



Review Article

Epidemiology and Etiology of Bacterial Meningitis in Iran: A Systematic Review and Meta-analysis

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Abstract

Background: Meningitis is a life-threatening disease that can manifest as acute, subacute, or chronic. This disease is characterized by various symptoms such as fever, nausea, and stiff neck. It can be caused by infectious (bacteria, viruses, fungi, and parasites) and non-infectious (drugs, neoplasms, and systemic diseases) agents. Bacterial meningitis, the deadliest type of meningitis, was the focus of this systematic review and meta-analysis, which aimed to examine the epidemiology and etiology of bacterial meningitis in Iran.

Methods: PubMed (Medline), Scopus, Web of Science, and ProQuest were searched for English articles and the Scientific Information Database and Magiran for Persian articles up to January 25, 2024. A total of 2240 articles were screened, and 58 articles were selected. Then, 51 studies were included in the epidemiological analysis and 48 in the etiological analysis.

Results: The pooled hospital-based prevalence of meningitis in Iran was 16.48%. *Streptococcus pneumoniae* was responsible for 27.89% of meningitis cases in Iran and was the main cause of bacterial meningitis. Other common bacteria included *Haemophilus influenzae* (15.96%), *Staphylococcus epidermidis* (15.88%), and *Klebsiella pneumoniae* (15.56%). Fever was observed in 89.37% of patients, while nausea, neck stiffness, vomiting, and headache were also common manifestations, affecting approximately half of the patients.

Conclusion: These findings highlight the importance of vaccination, especially against *pneumococcus*, and improved diagnostic practices. The results also underscore the need for stronger surveillance systems and expanded population coverage to enhance public health interventions and reduce the burden of bacterial meningitis in Iran.

Keywords: Bacterial, Meningitis, Systematic review, Meta-analysis, Iran



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Introduction

Meningitis is the inflammation of any of the three meningeal layers surrounding the brain or spinal cord, accompanied by pleocytosis in the cerebrospinal fluid (CSF). Meningitis is classified as acute (≤ 5 days), subacute (≤ 5 days), and chronic (≥ 4 weeks) (1-3). This condition is typically accompanied by fever, nausea, stiff neck, and headache (4). Other clinical manifestations may include changes in mental status, altered level of consciousness, seizures, photophobia, and skin rashes (5,6). CSF analysis is required for a definitive diagnosis (7-9). Meningitis can be caused by infectious agents (bacteria, viruses, fungi, and protozoa) or non-infectious causes (drugs,

neoplasms, and some systemic diseases). If bacteria are found in CSF, it is called bacterial meningitis; otherwise, it is called aseptic meningitis (10,11). In 3 approximately 0 to 65% of cases, the definitive cause of aseptic meningitis is unidentified (12).

According to the Centers for Disease Control and Prevention (CDC), viral and then bacterial infections are the most common causes of meningitis, with bacterial meningitis being the most dangerous type. If untreated, bacterial meningitis can be fatal in up to 50% of cases. Even with prompt treatment, 8 to 15% of patients may die within two days of symptom onset (13). The etiology of bacterial meningitis varies depending on age and regional microbial



flora. A review study conducted in 2015 examined articles related to acute meningitis in Iran and revealed that *Streptococcus pneumoniae*, *Haemophilus influenzae* type b, coagulase-negative *Staphylococcus aureus*, and *Neisseria meningitidis* were the most common causative agents (14). Another study identified *S. pneumoniae* and *N. meningitidis* as the most common bacteria causing the disease (15). This systematic review and meta-analysis aimed to achieve two main objectives: (1) to estimate the pooled prevalence of bacterial meningitis in Iran, and (2) to determine the most common bacterial species causing meningitis in Iran. In addition, the review will examine clinical manifestations presented in the included articles.

Methods

A systematic search was conducted to identify articles related to patients with bacterial meningitis in Iran. The protocol for this study was registered in Prospero (Registration number: CRD42024507783) on February 17, 2024. Relevant articles were identified using keywords such as “meningitis”, “bacterial”, and “Iran” along with their synonyms, as MeSH terms, in the title, abstract, and keywords. The international databases PubMed (Medline), Scopus, Web of Science, and ProQuest were searched until January 25, 2024. The search strategy for PubMed was as follows: (((Meningit*[MeSH Terms]) OR (Pachymeningit*[MeSH Terms])) OR ((Meningit*[tiab]) OR (Pachymeningit*[tiab]))) AND (((Bacteria*[MeSH Terms]) OR (Eubacteria*[MeSH Terms])) OR ((Bacteria*[tiab]) OR (Eubacteria*[tiab])))) AND (Iran*). Additionally, local databases such as the Scientific Information Database and the Magiran database were searched for Persian articles using the same search strategy and similar Persian keywords. Then, Google Scholar and the latest relevant review article (14) were searched to maximize the number of relevant articles.

Inclusion and Exclusion Criteria

All English and Persian articles related to the epidemiology and etiology of bacterial meningitis in Iran were included in the study, with no time limit applied. Articles were excluded if: (a) They were letters to the editor, reviews, intervention studies, cohort studies, or case-control studies; (b) They did not use a standard CSF test for diagnosis; (c) They involved patients with abnormal immune systems (e.g., patients with HIV, agranulocytosis, and the like); or (d) Studies that focused on the identification of one specific bacterial species.

Screening Process

All articles from the search results were entered into EndNote 21 software. After removing duplicate articles, two independent researchers screened the articles in three stages based on title, abstract, and full text. Any disagreements in the final selection of articles were resolved through consultation between two researchers, with the opinion of a third researcher sought if necessary.

Data Extraction

Two independent researchers performed data extraction. The extracted data included title, first author, year of publication, study location, study period, total number of samples, number of confirmed cases, type of meningitis, and the etiologic agent of meningitis. Other data extracted from the articles included clinical manifestations and/or drug resistance. These data were only analyzed if reported in at least 10% of the articles.

Quality Assessment

For quality assessment, two independent researchers used a modified version of the Newcastle-Ottawa Scale, specifically adapted for cross-sectional studies, as applied in a previous study (16). This version was originally adapted from the Newcastle-Ottawa Scale for cohort studies to suit cross-sectional designs, and it included seven questions across three domains: selection, confounders, and exposure. The domains covered key elements such as sampling strategy, response rate, exposure assessment, and statistical reporting. The total score ranged from 0 to 10. Studies were classified based on their total score as follows: very good (9–10 points), good (7–8 points), satisfactory (5–6 points), and unsatisfactory (0–4 points). Articles categorized as “unsatisfactory” were excluded from the study. Any disagreements between reviewers were resolved by a third independent researcher.

Meta-Analysis

Data analysis was conducted using Stata 11 software. The Metaprop command was used to calculate the pooled prevalence along with a 95% confidence interval (CI), results of which were presented in a forest plot. To assess the heterogeneity of studies, the Chi-square test and the I^2 index were used. Based on the Hygienist classification, studies with an I^2 index heterogeneity rate of more than 75% were considered in the very high heterogeneity category, 50–75% in the high heterogeneity category, 25–50% in the moderate heterogeneity category, and less than 25% in the low heterogeneity category. If the I^2 index was higher than 50%, a random-effects model using the DerSimonian and Laird method was used to estimate the pooled prevalence. Additionally, meta-regression was used to investigate the sources of heterogeneity in the results. The “metabias” command was used to check for publication bias, based on the results of the Egger test. In the case of observed bias, prevalence rates were corrected using the “metatrim” command with the “trim-and-fill” method. A significance level of 0.05 was set for all analyses.

Results

A total of 2240 articles were identified through a search of six databases, including the most recent relevant study (14), as depicted in Figure 1. After removing 543 duplicate articles, we screened 1697 articles. We excluded 1,313 articles in the first stage and 277 articles in the second stage, and reviewed the full text of 107 articles.

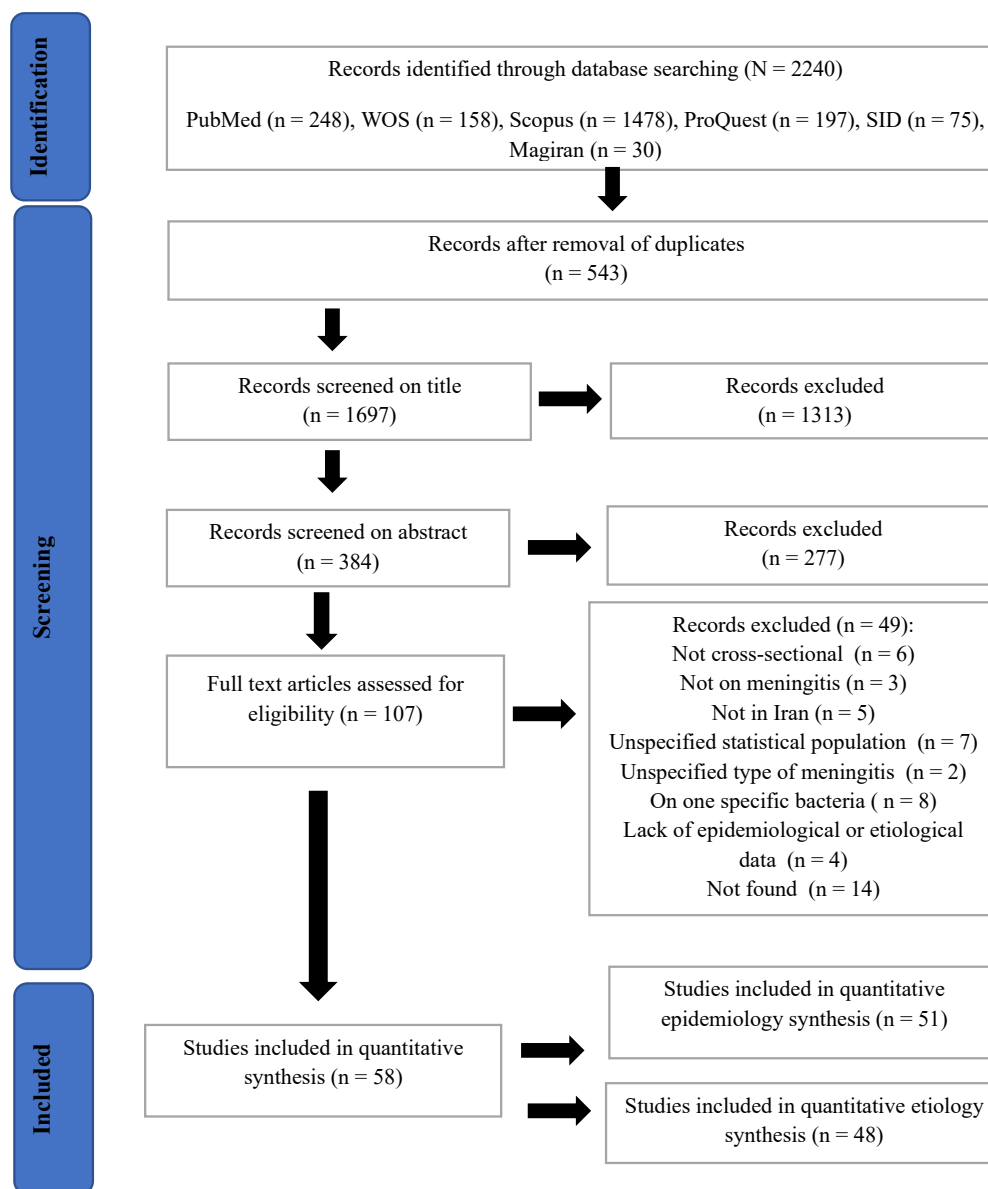


Figure 1. Search Flow Diagram and Article Screening

Finally, we excluded 49 additional articles and found 58 articles eligible for inclusion in this review, including 10 articles in Persian and 48 articles in English. Of these, 52 articles were included in the epidemiological analysis, while 48 articles were included in the etiological analysis (Figure 2). The studies covered 17 different cities. Most of the articles were from Tehran (n = 26), all of which were hospital-based studies. All diagnoses were confirmed by bacterial culture from CSF. If diagnosed using other methods, only samples with positive bacterial culture of CSF were included in this review. The primary objective of the study was to conduct categorical analyses based on acute, subacute, and chronic types. However, this was limited by the small number of studies on subacute and chronic types, as well as the lack of specification regarding meningitis types in many articles, making it impossible to separate these cases. Thus, all study data were examined cumulatively.

Epidemiology of Bacterial Meningitis

In this section, we included 51 articles collected from 17 different cities (Table 1). A total of 107766 cases were examined, of which 4062 were diagnosed with bacterial meningitis. As all studies were conducted in hospital settings, the resulting epidemiological data reflect a hospital-based perspective. Therefore, we were unable to estimate the broader community epidemiology. The epidemiology of bacterial meningitis in Iranian hospitals was 16.48% (95% CI: 13.70 – 19.46; I²: 99.16%), as illustrated in Figure 3. Patients ranged from infants to adults over 65 years, with approximately half being under 6 years old and 90% under 18 years. The prevalence in different studies ranged from 74% (17) to 0.14% (18). This epidemiological overview covered 25 years. The oldest article was published in 1998 (19), while the most recent studies appeared in 2022 (20-23). Most studies (n = 33) were published within the last decade (2013-2023).

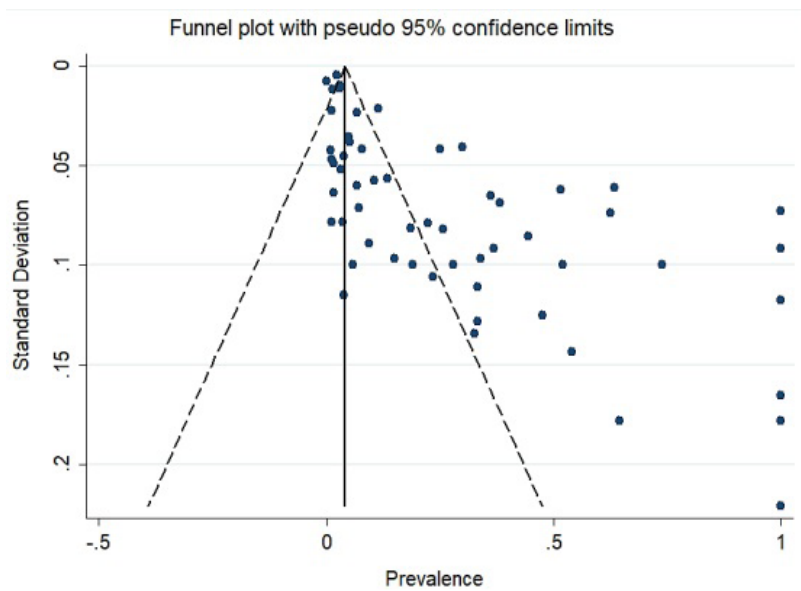


Figure 2. Funnel Chart for Imported Articles

Etiology of Bacterial Meningitis

In this section, we included 48 articles, 41 of which overlapped with the epidemiology section, and 7 articles (68-74) specifically examined etiology. A total of 1787 gram-positive and 1376 gram-negative bacteria were identified morphologically. Bacteria reported only as a genus (e.g., *Enterococcus*, *Klebsiella*, or *Acinetobacter*) without a species name were excluded from the analysis. *S. pneumoniae*, *H. influenza* (mostly type b), *N. meningitidis*, and *Escherichia coli* were reported in more than 60% of the articles. Table 2 lists bacterial species identified in at least five articles. *S. pneumoniae* was the cause of 27.89% of cases across 32 studies and was identified as the main cause of bacterial meningitis in Iran. Other frequently reported bacteria included *H. influenza*, *Staphylococcus epidermidis*, *Klebsiella pneumoniae*, *N. meningitidis*, and *Streptococcus agalactiae*.

Clinical Manifestations

As shown in Table 3, fever was the most common symptom, observed in 89.37% of patients with meningitis. Nausea, neck stiffness, vomiting, and headache were observed in approximately half of the patients. A quarter (25.42%) of patients had seizures. Other common symptoms, such as jaundice, cerebral edema, cough, and photosensitivity, were reported in fewer than five studies.

Discussion

This review collected information on the epidemiology and etiology of bacterial meningitis in Iran across all age groups. The articles were about all types of meningitis; however, most studies did not specify the subtype of meningitis, which may be due to the lack of clarity about the exact onset of symptoms. Furthermore, bacteria associated with acute meningitis may be seen in non-acute types, making diagnosis difficult (20). However, for several reasons, it can be argued that our results were

related to the acute type of meningitis: (a) Bacteria usually cause acute meningitis; in contrast, subacute and chronic types are mostly associated with fungi, other systemic diseases, and some unusual bacteria (1,75,76). On the other hand, one-third of chronic cases remain undiagnosed, so the number of chronic diagnoses is generally lower (77). (b) Chronic infectious meningitis cases generally occur in immunocompromised individuals, such as HIV patients or those taking immunosuppressive drugs (78). These cases were not included in our article. (c) *Mycobacterium tuberculosis*, *Leptospira*, *Brucella*, and *Treponema pallidum* are the most commonly known causes of subacute meningitis (75,78). In our search, only two studies reported *Brucella*, and three reported *Mycobacterium tuberculosis*. This may be attributed to limited attention given to these bacteria due to the small number of cases and challenges associated with their laboratory culture.

The hospital-associated epidemiology of bacterial meningitis in Iran was 16.48%, which varied significantly between regions and even within cities. In Tehran, reported prevalence ranged from 1.63% to 63.33% (27,37). On the other hand, all four studies conducted in Tabriz reported a prevalence of less than 20% (35,38,40,44). The two studies from Ahvaz showed lower prevalence rates of 13.46% and 7.14% (33, 52). These differences in reporting may be due to variations in population characteristics, sample size, diagnostic accuracy, and hygiene levels across cities. To accurately determine the epidemiology of meningitis in an area, studies with a wide range and large sample sizes must be conducted to obtain reliable data. In a three-year study in Taiwan, among 1803 children under five years of age, 13.5% had bacterial meningitis, which is close to the figure reported in our paper (79).

S. pneumoniae was the predominant species causing bacterial meningitis in Iran. This result is consistent with similar studies published in 2015 (80) and 2017 (14) in

Table 1. Characteristics of Articles Reviewed on the Prevalence of Meningitis in Iran

First Author	Sampling Area	Published Time	Study Sample	Diagnosis With Meningitis	Prevalence of Meningitis (%)	95% CI
Yousefi Mashouf et al (24)	Hamedan	2013	582	46	7.9	5.84 - 10.40
Ghadimi Moghaddam et al (25)	Yasuj	2019	106	36	33.96	25.04 - 43.80
Samiee-Rad and Karimfar (26)	Ghazvin	2012	567	6	1.06	0.39 - 2.29
Amid et al (19)	Tehran	1998	609	182	29.89	26.27 - 33.69
Ehsanipour et al (27)	Tehran	2005	245	4	1.63	0.45 - 4.13
Ataei et al (28)	Tehran	2005	100	28	28	19.48 - 37.87
Yousefi Mashouf et al (29)	Hamedan	2006	582	146	25.09	21.61 - 28.81
Taheri Kalani et al (30)	Tehran	2006	300	32	10.67	7.41 - 14.72
Haghi-Ashtiani et al (31)	Tehran	2008	1800	121	6.72	5.61 - 7.98
Bahador et al (32)	Kerman	2009	126	12	9.52	5.02 - 16.05
Alavi et al (33)	Ahvaz	2010	312	42	13.46	9.88 - 17.76
Hatami et al (34)	Tehran	2010	793	39	4.92	3.52 - 6.66
Bayat Makoo et al (35)	Tabriz	2010	100	19	19	11.84 - 28.07
Qurbanalizadegan et al (36)	Tehran	2010	161	36	22.36	16.18 - 29.59
Sarookhani et al (17)	Ghazvin	2010	100	74	74	64.27 - 82.26
Ataee et al (37)	Tehran	2011	270	171	63.33	57.28 - 69.09
Ghotaslou et al (38)	Tabriz	2012	277	19	6.86	4.18 - 10.50
Hamedei et al (39)	Mashhad	2012	81	27	33.33	23.24 - 44.68
Hojjati Bonab et al (40)	Tabriz	2012	106	16	15.09	8.88 - 23.35
Rezaeizadeh et al (41)	Tehran	2012	11269	329	2.92	2.62 - 3.25
Mahmoudi et al (42)	Tehran	2013	31	20	64.52	45.37 - 80.77
Rezaei et al (43)	Tehran	2013	55	18	32.73	20.68 - 46.71
Abdinia et al (44)	Tabriz	2014	7112	107	1.5	1.23 - 1.82
Attarpour-Yazdi et al (45)	Tehran	2014	182	114	62.64	55.17 - 69.68
Babamahmoudi et al (46)	Mazandaran	2014	16532	23	0.14	0.09 - 0.21
Heydarian et al (18)	Mashhad	2014	453	5	1.1	0.36 - 2.56
Tavasoli et al (47)	Tehran	2014	422	7	1.66	0.67 - 3.39
Bagheri-Nesami et al (48)	Mazandaran	2015	137	61	44.53	36.04 - 53.25
Moayedi et al (49)	Bandar Abbas	2015	100	6	6	2.23 - 12.60
Motamedifar et al (50)	Shiraz	2015	2229	255	11.44	10.15 - 12.83
Shirani et al (51)	Esfahan	2015	2229	6	3.7	1.37 - 7.89
Amin et al (52)	Ahvaz	2016	196	14	7.14	3.96 - 11.69
Farahani et al (53)	Arak	2016	150	28	18.67	12.78 - 25.84
Jesri et al (54)	Iran	2016	8411	250	2.97	2.62 - 3.36
Moafi et al (55)	Ghazvin	2016	680	35	5.15	3.61 - 7.09
Vakili et al (56)	Yazd	2016	261	135	51.72	39.17 - 68.63
Mofidi et al (57)	Tehran	2017	48	26	54.17	39.17 - 68.63
Sanaei Dashti et al (58)	Tehran	2017	370	12	3.24	1.69 - 5.60
Berangi et al (59)	Hamedan	2019	48006	1135	2.36	2.23 - 2.50
Hadi et al (60)	Shiraz	2019	89	21	23.6	15.24 - 33.78
Pormohammad et al (61)	Tehran	2019	119	44	36.97	28.31 - 46.31
Boskabadi et al (62)	Mashhad	2020	234	85	36.32	30.16 - 42.84
Kashaki et al (63)	Tehran	2020	75	3	4	0.38 - 11.25
Saboute et al (64)	Tehran	2020	163	2	1.23	0.15 - 4.36
Hemmati et al (65)	Ghazvin	2021	212	81	38.21	31.64 - 45.11
Mirjalili et al (66)	Tehran /Karaj	2021	148	38	25.68	18.85 - 33.50
Zeighami et al (67)	Zanjan	2021	100	52	52	41.78 - 62.10
Bineshfar et al (20)	Kerman	2022	2050	25	1.22	0.79 - 1.80
Farokhnia et al (21)	Kerman	2022	60	20	33.33	21.69 - 46.69
Pouladfar et al (22)	Shiraz	2022	492	19	3.86	2.34 - 5.97
Sherkatolabbasieh et al (23)	Khorramabad	2022	63	30	47.62	34.88 - 60.59

Note. CI: Confidence interval.

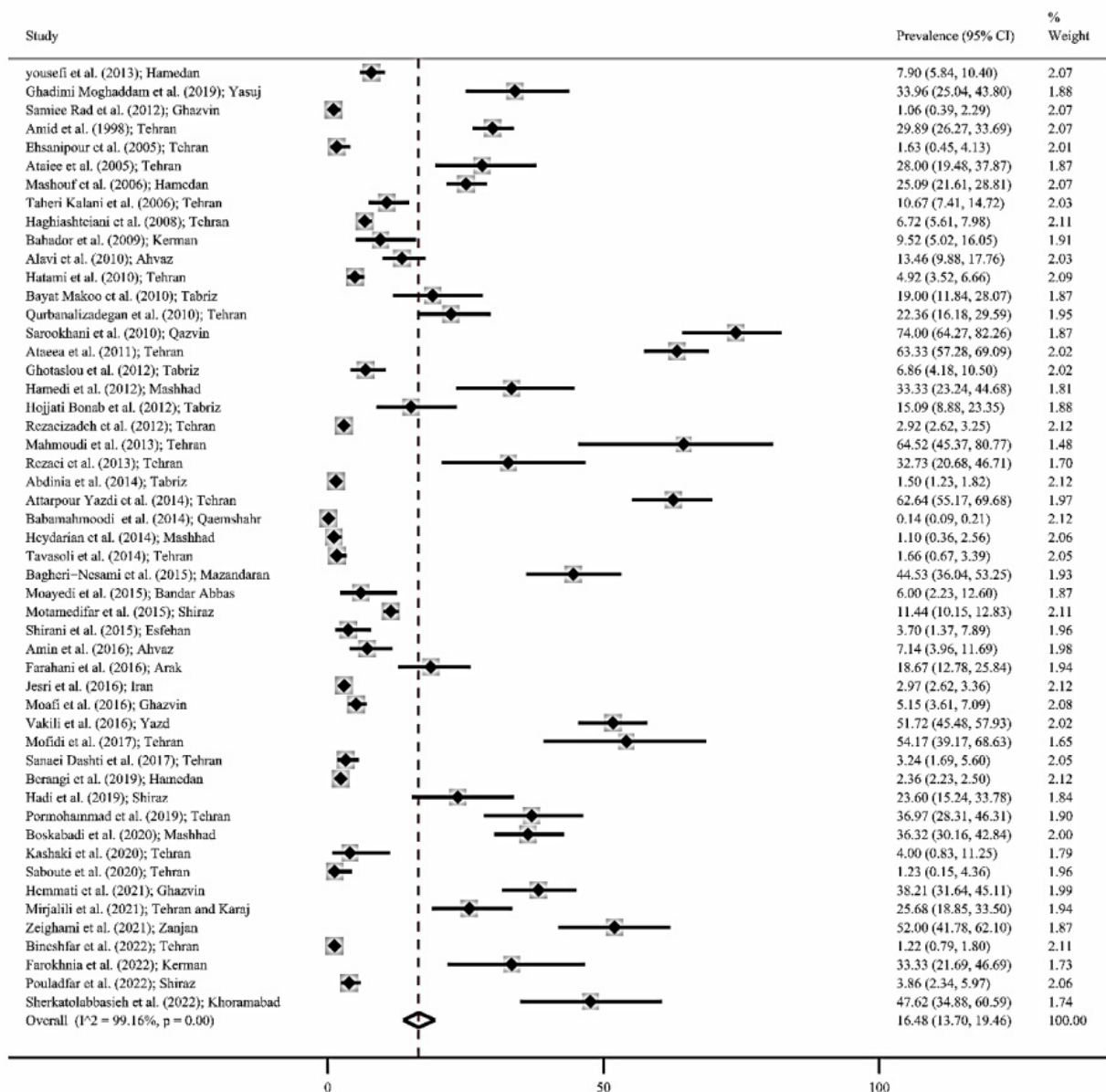


Figure 3. Forest Plot of Prevalence of Meningitis in Iran

Iran. In general, this bacterium has long been recognized as a major cause of bacterial meningitis (15,81,82). Similarly, *H. influenzae* was the second most common species in Iran, with a frequency of 15.96%. Although this bacterium is still a common strain of meningitis (82), its prevalence continues to decline. In the past, *H. influenzae* was the most frequently reported bacterium in meningitis cases; however, with the introduction of vaccination, its incidence has decreased (83). It should be noted that the pneumococcal vaccine for *S. pneumoniae* is available in Iran, but its administration is not mandatory within the country's health program (84). Based on the report in this article and the notably high prevalence of this bacterium among meningitis patients, vaccination is recommended for all children in Iran. Although *S. epidermidis* and *Klebsiella pneumoniae* were reported in a limited number of studies, they accounted for more than 15% of the cases

in those studies. Coagulase-negative staphylococci have also been identified as serious bacteria in cases of bacterial meningitis in Iran (14,80), but the specific species were not always mentioned. This article highlights *S. epidermidis* as the most important species. Given that *S. epidermidis* is a major cause of hospital-acquired infections, it can be inferred that most patients may have been infected in the hospital (85). Other species of this group, such as *S. haemolyticus* and *S. saprophyticus*, were also reported in the reviewed articles.

The prevalence of *K. pneumoniae* was found to be higher than previously reported. This increase might be due to the inclusion of a larger number of adult patients in this review, as this bacterium is recognized as a major cause of meningitis in adults (86). Furthermore, the reduction in incidence of primary causative agents of bacterial meningitis due to widespread vaccination may have led

to an increase in the reported prevalence of other bacteria.

Neisseria meningitidis is a leading cause of bacterial meningitis in many parts of the world, especially in America, Europe, and Africa (6,15). However, it is less prevalent in Iran. This article reported a rate of 13.13%, which is consistent with other previous studies in Iran, showing prevalence rates of 13% (14) and 10.5% (80). This could be due to three reasons: (a) *N. meningitidis* is commonly seen in meningitis among young adults, while Iranian studies often do not focus on this age group (87). (b) Most cases of *N. meningitidis* are reported in the meningitis belt of Africa. Given the differences in climate, ethnicity, and healthcare infrastructure between Iran and these countries, differences in the predominant types of meningitis are not surprising (88). (c) The development of the meningococcal vaccine has naturally led to a reduction in the rate of its infection. (59) *S. agalactiae* and *E. coli* were also significantly reported in Iran. Given that there is no vaccine in the national health program for meningitis caused by these two bacteria (13,89), it can be predicted that their prevalence may increase in the future.

Table 2. The Most Common Types of Bacterial Meningitis in Iran

Organism	Study Number	Prevalence (CI 95%)	P Value	I ² %
<i>S. pneumoniae</i>	38	27.89 (23.26 - 32.74)	<0.001	85.23
<i>H. influenzae</i>	36	15.96 (12.21 - 20.06)	<0.001	83.59
<i>S. epidermidis</i>	7	15.88 (5.35 - 30.27)	<0.001	94.97
<i>K. pneumoniae</i>	8	15.56 (6.61 - 27.01)	<0.001	88.39
<i>N. meningitidis</i>	29	13.13 (9.27 - 17.48)	<0.001	88.27
<i>S. agalactiae</i>	6	11.42 (6.15 - 17.96)	<0.001	77.33
<i>E. coli</i>	25	7.07 (4.84 - 9.61)	<0.001	66.49
<i>S. aureus</i>	16	6.15 (4.09 - 8.52)	<0.001	57.34
<i>P. aeruginosa</i>	15	4 (2.49 - 5.76)	<0.001	47.21

Note. CI: Confidence interval; *S. pneumoniae*: *Streptococcus pneumoniae*; *H. influenzae*: *Haemophilus influenzae*; *S. epidermidis*: *Staphylococcus epidermidis*; *K. pneumoniae*: *Klebsiella pneumoniae*; *Neisseria meningitidis*: *N. meningitidis*; *S. agalactiae*: *Streptococcus agalactiae*; *E. coli*: *Escherichia coli*; *S. aureus*: *Staphylococcus aureus*; *P. aeruginosa*: *Pseudomonas aeruginosa*.

It should be noted that *S. agalactiae* is now considered one of the leading causes of meningitis, especially in children (90,91).

In a 2015 review conducted in Iran, *Enterobacter* was reported as the third most common cause of meningitis, accounting for 12.24% of cases (80). In our study, a significant number of articles mentioned *Enterobacter* but not a specific species. *Listeria monocytogenes* was uncommon in this review, likely because this bacterium more commonly causes meningitis in infants, patients over 50 years of age, and those with weakened immune systems (91). The clinical manifestations are usually similar across different types of meningitis. In this review, fever was observed in about 90% of patients. About 50% of cases presented with nausea, neck stiffness, vomiting, and headache, in respective order of frequency. The classical triad of meningitis (i.e., fever, stiff neck, and altered mental status) is most commonly observed in people over 60 years of age and occurs in only 40% of cases overall (92). The triad, along with headache, constitutes the classical manifestations of meningitis, and nearly every patient presenting with at least two of these symptoms (93). The high incidence of nausea and vomiting in this review may be due to the younger age of most patients, as these symptoms are more common in children (6,14). This pattern is to some extent similar to a study conducted on Iranian children with bacterial meningitis, in which fever was reported in 71% of cases and nausea and vomiting in 67%, which supports our findings (14). Another study on bacterial meningitis across all age groups reported fever in 95% of cases, vomiting in 57%, and seizures in only 12%. Across all studies, fever remains the most consistent clinical symptom (94).

A study of bacterial meningitis in adults (6) reported headache and neck stiffness frequently (in more than 80% of cases) and seizures in only 5%. In this review, 25% of patients had seizures, indicating a higher seizure prevalence in children than in adults with meningitis. Altered mental status was not widely reported in our study. Sleepiness, restlessness, and irritability were observed in some patients as nonspecific neurological symptoms, which are also seen in younger meningitis patients.

Limitations

This study has several limitations. First, a significant

Table 3. Prevalence of Clinical Manifestations in Patients with Bacterial Meningitis

Clinical Manifestation	Study Number	Diagnosis With Meningitis	Patient With Manifestation	Prevalence (95% CI)	Weight (%)	I ²	P value
Headache	8	538	199	44.04	11.21	94.10	<0.001
Nausea	6	419	216	55.81	10.96	92.55	<0.001
Vomiting	5	362	164	46.58	6.84	94.53	<0.001
Neck stiffness	6	288	125	50.60	5.75	93.99	<0.001
Fever	9	566	511	89.37	46.67	90.12	<0.001
Seizure	9	493	108	25.42	18.57	91.36	<0.001

Note. CI: Confidence interval.

number of bacterial reports (over 500) lacked species-level identification, being reported only at the genus level or left unspecified. These cases were excluded from the analysis, which may have introduced bias and reduced the statistical power of the findings. Second, most of the included studies were conducted in Tehran, while data from many other cities were either limited or unavailable. Given the differences in climate, cultural practices, and hygiene standards across various regions of Iran, the lack of comprehensive geographic representation may have influenced the generalizability of the results. Lastly, inclusion in this review required a positive CSF culture result. Although CSF culture is considered the gold standard for diagnosing bacterial meningitis, it has a reported false-negative rate of 10–30% (81, 94). Therefore, some cases of bacterial meningitis may have been missed, potentially underestimating the true burden of the disease.

Conclusion

This article provides valuable insights into the burden and etiology of hospital-based bacterial meningitis in Iran. The results highlight the need for vaccination and improved diagnostic efforts to identify regional differences and address healthcare inequalities. To better understand the national burden of disease, future studies should not be limited to hospitalized cases but should also include population-based data from across the country. Moreover, implementing and evaluating nationwide vaccination strategies, especially against pneumococcal disease, alongside strengthening surveillance systems and broadening study coverage, could substantially improve prevention efforts and inform more effective public health planning.

Authors' Contribution

Conceptualization: Omid Raiesi, Mohammad Hossein Ekván.

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Competing Interests

The authors declare that they have no conflict of interests.

Ethical Approval

Not applicable.

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