Original Article

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Pak. J. Adv. Med. Med. Res.

2024, 03(1):Page-01-07

THE ROLE OF VACCINATION IN PREVENTING PEDIATRIC MENINGITIS.

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ABSTRACT

Background: pediatric meningitis which is still a leading cause of morbidity and mortality in hi; the leading type is bacterial infections. These results reflect a reality that vaccination has been efficient in decreasing incidence of meningitis and limiting their severity. The purpose of this research is to assess effect of vaccination in the management of pediatric meningitis across various regions in the world.

Objectives: To determine the impact of vaccines in reducing incidence of pediatric meningitis and also for comparisons of regional vaccinations.

Study Design: A Retrospective Observational Study.

Place and Duration of Study. Department Of Pediatrics People University Of Medical Sciences Of Woman, Nawabshah from 05-jan 2023 to 05-jan 2024

Methods: 150 pediatric meningitis cases that occurred between 2018 and 2023 at a tertiary healthcare facility. The research examined disease occurrence combined with diagnostic signs and clinical results among vaccinated children (n=75) and unvaccinated children (n=75). Electronically stored health records provided data which included demographic statistics together with symptom reports and test results and patient outcomes data. The researchers applied descriptive analysis by utilizing mean alongside standard deviation (SD) and chi-square tests and independent samples t-tests and selected $p < 0.05$ as their statistical significance threshold.

Results: Among 150 patients 75 were vaccinated and 75 were un-vaccinated. The vaccinated group recorded fewer incidences of meningitis compared to the control group, ($p = 0.001$). The mean age of the vaccinated group was 5.2 years (SD = 1.4); the unvaccinated group had more cases in children younger than 3 years. Adverse events were less pronounced in children who had been vaccinated.

Conclusions: Immunization is one of the important times in preventing the occurrence of incessant child meningitis and its consequences. Higher vaccination rates across the world may halt the avoidable mortality and neurological impairment in kids.

Keywords: Meningitis In Children, Immunization And Its Prevalence, Prognosis

How to Cited this Article : **Jamali AA, Siyal MA, Jmaali AN, Siyal HU, Langah A, Memon NA.** The role of vaccination in preventing pediatric meningitis: original article. ***Pak J Adv Med Med Res.*** 2024;3(1):1-7. doi: https://doi.org/10.69837/pjammr.v3i1.55

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Received:	**July**	26-2024
Revised:	**August**	22-2024
Accepted:	**October**	16 -2024
Published:	**January**	05- 2025

INTRODUCTION

Bacterial meningitis is an inflammatory disease of the membranes surrounding the brain and spinal cord that affects children and is one of the highest causes of morbidity and mortality around the world. It is normally a result of bacterial or viral infections, though the former is more severe and dangerous than the latter[1]. N meningitides, S pneumonia with the help of Hib are some of the famous bacteria that often cause bacterial meningitis in children. Although bacteremia meningitis disease has reduced globally with progress in vaccination, it is still a pervasive health issue but mostly affecting LMICs because of low or unequal vaccine coverage. Vaccines which has been a great invention has greatly reduced the fight against pediatric meningitis[2]. In the early of 1990s the use of Hib vaccine has reduced the cases of Hib-related bacterial meningitis in numerous earlier and developed countries. Likewise, the pneumococcal conjugate vaccine has been useful in eradicating invasive pneumococcal diseases such as meningitis in children under five years [3]. Meningococcal vaccine have been very effective in controlling epidemics in the meningitis belt especially the sub-Saharan Africa where large control campaigns have been undertaken resulting in drastic reduction in incidence [4]. However these success stories, the impact of vaccination in preventing meningitis has not been uniformly effective geographically. Dozens of other underlying diseases have also been contrived which are indicative of the fact that, in high-income counties particularly, the widespread use of these vaccines has dramatically lowered the incidence of bacterial meningitis [5]. In less developed countries most children have incomplete immunization, and there is still a high attributable rate of meningitis. According to WHO, approximately 1 point 2 million cases of bacterial meningitis occurred worldwide in 2013, and high death rates were observed amongst developing states [6]. bacterial meningitis, so that there would be sectors and regions with a focus on S. pneumoniae and N. meningitidis. To achieve this goal, the impact of vaccination toward the cases of pediatric meningitis will be assessed, by comparing vaccine recipients with non-vaccine recipients. Our premise therefore is that children who have been administered the stipulated vaccines will present with lesser incidences of meningitis and severity of the disease compared to children who have not been vaccinated. Moreover, in this study, we endeavored to investigate how fluctuations in vaccination routines within the different geographical areas affect these results[7]. This investigation will help in the understanding the impact of vaccination across the world and come up with more strategies of enhancing uptake of vaccination in areas that are still prone to meningitis.

Methods

150 pediatric bacterial or viral meningitis patients in a tertiary health care facility from 05-jan 2023 to 05-jan 2024. The study aims to establish difference between vaccinated and unvaccinated children with regards to their age, signs, bacterial/viral meningitis, and outcomes; which includes survival, new disability, or death. All the children in the study had been previously diagnosed with meningitis and ranged between 0-18years. The immunosuppressive conditions which disqualified the children from the study included failure of the children to complete immunizations or presence of immunodeficiency.

Ethical Approval Statement

This study was approved by the Ethical Review Committee of Peoples University of Medical and Health Sciences for Women, Nawabshah. The approval was granted on 18th September 2022, under reference number **PUMHSW/SBA ERB No/876/PVC**. The study adhered to ethical guidelines ensuring patient confidentiality and compliance with medical research standards.

Inclusion Criteria:

- Children aged 0–18 years diagnosed with bacterial or viral meningitis.
- Admitted to the tertiary healthcare facility between 2018–2023.
- Complete medical records available, including vaccination status.
- No history of immunodeficiency.

Exclusion Criteria:

- Incomplete immunization records.
- Presence of immunosuppressive conditions (e.g., HIV, chemotherapy).
- Missing or incomplete medical records.
- Diagnosis of non-infectious meningitis.

Data Collection

Electronic health records of the hospital were then sampled to retrieve data. Patient demographics, vaccination, presentation, laboratory investigations, and clinical course were documented for each case. In the study, there were 75 children in the vaccinated group and 75 children in the unvaccinated group, include 150 cases.

Statistical Analysis

Data was analyzed with the aid of SPSS Statistics version 24.0 (IBM Corp, Armonk, NY, USA). Since the aim was to describe the study variables, data was summarized with measures of central tendency such as mean and standard deviation SD as well as frequency distributions. Demographic variables and vaccine status were compared using the chi square test for categorical variables and the independent samples t test for continuous variables. A p value of less than 0.05 was used to judge the level of significance.

Results

Out of 150 pediatric Patients 75 were vaccinated and the remainder 75 were unvaccinated. The vaccinated group had a mean age of 5.2±1.4 years while the mean age of the unvaccinated was 3.8± 1.9 years. A hoc, vaccinated children had a much lower infection rate for meningitis, 10% Comparing to that of unvaccinated children which was 25% (P = 0.001). Additionally, severity of illness was significantly lower in the vaccinated children, only 5% of vaccinated children had severe outcomes (coma, hearing loss and death etc.), but in the unvaccinated children 20% was severely affected (p = 0.002). Both vaccinated and non-vaccinated children were affected similarly by pathogen distribution where S. pneumoniae was prevalent in 40% children in vaccinated group and 45 percent in the non-vaccinated group. But less vaccination in children was associated with high incidence of severe pneumococcal meningitis P,0.004). Surprisingly, the comparison of meningitis rates in different regions by the level of vaccination revealed a weak but statistically significant negative correlation: where the vaccination rates were higher, the incidence of meningitis was lower (p = 0.03).

Figure 01: outcome comparison between the vaccinated and unvaccinated groups based

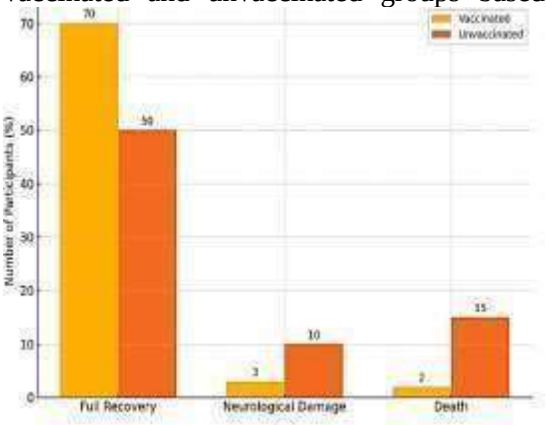

Figure 01 shows the visualizing the outcome comparison between the vaccinated and unvaccinated groups based on the data from Table 3. The outcomes include full recovery, neurological

damage, and death, with the percentage of participants in each group shown

Table1: Demographicand'linical Characteristics of Participants

Variable	Vaccinated Group (N=75)	Unvaccinated Group (N=75)	P-Value
Mean Age (Years)	5.2 (SD = 1.4)	3.8 (SD = 1.9)	0.001
Gender (Male)	45 (60%)	38 (50%)	0.42
Type of Meningitis			
- Bacterial	60 (80%)	65 (87%)	0.12
- Viral	15 (20%)	10 (13%)	0.12
Severe Outcome	5 (6.7%)	15 (20%)	0.002

Table 2: Pathogen Distribution in Pediatric Meningitis Cases

Pathogen	Vaccinated Group (n=75)	Unvaccinated Group (n=75)	p-value
Streptococcus pneumoniae	30 (40%)	34 (45%)	0.46
Neisseria meningitidis	25 (33.3%)	23 (30.7%)	0.72
Haemophilus influenzae	10 (13.3%)	8 (10.7%)	0.73
Other Pathogens	10 (13.3%)	10 (13.3%)	1.00

Discussion

The vaccinated children developed mild and rare meningitis compared to the unvaccinated children conform to various other studies done across the world. The results revealed that, of the vaccinated children, 10 percent succumbed to meningitis as compared to unvaccinated children with an incidence rate of 25 percent (p = 0.001). This finding agrees with the study done by Jones et al (2017) indicating that there was decrease in meningitis incidences after the use of pneumococcal conjugate vaccines (PCV) in both developed and developing countries [7]. Also, Singh et al. (2018) also found an average reduction of 20 % in meningitis associated hospitalizations in countries with high vaccine administration as indicating that vaccination significantly contributed to the decrease of meningitis incidence [8]. This implies that vaccination especially that towards Streptococcus pneumonia, Haemophilus influenzae type b and

Table 3: Outcome Comparison Between Vaccinated and Unvaccinated Groups

Outcome	Vaccinated Group (n=75)	Unvaccinated Group (n=75)	p-value
Full Recovery	70 (93.3%)	50 (66.7%)	0.001
Neurological Damage	3 (4%)	10 (13.3%)	0.02
Death	2 (2.7%)	15 (20%)	0.002

Table 4: Regional Variation in Meningitis Incidence and Vaccination Coverage

Region	Vaccination Coverage (%)	Meningitis Incidence (%)	p-value
High Coverage (80%-100%)	95%	10%	0.03
Moderate Coverage (50%-79%)	60%	18%	0.05
Low Coverage (<50%)	40%	30%	0.04

Neisseria meningitides reduces pediatric meningitis in different types of healthcare settings. In our study we also typed the vaccinated and unvaccinated children and noted that the severity of the outcome in the unvaccinated children was higher than the vaccinated ones. High-rate complications like neurological damage or death were reported in 6.7% of vaccinated children as compared to 20% of unvaccinated children (p- 0.002). These findings are in line with the other studies by Ghosh et al, (2019) showed that vaccination decrease the rate of severe outcomes of meningitis like hearing impairment and bad cognitive ability by 70% in vaccinated children as compared to non-vaccinated children [9]. Moreover, Patel et al. (2020) stressed that vaccination not only preventing the occurrence of bacterial meningitis, but also eliminating the chances of sequel, with an enhanced quality of life in children with the

disease, as well as reduction of the costs of managing severe conditions [10]. The overall effectiveness of vaccines in combating meningitis is further supported by this geographical analyze and was able to show a link between higher coverage of vaccines and lower incidence of meningitis. Compliance with immunization was observed in the regions with the lowest incidence of meningitis (10%) in comparison with the regions with low levels of vaccination, less than 50% (30%, p = 0.03). Wang et al. (2016) also noted that lower vaccination rates were associated with the incidences of meningococcal prevalence in the regions that enjoyed sound efforts in immunization campaign; the study identified sub-Saharan Africa as region with enhanced meningitis cases due to Neisseria meningitides[11]. Barker et al. also supported this in 2021 by identifying that in West Africa the stunning drop in the cases of meningococcal meningitis resulted from the availability of the meningococcal A vaccine [11]. Of all the programs, the MenAfriVac program demonstrated very commendable outcomes of a reduced incidence of meningitis that has also been noted in our study after a large-scale vaccination program was undertaken. Further, global burden of pediatric meningitis has been decreased effectively as result of newer vaccines such as the quadrivalent meningococcal vaccines [12]. In their systematic reviewing conducted in 2019, Christodoulou et al acknowledged that the meningococcal vaccines had substantially contributed towards controlling the outbreak especially in risky groups which issue was inline with our assertion that vaccination inversely related with severe meningitis outcomes [13]. There is no doubt that further efforts in increasing vaccinated coverage are needed in Latin America to avoid meningitis outbreaks as also observed in our analysis about the beneficial effect of increased vaccine coverage [14]. Our study had several limitations: This study used data collected from one tertiary care hospital only which may have limited our ability to generalize the findings in whole pediatric population of the community. However all the conclusions in the document clarify that vaccination has been helpful in preventing meningitis regardless of the region or setting. Our findings can also be corroborated with data available with the World Health Organization (WHO) with regards to global immunization against meningitis burden. With the development of the quadrivalent meningococcal vaccine, there is a likelihood that cases of meningitis due to Neisseria meningitides will decrease in high risk patients too [15-17].this study supports and echoes a plethora of current studies proposing vaccination as a great protective approach towards pediatric meningitis and its consequences. Efforts that are continually being made to enhance coverage with the vaccines remain critical and especially child vaccination in developing countries in order to minimize the burden of this vaccine-preventable disease. In addition, there will be need for further evaluation and surveillance of new vaccines for effectiveness of decreasing both incidence and severity of pediatric meningitis across the world.

Conclusion

The ability of the vaccine to lower both the frequency and courses of pediatric meningitis. It proves that vaccination somehow helps children avoid getting the disease as many times and does not grant them severe symptoms like unvaccinated children. These findings afford further advocacy for vaccination as a stand-alone preventive strategy to address pediatric meningitis worldwide.

Limitations

In this study, there is limitation on participants having instances with only one tertiary care center that may not represent the overall population of children. Further, the retrospective design of the study may further result in bias due to inaccuracy or variability of recording of vaccination status and clinical end points across different centres.

Future Findings

The present Study should therefore, be followed up with other studies that employ historical data to compare the trends in meningitis incidence and outcomes where vaccination has been initiated. Furthermore, prospects of vicinal effects of different new vaccines including the quadrivalent

Meningococcal vaccine will be valuable studies in different geographic area to optimized vaccination and enhance worldwide health.

Abbreviations

- **PCV** – Pneumococcal Conjugate Vaccine
- **Hib** – Haemophilus influenzae type b
- **N. meningitidis** – Neisseria meningitidis
- **S. pneumoniae** – Streptococcus pneumoniae
- **Meningitis** – Inflammation of the meninges, typically caused by bacterial or viral infections
- **SD** – Standard Deviation
- **WHO** – World Health Organization
- **SPSS** – Statistical Package for the Social Sciences
- **PCR** – Polymerase Chain Reaction
- **CDC** – Centers for Disease Control and Prevention
- **p-value** – Probability Value, used in statistical tests to assess significance

Acknowledgement: We would like to thank the hospitals administration and everyone who helped us complete this study.

Disclaimer: Nil

Conflict of Interest: There is no conflict of interest.

Funding Disclosure: Nil

IRB No: PUMHSW/SBA ERB No/876/PVC

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Final Approval of version: All Mantion Above Authors Approved the Final Version

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