. Development partners including local nongovernmental organizations supported the National Nutrition Services of Bangladesh to develop the national guidelines on continuing essential nutrition services during the COVID-19 pandemic.

It was anticipated that disruption to essential services may result in a 37% increase in child mortality in Bangladesh by 2021. In our analysis, although admissions of children to hospital fell in the pandemic period, a significantly higher percentage of the children admitted were critically ill with dehydration, sepsis, convulsions and electrolyte imbalances. During the pandemic there was a higher mortality than during the pre-pandemic period, although the difference was not statistically significant. This reduction in hospital admissions has raised concerns about late presentation of critically ill children.  

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The table below shows the risk of illness, death and undernutrition in children admitted to hospital during COVID-19 by age category, Bangladesh, March 2020–February 2021. 

| Variable                        | Children < 5 years | Infants < 6 months |
|---------------------------------|--------------------|--------------------|
| Illness and death               |                    |                    |
| Acute diarrhoea (watery and/ or invasive) | 1.00 (0.76–1.32)  | 0.93 (0.59–1.48)  |
| Some or severe dehydration      | 1.25 (1.15–1.38)  | 1.54 (1.28–1.84)  |
| History of fever                | 1.02 (0.92–1.14)  | 1.03 (0.83–1.28)  |
| Convulsions (during and/or after admission) | 1.74 (1.41–2.16)  | 1.89 (1.29–2.76)  |
| Pneumonia                       | 0.87 (0.77–0.99)  | 1.04 (0.84–1.28)  |
| Severe pneumonia                | 0.79 (0.67–0.93)  | 0.84 (0.65–1.08)  |
| Sepsis                          | 2.25 (1.88–2.69)  | 2.79 (2.11–3.68)  |
| Severe sepsis or septic shock   | 1.76 (1.28–2.41)  | 1.85 (1.15–2.98)  |
| Hospital-acquired infection     | 0.86 (0.60–1.22)  | 1.27 (0.75–2.16)  |
| Death                           | 0.97 (0.64–1.48)  | 1.66 (0.95–2.92)  |
| Anthropometric indices          |                    |                    |
| Stunting                        | 0.94 (0.85–1.04)  | 1.28 (1.05–1.56)  |
| Wasting                         | 1.00 (0.90–1.11)  | 1.38 (1.11–1.71)  |
| Severe acute malnutrition       | 0.87 (0.78–0.97)  | 0.98 (0.80–1.90)  |
| Electrolyte imbalance           |                    |                    |
| Hypernatraemia                  | 1.47 (1.19–1.82)  | 1.26 (0.84–1.88)  |
| Hyponatraemia                   | 0.59 (0.50–0.70)  | 0.80 (0.57–1.12)  |
| Hyperkalaemia                   | 0.94 (0.71–1.24)  | 1.14 (0.76–1.71)  |
| Hypokalaemia                    | 0.85 (0.71–1.02)  | 1.13 (0.78–1.64)  |
| Raised creatinine               | 1.25 (1.00–1.57)  | 1.56 (1.07–2.29)  |

a aOR: adjusted odds ratio; CI: confidence interval; SD: standard deviation.

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1 COVID-19: coronavirus disease 2019.
2 aOR: adjusted odds ratio; CI: confidence interval; SD: standard deviation.
3 OR: adjusted for age and sex.
4 Length- or height-for-age z-score < –2 SD.
5 Weight-for-length or height z-score < –2 SD.
6 Weight-for-length or height z-score < –3 SD or by the presence of bilateral pedal oedema, irrespective of anthropometric indicators.
7 Serum sodium ≥ 150 mmol/L.
8 Serum sodium < 135 mmol/L.
9 Serum potassium > 5.5 mmol/L.
10 Serum potassium < 3.5 mmol/L.
11 Serum creatinine > 35 μmol/L for < 12 months and > 65 μmol/L for 12–59 months.
12 History of fever.
13 Convulsions (during and/or after admission).
14 Pneumonia.
15 Severe pneumonia.
16 Sepsis.
17 Severe sepsis or septic shock.
18 Hospital-acquired infection.
19 Death.
20 Severe pneumonia.
21 WHO. United Nations Children’s Fund and Essential Nutrition Services of Bangladesh to develop the national guidelines on continuing essential nutrition services.
22 COVID-19 pandemic.
23 Breastfeeding improved in children younger than 5 years compared with the pre-COVID-19 period.
24 The use of health services for children of this age group in March 2020 fell by 25% compared with service use in March 2019.
25 Research on the indirect effect of COVID-19 in 118 low- and middle-income countries, based on the worst of three scenarios, suggested that even a minor disruption to health-care services could increase childhood wasting by 10%. Our study supports these findings. Among the young infants, wasting and stunting was significantly higher in the pandemic period and a greater proportion of children born during the pandemic were wasted compared with children in the same age group born in the pre-COVID-19 period. National nutrition strategies had been implemented in Bangladesh to reduce the rates of maternal and child undernutrition, but problems with coordination resulted in poor delivery of nutrition services. The uptake of maternal and newborn health services decreased by about 19% during the pandemic. Various initiatives have been adopted by the public and private sectors to deal with the adverse effects of the COVID-19 pandemic on the healthcare system. Development partners including local nongovernmental organizations supported the National Nutrition Services of Bangladesh to develop the national guidelines on continuing essential nutrition services during the COVID-19 pandemic. It was anticipated that disruption to essential services may result in a 37% increase in child mortality in Bangladesh by 2021. In our analysis, although admissions of children to hospital fell in the pandemic period, a significantly higher percentage of the children admitted were critically ill with dehydration, sepsis, convulsions and electrolyte imbalances. During the pandemic there was a higher mortality than during the pre-pandemic period, although the difference was not statistically significant. This reduction in hospital admissions has raised concerns about late presentation of critically ill children. The table below shows the risk of illness, death and undernutrition in children admitted to hospital during COVID-19 by age category, Bangladesh, March 2020–February 2021.
higher incidence of severe illness among children in the COVID-19 period than in the previous year may be a result of delays by caregivers in bringing their children to hospital because of strict movement restrictions, the nationwide stay-at-home order and the fear of contracting COVID-19. In an electronic survey on 24 April 2020 of 752 British paediatricians working in emergency departments and paediatric assessment units, 241 (32.05%) reported that they had observed delayed presentations. Sepsis was the second most common condition found in the children who presented late to the hospital.\textsuperscript{25} While COVID-19 and paediatric inflammatory multisystem syndrome temporally associated with SARS-CoV-2 or multisystem inflammatory syndrome in children have attracted particular attention, we should not forget non-COVID-19 sepsis, the incidence of which is still higher in children than sepsis associated with COVID-19.\textsuperscript{26} Our findings concur with this observation as we did not encounter any COVID-related illness in children in our hospital. In 2005 in the United States, there were 75 255 paediatric hospitalizations involving severe sepsis indicating that sepsis was common before COVID-19.\textsuperscript{27}

With regard to electrolyte imbalances, we observed that hypernatraemia and raised serum creatinine levels were the most common imbalances in the COVID-19 period. Hypernatraemia in children with diarrhoea has several causes. In our study, hypernatraemia was probably a result of delayed presentation of the children, because caregivers tried at home to treat the child with oral rehydration salts before coming to the health facility; these preparations may have been incorrectly made up or given

| Characteristic | All (n = 5662) | COVID-19 period (n = 1195) | Pre-COVID-19 period (n = 4467) | P |
|---------------|----------------|----------------------------|-------------------------------|---|
| Age in months, mean (SD) | 6.29 (2.94) | 5.59 (2.80) | 6.48 (2.95) | <0.001 |
| Sex, female | 2103/5662 (37.14) | 457/1195 (38.24) | 1646/4467 (36.85) | 0.375 |
| Delivery by caesarean section | 1756/3669 (41.20) | 450/895 (50.28) | 1306/2774 (47.08) | 0.096 |
| Immunization as per EPI schedule | 3475/4012 (86.62) | 786/923 (85.16) | 2689/3089 (87.05) | 0.138 |
| Exclusive or partial breastfeeding on admission | 2920/4509 (64.76) | 674/1008 (66.87) | 2246/3501 (64.15) | 0.112 |
| Stunting\textsuperscript{a} | 2323/4518 (51.42) | 575/1044 (55.08) | 1748/3474 (50.32) | 0.007 |
| Wasting\textsuperscript{a} | 1522/3694 (41.20) | 400/891 (44.89) | 1122/2803 (40.03) | 0.010 |
| Severe acute malnutrition\textsuperscript{a} | 1642/4548 (36.10) | 366/1041 (35.16) | 1276/3507 (36.38) | 0.470 |
| Acute diarrhoea (watery and/or invasive) | 5460/5662 (96.43) | 1159/1195 (96.99) | 4301/4467 (96.28) | 0.244 |
| Some or severe dehydration | 3033/5600 (54.16) | 740/1191 (62.13) | 2293/4409 (52.01) | <0.001 |
| History of fever | 1254/5662 (22.15) | 267/1195 (22.34) | 987/4467 (22.10) | 0.855 |
| Convulsions (during and/or after admission) | 219/5662 (3.87) | 70/1195 (5.8) | 149/4467 (3.34) | <0.001 |
| Pneumonia | 1097/5662 (19.37) | 225/1195 (18.83) | 872/4467 (19.52) | 0.591 |
| Severe pneumonia | 683/5662 (12.06) | 126/1195 (10.54) | 557/4467 (12.47) | 0.070 |
| Sepsis | 348/5662 (6.15) | 134/1195 (11.21) | 214/4467 (4.79) | <0.001 |
| Severe sepsis or septic shock | 110/5662 (1.94) | 32/1195 (2.68) | 78/4467 (1.75) | 0.038 |
| Hospital-acquired infection | 129/5662 (2.28) | 22/1195 (1.84) | 107/4467 (2.40) | 0.254 |
| Death | 82/5662 (1.45) | 20/1195 (1.67) | 62/4467 (1.39) | 0.463 |
| Hypernatraemia\textsuperscript{a} | 294/1419 (20.72) | 110/447 (24.61) | 184/972 (18.93) | 0.014 |
| Hyponatraemia\textsuperscript{a} | 499/1419 (35.17) | 116/447 (25.95) | 383/972 (39.40) | <0.001 |
| Hyperkalaemia\textsuperscript{a} | 175/1419 (12.33) | 56/447 (12.53) | 119/972 (12.24) | 0.879 |
| Hypokalaemia\textsuperscript{a} | 349/1419 (24.59) | 102/447 (22.82) | 247/972 (25.41) | 0.292 |
| Raised creatinine\textsuperscript{a} | 405/977 (41.45) | 128/258 (49.61) | 277/719 (38.53) | 0.002 |

COVID-19: coronavirus disease 2019; SD: standard deviation; EPI: Expanded Programme on Immunization.
\textsuperscript{a} All values are no. (%) unless otherwise stated.
\textsuperscript{b} Length-for-age z-score < −2 SD
\textsuperscript{c} Weight-for-length z-score < −2 SD
\textsuperscript{d} Weight-for-length z-score < −3 SD or by the presence of bilateral pedal oedema, irrespective of anthropometric indicators.
\textsuperscript{e} Serum sodium ≥ 150 mmol/L.
\textsuperscript{f} Serum sodium < 135 mmol/L.
\textsuperscript{g} Serum potassium > 5.5 mmol/L.
\textsuperscript{h} Serum potassium < 3.5 mmol/L.
\textsuperscript{i} Serum creatinine > 35 μmol/L for < 12 months and > 65 μmol/L for 12–59 months.

Notes: The COVID-19 period was March 2020–February 2021 and the pre-COVID-19 period was March 2019–February 2020. As data were collected from hospital records, information was missing for some variables. We calculated percentage value on the basis of available records.
too often or in too large a volume. An-
other study reported that children with
hypernatraemia were more likely to have
convulsions than children without
hypernatraemia. This observation could
explain why more children in our study
had hypernatraemia in the COVID-19
period than the pre-COVID-19 period.
Hypernatraemia is common in people
with cholera because of the high loss of
sodium in the stool. This condition is
more common in invasive diarrhoea be-
cause of the syndrome of inappropriate
antidiuretic hormone secretion. Dur-
ing the COVID-19 period, the higher
prevalence of handwashing might be
associated with the lower incidence of
cholera and invasive diarrhoea com-
pared with the pre-COVID-19 period
and hence the lower incidence of hy-
ponatraemia.

Our study had some limitations. We
used objective criteria from a guideline
on surviving sepsis and identification of
sepsis, severe sepsis and septic shock; even
so, there might have been subjec-
tive bias in identifying children with
sepsis. We lacked data on maternal
stress, maternal COVID-19 status and
non-COVID infections and inflamma-
tion during and after pregnancy, as well
as data on potential socioeconomic
cries faced by the families during this
pandemic. Although our study took
place in the largest diarrhoeal disease
facility in the world, these data, to-
gether with nationwide data on disease
severity and deaths among such young
infants during the COVID-19 pandemic
would have enhanced the reliability of
our observations.

We believe that more effective
means of risk assessment, the develop-
ment of a multisectoral management
taskforce and appropriate governance
for the proper management of the
health sector to ensure basic support
for patients, particularly for vulnerable
groups, are needed to reduce the adverse
effects of the COVID-19 pandemic on
the health and well-being of children,
especially that of young infants.

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Table 4. Risk of illness, death and undernutrition in infants born during the COVID-19
pandemic admitted to hospital, Bangladesh, March 2020–February 2021

| Variable                              | aOR (95% CI) |
|---------------------------------------|-------------|
| **Illness and death**                 |             |
| Acute diarrhea (watery and/or invasive)| 1.24 (0.86–1.79) |
| Some or severe dehydration            | 1.43 (1.26–1.64) |
| History of fever                      | 1.06 (0.91–1.24) |
| Convulsions (during and/or after admission)| 1.74 (1.30–2.34) |
| Pneumonia                             | 0.92 (0.78–1.08) |
| Severe pneumonia                      | 0.77 (0.62–0.94) |
| Sepsis                                | 2.21 (1.76–2.78) |
| Severe sepsis or septic shock         | 1.37 (0.90–2.09) |
| Hospital-acquired infection           | 0.75 (0.47–1.19) |
| Death                                 | 1.12 (0.67–1.86) |
| **Anthropometric indices**            |             |
| Stunting                              | 1.10 (0.96–1.27) |
| Wasting                               | 1.21 (1.03–1.41) |
| Severe acute malnutrition             | 0.91 (0.79–1.05) |
| **Electrolyte imbalance**             |             |
| Hypernatraemia                        | 1.43 (1.09–1.88) |
| Hyponatremia                          | 0.50 (0.39–0.64) |
| Hyperkalaemia                         | 0.92 (0.65–1.30) |
| Hypokalaemia                          | 0.85 (0.65–1.11) |
| Raised creatinine                     | 1.38 (1.03–1.86) |

COVID-19: coronavirus disease 2019; aOR: adjusted odds ratio; CI: confidence interval; SD: standard deviation.

Note: Reference categories are infants born and admitted to hospital before the COVID-19 pandemic, March 2019–February 2020.

■

Research
Children hospitalized during the COVID-19 pandemic, Bangladesh
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ملخص

الفترة الصعبة والتغذوية للأطفال الحاضرين للعلاج بالمستشفى خلال جائحة كوفيد 19، بنغلاديش
تتضمن البيانات التي تم جمعها الخصائص الإجتماعية السكانية، والأنتروپومترية، والإكلينيكية، والكيميائية الحيوية. فحصاً بمقارنة هذه البيانات الخاصة بالتحاق الأطفال بالبحث في فترة كوفيد 19، وفترة ما قبل كوفيد 19، بما في ذلك الوضع من المراة إلى عمر 11 شهرًا، والذين ولدوا أثناء الجائحة وقبيلها، والتحوا بالمستشفى. النتائج: كان التحاق الأطفال بالمستشفى كنسبة مئوية من إجمالي الاحترافات، أقل في مارس/أذار 2020 (2.47%) وINED 2552/559 (8.30%) عينه في مارس/أذار 2019 (2020) (4.73%) (67383) لكنه ارتفع خلال فترة كوفيد 19، بنغلاديش 2019 إلى 2.47% (75254) الفترة من مارس/أذار 2020 إلى فبراير/شباط 2021 (فترة كوفيد 19؛ العدد = 67383).
孟加拉国新型冠状病毒肺炎大流行期间住院儿童的健康和营养状况

目的 旨在比较孟加拉国新型冠状病毒肺炎（COVID-19）大流行期间和大流行之前的儿童健康和营养状况。

方法 我们从2020年3月至2021年2月（新型冠状病毒肺炎大流行期间，n = 2552）和2019年3月至2020年2月（新型冠状病毒肺炎大流行之前的时期，n = 6738）在孟加拉国国际腹泻疾病研究中心达卡医院治疗的59个月儿童的医院记录中收集数据。收集的数据包括社会人口学、体重测量学、临床和生物化学方面的数据。我们比较了新型冠状病毒肺炎大流行期间和大流行之前住院儿童的这些数据，包括大流行期间和大流行之前出生并住院的0-11个月大的婴儿。

结果 2020年3月的儿童住院率(2.47%；63/2552)比2019年3月(8.30%；559/6738)低，但在2021年2月增加到20.61%（526/2552），是新型冠状病毒肺炎大流行之前(6.69%；451/6738)的三倍。在新型冠状病毒肺炎大流行期间住院的儿童比大流行前(0.05)住院的儿童更容易出现脱水、严重败血症或感染性休克、抽搐、高钠血症和肌酐升高的症状。在不到6个月大的婴儿和大流行期间出生的婴儿中，出现发热迟缓和消瘦的婴儿明显高于新型冠状病毒肺炎大流行之前(0.05)的婴儿。在大流行期间，不到6个月大的婴儿的死亡风险更高(优势比：1.66；95%置信区间：0.95-2.92)。

结论 大流行期间，儿童患有更严重的疾病和更加营养不良。需要努力减少大流行对儿童健康的不利影响。
Resumen

Estado de salud y nutrición de los niños hospitalizados durante la pandemia de la COVID-19 en Bangladesh

Objetivo Comparar la salud y la nutrición de los niños menores de 5 años ingresados en el hospital durante y antes de la pandemia de la coronavirus de 2019 (COVID-19) en Bangladesh.

Métodos Se recopiaron datos de los registros hospitalarios de niños de entre 0 y 59 meses admitidos en el hospital de Dhaka del Centro Internacional de Investigación de Enfermedades Diarréicas, Bangladesh, entre marzo de 2020 y febrero de 2021 (período de la COVID-19; \(n\) = 2552) y entre marzo de 2019 y febrero de 2020 (período pre-COVID-19; \(n\) = 6738). Los datos recopiados incluyeron características sociodemográficas, antropométricas, clínicas y bioquímicas. Se compararon estos datos para los ingresos de niños en los periodos de la COVID-19 y pre-COVID-19, incluidos los bebés de entre 0 y 11 meses nacidos durante el período COVID-19, y sin embargo, se comparó la información de confianza del 95% (CI de 95%) entre los período COVID-19 y pre-COVID-19 (\(P < 0.05\)).

Resultados Los ingresos de los niños como porcentaje del total de ingresos fueron menores en marzo de 2020 (2,47%; 63/2552) que en marzo de 2019 (8,30%; 559/6738), pero aumentaron al 20,61% (526/2552) en febrero de 2021 (tres veces más que en el período pre-COVID-19 (6,69%; 451/6738). Los niños ingresados durante el periodo de la COVID-19 tuvieron una probabilidad mucho mayor de presentar deshidratación, sepsis grave o choque séptico, convulsiones, hipernatremia y elevación de la creatinina que los niños ingresados antes de la pandemia (\(P < 0.05\)).

En los lactantes <6 meses y en los nacidos durante la pandemia, el retraso en el crecimiento estatural y la emaciación fueron mucho mayores que en los nacidos durante el periodo pre-COVID-19 (\(P < 0.05\)). El riesgo de muerte fue mayor en los lactantes <6 meses durante la pandemia (oportunidad relativa: 1,66; intervalos de confianza del 95%: 0,95-2,92).

Conclusión Durante la pandemia, los niños presentaron enfermedades más graves y una peor nutrición. Es preciso esforzarse por reducir los efectos indeseables de la pandemia en la salud y el bienestar de los niños.
16. Kadambari S, Abo Y-N, Phuong LK, Osowicki J, Bryant PA. Decrease in infection-related hospital admissions during COVID-19: why are parents avoiding the doctor? Pediatr Infect Dis J. 2020 Nov;39(11):e385–6. doi: http://dx.doi.org/10.1097/INF.0000000000002870 PMID: 32852351

17. Raitio A, Ahonen M, Jääskeli M, Jalkanen J, Luoto TT, Haara M, et al. Reduced number of pediatric orthopedic trauma requiring operative treatment during COVID-19 restrictions: a nationwide cohort study. Scand J Surg. 2021 Jun;110(2):254–7. doi: http://dx.doi.org/10.1177/1457496920968014 PMID: 3310033

18. Vásquez-Hoyos P, Diaz-Rubio F, Monteverde-Fernandez N, Jaramillo-Bustamante JC, Carvajal C, Serra A, et al.; LARed Network. Provision and utilisation of health and nutrition services during COVID-19 pandemic in urban Bangladesh. Matern Child Nutr. 2021 Oct;17(4):e13218. doi: http://dx.doi.org/10.1111/mcn.13218 PMID: 34264002

19. Ahmed T, Rahman AE, Amole TG, Galadanci H, Matjila M, Soma-Pillay P, et al. The effect of COVID-19 on maternal newborn and child health (MNCH) services in Bangladesh, Nigeria and South Africa: call for a contextualised pandemic response in LMICs. Int J Equity Health. 2021 Mar 15;20(1):77. doi: http://dx.doi.org/10.1186/s12939-021-01414-5 PMID: 33722225

20. Hussain M, Abdullah M, Mamun A. COVID-19 in children in Bangladesh: situation analysis. Asia Pac J Pediatr Child Health. 2020;3:59–65.

21. Roberton T, Carter ED, Chou VB, Stegmuller AR, Jackson BD, Tam Y, et al. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. Lancet Glob Health. 2020 Jul;8(7):e901–8. doi: http://dx.doi.org/10.1016/S2214-109X(20)30229-1 PMID: 32405459

22. Billah SM, Saha KK, Khan ANS, Chowdhury AH, Garnett SP, Avis JL, et al. Quality of nutrition services in primary health care facilities: implications for integrating nutrition into the health system in Bangladesh. PLoS One. 2017 May 18;12(5):e0178121. doi: http://dx.doi.org/10.1371/journal.pone.0178121 PMID: 28542530

23. Shahrin L, Chisti MJ, Huq S, Christy MD, Hannan A, et al. Clinical manifestations of hyponatremia and hypernatremia in under-five diarrheal children in a diarrhoea hospital. J Trop Pediatr. 2016 Jun;62(3):206–12. doi: http://dx.doi.org/10.1093/jtpe/pfw028 PMID: 26851435

24. Isba R, Edge R, Jenner R, Broughton E, Francis N, Butler J. Where have all the children gone? Decrease in paediatric emergency department attendances at the start of the COVID-19 pandemic of 2020. Arch Dis Child. 2021 Jul;107(7):704. doi: http://dx.doi.org/10.1136/archdischild-2021-319985 PMID: 32586927

25. Lynn RM, Avis JL, Lenton S, Amin-Chowdhury Z, Mahalanabis D, Safina K, et al. Delayed access to care and late presentations in children during the COVID-19 pandemic: a snapshot survey of 407 paediatricians in the UK and Ireland. Arch Dis Child. 2021 Jul;106(12):e8. doi: http://dx.doi.org/10.1136/archdischild-2021-319848 PMID: 32586927

26. Weiss SL, Peters MJ, Agus MSD, Alhazzani W, Almohanna K, Flora HR, et al. Children’s Surviving Sepsis Campaign International Guidelines for the Management of Septic Shock and Sepsis-Associated Organ Dysfunction in Children Taskforce. Perspective of the surviving sepsis campaign on the management of pediatric sepsis in the era of coronavirus disease 2019. Pediatr Crit Care Med. 2020 Nov;21(11):e1–7. doi: http://dx.doi.org/10.1097/PCC.0000000000002553 PMID: 32866460

27. Hartman ME, Linde-Zwirble WT, Angus DC, Watson RS. Trends in the epidemiology of pediatric severe sepsis. Pediatr Crit Care Med. 2013 Sep;14(7):686–93. doi: http://dx.doi.org/10.1097/PCC.0b013e3182917fad PMID: 23897242

28. Shahnawaz M, Chisti MJ, Huq S, Nishath T, Christy MD, Hannan A, et al. Bubble continuous positive airway pressure for children with severe pneumonia and hypoxaemia in Bangladesh: an open, randomised controlled trial. Lancet. 2015 Sep 12;386(9998):1057–65. doi: http://dx.doi.org/10.1016/S0140-6736(15)62495-5 PMID: 26296950