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RISK FACTORS FOR MULTI ORGAN DYSFUNCTION SYNDROME IN SEPSIS AMONG CHILDREN

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ABSTRACT
Background: Sepsis is a major cause of morbidity and mortality among children, and progression to Multi Organ Dysfunction Syndrome (MODS) is associated with poor clinical outcomes.
Objective: To determine the frequency of MODS and assess associated risk factors among children with sepsis.
Methodology: This descriptive cross-sectional study was conducted in the Department of Pediatric Medicine, The Children's Hospital, Lahore from February 2026 to May 2026. A total of 150 children aged 1 month to 12 years diagnosed with sepsis were included using non-probability consecutive sampling. Data regarding age, gender, need for surgery, ventilator use, breastfeeding status, malnutrition, and MODS status were collected. Data were analyzed using SPSS version 26.0.
Results: The mean age was 1.80 ± 2.83 years. MODS was present in 37 (24.7%) children, while 113 (75.3%) had non-MODS. Ventilator use was significantly associated with MODS (35.1% vs 11.5%, p = 0.001). Gender, need for surgery, breastfeeding status, and malnutrition showed no significant association with MODS.
Conclusion: MODS occurred in nearly one-fourth of septic children. Ventilator use was significantly associated with MODS, indicating the importance of early recognition of respiratory compromise and timely supportive care.

KEYWORDS: Sepsis, children, MODS, ventilator use, malnutrition, pediatric critical care.

INTRODUCTION

In Multi-organ Dysfunction Syndrome (MODS) two or more organ systems fail, typically as a result of a condition like sepsis. Sepsis is the extreme reaction of the body to infection, causing too much inflammation, clotting and loss of circulation to important tissues [1]. When not treated or if the sepsis is severe, it may develop into MODS. The MODS is a major clinical problem in children because of its rapid onset and progression and high mortality rates if not promptly recognized and managed. Pathophysiology of Sepsis-induced MODS includes inflammatory mediators, immune system dysfunction, endothelial dysfunction, and microvascular thrombosis. The exact mechanisms remain to be elucidated, and knowledge of predisposing factors can help to stratify the risk and for the development of targeted therapeutic strategies [1,2]. Sepsis is a leading cause of morbidity and mortality in children, worldwide, among its most serious complications is MODS. Severe estimates for the prevalence of pediatric sepsis vary by healthcare systems, reporting and diagnostic criteria, but studies indicate that a large percentage of cases of pediatric sepsis progress to MODS [3]. Based on WHO stats, sepsis causes about 11 million of the 48 million deaths each year and MODS is responsible for major deaths in critical situations [4,5]. Pediatric patients are at increased risk for MODS, especially as part of a septic process, highlighting the need for knowledge of risk factors and implications for prognosis [6,7]. The prevalence of MODS in children in sepsis was reported to be 26.0% [8].

There has been a considerable amount of research evaluating the risk factors for MODS in sepsis in children from around the world, which highlights the wide range of clinical and demographic factors that can affect the development of MODS in children [8]. A study performed in the United States found that prematurity, underpinning chronic ailments and how sick the patient is are major risk factors for MODS in children with sepsis4. In United Kingdom, researchers discovered that children who are not diagnosed early with sepsis have a higher risk of developing MODS [9,10]. Furthermore, the microbial etiology and suboptimal initial antibiotic therapy on the development of MODS in children with sepsis was highlighted [11]. In addition, research from Brazil stressed the factors of socioeconomic status and unequal healthcare that affect results in regards to MODS in children with sepsis. Comparable studies confirm that MODS is a result of a combination of medical, age, infection and hospital conditions present in all settings. Early recognition of these risk factors is critical for treating pediatric sepsis, to avoid MODS and improve patient outcomes [7-10]. Sun et al. (2021) in China reported

male gender a significantly higher risk factor in MODS versus non-MODS groups as 78.9% vs. 64.4%;p-value=0.032, need for surgery significantly less in MODS group as 43.3% vs. 60.0%; p-value=0.025 and ventilator usage significantly less 84.4% vs. 94.4%; p-value 0.025 [12]. This study aims to fill the gap in existing literature on the risk factors for MODS in pediatric sepsis. Sepsis is a recognized phenomenon, but little is known about the factors that predispose to the occurrence of MODS in childhood.

OBJECTIVES:

- To determine frequency of MODS in children presenting with sepsis.
- To compare frequency of various risk factors among sepsis children with and without MODS.

METHODS

This descriptive cross-sectional study was conducted at Department of Pediatric Medicine, the Children's Hospital, Lahore from February 2026 to May 2026. Using an expected prevalence of MODS in septic children of 26.0%, a 95% confidence interval, and a 7% margin of error, sample size was calculated to be 151[8]. A total of 150 patients were included in the final study. Non-probability consecutive sampling technique was used to collect the data. The study included children 1 month – 12 years of age who had a diagnosis of sepsis. Known chronic organ dysfunction in children prior to sepsis was excluded. Also excluded were children with leukemia, children receiving organ transplants, children undergoing continuous chemotherapy, and children who had immune system suppression caused by other diseases. Children who had only localized infections with no systemic signs of infection were excluded. If a patient's clinical data was incomplete, or if medical records were incomplete, they were not included in the analysis.

Data Collection

The children between 1 month and 12 years presenting with sepsis at the Department of Pediatric Medicine, The Children's Hospital, Lahore, who met the inclusion criteria were recruited. It was obtained from their parents/legal guardians in writing. Participants were subjected to detailed clinical examination and to routine laboratory investigations to confirm sepsis and to assess organ dysfunction. Laboratory tests performed were complete blood count, liver function tests, renal function tests, and arterial blood gas analysis. Fense of MODS was determined by the presence of dysfunction in at least two organ systems, such as renal, respiratory, and hepatic systems. Renal dysfunction was defined as an increase in serum creatinine or a reduction in urine output. Liver enzymes (AST, ALT and bilirubin) were used as markers for hepatic dysfunction. Respiratory dysfunction was detected by mechanical ventilation, hypoxia (SpO_2 < 90%) or abnormal PaO_2/FiO_2 ratio. The separation between the two groups was confirmed by the presence of dysfunction in 2 or more organ systems, which was consistent for both groups.Dysfunction in 2 or more organ systems confirmed the diagnosis of MODS, and was consistent in both groups. A structured proforma was used for the collection of demographic information, clinical information, and laboratory results. A history was taken that included details regarding potentially modifiable risk factors for MODS such as age, gender, comorbidities, surgery, use of ventilators, breastfeeding status, and malnutrition. Data was collected in a consecutive fashion and compliance with inclusion and exclusion criteria was ensured. To reduce bias, the data were collected by the principal investigator and trained assistants.

Data Analysis

Data collected were entered and analyzed using SPSS version 26.0. Age was presented as mean ± (SD) for numerical variables. Categorical variables like gender, need for surgery, ventilator use, breastfeeding status, malnutrition and MODS status were expressed in terms of frequencies and percentages. The following risk factors were compared between MODS and non-MODS groups: Gender, need for surgery, ventilator utilization, breastfeeding and malnutrition. Where appropriate, the data were analyzed with the chi-square test or Fisher's exact test. To control for the effects of effect modifiers, frequency of MODS and non-MODS was stratified by gender, surgery, ventilator use, breastfeeding and malnourishment. A p-value of < 0.05 was deemed as statistically significant.

RESULTS

A total of 150 patients were included in the study, with a mean age of 1.80 ± 2.83 years. Male patients were more common, 87 (58.0%), while 58 (38.7%) were female and gender was missing in 5 (3.3%). MODS was present in 37 (24.7%) children, while 113 (75.3%) had non-MODS. Ventilator use was required in 26 (17.3%), breastfeeding was reported in 59 (39.3%), malnutrition was present in 76 (50.7%), surgery was required in 8 (5.3%), hepatic dysfunction was seen in 5 (3.3%), and renal dysfunction in 34 (22.7%) patients.

Table 1. Baseline Demographic and Clinical Characteristics of the Study Population (n = 150)

Variable	Value
Age (years), Mean ± SD	1.80 ± 2.83
Male gender	87 (58.0%)
Female gender	58 (38.7%)
Missing gender	5 (3.3%)
MODS	37 (24.7%)
Non-MODS	113 (75.3%)
Ventilator use	26 (17.3%)

Breastfeeding	59 (39.3%)
Malnourished	76 (50.7%)
Surgery required	8 (5.3%)
Hepatic dysfunction	5 (3.3%)
Renal dysfunction	34 (22.7%)
Distribution of MODS	
MODS	37 (24.7%)
Non-MODS	113 (75.3%)
Total	150 (100%)

Gender was not significantly associated with MODS. Among children with MODS, 23 (62.2%) were male and 14 (37.8%) were female, while in the non-MODS group, 64 (56.6%) were male and 44 (38.9%) were female, with 5 (4.4%) missing gender entries.

Table 2. Association of Gender with MODS

Gender	MODS (n=37)	Non-MODS (n=113)	Total	p-value
Male	23 (62.2%)	64 (56.6%)	87	0.408
Female	14 (37.8%)	44 (38.9%)	58	
Missing	0 (0.0%)	5 (4.4%)	5	

Chi-square test

Ventilator use was present in 13 (35.1%) children with MODS compared with 13 (11.5%) children without MODS, with p = 0.001. Surgery was required in 3 (8.1%) MODS patients and 5 (4.4%) non-MODS patients, p = 0.387. Breastfeeding was present in 15 (40.5%) MODS patients and 44 (38.9%) non-MODS patients, p = 0.862. Malnutrition was present in 20 (54.1%) MODS patients and 56 (49.6%) non-MODS patients, p = 0.635.

Table 3. Comparison of Clinical Risk Factors Between MODS and Non-MODS

Variable	MODS (n = 37)	Non-MODS (n = 113)	p-value
Surgery			
Yes	3 (8.1%)	5 (4.4%)	
No	34 (91.9%)	108 (95.6%)	0.387
Ventilator use			
Yes	13 (35.1%)	13 (11.5%)	
No	24 (64.9%)	100 (88.5%)	0.001
Breastfeeding			
Yes	15 (40.5%)	44 (38.9%)	
No	22 (59.5%)	69 (61.1%)	0.862
Malnutrition			
Yes	20 (54.1%)	56 (49.6%)	
No	17 (45.9%)	57 (50.4%)	0.635

Chi-square test

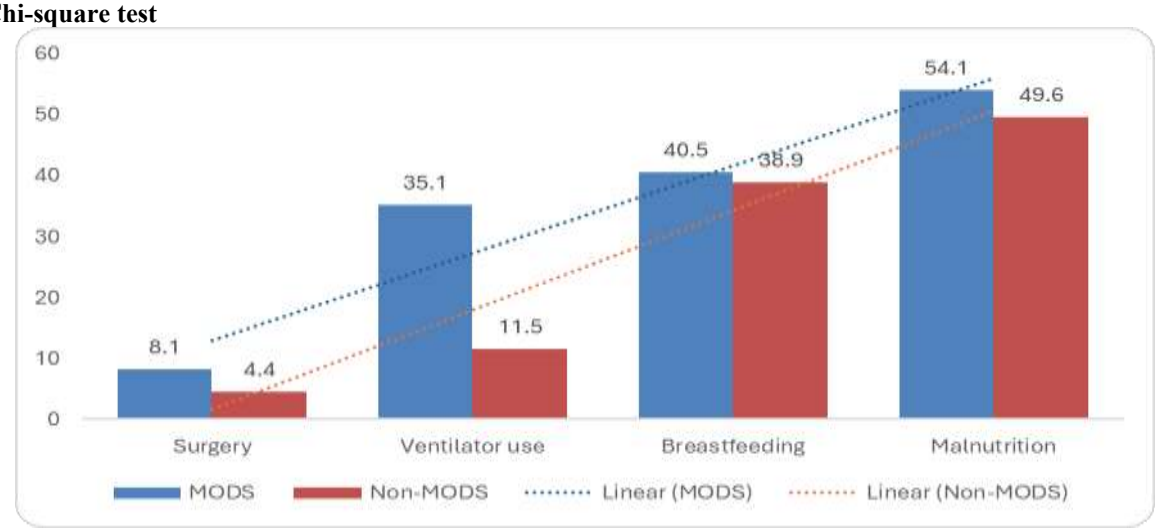

Figure 1: Clinical Risk Factors Between MODS and Non-MODS

The statistical comparison showed that ventilator use had a significant association with MODS, with a chi-square value of 10.863 and p = 0.001.

Table 4. Statistical Comparison Between Risk Factors and MODS

Risk Factor	Test Statistic	p-value

Gender	1.793	0.408
Surgery	0.749	0.387
Ventilator use	10.863	**0.001**
Breastfeeding	0.030	0.862
Malnutrition	0.225	0.635

Chi-square test; $p \leq 0.05$ considered statistically significant.

DISCUSSION

Sepsis is one of the most common causes of morbidity and mortality in children around the world, and the development of Multi Organ Dysfunction Syndrome (MODS) is a key factor in the poor prognosis. Children recognized to be at high risk for MODS can be treated appropriately, and supportive management optimized, early. The current study aimed to assess the incidence of MODS and explore some clinical risk factors among children admitted with sepsis. The results showed that 24.7% of the septic children had MODS. Gender was not significantly associated with MODS, nor were breastfeeding status or malnutrition, but ventilator use was significantly associated. The participants were mainly younger children with a mean age of 1.80 ± 2.83 years. Previous studies have also found that infants and young children are most seen in the hospital setting with sepsis as their initial diagnosis due to their less developed immune systems and greater vulnerability to severe infections [13]. This is like earlier studies, which also showed that infants are the most susceptible age group when it comes to sepsis and its complications. In this study, MODS occurred in 24.7% of children with sepsis, a rate that was like what was reported previously (20-35%). The differences between the studies could be due to the differences in severity of the disease and the criteria used for diagnosis, as well as the different health care facilities and the different populations studied. However, the results suggest the rate of MODS continues to be high and a significant issue in children's septicemia for which prompt diagnosis and treatment are essential [14-17].

There was no statistically significant association between gender and MODS ($p = 0.408$). The distribution of MODS was found to be comparable between male and female patients, but males made up a slightly larger percentage of the study population. Gender has also not been found to be an independent risk factor in children with sepsis in previous studies and therefore, disease severity and physiological response is the more important risk factor than sex. Likewise, MODS was not significantly related to the need for surgery ($p = 0.387$). A small percentage of children needed surgery, and MODS was not related to the type of surgery. This is in line with previous studies reporting that the severity of the infection and origin of the infection, not surgery itself, is responsible for organ dysfunction [18].

The main finding of the present study was that the use of ventilators significantly affected the development of MODS ($p = 0.001$). A higher proportion of the children with MODS (more than one-third) than the children without MODS (11.5%) required mechanical ventilation. Mechanical ventilation has long been known to be associated with worse outcomes and severe disease in pediatric sepsis. The need for ventilatory support is evidence of severe respiratory dysfunction and systemic illness, and is closely associated with several organ failures. The effect of breastfeeding status on MODS was not significant ($p = 0.862$). Breastfeeding is also known to improve immune protection against childhood infections but its role in the progression of disease once the child has developed sepsis is unclear [19]. There have also been mixed associations between breastfeeding history and the severity of already established sepsis reported previously, which implies that breastfeeding primarily affects disease prevention and not progression [17].

Malnutrition (about half of the study participants) was not significantly correlated with MODS ($p = 0.635$). It has long been recognised that malnutrition is an important risk factor for childhood infections because of nutrition on immune function and poor nutritional reserves. But, conflicting results have been reported previously about its relationship with MODS, some showing a positive association with mortality in malnourished children, while others did not find malnutrition to be an independent predictor after adjusting for severity of illness. The lack of association observed in the current study may be the result of several clinical factors that can drive disease progression. Hepatic dysfunction and renal dysfunction were found in some of the patients; however, these were more likely to reflect the clinical presentation of organ dysfunction and not baseline risk factors as they were part of the evaluation of MODS [20]. Despite this, they serve as an indicator of multisystem involvement in severe paediatric sepsis and highlight the need for monitoring of multiple organ functions during the hospital stay.

Limitations

There were some limitations of this study. The first limitation was the cross-sectional study design, which did not allow for causality to be determined between the risk factors identified and the development of Multi Organ Dysfunction Syndrome (MODS). Second, the study was carried out in a single tertiary care hospital, which might not be representative of other hospital settings and patients. Third, the sample size was relatively small and may have limited the ability to find any significant associations for some variables. Fourth, only a few of the clinical risk factors (gender, surgical interventions, ventilator dependency, breastfeeding, malnutrition) were investigated; however, other clinically important risk factors such as severity of illness scores, microbiological profile, inflammatory biomarkers, timing of antibiotic administration, and comorbid conditions were not analyzed. Fifth, the data were obtained in a hospitalized setting, so that long-term clinical outcomes, as well as mortality following discharge and neurological sequelae could not be assessed.

CONCLUSION

MODS was observed in 24.7% of children with sepsis. Ventilator use was significantly associated with the development of MODS, while gender, need for surgery, breastfeeding status, and malnutrition showed no significant association. Early recognition of respiratory compromise and timely supportive care may help reduce progression to multiple organ dysfunction in septic children.

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