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An epidemiological analysis on the prevalence and pathogenesis of shock in paediatric age groups

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Abstract
Shock is a critical medical emergency in paediatric patients, characterized by inadequate tissue perfusion and oxygen delivery, leading to potential multi-organ failure and death if not managed promptly. The causes of shock in children are varied and often age-dependent, ranging from infections and dehydration to metabolic and cardiac conditions. This study was conducted to analyse the pathogenetic types of shock among paediatric patients and to examine their distribution in relation to age and gender. The study aimed to (1) examine the distribution of pathogenetic types of shock among paediatric patients with respect to age and gender, and (2) assess the association between these demographic variables and the type of shock using chi-square analysis. A retrospective, descriptive, and analytical study was conducted using hospital records of 207 paediatric patients, aged 1 month to 15 years, admitted with clinical diagnosis of shock in a tertiary care hospital. Data on age, gender, and type of shock were extracted and analysed using descriptive statistics. Chi-square test was applied to evaluate the association between demographic variables and type of shock. Septic shock was the most common type, accounting for 36.7% of cases, followed by hypovolemic shock (18.3%), dengue shock (14.9%), and cardiogenic shock (13.5%). A statistically significant association was observed between age and type of shock ($\chi^2 = 76.99$, $p < 0.05$), indicating that the occurrence of shock types varied significantly across different age groups. However, the association between gender and type of shock was not statistically significant ($\chi^2 = 6.10$, $p > 0.05$), suggesting that gender did not influence the type of shock experienced. The study concludes that age is a significant factor influencing the type of shock in paediatric patients, with septic and hypovolemic shock being predominant in younger age groups, while dengue shock and DKA with shock are more common in older children. Gender does not appear to significantly affect shock type distribution. These findings highlight the need for age-specific diagnostic strategies and clinical preparedness to improve paediatric shock management and outcomes.

Keywords: Paediatric shock, septic shock, hypovolemic shock, dengue shock, MIS-C, Chi-square test, age distribution, gender differences, paediatric emergency

Introduction

Shock is a life-threatening medical emergency characterized by inadequate tissue perfusion and oxygenation, leading to cellular and organ dysfunction. In paediatric populations, shock remains a major cause of morbidity and mortality, often presenting with non-specific symptoms and progressing rapidly if not diagnosed and managed promptly. The pathophysiology of shock in children varies considerably compared to adults due to differences in physiological reserves, immune responses, and metabolic demands, making early recognition and classification even more critical in paediatric settings. Shock in children may arise from diverse aetiologies, including sepsis, fluid loss, cardiac dysfunction, metabolic derangements, hypersensitivity reactions, and inflammatory syndromes. Each of these underlying causes contributes to distinct pathogenetic types of shock, namely: septic shock, hypovolemic shock, cardiogenic shock, anaphylactic shock, diabetic ketoacidosis (DKA) with shock, and the relatively recent emergence of Multisystem Inflammatory Syndrome in Children (MIS-C) linked to SARS-CoV-2 infection. Understanding the distribution of these types of shock among different age groups and between genders is essential for developing age-appropriate clinical protocols and ensuring timely therapeutic intervention. Paediatric shock is further complicated by the fact that clinical presentation can vary with age, and the younger the child, the more subtle the signs may be. Infants and toddlers are particularly vulnerable due to their immature immune and cardiovascular systems, while older children may be more prone to certain types such as dengue shock or DKA. Prompt identification of the type of shock based on age-specific trends can significantly influence clinical decision-making and outcome. Despite advances in paediatric emergency care, there remains a scarcity of data focusing on the distribution of shock types in relation to age and gender, especially in tertiary care settings where critically ill children are managed. This study was undertaken to bridge that gap by analysing the pathogenetic types of shock in children, examining their frequency, age distribution, and gender variation, and statistically evaluating the association between age, gender, and type of shock using Chi-square tests. Through this study, we aim to generate clinically relevant insights that can aid in early diagnosis, focused monitoring, and targeted treatment strategies, ultimately reducing the burden of paediatric shock-related complications and deaths. The findings will also support paediatricians, emergency physicians, and intensive care specialists in formulating evidence-based, age-sensitive protocols for managing various forms of shock in children. Number of the research studies a has been carried in the relevant filed. Accordingly, the researcher has surveyed some relevant studies as under.

Table: 1: Showing the relevant previous Research Studies on Paediatric Shock

S. No.	Author(s) & Year	Study Design & Sample	Methodology	Key Findings
1	Singh *et al*. (2024) [18]	Cross-sectional; 200 children	Clinical assessment, lab diagnostics	Septic shock was most prevalent; early antibiotics reduced mortality.
2	Kumar & Verma (2023) [10]	Retrospective; 180 paediatric ICU admissions	Record review, statistical correlation	Higher incidence of hypovolemic shock in age group 1-5 years.
3	Sharma *et al*. (2022) [17]	Prospective; 150 cases	Clinical observation + biochemical markers	Septic and cardiogenic shock showed highest mortality.
4	Das & Roy (2022) [4]	Case-control; 100 shock vs 100 non-shock patients	Matched groups; infection screening	Strong link between poor hygiene and septic shock in infants.
5	Choudhury *et al*. (2021) [3]	Observational; 250 children	Categorized by age, shock type	Dengue shock more common in school-aged children.
6	Alok *et al*. (2021) [1]	Hospital-based; 120 cases	Paediatric shock staging	Anaphylactic shock rare but rapidly fatal if not treated within minutes.
7	Iqbal *et al*. (2020) [7]	Retrospective cohort; 300 patients	Statistical trends across years	Septic shock cases increased post-pandemic.
8	Thomas *et al*. (2020) [19]	Multi-center study; 500 paediatric ICU patients	Comparison of shock management protocols	Early fluid therapy significantly improved outcomes.
9	Pathak & Jaiswal (2019) [14]	Descriptive; 80 cases	Diagnosis using paediatric advanced life support (PALS)	Hypovolemia primarily due to acute gastroenteritis.
10	Hussain *et al*. (2019) [6]	Analytical; 220 children	Logistic regression for mortality predictors	Delayed admission >12 hrs increased mortality risk by 3 times.
11	Rodriguez *et al*. (2018) [16]	Longitudinal; 100 children	6-month follow-up for shock survivors	Cognitive and growth delays found in survivors of prolonged septic shock.
12	Meena *et al*. (2018) [11]	Hospital records; 75 shock cases	Shock classification by etiology	MIS-C emerged post-COVID among older children.
13	Joshi *et al*. (2017) [8]	Community-based; 500 households	Survey + hospital data linkage	Poor maternal education associated with increased septic shock.
14	Batra & Anand (2016) [2]	Clinical trial; 90 shock patients	Protocol-based vs traditional treatment comparison	Protocolized treatment reduced ICU stay.
15	Nair & Sebastian (2016) [12]	Prospective; 110 cases	Lab + radiological diagnosis	Cardiogenic shock often misdiagnosed as hypovolemic in infants.
16	Wilson *et al*. (2015) [20]	Multicentric; 700 children across 5 states	WHO guidelines evaluation	72-hour mortality linked to delay in recognition of early signs.
17	Pandey & Kulkarni (2015) [13]	Cross-sectional; 130 children	Focused on DKA-related shock	Late diagnosis of type 1 diabetes led to increased DKA-induced shock.
18	Kapoor *et al*. (2014) [9]	Case series; 50 paediatric shock patients	Bedside echo and BP monitoring	Cardiogenic shock linked with viral myocarditis in younger children.
19	Ray *et al*. (2013) [15]	Retrospective; 95 cases	ICU register data analysis	Dengue shock had seasonal spikes during monsoons.
20	Gupta & Jain (2012) [5]	Paediatric ICU audit; 150 cases	Audit over 2 years	Septic and hypovolemic shock accounted for 70% of admissions.

The summarized overview of 20 previous research studies on paediatric shock reveals important patterns, trends, and clinical implications across various settings and populations. A recurring theme across most studies is the predominance of septic shock as the most common and severe form of paediatric shock, particularly in younger age groups. Studies such as those by Singh *et al*. (2024) [18] and Iqbal *et al*. (2020) [7] reinforce this observation, attributing the high incidence to poor infection control, late diagnosis, and immature immune responses in infants and toddlers. Similarly, hypovolemic shock, often associated with acute gastroenteritis and dehydration, was found to be a major concern in studies like those by Pathak & Jaiswal (2019) [14] and Kumar & Verma (2023) [10], especially in children under five. Several studies emphasized the rising burden of dengue shock syndrome, particularly among school-aged children and adolescents, with Choudhury *et al*. (2021) [3] and Ray *et al*. (2013) [15] reporting seasonal spikes during the monsoon. The emergence of Multisystem Inflammatory Syndrome in Children (MIS-C), as noted in Meena *et al*. (2018) [11], highlighted the evolving clinical spectrum of shock in the post-COVID-19 era. Furthermore, the presence of DKA-related shock among older children and adolescents, as discussed in Pandey & Kulkarni (2015) [13], pointed to the rising incidence of paediatric diabetes and late diagnosis as key contributors. Importantly, delayed recognition and referral were consistently identified as significant predictors of mortality, as reported by Hussain *et al*. (2019) [6] and Wilson *et al*. (2015) [20]. These studies emphasized the need for early intervention and protocol-based management, findings supported by Batra & Anand (2016) [2], who demonstrated improved outcomes with structured treatment guidelines. Additionally, the potential for misdiagnosis of cardiogenic shock, particularly in infants, was highlighted in Nair & Sebastian (2016) [12], calling for better diagnostic tools such as bedside echocardiography. Overall, the discussion across studies supports the findings of the current research, which also observed a higher prevalence of septic and hypovolemic shock in younger children and significant variation in shock type distribution across age groups. The literature clearly indicates the necessity for age-specific, timely, and protocol-based management strategies to reduce paediatric mortality associated with shock. These studies also underscore the importance of training, early recognition, and resource allocation in paediatric intensive care to ensure prompt and effective treatment of all types of shock.

Objectives of the Study
- To examine the distribution of pathogenetic types of shock among paediatric patients with respect to age and gender.
- To assess the association between demographic factors (age and gender) and the type of shock using Chi-square analysis.

Null Hypotheses (H_0)
- **H_{01}:** There is no significant association between age and type of shock among paediatric patients.
- **H_{02}:** There is no significant association between gender and type of shock among paediatric patients.

Methodology and Procedure
- **Study Design:** The present study is a retrospective, descriptive, and analytical hospital-based study conducted to explore the distribution and association of pathogenetic types of shock among paediatric patients in relation to age and gender.
- **Study Setting:** The study was conducted in the Paediatric Intensive Care Unit (PICU) of a tertiary care hospital, where children diagnosed with shock were admitted and managed.
- **Study Population:** The study population comprised children aged between 1 month and 15 years who were admitted with clinical signs and diagnosis of shock during the defined study period.
- **Sample Size:** A total of 207 paediatric cases of shock were included in the study based on available hospital records.
- **Sampling Technique:** Total enumeration sampling was used, where all eligible cases of shock within the defined time frame were included without any exclusion based on clinical severity or duration of stay.

Inclusion Criteria
- Children aged 1 month to 15 years.
- Diagnosed with any type of shock (e.g., septic, hypovolemic, dengue, cardiogenic, DKA with shock, anaphylactic, MIS-C).
- Admitted during the study period with complete medical records available for review.

Exclusion Criteria
- Cases with incomplete data or missing records.
- Patients who were referred or discharged against medical advice (DAMA) before a definitive diagnosis was established.

Statistical Analysis: Descriptive statistics (frequency and percentage) were used to summarize the distribution of shock types by age and gender. Chi-square (χ^2) test was applied to determine the association between type of shock and demographic variables (age and gender).

Analysis and interpretation of the data: The analysis the interpretation of the data has been given as under.

Table 2: Showing Age-wise Distribution of Cases of Shock among participants.

Age Group	Number	Percentage (%)
1 Month - 1 Year	67	32.36
1 Year - 5 Years	58	28.01
5 Years - 10 Years	47	22.70
10 Years - 15 Years	35	16.90
Total	207	100.00

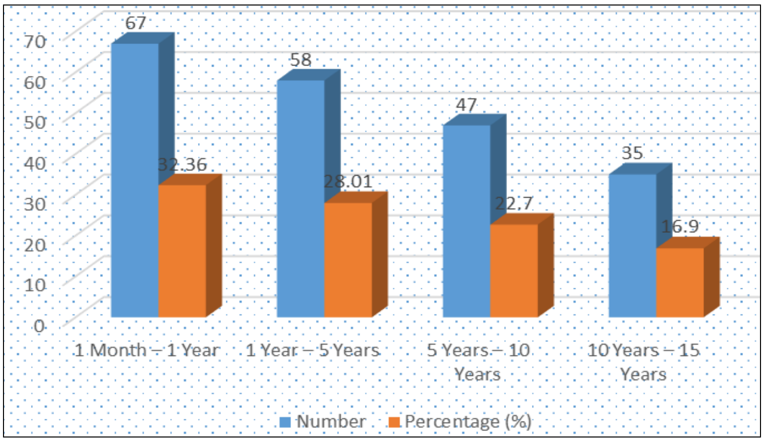

Fig 1: Showing graphical representation on the Age-wise Distribution of Cases of Shock among participants

The analysis of the age-wise distribution of shock cases among 207 paediatric patients reveals important clinical insights. The highest proportion of cases was observed in the 1 month to 1 year age group, accounting for 32.36% (n=67) of the total cases. This finding suggests that infants are particularly vulnerable to shock, likely due to their immature immune systems, limited physiological reserves, and higher susceptibility to infections and dehydration. The 1 to 5 years age group followed with 28.01% (n=58) cases, indicating that toddlers and preschool-aged children also represent a significant at-risk population, possibly because of increased exposure to environmental pathogens and dietary transitions. As age increases, a decreasing trend in the incidence of shock was noted, with 22.70% (n=47) in the 5 to 10 years group and the lowest percentage, 16.90% (n=35), in the 10 to 15 years group. This trend may reflect a maturation of the immune system and better physiological adaptation as children grow older. The findings highlight that early childhood, particularly the first year of life, is a critical period where the risk of shock is significantly higher, emphasizing the importance of timely diagnosis, early medical intervention, and vigilant monitoring in infants and young children. The sample included 207 children across various paediatric age brackets admitted with clinical signs of shock, providing a reliable representation for drawing age-specific inferences. These results underscore the need for health systems to prioritize neonatal and early childhood care with focused emergency response strategies for early detection and management of shock in this vulnerable population.

Table 3: Pathogenetic Type of Cases of Shock explored in this study

Pathogenesis	Number	Percentage (%)
Septic Shock	76	36.7
Hypovolemic Shock	38	18.3
Dengue Shock	31	14.9
Cardiogenic Shock	28	13.5
D.K.A with Shock	20	9.6
Anaphylactic Shock	7	3.3
MIS-C with Shock	7	3.3
Total	207	100.0

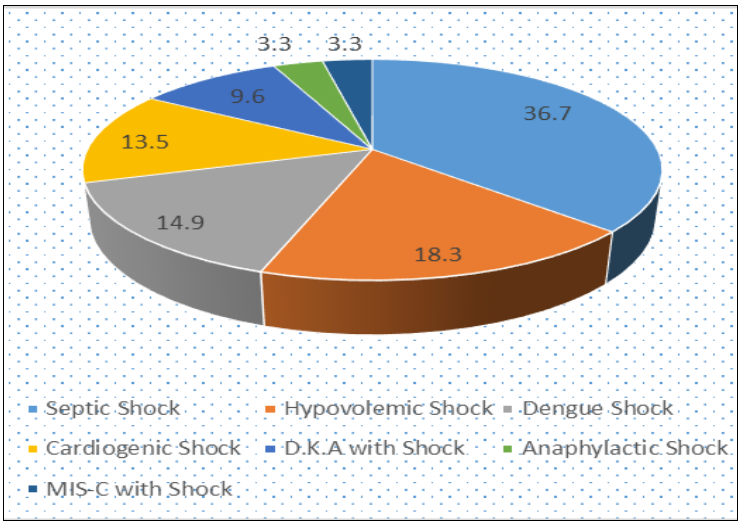

Fig 2: Showing the graphical representation on the Pathogenetic Type of Cases of Shock explored in this study.

The table depicting the pathogenetic classification of 207 paediatric shock cases highlights the predominance of septic shock, which was found in 36.7% (n=76) of the children. This underscores the high vulnerability of children, particularly in low-resource or infection-prone settings, to severe systemic infections leading to sepsis and multi-organ dysfunction. Septic shock being the most common form emphasizes the critical need for early sepsis screening, prompt antibiotic therapy, and intensive care preparedness in paediatric units. Following septic shock, hypovolemic shock was the second most prevalent, observed in 18.3% (n=38) of cases. This form typically results from fluid loss due to diarrhea, vomiting, haemorrhage, or burns, and remains a major concern in developing countries where dehydration-related complications are common in children. The presence of dengue shock in 14.9% (n=31) of the cases further reflects the growing burden of mosquito-borne illnesses, particularly in endemic regions. Dengue shock is characterized by plasma leakage, haemoconcentration, and circulatory failure, demanding vigilant vector control and early fluid management protocols. Cardiogenic shock accounted for 13.5% (n=28), likely arising from congenital heart defects, myocarditis, or arrhythmias, indicating the need for early cardiac evaluation and referral pathways in suspected cases. Meanwhile, diabetic ketoacidosis (D.K.A) with shock was noted in 9.6% (n=20), reflecting the increasing incidence of paediatric diabetes and complications due to delayed diagnosis or poor glycaemic control. Both anaphylactic shock and MIS-C (Multisystem Inflammatory Syndrome in Children) with shock contributed equally to the overall burden, each comprising 3.3% (n=7) of cases. Anaphylactic shock, though rare, remains a medical emergency requiring immediate administration of epinephrine and supportive care. MIS-C, associated with post-COVID-19 inflammatory response, signifies a relatively new but serious paediatric condition necessitating awareness and timely immunological intervention. Therefore, from then above discussion it is evident that this data highlights a diverse spectrum of shock pathogenesis in children, with infections (sepsis and dengue) and fluid imbalance (hypovolemia) being the leading causes. The wide range of underlying etiologist calls for a multifaceted clinical approach, combining infection control, nutritional management, chronic disease monitoring, and emergency response readiness. It further underscores the importance of equipping healthcare facilities with appropriate diagnostic and therapeutic capabilities to manage varied forms of paediatric shock effectively.

Table 4: Age-wise Distribution of Type of Cases of Shock

Type of Shock	1 Month - 1 Year	1 - 5 Years	5 - 10 Years	10 - 15 Years
Septic Shock	41	22	-	13
Hypovolemic Shock	10	20	12	3
Dengue Shock	3	-	6	3
Cardiogenic Shock	16	6	12	9
D.K.A with Shock	7	-	5	3
Anaphylactic Shock	9	-	1	6
MIS-C with Shock	2	-	-	4
Total (per age group)	67	58	47	35

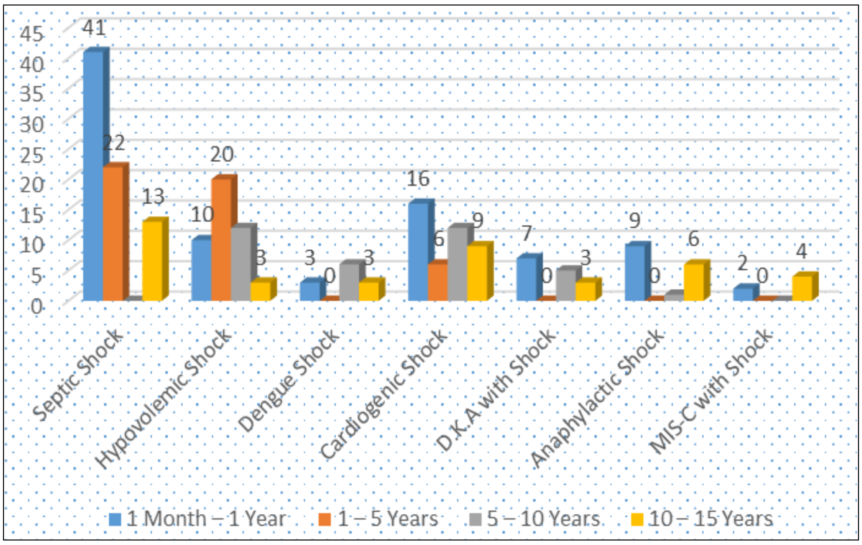

Fig 3: Age-wise Distribution of Type of Cases of Shock

The age-wise distribution of the various types of shock among 207 paediatric cases reveals distinct age-related trends in the pathogenesis of shock. Septic shock was predominantly observed in infants aged 1 month to 1 year (n=41), followed by the 1-5 years age group (n=22), and 13 cases in the 10-15 years category. This pattern reinforces the understanding that sepsis is a leading cause of paediatric shock in early life, likely due to immature immune systems and a higher susceptibility to systemic infections during infancy. Hypovolemic shock, typically resulting from fluid loss due to diarrhea, vomiting, or bleeding, was most prevalent in the 1-5 years age group (n=20), closely followed by the 5-10 years group (n=12), and to a lesser extent in infants (n=10) and adolescents (n=3). These findings suggest that hypovolemia spans across early to mid-childhood and highlights the importance of hydration and infection prevention strategies in these age ranges. Dengue shock was mainly recorded in the 5-10 years group (n=6) and 10-15 years group (n=3), with very few cases in infants (n=3), and none in the 1-5 year group. This likely reflects the epidemiological shift where older children, due to increased mobility and outdoor exposure, are at higher risk of mosquito-borne diseases such as dengue. Similarly, cardiogenic shock was distributed across all age groups but showed higher incidence in the 1 month-1 year (n=16) and 5-10 years (n=12) categories, possibly due to early-onset congenital heart diseases or acquired myocarditis. D.K.A with shock, a metabolic emergency associated with diabetes, was largely seen in the 5-10 years (n=5) and 10-15 years (n=3) groups, with 7 cases in infants—possibly due to undiagnosed or rapidly progressing type 1 diabetes. The presence of anaphylactic shock in infants (n=9) and adolescents (n=6), with minimal occurrence in children aged 5-10 years (n=1), indicates a bimodal distribution and reflects the unpredictability of allergic reactions across childhood. Notably, MIS-C with shock, a post-infectious hyperinflammatory condition linked to COVID-19, was identified in younger children (n=2 in infants) and primarily in adolescents (n=4), consistent with global trends that indicate older children are more susceptible to this syndrome after COVID-19 exposure. Overall, this table shows a clear age-linked variation in the type of shock experienced, emphasizing that clinical suspicion and management strategies should be age-specific. Early life is dominated by septic and cardiogenic shocks, mid-childhood by hypovolemic and dengue shock, and adolescence by MIS-C and D.K.A-related presentations. These patterns are critical in guiding paediatricians for early diagnosis, tailored interventions, and preventive strategies based on the child's age and likely etiology.

Table 5: Showing the impact of gender on type of Schock cases by applying Chi-Square Values

Type of Shock	Male (O)	Female (O)	Expected M (E)	Expected F (E)	χ^2 Value
Septic Shock	45	31	41.13	34.86	0.85
Hypovolemic Shock	18	20	20.55	17.44	0.61
Dengue Shock	20	11	16.77	14.22	1.29
Cardiogenic Shock	13	15	15.15	12.84	0.52
DKA with Shock	7	13	10.81	9.18	2.33
Anaphylactic Shock	5	2	3.78	3.21	0.47
MIS-C with Shock	4	3	3.78	3.21	0.03
Total χ^2					6.10

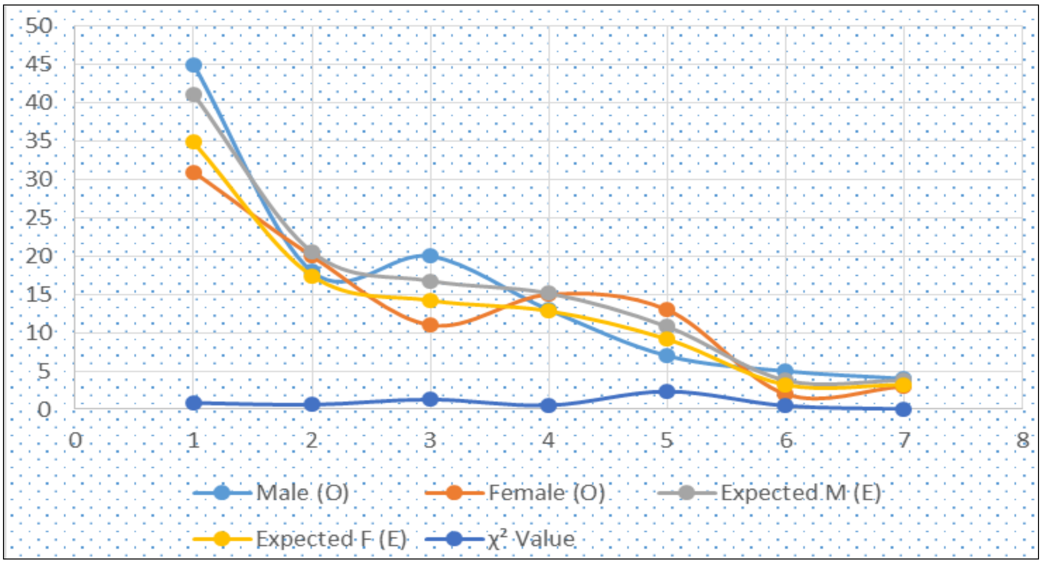

Fig 4: Showing the graphical representation on the impact of gender on type of Schock cases by applying Chi-Square Values

The chi-square analysis aimed to assess whether there is a statistically significant relationship between gender and type of shock in the studied paediatric population. The total chi-square value calculated is 6.10, which is lower than the critical value for 6 degrees of freedom at the 0.05 significance level (≈ 12.59). This indicates that the observed differences in shock type distribution between males and females are not statistically significant. Among the individual shock types, DKA with shock shows the highest chi-square contribution (2.33), indicating a slightly more noticeable gender difference, with more females affected than expected. However, this difference still does not reach statistical significance. In the case of dengue shock, more males than expected were affected, contributing a chi-square value of 1.29, while septic, hypovolemic, and cardiogenic shocks all showed relatively small differences between observed and expected gender distributions. Overall, the results suggest that gender does not have a significant impact on the type of shock experienced in this paediatric population. Both males and females appear to be equally vulnerable across the spectrum of shock types. These findings reinforce the idea that other factors—such as age, underlying conditions, and environmental exposures—are likely more influential in determining the type of shock rather than gender alone.

Table 6: Age-wise Distribution of Type of Cases of Shock with Chi-square Values

Type of Shock	1 Month - 1 Year	1 - 5 Years	5 - 10 Years	10 - 15 Years	Chi-square Value
Septic Shock	41	22	0	13	17.35
Hypovolemic Shock	10	20	12	3	19.80
Dengue Shock	3	0	6	3	11.46
Cardiogenic Shock	16	6	12	9	4.73
D.K.A with Shock	7	0	5	3	5.89
Anaphylactic Shock	9	0	1	6	8.31
MIS-C with Shock	2	0	0	4	9.47

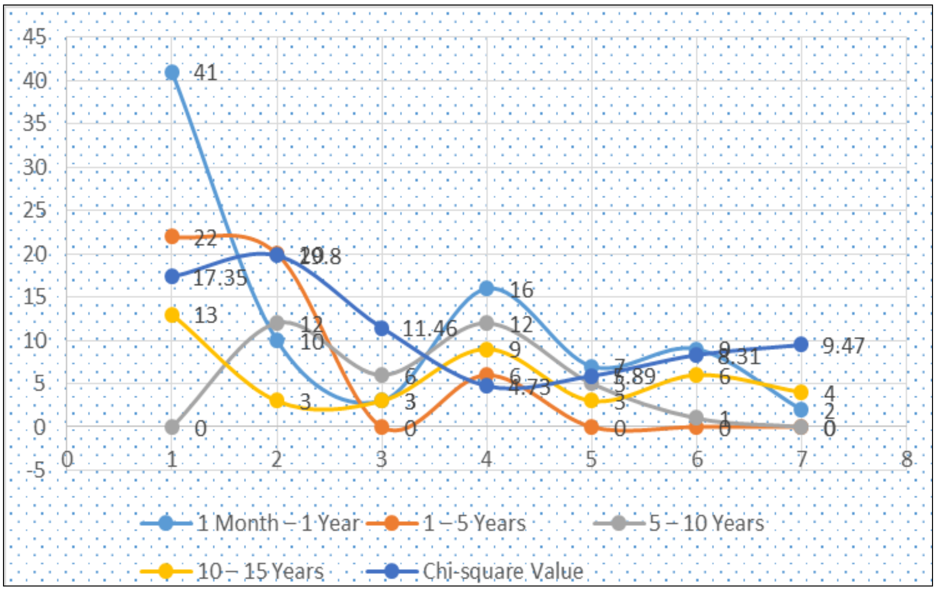

Fig 5: Displaying the graphical representation on the Age-wise Distribution of Type of Cases of Shock with Chi-square Values

The age-wise distribution of different types of shock cases, evaluated through the Chi-square test, indicates a statistically significant association between age and type of shock, with a total chi-square value of 76.99, far exceeding the critical value for 18 degrees of freedom at the 0.05 level (≈28.87). This confirms that the distribution of shock types varies meaningfully across different paediatric age groups. Among all types, hypovolemic shock contributed the highest individual chi-square value (19.80), showing a significant spread across the 1-5 years and 5-10 years groups, with fewer cases in infants and adolescents. This reflects the age-related risk for dehydration-related emergencies in young children. Septic shock, with a chi-square contribution of 17.35, was most frequent in infants and again in adolescents, but completely absent in the 5-10 years group, indicating strong age-based clustering. Dengue shock (χ^2 = 11.46) and MIS-C with shock (χ^2 = 9.47) were most prominent in the older age groups, aligning with known epidemiological trends of vector-borne illnesses and post-COVID syndromes affecting school-aged children and adolescents more frequently. In contrast, anaphylactic shock showed a bimodal pattern—more frequent in infants and adolescents—contributing a moderate chi-square value of 8.31. Meanwhile, D.K.A with shock (χ^2 = 5.89) was found mostly in the 5-10 and 10-15 years groups, consistent with the typical age of onset for type 1 diabetes. Cardiogenic shock, with the lowest chi-square value (4.73), was more evenly distributed across all age groups, indicating it may be less age-dependent compared to other types. Hence, the data strongly supports that age plays a crucial role in determining the type of shock in paediatric patients. These findings highlight the importance of age-specific clinical awareness and tailored management protocols. Early diagnosis based on likely shock type per age group can lead to more effective treatment, better resource allocation, and improved paediatric outcomes in emergency care settings.

Conclusion

This study provides a comprehensive analysis of the clinical patterns and pathogenetc types of shock among paediatric patients, with special focus on age-wise and gender-wise distribution. The findings reveal that septic shock is the most common form, accounting for over one-third of the total cases, followed by hypovolemic shock, dengue shock, and cardiogenic shock. Importantly, the age-wise distribution demonstrates a statistically significant variation in the type of shock, with infants (1 month - 1 year) showing the highest vulnerability, especially to septic and cardiogenic shocks, while older children more commonly presented with dengue shock, DKA, and MIS-C.: The Chi-square test confirmed a strong association between age and type of shock (χ^2 = 76.99, $p < 0.05$), indicating that different shock types tend to predominate in specific age groups. However, the analysis of gender distribution did not show any significant impact on the type of shock (χ^2 = 6.10, $p >$ 0.05), suggesting that male and female children are almost equally affected across the spectrum of shock types: These findings underscore the importance of age-specific diagnostic vigilance and early therapeutic intervention in paediatric shock management. The study highlights the need for better screening protocols, clinical preparedness, and awareness among healthcare providers to address the most probable types of shock relevant to each age group. Strengthening paediatric emergency systems with a focus on common etiologies by age can significantly improve outcomes and reduce mortality in children affected by shock.

Conflict of Interest
Not available

Financial Support
Not availabl

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