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Original Research Article

Age Related Clinical Manifestations of Acute Bacterial Meningitis in Children. A Study at a Tertiary Care Hospital Abbottabad Pakistan

Article History:

Name of Author:
Ubaid Ali[1], Zoya Fayaz[2], Saima Bibi[3], Hareem Shahzad Khan[4], Asif Nawaz[5], Wajid Khan[6]

Affiliation:
[1-6]Department of Paediatrics, Ayub Teaching Hospital Abbottabad, Pakistan.

Corresponding Author:
Ubaid Ali
Email: ubaidali965@gmail.com

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Abstract:
Objective: To determine the frequency of age related clinical manifestations of acute bacterial meningitis in children admitted at a tertiary care hospital in Abbottabad Pakistan. **Study Design:** Cross-sectional study. **Place and Duration of Study:** Conducted from 26th June 2025 to 26th November 2025 at the Paediatrics Unit, Ayub Teaching Hospital. **Methodology:** A total of 180 children aged 1 month to 16 years diagnosed with acute bacterial meningitis were included in the study. Manifestations including fever, vomiting, seizure, altered mental state, stiff neck, photophobia, irritability, lethargy, bulging fontanelle, Kernig's sign, Brudzinski's sign, focal neurological deficit and cranial nerve abnormalities were assessed. SPSS 27 was used for data analysis. Chi-square test and Fisher exact test were applied for stratification with age groups. **Results:** Mean age was 8.68 ± 4.33 years and mean weight was 28.88 ± 15.65 kg. Male children were 107 (59.4%). Fever was the commonest manifestation seen in 173 (96.1%) patients, followed by vomiting and stiff neck in 113 (62.8%) each. Photophobia and lethargy were present in 70 (38.9%) patients each. Stiff neck, photophobia, irritability, bulging fontanelle, Kernig's sign and Brudzinski's sign showed significant association with age ($p<0.05$). Bulging fontanelle was observed only in infants 11 (50.0%). **Conclusion:** Clinical manifestations of acute bacterial meningitis varies significantly with age. Younger children commonly present with non-specific symptoms, whilst older children more frequently show classical meningeal signs.

Keywords: Bacterial meningitis; Child; Fever; Kernig sign; Meningitis, bacterial; Photophobia

INTRODUCTION

Childhood acute bacterial meningitis represents a severe infection affecting the membranes surrounding the brain and spinal cord.1 This illness is considered an emergency medical situation due to the potential for life-threatening complications and death if not promptly diagnosed and treated.2 Bacterial meningitis is typically caused by infections from bacteria like Streptococcus pneumoniae, Neisseria meningitidis, and Haemophilus influenzae. The prevalence of childhood acute bacterial meningitis is quite high in developing nations, with several factors, including crowding, poor nutrition, lack of vaccination and substandard healthcare systems, contributing to its high incidence rate.3

The clinical signs of acute bacterial meningitis among pediatric cases differ according to the age and severity of the infection. The presence of fever is considered to be among the most common signs of this infection, often along with shivers and general malaise.4 Vomiting is common among pediatric patients and may be indicative of increased intracranial pressure and irritation of the meninges. Seizures are important signs that are common among young children and infants, especially those who suffer from recurrent seizures, which indicates a severe infection or damage to the brain.5 Changes in mental state may include confusion and drowsiness, as well as unconsciousness. Stiffness of the neck is among the hallmark signs of this infection among

older children, although it may be absent among infants owing to the underdeveloped neck muscles.6 Photophobia is also common among older children, where light irritates their eyes and causes pain.

Additional neurological symptoms that are worth mentioning are Kernig sign and Brudzinski sign. The latter can help in diagnosing meningeal irritation in older children because the former appears when there is pain and resistance in the extension of the leg after the hip is flexed while the latter is seen when there is an involuntary flexion of the hips and legs following the flexion of the neck.7

Both tests are less reliable among infants and newborns because of their immature neurological system. In some patients, focal neurological deficit may occur, involving weakness in limbs, poor coordination, difficulty in talking, or abnormal reflexes.8 Moreover, there could be some issues with the cranial nerves, including cranial nerves six, seven and eight.9

Bacterial meningitis remains an important source of morbidity and mortality in childhood, especially among developing countries. The signs and symptoms associated with this disease depend on age, making its diagnosis difficult especially in neonates and younger children who show nonspecific symptoms. Failure to recognize the disease early enough often leads to devastating consequences like seizures, sensorineural deafness, cranial nerve palsies, and intellectual disability. So we planned to determine the frequency of age related clinical manifestations of acute bacterial meningitis in children.

METHODOLOGY

This cross-sectional study was carried out from 26th June 2025 to 26th November 2025 at the Paediatrics Unit of Ayub Teaching Hospital. The study was conducted after obtaining approval from the hospital ethical and research committee under ethical approval code Ref.No.RC-EA-2024/212. A total of 180 children were included in the study. Sample size was calculated by using OpenEpi software while taking expected frequency of Kernig's sign positivity as 13.5%,10 confidence level of 95% and margin of error of 5%.

Children of either gender aged 1 month to 16 years who were admitted in paediatric ward and diagnosed as cases of acute bacterial meningitis were included in the study. Acute bacterial meningitis was considered as acute inflammation of leptomeninges and subarachnoid space due to bacterial infection, presented within 72 hours with fever and/or vomiting and/or altered mental state and/or fits along with abnormal cerebrospinal fluid findings including white blood cell count ≥10/mm^3, raised protein 20–45 mg/dl, decreased glucose <40 mg/dl and positive bacterial culture or gram stain.

Children having congenital brain malformations, intracranial bleed, brain tumours, recurrent meningitis or immunocompromised status were excluded from the study.

Written informed consent was taken from parents or guardians before enrolment in the study. Confidentiality of all participants was maintained throughout the study and there was no additional risk to the patients during participation. Demographic details including age, gender, weight, family socioeconomic status, parents educational level and residential status were recorded.

Detailed history was taken from parents or guardians and clinical examination was performed in all patients. Medical records and cerebrospinal fluid reports were also reviewed for confirmation of diagnosis and assessment of clinical manifestations. Clinical manifestations including fever, vomiting, seizure, altered mental state, neck stiffness, photophobia, irritability, lethargy, bulging anterior fontanelle, Kernig's sign, Brudzinski's sign, focal neurological deficit and cranial nerve abnormality were assessed and recorded as per standard definitions.

All collected data were entered and analysed by using Statistical Package for Social Sciences (SPSS) version 27.0. Quantitative variables including age and weight were presented as mean ± standard deviation. Categorical variables including gender, family socioeconomic status, parents educational level and clinical manifestations were expressed as frequency and percentages. Clinical manifestations were stratified with age. Post-stratification Chi-square test or Fisher exact test was applied where appropriate and p-value ≤0.05 was considered statistically significant.

RESULTS

A total of 180 children with acute bacterial meningitis were included in the study. The mean age of the patients was 8.68 ± 4.33 years, and the mean weight was 28.88 ± 15.65 kg. The majority of the patients were male, comprising 107 children (59.4%), whilst female patients were 73 (40.6%). With regard to socioeconomic status, most families belonged to low socioeconomic class, accounting for 102 patients (56.7%), followed by middle class at 56 (31.1%) and high class at 22 (12.2%) (Table 1).

Table 1. Patient Demographics

Demographics	n (%) or Mean ± SD
Age (years)	8.68 ± 4.33
Weight (kg)	28.88 ± 15.65
Gender	
Male n (%)	107 (59.4%)
Female n (%)	73 (40.6%)
Family Socioeconomic Status	
Low n (%)	102 (56.7%)
Middle n (%)	56 (31.1%)
High n (%)	22 (12.2%)
Residential Status	
Rural n (%)	114 (63.3%)
Urban n (%)	66 (36.7%)
Parents Educational Level	
Uneducated n (%)	73 (40.6%)
Primary n (%)	52 (28.9%)
Secondary n (%)	36 (20.0%)
Higher n (%)	19 (10.6%)

Among the clinical manifestations documented, fever was the most frequently observed symptom, present in 173 children (96.1%), followed by vomiting and stiff neck, each recorded in 113 patients (62.8%). Photophobia and lethargy were present in 70 patients each (38.9%), whilst altered mental status was noted in 61 cases (33.9%). Irritability was observed in 57 children (31.7%), Kernig's sign in 49 (27.2%), and Brudzinski's sign in 47 (26.1%). Seizures were documented in 42 patients (23.3%), whilst bulging fontanelle was seen in 11 (6.1%), cranial nerve abnormalities in 8 (4.4%), and focal neurological deficits in 6 (3.3%) (Table 2).

Table 2. Frequency of Clinical Manifestations of Acute Bacterial Meningitis in Children

Clinical Manifestations	Frequency	%age
Fever	173	96.10%
Vomiting	113	62.80%
Stiff Neck	113	62.80%
Photophobia	70	38.90%
Lethargy	70	38.90%
Altered Mental Status	61	33.90%
Irritability	57	31.70%
Kernig's Sign	49	27.20%
Brudzinski's Sign	47	26.10%
Seizures	42	23.30%
Bulging Fontanelle	11	6.10%
Cranial Nerve Abnormalities	8	4.40%
Focal Neurological Deficits	6	3.30%

Stiff neck showed a highly significant association with age group ($p < 0.001$), being least common in infants at 5 (22.7%) and progressively more frequent in older children, reaching 43 (74.1%) in the 12–16 years group. Photophobia was similarly significant ($p < 0.001$), with only 1 (4.5%) in the youngest group as compared to 38 (65.5%) in the oldest group. Irritability demonstrated a reverse pattern, being most prevalent in younger children — 15 (68.2%) in infants and 28 (68.3%) in 1–5 years — but markedly declining in the older groups, at 9 (15.3%) and 5 (8.6%) respectively ($p < 0.001$). Bulging fontanelle was exclusively present in infants, observed in 11 (50.0%) of the 1 month to 1-year group, with complete absence in all older age groups ($p < 0.001$). Kernig's sign and Brudzinski's sign both showed statistically significant age-related differences, with increasing prevalence in older children ($p=0.002$ and $p=0.004$, respectively) (Table 3).

Table 3. Association of Age Groups with Clinical Manifestations of Acute Bacterial Meningitis in Children

Clinical Manifestations	Age Group	Yes n (%)	No n (%)	p-value
Fever	1 month – 1 year	21 (95.5%)	1 (4.5%)	0.567**
	1 – 5 years	40 (97.6%)	1 (2.4%)	
	6 – 11 years	55 (93.2%)	4 (6.8%)	
	12 – 16 years	57 (98.3%)	1 (1.7%)	
Vomiting	1 month – 1 year	15 (68.2%)	7 (31.8%)	0.283*
	1 – 5 years	24 (58.5%)	17 (41.5%)	
	6 – 11 years	42 (71.2%)	17 (28.8%)	
	12 – 16 years	32 (55.2%)	26 (44.8%)	
Altered Mental Status	1 month – 1 year	8 (36.4%)	14 (63.6%)	0.467*
	1 – 5 years	15 (36.6%)	26 (63.4%)	
	6 – 11 years	23 (39.0%)	36 (61.0%)	
	12 – 16 years	15 (25.9%)	43 (74.1%)	
Seizures	1 month – 1 year	7 (31.8%)	15 (68.2%)	0.053*
	1 – 5 years	15 (36.6%)	26 (63.4%)	
	6 – 11 years	9 (15.3%)	50 (84.7%)	
	12 – 16 years	11 (19.0%)	47 (81.0%)	
Stiff Neck	1 month – 1 year	5 (22.7%)	17 (77.3%)	<0.001**
	1 – 5 years	23 (56.1%)	18 (43.9%)	
	6 – 11 years	42 (71.2%)	17 (28.8%)	
	12 – 16 years	43 (74.1%)	15 (25.9%)	
Photophobia	1 month – 1 year	1 (4.5%)	21 (95.5%)	<0.001**
	1 – 5 years	4 (9.8%)	37 (90.2%)	
	6 – 11 years	27 (45.8%)	32 (54.2%)	
	12 – 16 years	38 (65.5%)	20 (34.5%)	
Irritability	1 month – 1 year	15 (68.2%)	7 (31.8%)	<0.001**
	1 – 5 years	28 (68.3%)	13 (31.7%)	
	6 – 11 years	9 (15.3%)	50 (84.7%)	
	12 – 16 years	5 (8.6%)	53 (91.4%)	
Lethargy	1 month – 1 year	12 (54.5%)	10 (45.5%)	0.176*
	1 – 5 years	18 (43.9%)	23 (56.1%)	
	6 – 11 years	23 (39.0%)	36 (61.0%)	
	12 – 16 years	17 (29.3%)	41 (70.7%)	
Bulging Fontanelle	1 month – 1 year	11 (50.0%)	11 (50.0%)	<0.001**
	1 – 5 years	0 (0.0%)	41 (100.0%)	
	6 – 11 years	0 (0.0%)	59 (100.0%)	
	12 – 16 years	0 (0.0%)	58 (100.0%)	
Focal Neurological Deficits	1 month – 1 year	0 (0.0%)	22 (100.0%)	0.196**
	1 – 5 years	0 (0.0%)	41 (100.0%)	
	6 – 11 years	2 (3.4%)	57 (96.6%)	
	12 – 16 years	4 (6.9%)	54 (93.1%)	
Cranial Nerve Abnormalities	1 month – 1 year	2 (9.1%)	20 (90.9%)	0.758**
	1 – 5 years	2 (4.9%)	39 (95.1%)	
	6 – 11 years	2 (3.4%)	57 (96.6%)	
	12 – 16 years	2 (3.4%)	56 (96.6%)	
Kernig's Sign	1 month – 1 year	1 (4.5%)	21 (95.5%)	0.002**
	1 – 5 years	6 (14.6%)	35 (85.4%)	
	6 – 11 years	19 (32.2%)	40 (67.8%)	
	12 – 16 years	23 (39.7%)	35 (60.3%)	
Brudzinski's Sign	1 month – 1 year	0 (0.0%)	22 (100.0%)	0.004**
	1 – 5 years	8 (19.5%)	33 (80.5%)	
	6 – 11 years	17 (28.8%)	42 (71.2%)	
	12 – 16 years	22 (37.9%)	36 (62.1%)	

*Chi-square test **Fischer Exact Test

DISCUSSION

In present study regarding age related differences, stiff neck was significantly more common in older children, increasing from only 22.7% in infants to 74.1% in the 12–16 years age group. This is because in younger infants, the neck muscles are not fully developed and meningeal signs is often unreliable due to immature nervous system and less developed inflammatory response. Photophobia also showed highly significant increase with age, from just 4.5% in infants to 65.5% in oldest group. This can be explained by the fact that photophobia require intact cortical processing of visual stimuli, which is more developed in older children. Kernig's sign and Brudzinski's sign both was more frequently observed in older children, with significant p-values of 0.002 and 0.004 respectively. These meningeal signs depend upon the ability to elicit stretch reflex in spinal nerve roots, which becomes more reliable and demonstrable as the nervous system matures with increasing age.11

The present study found that fever was the commonest presenting symptom, observed in 173 children (96.1%), which is closely comparable to the findings of Abd et al. 12 who reported fever in 94% of their patients, and also consistent with Fayyaz et al. 10 who similarly identified fever as the predominant symptom across all age groups. This high frequency of fever across different studies and settings reflect the universal role of pyrogen mediated hypothalamic stimulation in response to bacterial invasion, regardless of geographical variation.

Vomiting was present in 113 patients (62.8%) in the present study, which is comparable to Abd et al. 12 who reported vomiting in 64% of cases. Stiff neck was equally observed in 113 patients (62.8%), and this finding is in agreement with the general literature which identifies neck stiffness as a classical sign of meningeal irritation in older children. However, the present study demonstrated that stiff neck was significantly less frequent in infants, being present in only 5 (22.7%) of children aged 1 month to 1 year, which is well supported by Abd et al. 12 and Fayyaz et al. 10 who both reported that meningeal signs are often unreliable or absent in younger age groups due to immature neurological development and less pronounced inflammatory response.

Irritability was noted in 57 children (31.7%) overall, however when analysed by age, it was predominantly seen in infants 15 (68.2%) and children aged 1–5 years 28 (68.3%), with a sharp decline in older age groups. This pattern is consistent with observations of Fayyaz et al. 10 and Abd et al. 12 both of whom reported that irritability and bulging fontanelle are predominant features in younger children, whilst older children tends to present with more classical signs such as headache, neck pain and photophobia.

Seizures was observed in 42 patients (23.3%) in the present study. This is somewhat lower than what was reported by Javed et al. 13 who found seizures in 139 (63.2%) of their patients, and also lower than Kaplan et al. 14 who stated that seizures occurs in approximately 30% of bacterial meningitis cases. The difference may be related to the age distribution of the study sample, as the present study included older children up to 16 years whilst Javed et al. 13 focused on a younger age group of 6–24 months, in whom seizure threshold is generally lower due to immature cortical inhibitory mechanisms.

Kernig's sign and Brudzinski's sign were present in 49 (27.2%) and 47 (26.1%) patients respectively, with both signs showing statistically significant increase in prevalence with advancing age (p=0.002 and p=0.004). Fayyaz et al. 10 similarly highlighted that classical meningeal signs may be absent in almost 20% of children, further supporting the notion that clinical diagnosis in younger age groups remain particularly challenging.

Male predominance was observed in the present study with 107 males (59.4%), which is comparable to findings of Bari et al. 15 who reported 127 males (63.8%), and Camara et al. 11 who also reported male predominance in their paediatric meningitis cohort. This consistent male predominance across studies may reflects a combination of biological susceptibility and behavioural factors leading to greater exposure to pathogens in male children.17 Furthermore, the majority of patients in the present study belonged to low socioeconomic class 102 (56.7%) and rural areas 114 (63.3%), which is in keeping with the broader observation that bacterial meningitis disproportionately affects children from resource limited settings where vaccination coverage, healthcare access and early recognition of symptoms remains inadequate.18

There are many limitations that exist within this research study and these need to be considered. This is due to the fact that the study was carried out in a single location; a tertiary care hospital. This implies that the results obtained cannot be generalized to all people of Pakistan as well as other third world countries. Moreover, this study used clinical diagnosis without conducting any tests to confirm its validity.

CONCLUSION

Conclusions drawn from the current investigation indicate that age plays a vital role in determining the clinical presentation of acute bacterial meningitis among children, and there is considerable variability in symptom presentation according to different ages.

Disclaimer: None
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Conflict of Interest:

Author declared that no conflict of interest was present regarding this research work.

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