BMC Pediatrics

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# The severity of pediatric COVID-19 during hospitalization is not associated with mortality within six months of discharge

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## Abstract

**Background** COVID-19 has become a global pandemic. However, studies examining the outcomes for pediatric patients after hospital discharge, post-COVID-19, and the predictive factors influencing their high mortality rates, are still limited, especially in Indonesia. Therefore, this study aimed to determine the predictor that predict mortality six months after hospitalization for COVID-19.

**Methods** A retrospective cohort study was performed. The participants were children who were admitted to Dr. Sardjito General Hospital from February-April 2022. The inclusion criteria were pediatric patients who were hospitalized in the pediatric ward and discharged after recovering or completing isolation. COVID-19 hospitalization deaths and incomplete medical records were omitted from the study. Bivariate analysis was performed with chi-square log rank test. Kaplan-Meier method was used for calculating the cumulative survival between comparison groups of the predictor variables. Multivariate analysis was performed with a Cox regression. The relationships between the variables are presented as the Hazard ratios (HRs), confidence intervals of 95% (95%CI), and statistical significance levels, with $p < 0.05$.

**Results** Among the 114 patients studied, the mortality rate during the six months after COVID-19 was 29.8%. The multivariate analysis revealed that mortality was correlated with comorbidities ($p < 0.021$; HR 11.415; CI 95% 1.449–89.912) and obesity ($p = 0.032$; HR 4.617; CI 95% 1.139–18.721).

**Conclusion** The presence of comorbidities and obesity are significant predictors of mortality in pediatric patients with COVID-19 within six months following hospital discharge.

**Clinical trial number** Not applicable.

**Keywords** Post-COVID-19 infection, Six months post infection, Children, Predictor factors, Mortality

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## Background

The World Health Organization identified the novel virus that caused a new pneumonia in China as severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) and the disease as coronavirus disease 2019 (COVID-19) on February 11, 2020, and it declared COVID-19 a pandemic one month later [1–3].

The first case of COVID-19 in Indonesia was announced on March 2, 2020, which was almost four months after the initial case was reported in Wuhan, China. The first peak of COVID-19 cases occurred in January 2021, and the second peak occurred in July 2021 with the number of daily cases reaching 51,000 new cases and a mortality rate of 2,000 cases per day. Indonesia began to experience an increase in cases again, due to the Omicron variant, in early 2022. Epidemiological studies have shown that the Omicron variant rapidly replaced the Delta variant as the most common variant worldwide. The Omicron variant is a variant of concern because of the high number of mutations in the spike protein, which may increase its ability to evade the immune system and increase its transmission rate [4].

Seroprevalence studies estimate that as many as 80% of children in low- to middle-income countries have experienced at least one SARS-CoV-2 infection [5]. As of April 2023, SARS-CoV-2 had infected more than 39 million children worldwide [6]. In Indonesia, the proportion of COVID-19 cases among Indonesian children was first reported to be between 1% and 2% at the beginning of the pandemic. However, more recent statistics from December 2022 suggested a considerable increase in incidence, which was 13.5% [7]. The appearance of the Omicron variant led to extremely high infection rates across all age groups, particularly among young children, who were the last group to remain uninfected and unvaccinated at that time [8]. During this period, there was also an increase in hospitalizations among children who tested positive for SARS-CoV-2. The characteristics of fatal cases in children in Indonesia are limited, although COVID-19 is prevalent among children [9]. In July 2020, the Indonesian Pediatric Society reported 2,712 confirmed pediatric cases of COVID-19, with a mortality rate of 1.9%, or 51 deaths. The variables of age, comorbidities, poor blood oxygen saturation, and inflammatory markers, such as elevated C-reactive protein (CRP), are predictors of the severity of COVID-19 in children [9, 10]. While many studies have explored mortality predictors, most have concentrated primarily on adults and older individuals, making it difficult to apply these findings to pediatric populations, particularly during the six-month period following hospitalization for COVID-19 [11–14], and especially in Indonesia. In this context, the aim of this study was to identify the predictive factors for mortality events occurring six months after a patient's release from the hospital for COVID-19 infection, particularly in children.

## Methods

This retrospective cohort study was conducted in inpatient pediatric patients at Dr. Sardjito General Hospital, Yogyakarta, Indonesia, from February 1 to April 30, 2022; data collection forms were used to gather the required information from medical records.

The target population for this study comprised all the inpatients with confirmed cases of COVID-19 at Dr. Sardjito General Hospital. The subjects were identified using the total sampling method. Patients were eligible for inclusion if they met the following criteria: pediatric patients age 1 month to 18 years old who were hospitalized in the pediatric ward and were discharged, having either recovered or completed the isolation period. Patients who died during hospitalization and whose medical records had incomplete data were excluded from the study.

The independent variables in this study included patient age, length of hospital stay, the presence of pneumonia, comorbid conditions, the use of supplemental oxygen, the severity of COVID-19, malnutrition, and the neutrophil-to-lymphocyte ratio (NLR). Blood was drawn from the patients within 24 h of admission to assess the NLR. The length of hospitalization was categorized into ≥ 10 days and < 10 days, because in studies of non-severe cases, the virus was detectable for up to 10 days after symptom onset [15]. Additionally, WHO guidelines allow for the discontinuation of isolation without requiring a SARS-CoV-2 test 10 days after the onset of symptoms in symptomatic patients [16]. The length of hospitalization was calculated based on the basis of discharge date minus the admission date, as recorded in the medical records. Comorbidities refer to the diagnosis of other diseases (such as heart, lung, hematological, neurological, or endocrine conditions, as well as immunodeficiency) as documented in the medical records. The use of supplemental oxygen refers to the provision of oxygen to children with impaired oxygen needs through the use of nasal cannulas, face masks, or ventilators.

The clinical case definition of COVID-19 was based on the guidelines issued by the COVID-19 Indonesian Task Force [17] as mild, moderate, severe and critical case. In mild cases, the patient presented symptoms but no evidence of viral pneumonia or hypoxia (SpO2 > 95% in room air). Moderate case: clinical signs of pneumonia but no signs of severe pneumonia, including SpO2 > 93% in room air. The criteria for rapid breathing were as follows: age < 2 months, ≥ 60 breaths/minute; age 2–11 months, ≥ 50 breaths/minute; age 1–5 years, ≥ 40 breaths/minute; and age > 5 years, ≥ 30 breaths/minute. Severe cases: clinical signs of pneumonia, and one of the following:

respiratory rate > 30 breaths/minute, severe respiratory distress (such as rapid breathing, grunting, or severe chest indrawing), SpO2 < 93% in room air, inability to breastfeed or drink, lethargy or decreased consciousness, or seizures. Critical cases: patients with acute respiratory distress syndrome (ARDS), sepsis, septic shock, or other conditions requiring life support, such as mechanical ventilation or vasopressor therapy [17].

The classifications of nutritional status were as follows: obese, weight-for-length/height or BMI-for-age > 3 standard deviations (SD) of the median; normal, weight-for-length/height or BMI-for-age 2 SD and >-2 SD of the median; moderate malnutrition, weight-for-length/height ≤ − 2 SD and ≥ − 3 SD of the median; and severe malnutrition, weight-for-length/height < − 3 SD of the median [18]. The NLR was categorized into > 5.94 and ≤ 5.94 because a cutoff value of 5.94 was associated with an odds ratio of 3.9 for mortality [19]. The dependent variable was mortality occurring within six months of hospitalization for COVID-19.

Statistical analyses were performed by SPSS statistical software version 25.0 for Windows (IBM Corp., Armond, New York, USA). Categorical variables were presented as count and percentages. Bivariate analysis was performed with chi-square log rank test. Kaplan–Meier survival analysis with log-rank test was performed to compare groups of the predictor variables. Multivariate Cox proportional hazard models were performed to investigate which factors were associated with six-month survival. Factors had significant association with survival were included in multivariate analysis. Variables included multivariate analysis were those with P-value < 0.25 on bivariate analysis.

The study protocol was approved by the Medical and Health Research Ethics Committee (MHREC), Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada – Dr. Sardjito General Hospital (Ref. No. KE/FK/0188/EC/2023).

## Results

The total number of pediatric patients confirmed with COVID-19 between February and April 2022 was 225. Among these patients, 180 were hospitalized, with 131 patients (58.2%) in the pediatric ward, 49 patients (21.7%) in non-pediatric wards (including surgery; ophthalmology; ear, nose, and throat); and 45 patients (20%) managed as outpatients. Among those hospitalized in the pediatric ward, 131 patients (72.7%) were either declared cured or had completed their isolation period, whereas 13 patients died during hospitalization, resulting in a mortality rate of 9.9%. Throughout the treatment period, nine patients (7.8%) received care in the intensive pediatric ward, whereas 105 patients (92.1%) were treated in the non-intensive pediatric ward. A detailed analysis was subsequently conducted on a total sample of 114 patients. Additionally, within the six-month follow-up period after receiving COVID-19 treatment at Dr. Sardjito General Hospital, 34 of the 114 children (29.8%) died. Figure 1 illustrates the sampling process of this study.

The characteristics of the pediatric patients with COVID-19 from February to April 2022 who were included in the study are summarized in Table 1. A research sample of 114 subjects was used to provide the data, which were then analyzed.

In this study, of the total number of patients observed during the six-month post-hospitalization period, 34 died. Among these patients, 27 (79.4%) died at Dr. Sardjito General Hospital, whereas seven subjects (20.6%) died outside the hospital with no available data on the cause of death. The cause of death for each patient who died at Dr. Sardjito General Hospital is detailed in Table 2.

Table 3 presents the bivariate log rank test of mortality patients with COVID-19 within 6 months of discharge for the eight independent variables examined in the study. These variables include the patient's age, length of hospital stay, presence of pneumonia, comorbid conditions, use of supplementary oxygen, COVID-19 severity, malnutrition, and the NLR.

The association of variables with survival was shown in the Kaplan-Meier curve in Fig. 2. Having pneumonia, comorbidities, and supplementary oxygen during hospitalization, as well as being obese and malnourished, are significantly associated with survival within 6 months after hospital discharge ($p < 0.05$).

The results of multivariate Cox proportional hazard models were presented in Table 4. Factors had significant association with survival were included in multivariate analysis. Subjects with comorbidities and being obese had significantly higher hazard of mortality than those without (HR = 11.415, $p = 0.021$; and HR = 4.617, $p = 0.032$; respectively).

## Discussion

The long-term health consequences of COVID-19 remain unclear, especially outcome in pediatric population. While major publication covers the post COVID condition or long COVID in adults [11–14], there is limited report about the outcome mortality 6 months after discharge in children.

In this study, the mortality rate of patients during hospitalization, including those in both intensive and non-intensive care, was 9.9% (13 out of 131 patients). The mortality rate within six months of discharged was 29.8% (34 out of 114 patients). A study conducted at a tertiary hospital in Jakarta, Indonesia reported a higher mortality rate of 40% among children with COVID-19, who were treated in the intensive care unit [9]. The lower mortality

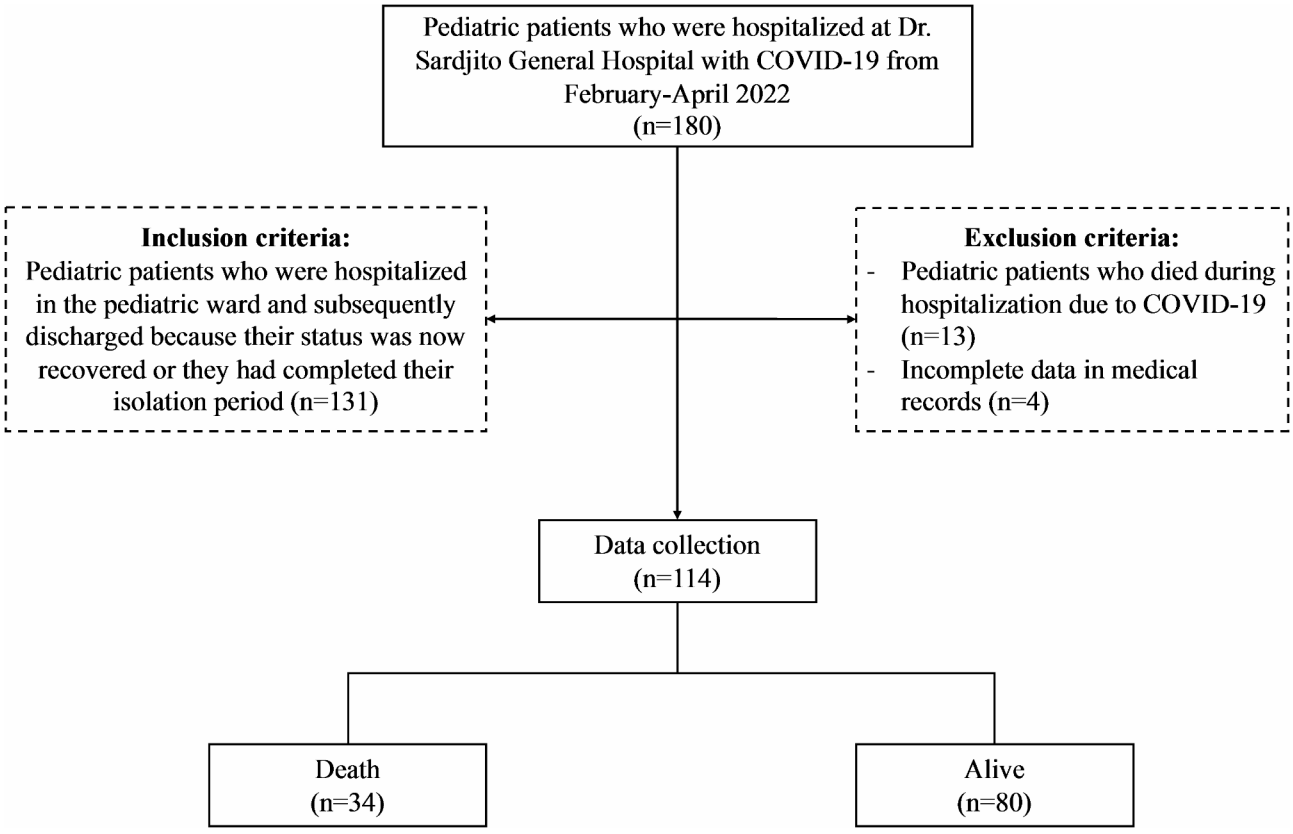


**Fig. 1** Sampling flow

rate observed in our study can be attributed to the fact that their research exclusively involved patients treated in the pediatric intensive care unit (PICU), whereas our study included COVID-19 patients hospitalized in both the PICU and non-PICU settings.

A study conducted in Germany across all age groups revealed that, after a six-month follow-up, out of the 6,235 patients who had been discharged following COVID-19 treatment, 1,668 were re-hospitalized, resulting in a mortality rate of 29.6% [11]. The major findings show a high 6-month all-cause mortality rate in COVID-19 patients, especially 53% that need mechanical ventilation. In addition, women have a significantly better 6-month prognosis than men. The worst outcomes are for individuals over 80, with a 6-month all-cause mortality rate of 52% and 71% for ventilated patients. Coagulopathy, liver disorders, and extreme obesity increase 6-month all-cause mortality [11].

In this current study, even though bivariate analysis showed that the need for pneumonia and supplementary oxygen contributed to mortality within six months following COVID-19 infection, however they failed to be proven significant in multivariate analysis. A cohort study in adults showed that the persistent X-ray abnormalities occurred in 4% respondents, but this outcome is not correlate with the initial disease severity [12]. The marked inflammatory response and coagulopathic state in response to SARS-CoV-2 may promote pulmonary fibrosis and lung damage [20], and this severe condition may cause acute respiratory distress syndrome (ARDS) with refractory hypoxemia that became primary cause of death in COVID-19. In our study, pneumonia that likely need supplementary oxygen in acute infection did not correlate with 6-month mortality after discharge may be caused by because the treatment done is adequate and the disease resolve without any respiratory sequelae.

Nearly half of the cases in our study fell into the severe-critical category, with a mortality rate of 27.1%, however unexpectedly this variable was not correlate with the mortality within 6 months after hospital discharge. A recent scoping review indicated that a majority (80%) of patients with post-acute sequelae of COVID-19 (PASC) experienced mild initial symptoms [21]; furthermore, the most significant study, a multi-center retrospective review of electronic health records, involved 659,286 children and reported a 3.7% incidence of non-MISC PASC [22]. One publication from adult population also showed that the persistent poor health after COVID-19 is not associated with respiratory complications or initial disease severity [12].

To date, numerous papers have assessed the epidemiological aspects [23], risk factors [24], and clinical

**Table 1** Baseline characteristics of the children with confirmed COVID-19 ($n = 144$)

| Subject characteristics | Total (number %) |
|---|---|
| Age | |
| ≤ 5 years | 67 (58.7) |
| 5–18 years | 47 (41.2) |
| Long hospitalization | |
| ≥ 10 days | 72 (63.1) |
| < 10 days | 42 (36.8) |
| Ward | |
| Intensive | 9 (7.8) |
| Non-intensive | 105 (92.1) |
| The presence of pneumonia | |
| Yes | 68 (59.6) |
| No | 46 (40.4) |
| Comorbid | |
| Hematological malignancy | 31 (27.1) |
| Neurological disorders | 12 (10.5) |
| Kidney disease | 10 (8.7) |
| Heart disease | 10 (8.7) |
| Gastrohepatological disease | 8 (7.0) |
| Lung disease | 5 (4.3) |
| Immunodeficiency disorders | 4 (3.5) |
| Endocrine disorders | 2 (1.7) |
| History of supplementary oxygen | |
| Without supplementary oxygen | 38 (33.3) |
| Nasal cannula | 66 (57.8) |
| Non-rebreathing mask | 4 (3.5) |
| Non-invasive ventilator | 1 (0.8) |
| Mechanical ventilator | 5 (4.3) |
| Severity of COVID-19 | |
| Severe-critical | 75 (65.7) |
| Mild-moderate | 39 (34.2) |
| Nutritional status | |
| Obese | 7 (6.1) |
| Moderate malnulrition | 24 (21) |
| Severe malnutrition | 23 (20.1) |
| Good nutrition | 60 (52.6) |
| Neutrophil lymphocyte ratio value | |
| ≥ 5.94 | 20 (17.5) |
| < 5.94 | 93 (81.5) |
| Antiviral therapy | 65 (57) |
| Enoxaparin therapy | 4 (3.5) |
| Tocilizumab therapy | 4 (3.5) |
| Immunoglobulin therapy | 3 (2.6) |
| Adherence to therapy guideline | |
| Yes | 103 (90.3) |
| No | 11 (9.7) |
| Died within 6 months after discharge | 34 (23.6%) |

implications [25] of adult post-COVID-19 condition (PCC). However, the most prevalent symptomatology, and associated factors of PCC in children and adolescents remain particularly unclear. In 2024, Heidar Alizadeh et al. conducted a recent review of pediatric PCC, which showed that the most frequently reported symptoms were fatigue and respiratory difficulties. In addition, they demonstrated a robust correlation with severe COVID-19 disease during the acute phase of infection (OR1 = 2.78, 95% CI 1.78–4.33). Unfortunately, the mortality outcome was not reported in this study [26].

The prognosis for most children and adolescents with PASC is favorable, with symptoms typically declining within six months [27, 28]. The mortality observed within six months post-hospital discharge in our current study may be more closely associated with factors such as nutritional status and comorbidities.

In the multivariate analysis, obesity emerged as a significant predictor of mortality. This finding is supported by several studies that highlighted obesity as a key factor in identifying the severity of COVID-19 [29]. The hypertrophy of adipose tissue, which leads to immune system dysregulation and an increased inflammatory response, can increase the risk of death from COVID-19 [30]. Comorbidities such as obesity and overweight are quite common, and they frequently serve as risk factors for mortality in children who have COVID-19 [9]. Another study reported that among 255 children infected with SARS-CoV-2, 100 were hospitalized and 27 died, with 30% of the deceased suffering from malnutrition [31]. For adults, BMI ≥ 40 (OR 2.01, 95% CI 1.33 to 3.05) also has strong associations with increased odds of 180-day all-cause mortality [11].

Comorbidity was also identified as a significant predictor of mortality in this study. This result aligns with previous research in Iran, which indicated that children with underlying comorbidities constitute a high-risk group for hospitalization, ICU admission, and mortality [32]. These findings are consistent with multicenter studies from the United States and Europe, which reported that 50–80% of children with severe COVID-19 who require PICU admission have comorbidities. Furthermore, the spectrum of comorbid diseases differs between developed and developing countries, with infections (particularly tuberculosis) and hematological malignancies being the most prevalent in the latter [31]. In accordance with this study, hematologic malignancies were the comorbidities associated with the highest mortality rate (11.4%).

The impact of COVID-19 infection on individuals with pre-existing comorbidities is challenging to delineate, as many of these patients have underlying immunosuppressive conditions. However, several studies of adult patients have proposed mechanisms that contribute to symptoms and mortality within six months of being infected. These mechanisms include impaired lung diffusion capacity due to chronic inflammatory processes, fibrotic changes in lung tissue, thromboembolism, and a decrease in neutralizing antibodies, which may lead to re-infection with SARS-CoV-2, resulting in severe respiratory syndrome

**Table 2** Causes of death

| Comorbidities and other diagnoses recorded in the last hospitalization period at death | Cause of death | Total (*n* %) |
|---|---|---|
| NHL relapse (*n* = 1)<br>Tuberculosis (*n* = 1)<br>Biliary atresia (*n* = 1)<br>VSD (*n* = 2)<br>Epilepsy (*n* = 1)<br>CKD (*n* = 1) | Septic shock | 7 (20.5) |
| Mediastinal tumor (*n* = 1)<br>ALL (*n* = 1)<br>Hepatic cirrhosis (*n* = 1)<br>Lung malformation (*n* = 1) | Acute respiratory distress syndrome | 4 (11.7) |
| Biliary atresia (*n* = 1)<br>ALL (*n* = 1)<br>CKD (*n* = 1) | Intracranial hemorrhage | 3 (8.8) |
| ALL (*n* = 1)<br>CKD (*n* = 1) | Pneumonia | 2 (5.8) |
| Aplastic anemia (*n* = 1)<br>ALL (*n* = 1) | Pulmonary hemorrhage | 2 (5.8) |
| Biliary atresia (*n* = 1)<br>Cholangitis (*n* = 1) | Hepatic encephalopathy | 2 (5.8) |
| ALL (*n* = 1) | Disseminated Intravascular Coagulation | 1 (2.9) |
| VSD (*n* = 1) | Pulmonary hypertensive crisis | 1 (2.9) |
| Sarcoma (*n* = 1) | Lung metastases | 1 (2.9) |
| Without comorbid (*n* = 1) | Cardiomyopathy | 1 (2.9) |
| ASD (*n* = 1) | Double outlet right ventricle | 1 (2.9) |
| Hydrocephalus (*n* = 1)<br>ALL (*n* = 3)<br>ASD (*n* = 2)<br>Epilepsy (*n* = 1) | No data (died outside the hospital) | 7 (20.5) |

NHL: non-hodgkin lymphoma; VSD: ventricular septal defect; CKD: chronic kidney disease; ALL: acute lympoblastic leukaemia; ASD: atrial septal defect

**Table 3** Results of bivariate log rank test of mortality patients with COVID-19 within 6 months of discharge

| Variable | Conditions in 6 months (*n* = 114) | | | | *p* | HR | 95%CI |
|---|---|---|---|---|---|---|---|
| | Death | | Alive | | | | |
| | *n* | % | *n* | % | | | |
| Age | | | | | | | |
| ≤ 5 years | 21 | 18.4 | 46 | 40.3 | 0.733 | 1.062 | 0.751-1.500 |
| 6–18 years | 13 | 11.4 | 34 | 29.8 | | | |
| Length of stay | | | | | | | |
| ≥ 10 days | 25 | 21.9 | 47 | 41.2 | 0.143 | 1.323 | 0.903–1.936 |
| < 10 days | 9 | 7.8 | 33 | 28.9 | | | |
| Pneumonia | | | | | | | |
| Yes | 29 | 25.4 | 39 | 34.2 | < 0.001 | 2.212 | 1.375–3.558 |
| No | 5 | 4.3 | 41 | 35.9 | | | |
| Comorbidities | | | | | | | |
| Yes | 32 | 22.2 | 50 | 43.8 | < 0.001 | 3.853 | 1.425–10.422 |
| No | 2 | 1.7 | 30 | 26.3 | | | |
| Supplementary oxygen | | | | | | | |
| Yes | 31 | 27.1 | 45 | 39.4 | < 0.001 | 2.577 | 1.424–4.664 |
| No | 3 | 2.6 | 35 | 30.7 | | | |
| Severity of COVID-19 | | | | | | | |
| Severe-critical | 31 | 27.1 | 44 | 38.5 | 0.867 | 1.029 | 0.735–1.441 |
| Mild-moderate | 3 | 2.6 | 36 | 31.5 | | | |
| Malnutrition | | | | | | | |
| Obese | 5 | 4.3 | 2 | 1.7 | < 0.001 | 6.399 | 2.137–19.159 |
| Moderate-severe malnutrition | 20 | 17.5 | 27 | 23.6 | 0.004 | 3.197 | 1.454–7.028 |
| Good nutritional status | 9 | 7.8 | 51 | 44.7 | | | |
| Neutrophil lymphocyte ratio value | | | | | | | |
| ≥ 5.94 | 6 | 5.2 | 14 | 12.2 | 0.997 | 0.999 | 0.643–1.553 |
| < 5.94 | 27 | 23.6 | 66 | 57.8 | | | |

HR: Hazard ratio; CI: Confidence interval

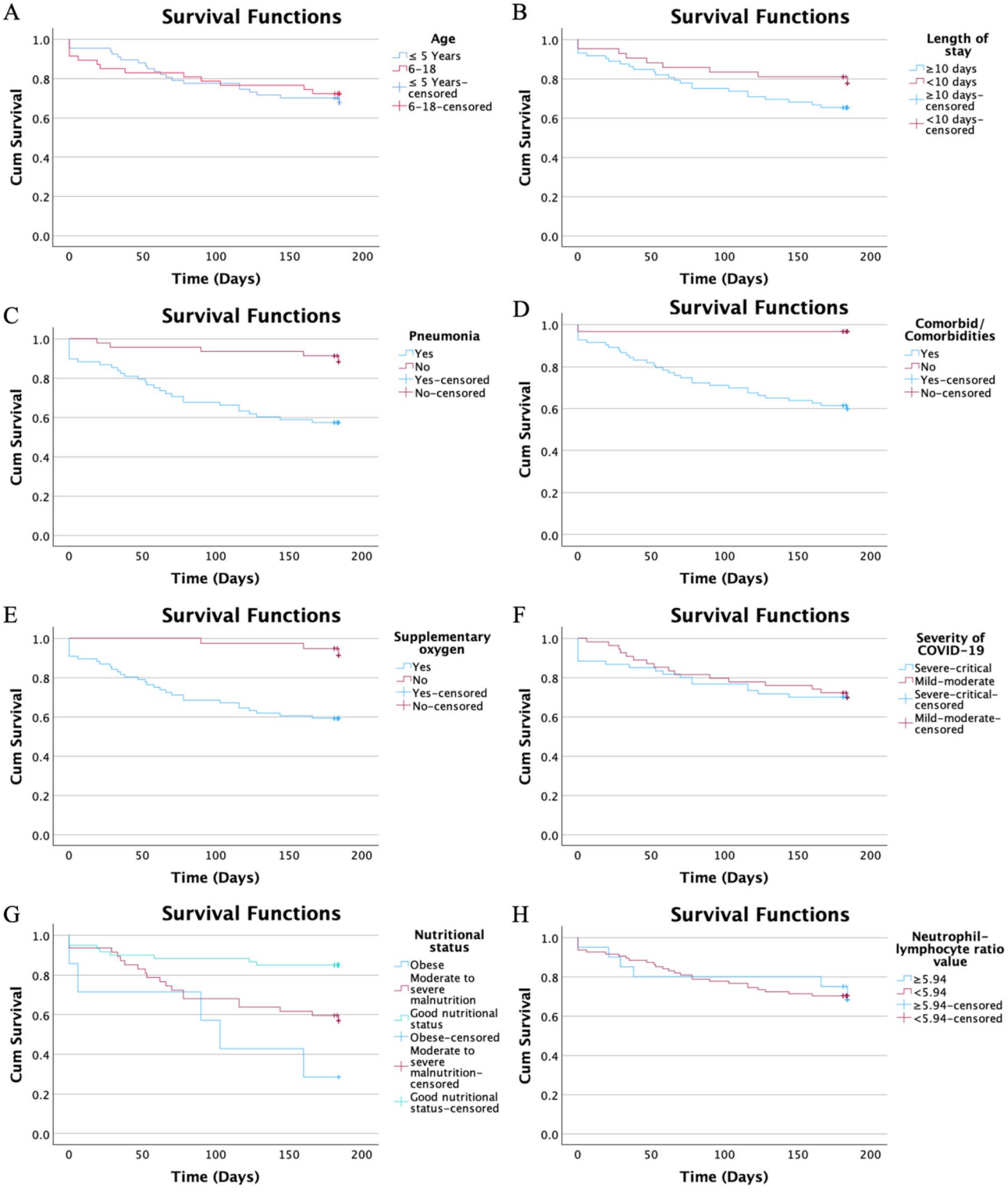


**Fig. 2** Kaplan-Meier survival curves of all hospitalized COVID-19 pediatric patients on 6 months after hospital discharge for different predictor factors. The figure displays the Kaplan-Meier survival plots according to (**A**) age, (**B**) length of stay, (**C**) pneumonia, (**D**) comorbidities, (**E**) supplementary oxygen, (**F**) severity of COVID-19, (**G**) nutritional status, and (**H**) neutrophil-lymphocyte ratio value

**Table 4** Results of multivariate Cox proportional hazard regression models of death in COVID-19 patients within 6 months of discharge

| Variable | *p* | HR | CI 95% |
|---|---|---|---|
| Length of stay | 0.769 | 0.882 | 0.382–2.036 |
| Pneumonia | 0.255 | 2.094 | 0.587–7.475 |
| Comorbid | 0.021 | 11.415 | 1.449–89.912 |
| Supplementary oxygen | 0.161 | 3.007 | 0.645–14.023 |
| Malnutrition | 0.424 | 1.440 | 0.589–3.525 |
| Obese | 0.032 | 4.617 | 1.139–18.721 |

HR: Hazard ratio; CI: Confidence interval

and death. Additionally, some studies suggest that mortality in COVID-19 patients is not solely attributable to comorbidities. Factors such as innate immune responses, a patient's nutritional status, environmental influences such as vaccination, a history of infection, and the severity of acute respiratory symptoms during initial COVID-19 infection also play significant roles in determining outcomes [33, 34].

It is essential to assess the long-term outcomes of COVID-19 following hospital discharge. A study of adult patients, who were monitored for six months post-discharge, revealed that 33 out of 2,469 patients (1.3%) died due to exacerbation of pre-existing pulmonary, cardiac, and renal conditions. Six months after acute infection, patients with severe COVID-19 had an elevated risk of pulmonary diffusion abnormalities, fatigue or muscle weakness, and anxiety or depression. Hospitalized patients in severe and critical condition exhibited greater impairment of lung diffusion capacity and abnormal chest imaging. This group of patients requires more attention, especially for long-term rehabilitation [34].

Notably, this is the first study to predict mortality during the six-month period post-discharge using a subject of pediatric patients from both intensive and non-intensive care settings in Indonesia. Nevertheless, we acknowledge study limitations. The study's general limitations include the inability to establish causality between risk factors and long-term mortality, as well as the absence of information regarding the cause of death of the various patients, due to its observational nature. A larger cohort prospective study is needed to understand more about the causative of mortality events. Other limitations to consider include the small sample size and the single-center study, which limit our ability to generalize the results to the broader Indonesian pediatric population. Especially to interpret the lack of association with COVID-19 infection severity with mortality after 6 months of discharge. Secondly, patients with mild COVID-19 symptoms who stayed home were not enrolled. Further efforts are needed to compare the long-term outcomes between inpatients and outpatients, between the SARS-CoV-2 infection status, and also among SARS-CoV-2 variants. Prospective research on COVID-19 patients without comorbidities is essential to observe potential adverse outcomes, thereby enhancing our understanding of post-acute sequelae of COVID-19 in children. Additionally, variations in post-discharge care were noted, as not all the patients were consistently monitored at the hospital. Future research should involve multiple hospital sites to assess mortality predictors across broader demographics, and longer follow-up studies in a larger population are necessary to understand the full spectrum of health consequences from COVID-19.

These findings underscore the necessity for post-discharge care in hospitals, particularly for those with indicators of adverse outcomes, both in the short and long term, following COVID-19 infection. As far as we are aware, there are presently lacking recommendations for COVID-19 discharge and follow-up. It is essential to gain a clear understanding of the best healthcare pathway for both patients and healthcare systems. Follow-up appointments should take place within a week of the initial post-discharge period and incorporate telemedicine when suitable, concentrating on the late medical complications and psychological effects of COVID-19.

## Conclusions

An alarmingly high mortality rate was observed among children diagnosed with COVID-19 during the six-month period after their discharge from the hospital. The presence of comorbidities and obesity are significant predictors of mortality within six months following hospital discharge. Follow-up monitoring after discharge is important in patients with unfavorable outcome predictors.

### Abbreviations

| | |
|---|---|
| ARDS | Acute respiratory distress syndrome |
| BMI | Body mass index |
| CI | Confidence interval |
| COVID-19 | Coronavirus disease 2019 |
| CRP | C-reactive protein |
| HR | Hazard ratio |
| ICU | Intensive care unit |
| IQR | Interquartile range |
| MISC | Multisystem inflammatory syndrome in children |
| NLR | Neutrophil-to-lymphocyte ratio |
| OR | Odds ratio |
| PASC | Post-acute sequelae of COVID-19 |
| PCC | Post-COVID-19 condition |
| PICU | Pediatric intensive care unit |
| SARS-CoV-2 | Severe acute respiratory syndrome coronavirus-2 |
| SD | Standard deviation |
| SPSS | Statistical package for the social sciences |
| UNICEF | United Nations Children's Fund |
| WHO | World Health Organization |

### Acknowledgements

Not applicable.

### Author contributions

I.B. wrote the main text of the manuscript, the data collection, and analysis. D.K.S. and E.A. were involved in the conceptualization of the study's design

and the manuscript's writing. A.N.C was involved in the analysis and writing the manuscript. All the authors have read and approved the final manuscript.

**Funding**
None.

**Data availability**
Data is provided within the manuscript. Datasets used or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Ethics approval and consent to participate**
Ethical approval was given by Medical and Health Research Ethics Committee (MHREC), Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada – Dr. Sardjito General Hospital (Ref. No: KE/FK/0188/EC/2023). We did not obtain written informed consent from study participants because we analyzed secondary data from existing medical records. The ethics committee waived the requirement for informed consent.

**Consent for publication**
All authors have provided their consent for publication and have reviewed the manuscript. The content of this manuscript has not been copyrighted or published previously and is not currently under consideration for publication elsewhere.

**Competing interests**
The authors declare no competing interests.

Received: 7 October 2024 / Accepted: 24 February 2025
Published online: 17 March 2025

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