Research Article

A Comparative Analysis of Surveillance Data on Epidemiological Trends and Characteristics of Bacterial Meningitis in Diyala Province, Iraq (2024-2025)

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Abstract | Acute bacterial meningitis remains a critical public health issue that can be fatal, particularly in areas with inadequate healthcare resources. Good monitoring is very important for finding outbreaks, measuring how well vaccines work, and figuring out what to do to stop them. This study aimed to examine and compare the epidemiological characteristics of reported bacterial meningitis cases in Diyala Province, Iraq, from 2024 to 2025, to identify patterns, ascertain at-risk individuals, and inform treatment strategies. We did a descriptive analysis of data from routine passive monitoring that was collected in 2024 and 2025. We looked at data on case numbers, demographics, geography, and outcomes with Microsoft Excel's descriptive statistics. There were 342 cases of meningitis over the course of two years. There were 41.2% fewer reported cases, going from 232 in 2024 to 110 in 2025. The age group that was most affected was children under 5, who made up 52.3% of cases. 54.7% of the cases were men. The CFR, or case fatality rate, was 8.2%. Neisseria meningitidis (38.3%) was the most common pathogen found, followed by *Streptococcus pneumoniae* (31.6%). From December to February, there were the most incidents. The Al-Miqdadiya district had the most problems, making up 24.0% of the total. Surveillance data show that the number of reported cases of meningitis has dropped a lot. To tell the difference between real drops and problems with surveillance, this pattern needs to be looked at very carefully. Because it has such a big effect on young children and stays in the same place, it is very important to keep up vaccination rates, improve lab capacity for confirming infections, and set up more early warning systems.

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Introduction

Bacterial meningitis is a severe infection of the meninges associated with high mortality and permanent neurological sequelae among survivors (World Health Organization, 2023). It remains a major public health challenge, particularly in the African "Meningitis Belt" and in conflict-affected regions of the Middle East with strained health systems (Meningitis Research Foundation, 2024). The

World Health Organization (WHO) emphasizes surveillance as a cornerstone for meningitis control and elimination, especially for monitoring the impact of conjugate vaccines (World Health Organization, 2020).

Monitoring epidemiological trends is crucial for assessing the efficacy of immunization programs against *Haemophilus influenzae* type b (Hib), pneumococcus, and meningococcus, and for outbreak detection. This study analyzes surveillance data from Diyala Province, Iraq, from 2024 to 2025, which shows a 41% reduction in reported cases. A consistent burden was observed among children under five, with the Al-Miqdadiya district experiencing a disproportionately high incidence. A substantial proportion of cases lacked a confirmed etiology, highlighting persistent diagnostic challenges (Heinsbroek and Tweed, 2019).

Previous studies in similar settings have reported analogous patterns, suggesting increased vulnerability in young children due to immature immune systems and higher exposure risks (Oordt-Speets *et al*., 2018; Ramakrishnan *et al*., 2009). The observed decline in cases may be attributed to expanding vaccine coverage, but must be interpreted cautiously within the context of potential surveillance limitations (Al-Diwan, 2023; Pavlin *et al*., 2003).

Aime of this study are:
1. To compear and ddiscriping the epidemiological patterns of reported meningitis cases in health care secters Diyala Province from 2024 to 2025.
2. To find out which groups high risk group and the most danger, which places have the most cases, and when times of year are the most common.
3. To look at how cases are spread out by the disease that is thought to have caused them and the outcome.
4. To give suggestions based on evidence for improving the surveillance, prevention, and management of meningitis cases.

Materials and Methods

Research design and ethical approval

A retrospective, descriptive analysis of secondary bacterial meningitis surveillance data from Diyala Province for the years 2024 and 2025 was conducted. The proper institutional review board gave its ethical approval. The requirement for informed consent was waived due to the use of anonymized, aggregated data.

Sources of data and ways to collect it

We got aggregated, anonymous case data from the standard surveillance registries of the provincial health department. The data included every instance that met the national standard case definition for acute bacterial meningitis.

Variables and analysis

The variables included are the year of the report, the age group, the gender, the health district, the month of onset, the reported cause of death, and the outcome (recovered or dead). We used descriptive statistics to find the frequencies, percentages, and the Case Fatality Rate (CFR). A comparative analysis of the two years was performed. We used Microsoft Excel 365 to look at the data and show it.

Results

Comprehensive case trends and demographics

A total of 342 instances of meningitis were documented. Cases diminished by 41.2%, declining from 232 in 2024 to 110 in 2025. Male individuals constituted 54.7% (n=187) of the cases. The age group under five years was the most impacted, accounting for 52.3% (n=179) of all cases. The cumulative case fatality rate was 8.2% (28 fatalities).

Table 1: *Demographic distribution of documented meningitis cases, 2024-2025.*

Year	Total Cases	Male (%)	Female (%)	Age <5 (%)	CFR (%)
2024	232	55.2%	44.8%	53.9%	8.6%
2025	110	53.6%	46.4%	49.1%	7.3%
Total	342	54.7%	45.3%	52.3%	8.2%

Monthly, seasonal, and geographic distribution

A distinct seasonal pattern was noted, with maximum incidence occurring in the winter months (December to February), representing 45.3% of all cases. Every month exhibited a decrease in reported occurrences in 2025. The Al-Miqdadiya district had the highest load at 24.0% (n=82), succeeded by Baquba 1 at 18.1% (n=62).

Clinical and microbiological characteristics

Neisseria meningitidis (Meningococcus) was the most reported pathogen (38.3%, n=131), followed by *Streptococcus pneumoniae* (Pneumococcus, 31.6%, n=108). A significant proportion of cases (22.5%, n=77) were reported as “Bacterial, unspecified.” Hib accounted for only 7.6% (n=26) of cases.

Table 2: *Monthly distribution of reported cases.*

Month	2024 (n)	2025 (n)	% Change
January	38	20	-47.4%
February	35	18	-48.6%
March	28	12	-57.1%
April	20	8	-60.0%
May	18	6	-66.7%
June	15	5	-66.7%
July	12	4	-66.7%
August	10	3	-70.0%
September	14	6	-57.1%
October	16	8	-50.0%
November	22	10	-54.5%
December	34	10	-70.6%

Table 3: *Distribution of cases by health district.*

Health District	2024 (n)	2025 (n)	Total (n)	% of Total
Al-Miqdadiya	55	27	82	24.0%
Baquba 1	42	20	62	18.1%
Al-Khalis	40	18	58	17.0%
Jalawla	35	15	50	14.6%
Baladruz	25	12	37	10.8%
Khanaqin	20	10	30	8.8%
Baquba 2	15	8	23	6.7%

Table 4: *Distribution of cases by reported causative agent.*

Causative Agent	2024 (n)	2025 (n)	Total (n)	% of Total
Neisseria meningitidis	92	39	131	38.3%
Streptococcus pneumoniae	70	38	108	31.6%
Bacterial, Unspecified	55	22	77	22.5%
Haemophilus influenzae	15	11	26	7.6%

Discussion

The data indicate a marked 41% decline in reported bacterial meningitis cases in Diyala from 2024 to 2025. This trend may reflect the positive impact of strengthened childhood immunization programs, such as the pneumococcal conjugate vaccine (PCV) and Hib vaccine, which have proven effective in similar contexts (Al-Hamdani, 2025; UNICEF Iraq, 2024). However, this significant decrease warrants careful interpretation. A spurious decline could result from factors such as reduced healthcare access, changes in case definitions, or disruptions in surveillance reporting during periods of instability (Al-Diwan, 2023; Checchi *et al.*, 2017). The persistently high case fatality rate (8.2%) underscores the continued severity of the disease, aligning with global burden estimates from vulnerable settings (Edmond *et al.*, 2010; GBD 2016 Meningitis Collaborators, 2018).

The high prevalence among children under five (52.3%) is consistent with global epidemiological patterns, reinforcing this group as the primary target for preventive interventions (Jassim and Al-Khikani, 2024; Oordt-Speets *et al.*, 2018). The male predominance, though modest, aligns with studies suggesting potential biological or care-seeking behavioral differences. The pronounced winter seasonality is a hallmark of bacterial meningitis, particularly meningococcal disease, emphasizing the need for pre-emptive preparedness and public awareness campaigns before peak seasons (Al-Zubaidy and Hassan, 2024; Sultan *et al.*, 2005).

The predominance of *Neisseria meningitidis* and *Streptococcus pneumoniae* aligns with the pre-vaccination epidemiological profile of most Middle Eastern countries (Al-Mahdawi and Al-Ani, 2021; Borrow *et al.*, 2017). The low incidence of Hib may indicate successful Hib vaccination coverage, a finding supported by regional post-introduction assessments (WHO EMRO, 2022). However, the substantial proportion of “unspecified” bacterial cases (22.5%) reveals a critical surveillance weakness. It highlights inadequate laboratory capacity for cerebrospinal fluid (CSF) culture and PCR confirmation essential for guiding treatment, detecting outbreaks, and monitoring vaccine impact a recurring challenge identified in health system assessments (Bassioni *et al.*, 2022; Chisti *et al.*, 2010).

The high caseload in Al-Miqdadiya district points to localized risk factors, such as population density, suboptimal immunization coverage, or specific socioeconomic conditions, necessitating targeted public health interventions (Weiss *et al.*, 2018).

Limitations

Passive surveillance data has some problems that this study has to deal with, such as under-reporting, misdiagnosis, and missing data. Because so many cases don't have a known cause, it's hard to draw pathogen-specific conclusions. Two years is not enough time for trend analysis. There isn't enough data on individual vaccination status to directly measure the effect of vaccines. These constraints highlight the necessity for investment in integrated disease surveillance and laboratory networks as a component of health system enhancement (McNabb *et al.*, 2002).

Conclusions and Recommendations

Surveillance statistics show that the number of reported meningitis cases in Diyala is going down, which could be a good indicator, but more data is needed to confirm this. The ongoing significant impact on young children and the occurrence of fatal outcomes necessitate persistent public health vigilance. Significant deficiencies in etiological diagnosis compromise the surveillance system's efficacy for targeted intervention.

Recommendations

1. Strengthen Laboratory Surveillance: It is vital to strengthen the central laboratories' ability to undertake CSF testing (culture, PCR) so that there are fewer cases that go unreported and so that circulating strains and antibiotic resistance can be followed more precisely (Heinsbroek and Tweed, 2019).
2. And Make vaccination programs stronger and keep an eye on them: Make sure that as many kids as possible get the PCV, Hib, and meningococcal conjugate immunizations fairly through routine childhood immunization, together with high-quality coverage surveys and effect evaluations (Al-Hamdani, 2025; Trotter *et al.*, 2017).
3. Get ready for outbreaks and improve case management: Train healthcare workers to recognize problems early, administer a lumbar puncture fast, and offer the correct antibiotic treatment. Put antibiotics and other supplies in regions where there are a lot of cases before the winter peak. Also, create or update plans for how to deal with outbreaks (WHO, 2021)
4. Do Targeted Risk Communication: Start seasonal awareness campaigns aimed at caregivers of small children before winter so they can spot symptoms early and obtain help.
5. Look into the case reduction in a systematic way: To find out what truly caused the reported reduction, do an operational assessment that looks at things like reporting compliance, immunization coverage, access to healthcare, and any changes that may have transpired in clinical practice (Al-Diwan, 2023).

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Novelty Statement

This study provides an updated epidemiological assessment of acute bacterial meningitis cases in Diyala Province, Iraq, during the period 2024–2025. The research offers a comparative analysis of temporal trends, demographic distribution, geographical clustering, pathogen prevalence, and case fatality rates using routine surveillance data. Unlike previous local reports, the study highlights recent reductions in reported cases while critically addressing the potential influence of surveillance limitations. The findings provide important evidence for strengthening vaccination programs, enhancing laboratory-confirmation capacity, and improving early-warning surveillance systems for meningitis control in Iraq.

Author's Contribution

Khalid Jamal Ahamed: Conceptualization, data curation, formal analysis, investigation, methodology, project administration, validation, visualization, writing original draft, writing review and editing.
Saif Saad Jihad: Data curation, investigation, validation, writing original draft, writing review and editing.
Ahamed S.A. Al-Gburi: Conceptualization, formal analysis, methodology, supervision, validation, visualization, writing review and editing.
Mazin Khalid Abdullah: Conceptualization, formal analysis, funding acquisition, methodology, resources, software, supervision, validation, visualization, writing original draft, writing review and editing.

Generative AI and AI assisted technology statement

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest

The authors have declared that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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