



Original Article



Assessment of Levels of Disability in Children Following Post-Meningitis Sequelae: A Hospital-Based Cross-Sectional Study

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ABSTRACT

Meningitis is a globally rampant disease, particularly affecting children, and often results in a series of debilitating neuro-physiological and cognitive impairments. These outcomes are collectively classified as post-meningitis sequelae in the pediatric population. **Objectives:** To assess the levels of disability among children following post-meningitis sequelae. **Methods:** A descriptive cross-sectional study was conducted on 144 children (aged 3–10 years) with post-meningitis sequelae at The Children's Hospital, Lahore. Participants were selected using non-probability purposive sampling. Functional outcomes were assessed using a modified Pediatric Glasgow Outcome Scale – Extended (Peds-GOSE). Data were analyzed using SPSS version 26.0. Frequencies and percentages were calculated, and chi-square tests were applied to determine associations between demographic variables and disability levels. **Results:** Out of 144 children, 8% were in a vegetative state (Peds-GOSE 7), 36% had Lower Severe Disability (Peds-GOSE 6), 23% had Upper Severe Disability (Peds-GOSE 5), 17% had Lower Moderate Disability (Peds-GOSE 4), and 6% had Upper Moderate Disability (Peds-GOSE 3). Only 35% showed good recovery (Peds-GOSE 1–2). Overall, 65% experienced unfavorable outcomes (Peds-GOSE 3–7). A statistically significant association was found between age and disability level ($\chi^2 = 63.713$, $df = 12$, $p < 0.001$). **Conclusion:** The majority of children with post-meningitis sequelae demonstrated unfavorable outcomes, with 65.3% falling into moderate to severe disability categories. Lower Severe Disability (25%) was most common, while only 18.8% achieved complete recovery. Younger age was significantly associated with greater disability severity ($p < 0.001$), indicating increased vulnerability in early childhood.

INTRODUCTION

Post-viral or bacterial meningitis in children is a concern because of its long-term effects [1, 2]. The prevalence of meningitis is still a threat to public health in the world as children below the age of five years often contract the disease and hence face high morbidity and mortality rates due to the infection [3]. Even after enhanced prevention and treatment, such as conjugate vaccines, there are still long-term disabilities among the survivors, commonly

known as post-meningitis sequelae [4]. They are generally wide-ranging neuropsychological and physical sequelae and have major impacts upon the development, quality of life, and overall functioning of children [5]. There is strong evidence that suggests that the survivors of bacterial meningitis often face lifelong disabilities, and likely in 36 percent of cases in children, the result is sustained neurological morbidities [6]. In particular, the literature



states that the probability of developing chronic health conditions is high, such as cognitive slow development, behavioral symptoms, hearing and sight deficiency, which could be even more evident as the child ages and experiences growing societal and educational challenges [7]. In a recent study in Denmark and the Netherlands, it was identified that children with bacterial meningitis are more prone to show neurodevelopmental impairments and that they increase over time, which supports the necessity of early intervention measures [7]. The sequelae may present differently in other populations, and some of them include partial deafness and motor impairment, among others. These impairments often require intensive rehabilitation and pose challenges to reintegration into traditional education and social systems [6, 8]. As well, some inequalities in the prevalence and recognition of these sequelae in various geographical areas point to the lack of studies that will fill this knowledge gap efficiently. Research concerning the low- and middle-income settings tends to indicate more cases of such disabilities, potentially due to poorer access to the healthcare system and subsequent treatment of these conditions in the event of recovery [9]. Although there is a lot of literature on the subject matter, there are gaps in terms of a comprehensive understanding of the long-term consequences of bacterial meningitis in children. Some reports highlight the importance of conducting more extensive, longitudinal studies that encompass standardized assessment methodologies to be used to investigate the entirety of the consequences of meningitis [10]. The assessment of a variety of studies by means of the meta-analysis suggests that the risk of the long-term health-related quality of life being negatively impacted is rather high, especially in individuals with an adverse outcome in the form of the neurologic and audiologic sequelae after the acute illness [11]. This necessitates urgent attention to the approaches to evaluating the outcomes and the significance of follow-up assessments to detect disabilities that would otherwise remain hidden over the course of a long time [6, 10]. Since post-meningitis sequelae are multidimensional, the combination of pediatricians, neurologists, audiologists, and psychologists is crucial when dealing with children affected by it, as it targets a broader scope of post-meningitic sequelae needing treatment [11]. Moreover, the possible expenses that such consequences could bring are highlighted in recent studies, and policymakers should focus on programs to enhance preventive activities as well as the access to rehabilitation services by the affected children [12]. Accordingly, a suggested cross-sectional research that will be hospital-based aims at systematically evaluating the rates of disability in post-meningitis sequelae children and fills the gaps in the existing body of

research, and can consequently assist in establishing specific protocols of medical intervention in clinical practice. Current research highlights the need to identify different types of sequelae, including emotional and cognitive disorders, which can vary dramatically in their ways of appearance in children with different backgrounds, and this may require specialized treatment in dealing with sequelae [13]. The validated scales that will be used to measure these conditions will give a more definitive knowledge of the consequences of meningitis. Despite the high burden of meningitis in the Asian meningitis belt, there is a notable lack of comprehensive data on the levels of disability experienced by children following post-meningitis sequelae in this region. Existing studies often focus on acute management or isolated complications, while detailed functional assessments remain limited. This study aims to fill this critical gap by systematically evaluating the degree of disability using the Pediatric Glasgow Outcome Scale - Extended (Peds GOS-E), a validated tool for assessing neurological and functional outcomes in pediatric populations. Understanding these disability levels is essential for guiding clinical interventions and rehabilitation strategies to improve long-term quality of life for affected children.

Despite the well-documented neurological and functional consequences of pediatric meningitis, there remains limited hospital-based data from Pakistan quantifying the spectrum and severity of disability using standardized outcome measures. Most regional studies emphasize acute management and mortality, while structured evaluation of long-term functional outcomes, particularly using validated tools such as the Pediatric Glasgow Outcome Scale, Extended (Peds-GOSE) is scarce. Additionally, age-stratified analysis of disability severity in local populations has been inadequately explored. This gap in systematic functional assessment underscores the need for context-specific evidence to better inform rehabilitation planning and long-term care strategies. This study aimed to assess the levels of disability in children following post-meningitis sequelae.

METHODS

This cross-sectional study was conducted on 144 children at the Department of Physical Medicine and Rehabilitation and the Pediatric Neurology Ward, The Children's Hospital, and the University of Child Health Sciences, Lahore, between June 2024 and January 2025. Ethical clearance was obtained from the ethical committee of The School of Allied Health Sciences, The Children's Hospital, and The University of Child Health Sciences, Lahore (No.700/SAHS). The sample size included 144 children undergoing post meningitis sequelae calculated by the following formula: $n = (Z^2 \times p \times (1 - p) / e^2)$. Where: $Z = 1.96$

(confidence level), $e = 0.05$ (margin of error), $p = 0.105$ (prevalence based on reference [14]). The calculated value (143.3) was rounded up to 144 using the ceiling method. No additional adjustment for non-response was made, as all selected participants were available for inclusion. Non-probability convenience sampling technique was used to collect data. Children ranging from 3 years to 10 years with CSF-diagnosed meningitis were included in the study. Children with a history of meningitis before three years of age were excluded from the study. Patients with encephalitis, cerebral palsy, and developmental delay, and those who were admitted with suspected meningitis attributable to head injury, neurosurgical procedures, or brain abscesses, were not a part of the study. In addition, children who died during post-meningitis sequelae were not included in the research assessment. Upon obtaining IRB approval, patients meeting the inclusion criteria were recruited and informed about the study. Informed written consent was obtained from the parents or legal guardians of all participants before data collection. The hospital records provided demographic information such as age, sex, and other pertinent clinical details, which were confirmed using the interviews of the parents/caregivers. The Pediatric Glasgow Outcome Scale-Extended (Peds-GOSE) was used to determine the disability outcomes. The Peds-GOSE categorizes the children into seven ordinal options (scores 1-7) according to their consciousness, independence both at home and out of home, mobility, school performance, behavioral interactions, psychological adjustment, and recovery to the pre-injury functioning. The highest degree of disability was then assigned a score, with a score of 7 representing a vegetative state (no command following), a score of 6 representing dependence in the basic self-care, a score of 5 representing dependence outside of home with aids or use of a wheelchair, a score of 4 representing the inability to resume school or work with reduced role performance, a score of 3 representing social or behavioral problems that limited participation, a score of 2 representing lower good recovery with residual symptoms and functional independence, and a score of 1 representing upper good recovery with complete performance of previous functions. As the Peds-GOSE is an ordinal categorical scale, cumulative scoring cannot be used, and every child was put

in one of the seven categories. The Peds-GOSE has previously been found to be valid in pediatrics [15]. The data were entered and analyzed using IBM SPSS version 26.0. The categorical variables were illustrated in the form of frequencies and percentages.

RESULTS

A total of 144 Children were included in the study between 3 years of age to 10 years old through a non-probability sampling technique from the Physical Medicine and Rehabilitation Department of the Children's Hospital, Lahore. Since it's a cross-sectional study, the data were recorded at the same time and place. 63 children were between the ages of 3-5, 52 children were between the ages of 6-8, and 29 children were between the ages of 9-10. Among 144 children, 106 were male and 38 were female (Table 1).

Table 1: Demographic Characteristics of Study Participants

Demographics	Frequency (%)
Age	
3-5 Years	63 (43.8%)
6-8 Years	52 (36.1%)
9-10 Years	29 (20.1%)
Total	144 (100%)
Gender	
Male	106 (73.6%)
Female	38 (26.4%)
Total	144 (100%)

Results illustrate the levels of disability assessed through the Peds-GOSE scale; out of 144 children, 132 children were in complete consciousness; however, 12 children were found to be in a vegetative state. Similarly, 48 children out of 144 required assistance for basic ADLs, and 71 children from a sample of 144 required assistance to ambulate freely outside the home. 88 children out of 144 were unable to resume school at the previous capacity, and a predominant number of children, 88 out of 144, suffered from complete withdrawal from any sort of active participation and severe psychological distress. After a thorough evaluation and examination, only 27 children out of 144 returned to normal life, while the remaining children faced incomprehensible impairment due to the sequelae (Table 2).

Table 2: Pediatric Glasgow Outcome Scale-Extended (Peds-GOSE) Assessment Responses

Questions	Response	Frequency (%)	GOSE Score
Consciousness: Is the patient able to obey simple commands or say any words?	Yes	132 (91.7%)	7
	No (Vegetative State)	12 (8.3%)	
Independence inside the home: Can the child perform basic daily life activities, like brushing, eating, and toileting, without any assistance?	Needs No Assistance	96 (66.7%)	6
	Dependent for Basic ADLs	48 (33.3%)	
Independence outside Home: Is the child able to travel without assistance?	Yes	73 (50.7%)	5
	No	71 (49.3%)	

School Performance: Is the child able to resume school at his previous capacity	Yes	88 (61%)	4
	No	56 (39%)	
Social Participation: Is the child able to resume regular social or leisure activities	No	88 (61.1%)	3
	Moderate	6 (4%)	
	Slight	23 (16%)	
Family and Friends: Psychological Irritability	Complete Social Participation	27 (18.8%)	2
	Marked/Constant	88 (61.1%)	
	Moderate Psychological Discomfort	19 (13.3%)	
	Slight Psychological Discomfort	8 (5.5%)	
Return to Normal Life: Are there any problems related to injury that affect daily life?	No	27 (19%)	1
	Yes	117 (81%)	
Total	-	144 (100%)	-

The Pediatric Glasgow Outcome Scale-Extended (Peds-GOSE) was used to classify levels of disability among children with post-meningitis sequelae. The majority of children (65.3%) demonstrated unfavorable outcomes, falling into the moderate to severe disability categories (scores 3-7). The most common category was Lower Severe Disability (score 6), found in 36 children (25.0%), followed by Upper Severe Disability (score 5) in 23 children (16.0%). Only 27 children (18.8%) achieved complete recovery, corresponding to Upper Good Recovery (score 1). This distribution shows that most children continued to experience significant functional limitations after meningitis, with only a small proportion regaining full pre-illness function (Table 3).

Table 3: Levels of Disability Based on Peds-GOSE with 95% Confidence Intervals

Peds-GOSE Score	Level of Disability	Criteria (Summary)	n (%)	95% CI (%)
7	Vegetative State (VS)	No response or only reflexive; unable to follow simple commands	12 (8.3%)	3.8 – 12.8
6	Lower Severe Disability (LSD)	Dependent in basic self-care (feeding, grooming, dressing)	36 (25.0%)	17.7 – 32.3
5	Upper Severe Disability (USD)	Requires mobility aids/wheelchair; dependent outside the home	23 (16.0%)	9.9 – 22.1
4	Lower Moderate Disability (LMD)	Unable to resume school/work; reduced role performance	17 (11.8%)	6.5 – 17.1
3	Upper Moderate Disability (UMD)	Social/behavioral difficulties limiting play or peer interaction	6 (4.2%)	1.0 – 7.4
2	Lower Good Recovery (LGR)	Functional independence achieved, but residual symptoms/behavioral issues present	23 (16.0%)	9.9 – 22.1
1	Upper Good Recovery (UGR)	Complete recovery to pre-injury level (per caregiver report)	27 (18.8%)	12.3 – 25.3

The association between age groups and the level of disability measured by the Pediatric Glasgow Outcome Scale Extended (Peds-GOSE) was assessed using the chi-square test. The study shows the distribution of Peds-GOSE categories across three age groups (3-5 years, 6-8 years, and 9-10 years) (Table 4).

Table 4: Distribution of Peds-GOSE Disability Categories by Age Group

Peds-GOSE Category	Age 3-5	Age 6-8	Age 9-10	Total
Upper Good Recovery (UGR)	11	5	11	27
Lower Good Recovery (LGR)	11	6	6	23
Upper Moderate Disability (UMD)	6	0	0	6
Lower Moderate Disability (LMD)	0	17	0	17
Upper Severe Disability (USD)	11	12	0	23
Lower Severe Disability (LSD)	18	6	12	36
Vegetative State (VS)	6	6	0	12
Total	63	52	29	144

The chi-square test revealed a statistically significant association between age and disability level ($\chi^2 = 63.713$, $df = 12$, $p < 0.001$), indicating that the distribution of disability severity significantly varies with age among the children

studied (Table 5).

Table 5: Chi-Square Test for Association Between Age Group and Peds-GOSE Disability Categories

Statistic	Value	df	p-Value
Pearson Chi-Square	63.713	12	<0.001
Number of Valid Cases	144	-	-

DISCUSSION

The findings of the study provide critical information on the follow-up disability cases in children with post-meningitis sequelae. The number of children assessed was 144 children aged between 3 and 10 years old. The predominance of male participants (73.6%) is notable, as it may relate to variance in independence, social participation, and overall quality of life. This gender disparity in the cases of meningitis reflects itself in a study by Block et al. who reported the higher rate of bacterial infection cases in males as compared to females because of the immune response differences [16]. The age distribution of the children in this study indicates that the younger children (3-5 years) comprised the largest

proportion of the sampling percentage (43.8%), indicating that the outcome of affected children in that age group tends to have worse implications after getting meningitis. Mohanty *et al.* also highlight this sentiment, citing that younger children with the diagnosis of bacterial meningitis experience much higher risks of developing cognitive impairments and related disorders, with the most emphasis made on the emergence of emotional and behavioral disorders [3]. In keeping with this, the chi-square test conducted in this study (i.e., 63.713, $p < 0.001$) has shown a statistically significant relationship between age and the level of disability, thus outlining the vulnerabilities of younger children. The distribution of disability levels, as assessed by the Pediatric Glasgow Outcome Scale Extended (Peds-GOSE), shows a concerning trend in the outcome of the recovery outcomes of meningitis. Although 91.7% of participants had intact consciousness, 8.3% were in a vegetative state. This fact aligns with the previous research by Schiess *et al.* where significant proportions of children also showed either severe impairments or altered consciousness after experiencing bacterial meningitis [17]. This important observation illustrates the significant neurological effects reported in the literature, with many survivors experiencing severe impairments in terms of cognitive and communicative skills [8]. Specifically, Garg *et al.* reported that young children (up to 36%) became profoundly disabled due to bacterial meningitis [5]. It was caused by the pathogenic effect of the high-risk pathogens, such as *Streptococcus pneumoniae* [9]. Moreover, the level of psychological distress reported was alarming; 61.1% of children exhibited marked or constant irritability, indicating potential underlying issues that warrant attention. Studies by Schiess *et al.* corroborate these observations, documenting that neurological sequelae can manifest not only as physical disabilities but also as significant psychological distress and behavioral issues [17]. The high rate of social withdrawal (61.1%) and the failure to resume schooling (39%) indicate that these consequences may be disastrous in terms of both their education and development. This observation is reflected in the literature, showing that returning to academic life can be rather problematic with survivors of meningitis unless special assistance is offered to them. Lee *et al.* added that it would delay the development of the children and render them socially withdrawn, which could negatively impact their performance at school and towards their peers [18]. The need for assistance with daily living activities among nearly one-third of the children highlights significant functional limitations caused by post-meningitis sequelae. The evidence provided in one of the meta-analyses carried out by Teixeira *et al.* confirms the

validity of this statement, as it reported that pediatric patients who have had bacterial meningitis as their underlying condition have challenges with the ability to complete ADLs and may need a long period to be rehabilitated [9]. Remarkably, almost 61.1% of children in our study could not restart their social lives, which means a serious decrease in their quality of life that corresponds to reported psychosocial burdens in the cohorts of similar patients [17]. A further analysis of the results depicts that the study found 27 children who returned to a normal life after being affected by post-meningitis sequelae. This highlights the long-term economic and social burden associated with post-meningitis sequelae [19]. It is in line with what Francisco *et al.* conclude, which refers to multiple long-term implications that largely include several disabilities that influence the functioning of the child and affect the family significantly [20]. The disabling consequences of meningitis in this research are similar to the conclusions gathered in the literature at a larger scale, and it is clear that more support and rehabilitation among this at-need population is necessary. The chi-square test revealed a statistically significant correlation between age and severity of disability, which also complies with an earlier study by Block *et al.* that proposes that younger children have greater odds of having enduring neurological deficits in the aftermath of meningitis, attributed to the underdeveloped qualities of the brains of the affected children at the crucial phase of development [16]. In summary, some children exhibited recovery, but most of them were at significant risk because they exhibited several disabilities, including psychological, social, and functional areas. The extent of impairment observed in this study highlights the urgent need for improved support systems for children recovering from bacterial meningitis. This is in tandem with recommendations in the literature that support a holistic approach that emphasizes the use of long-term follow-ups and customized rehabilitation strategies [21].

This study has certain limitations, including its single-center design and use of non-probability sampling, which may limit generalizability to the broader pediatric population. The cross-sectional nature of the study precludes assessment of longitudinal recovery trajectories and causal relationships between clinical factors and disability severity. Additionally, pre-morbid developmental status and detailed microbiological subtyping were not analyzed, which may influence outcomes. Future multicenter longitudinal studies incorporating pathogen-specific data, neuropsychological assessments, and long-term follow-up are warranted to better delineate recovery patterns and optimize early rehabilitation interventions for children with post-meningitis sequelae.

CONCLUSIONS

The majority of children with post-meningitis sequelae demonstrated unfavorable outcomes, with 65.3% falling into moderate to severe disability categories. Lower Severe Disability (25%) was most common, while only 18.8% achieved complete recovery. Younger age was significantly associated with greater disability severity ($p < 0.001$), indicating increased vulnerability in early childhood.

Authors' Contribution

Conceptualization: SRN

Methodology: SRN, Z²

Formal analysis: SHG, Z¹

Writing and Drafting: SA, MS, TB, ZR

Review and Editing: SA, MS, TB, ZR, SRN, Z², SHG, Z¹

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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