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Original Article

The Trend of Meningitis in Guilan Province, Northern Iran During 2011-2022: An Ecological Study

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Abstract

Background and aims: Despite the availability of vaccines, antibiotics, and healthcare services, meningitis is a serious cause of morbidity and mortality worldwide. Thus, this study investigated the incidence of meningitis and identified areas with the highest incidence in Guilan.

Methods: This study calculated the cumulative incidence of meningitis (confirmed and probable cases) and fever and neurological symptoms syndrome per 100,000 population each year. Join point regression analysis was used to identify noticeable changes in the trend of disease, and ArcGIS software was employed to determine high-risk areas.

Results: Overall, 653 cases of syndrome were reported during 2011-22, of whom 404 (61.87%) were confirmed and probable cases of meningitis. The age of 148 (36.63%) meningitis patients was less than 5 years, and 255 (63.12%) were male. The outcome of death was reported in 11.54% of confirmed cases and 6.28% of all cases. Joinpoint regression analysis revealed significant decreasing trends in the incidence of fever and neurological symptoms post-2018 across all age groups (APC: -37.45%, $P<0.05$), with a notable decrease in children<5 (APC: -54.03%, $P<0.05$). Additionally, a significant reduction was found in those over 5 years after 2015. For meningitis cases across all ages and children under 5, non-significant trends included a breakpoint in 2019, with a subsequent decline. Meningitis incidence demonstrated a non-significant decreasing trend among individuals over 5 years throughout 2011-2022.

Conclusion: The annual incidence of meningitis and syndrome in Guilan was lower than the average in the whole country, but the case fatality rate was higher.

Keywords: Incidence, Meningitis, Spatio-temporal analysis, Iran, Guilan

Introduction

Meningitis is an inflammation of the meninges, protective membranes surrounding the brain and spinal cord.[1] Bacterial, viral, and fungal infections are the leading causes of this inflammation.[2] In addition, *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Neisseria meningitidis* are the most common bacterial pathogens causing meningitis, which can be prevented by vaccination.[3]

The incidence and mortality rates of meningitis vary among different regions and age groups.[4] Its incidence rate ranges from 0.9 per 100,000 person-years to 80 per 100,000 person-years in high-income and low-income countries, respectively.[5] This rate is less than 2 cases per 100,000 person-years in other countries, including France, Germany, Italy, Poland, the United States of America, and China, and more than 10 cases per 100,000 person-years in the African Meningitis Belt Countries.[6] Moreover, the annual incidence of meningitis in Iran has been reported at 2.72 per 100,000 population.[2]

Viral meningitis recovers without treatment.[7] However, bacterial meningitis is serious and fatal without adequate antibiotic therapy.[8] The mortality of meningitis ranges between 2% and 30%.[9] Despite treatment with antibiotics, up to 23% of survivors may still suffer from long-term neurological sequelae.[10]

Meningitis is a compulsory notification disease in Iran, and all suspected cases should be reported to the disease surveillance system.[2,11] The routine surveillance of suspected meningitis cases is conducted to identify demographic characteristics and clinical symptoms of patients, as well as to detect epidemics, in accordance with the recommendations of the World Health Organization.[12]

Until 2019, 191 countries had introduced the vaccination of *H. influenzae* type b (Hib) in their national immunization programs, but vaccine coverage noticeably

varied by region.[13] Iran has added a Hib vaccine to its routine immunization program since November 18, 2014, in the form of a pentavalent vaccine that includes hepatitis B, diphtheria, pertussis, tetanus, and Hib. The pentavalent vaccine is given at 2, 4, and 6 months old, and the rate of vaccination coverage is 99%.[14]

Bacterial meningitis is considered a globally serious cause of morbidity and mortality, despite access to antibiotics, vaccines, and health care.[11,15,16] Accordingly, there is a critical need for continuous monitoring of this disease in order to evaluate the effectiveness of current prevention and control strategies. The World Health Organization has also launched a comprehensive roadmap to defeat meningitis by 2030, due to the importance of the disease and the annual outbreaks caused by this pathogen.[17,18] However, regional variations in disease burden necessitate localized studies to guide suitable interventions. Therefore, this study was conducted to investigate trends in the incidence of meningitis and identify areas with the highest incidence in Guilan province using national disease surveillance data over 11 years. It is expected that the results of this study will provide valuable insights for public health authorities to efficiently optimize vaccination strategies, enhance surveillance, and allocate healthcare resources to reduce disease burden in vulnerable populations.

Materials and Methods

Data Source

This research was an ecological study of information on all cases of fever and neurological symptoms in Guilan Province reported to the Center for Communicable Diseases Control of the Ministry of Health from March 21, 2011, to March 20, 2022.

Data on demographic variables (i.e., age group, gender, occupation, and area of residence, along with clinical symptoms, date of symptom onset, season, outcome, and type of meningitis, were extracted from the surveillance system.

Case Definition

The diagnosis of meningitis was based on the National Meningitis Care Program guidelines, classifying patients into suspected, probable, and confirmed cases.

Suspected cases were defined as individuals of any age with a fever above 38.5°C and at least one meningeal symptom (neck stiffness, decreased consciousness, headache, vomiting, or neurological complications) or bulging fontanelle in children. Moreover, probable cases had to meet suspected case criteria plus cerebrospinal fluid findings, such as turbidity, elevated white blood cells (>100 cells/mm^3), and an increase in white blood cells of 10–100 cells/mm^3, along with an increase in protein more than 100 mm/dL or a decrease in glucose to less than 40 mg/d:, or Gram stain indicative of specific bacteria (e.g., *H. influenzae*, *N. meningitidis*, and *S. pneumoniae*). Eventually, confirmed cases had to have positive cultures or antigen detection by the latex agglutination test.[2]

Statistical Analysis

The cumulative incidence rates of meningitis (including confirmed and probable cases) and fever with neurological symptoms were calculated annually per 100,000 population for all ages, as well as separately for individuals under and over 5 years of age.

In addition, population data by age were extracted from the national censuses of 2012 and 2017, and the population forecast for the year 2021 was used as the denominator to calculate incidence rates per 100,000 population. Further, the linear interpolation method was utilized for the intervening years. The average annual percent changes (AAPCs) and annual percent changes (APCs) were estimated with corresponding 95% confidence intervals (CIs) using joinpoint regression analysis. [19]

AAPCs were calculated for the five periods: (a) the entire study period (2011–2022), (b) before the implementation of the Hib vaccination program (2011-2014), (c) after the implementation of the vaccination program and before the coronavirus disease 2019 (COVID-19) pandemic (2015-2019), (d) after the COVID-19 pandemic (2020–2022), and (e) during the period without considering the COVID-19 pandemic years (2011-2019). The pentavalent vaccination was implemented on November 18, 2014. The post-COVID-19 period was after the announcement of COVID-19 on March 4, 2020, in Iran.

Qualitative demographic variables were expressed as frequencies and percentages. Furthermore, missing data were quantified and reported as both frequencies (n) and percentages to provide a detailed description of data completeness.

Additionally, cumulative incidence was computed using Microsoft Excel 2016. Moreover, the Joinpoint software (version 5.0) was employed to determine the trend of disease incidence. Time trends were considered statistically significant when APCs or AAPCs had a *P*-value of less than 0.05. Likewise, the weighted Bayesian information criterion was used to introduce the best-fit model. Finally, ArcGIS software (version 10.2) was utilized to create a geographical map of the cumulative incidence of meningitis in each district.

Results

In total, 653 cases of fever and neurological symptoms were reported during 2011–2022, 404 (61.87%) of whom were confirmed and probable cases (meningitis disease). Of the total meningitis cases, 148 (36.63%) people were under 5 years old. In addition, 255 (63.12%) patients were male, and 281 (69.55%) people resided in the city. Further, the majority of people (n = 95, 23.51%) were employed, and the type of meningitis was not specified in 23 (88.46%) of the total confirmed cases. Furthermore, the outcome of death was reported in 3 (11.54%) confirmed cases and in 41 (6.28%) cases of fever and neurological symptoms (Table 1).

Table 1. The Epidemiological and Clinical Characteristics of Patients

Variables	Level	n (%)	Variables	Level	n (%)
Classification of fever and neurological symptoms syndrome	Suspected	249 (38.13)	Age group (probable and confirmed cases)	Under 5 years	148 (36.63)
	Probable	378 (57.88)		5-14 years	32 (7.92)
	Confirmed	26 (3.98)		15-44 years	123 (30.45)
Gender (probable and confirmed cases)	Female	147 (36.39)		45-64 years	60 (14.85)
	Male	255 (63.12)		>65	41 (10.15)
	Unknown	2 (0.5)		Unknown	-
Occupation (probable and confirmed cases)	Children and neonates	160 (39.60)	Type of meningitis (confirmed cases)	*S. pneumonia*	1 (3.85)
	Employed	95 (23.51)		*N. meningitis*	2 (7.69)
	Housewife	66 (16.34)		*H. influenza*	-
	Student	30 (7.42)		Other things	23 (88.46)
	Unemployed	27 (6.68)			
	Retired	17 (4.21)	Outcome of the disease (suspected, probable, and confirmed cases)	Improved	461 (70.60)
	Soldier	2 (0.50)		Death	41 (6.28)
	Unknown	7 (1.73)		Unknown	151 (23.12)
Residency area (probable and confirmed cases)	Urban	281 (69.55)	Outcome of the disease (confirmed cases)	Improved	13 (50.00)
	Rural	122 (30.20)		Death	3 (11.54)
	Unknown	1 (0.25)		Unknown	10 (38.46)

Note. *S. pneumoniae*: *Streptococcus pneumoniae, H. influenzae*: *Haemophilus influenzae; N. meningitidis*: *Neisseria meningitidis*.

Information related to clinical symptoms (e.g., fever, headache, vomiting, decreased consciousness, neck stiffness, seizures, bulging fontanelle, Kernig's sign, and Brudzinski's sign) was collected from 2016 in Iran.

The most common clinical symptoms in meningitis patients were fever, headache, vomiting, neck stiffness, seizures, decreased consciousness, Kernig's sign, bulging fontanelle, and Brudzinski's sign, respectively. Additionally, fever was observed in 95.53% of patients, and Brudzinski's sign was noted in 1.28% of those with fever and neurological symptoms. Related results are provided in Table 2.

The highest frequency of cases of fever, neurological symptoms, and meningitis was reported in the autumn, summer, spring, and winter seasons, respectively. Spring is from March 20 to June 20, summer is from June 21 to September 21, autumn is from September 23 to December 20, and winter is from December 21 to March 19 in Iran. The highest frequency of cases was observed in August and September. The results are shown in Figure 1(a-b).

The cumulative incidence of meningitis was 16.28, 103.10, and 10.95 per 100,000 at all ages, age groups under and over 5 years old, respectively, during the entire period. Moreover, the incidence of fever and neurological symptoms cases was 26.32, 151.85, and 18.61 per 100,000 at all ages, age groups under and over 5 years old, respectively (Table 3).

For meningitis (confirmed and probable cases) at all ages, the joinpoint regression identified a model with one breakpoint in 2019. The trend demonstrated an increasing pattern from 2011 to 2019, with an AAPC of 1.36% (95% CI: -14.70 to 106.60), followed by a decreasing trend from 2019 to 2022, with an APC of -48.62% (95% CI: -81.40 to 4.12). However, these changes were not

Table 2. Clinical Symptoms of Meningitis and Cases of Fever and Neurological Symptoms Syndrome

Variables	Level	Meningitis N (%)	All Patients N (%)
Fever	Yes	195 (94.66)	299 (95.53)
	No	11 (5.34)	14 (4.47)
	Unknown	-	-
Headache	Yes	121 (58.74)	195 (62.30)
	No	42 (20.39)	61 (19.49)
	Unknown	43 (20.87)	57 (18.21)
Neck stiffness	Yes	133 (64.56)	179 (57.19)
	No	66 (32.04)	121 (38.66)
	Unknown	7 (3.40)	13 (4.15)
Vomiting	Yes	120 (58.25)	186 (59.42)
	No	82 (39.81)	120 (38.34)
	Unknown	4 (1.94)	7 (2.24)
Seizures	Yes	53 (25.73)	80 (25.56)
	No	147 (71.36)	225 (71.88)
	Unknown	6 (2.91)	8 (2.56)
Decreased consciousness	Yes	50 (24.27)	69 (22.04)
	No	148 (71.84)	231 (73.80)
	Unknown	8 (3.88)	13 (4.15)
Bulging fontanelle	Yes	15 (7.28)	17 (5.43)
	No	182 (88.35)	284 (90.73)
	Unknown	9 (4.37)	12 (3.83)
Kernig's sign	Yes	11 (5.34)	18 (5.75)
	No	179 (86.89)	271 (86.58)
	Unknown	16 (7.77)	24 (7.67)
Brudzinski's sign	Yes	2 (0.97)	4 (1.28)
	No	185 (89.81)	282 (90.10)
	Unknown	19 (9.22)	27 (8.63)

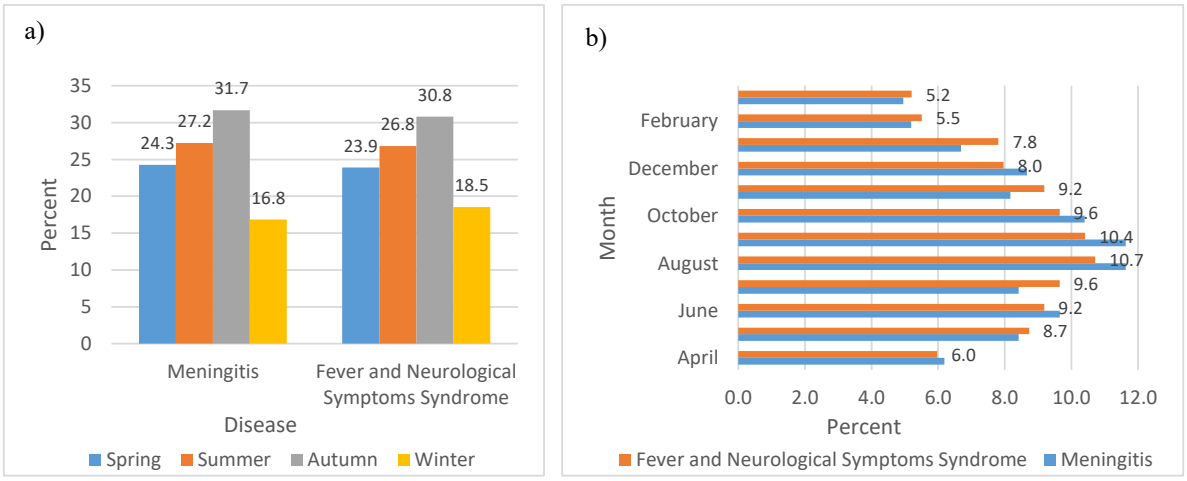

Figure 1. Frequency of Cases of Meningitis, Fever, and Neurological Symptoms: **(a)** by Season and **(b)** by Month

Table 3. Cumulative Incidence of Meningitis, Fever, and Neurological Symptoms per 100,000 Population

Year	Number and Incidence of Meningitis						Number and Incidence of the Syndrome					
	At All Ages		Under 5 Years Old		Over 5 Years Old		At All Ages		Under 5 Years Old		Over 5 Years Old	
	n	Incidence (95% CI)	N	Incidence (95% CI)	n	Incidence (95% CI)	n	Incidence (95% CI)	n	Incidence (95% CI)	n	Incidence (95% CI)
2011	31	1.25 (0.8-1.7)	14	9.75 (4.6-14.9)	17	0.73 (0.4-1.1)	44	1.77 (1.2-2.3)	20	13.93 (7.8-20.0)	24	1.03 (0.6-1.4)
2012	40	1.61 (1.1-2.1)	10	6.94 (2.6-11.2)	30	1.28 (0.8-1.7)	62	2.49 (1.9-3.1)	15	10.41 (5.1-15.7)	47	2.00 (1.4-2.6)
2013	42	1.68 (1.2-2.2)	19	13.14 (7.2-19.0)	23	0.98 (0.6-1.4)	74	2.96 (2.3-3.6)	26	17.98 (11.1-24.9)	48	2.04 (1.5-2.6)
2014	51	2.03 (1.5-2.6)	19	13.09 (7.2-19.0)	32	1.35 (0.9-1.8)	77	3.07 (2.4-3.8)	28	19.30 (12.1-26.4)	49	2.07 (1.5-2.7)
2015	34	1.35 (0.9-1.8)	11	7.55 (3.1-12.0)	23	0.97 (0.6-1.4)	83	3.29 (2.6-4.0)	21	14.42 (8.3-20.6)	62	2.61 (2.0-3.3)
2016	55	2.17 (1.6-2.7)	23	15.74 (9.3-22.2)	32	1.34 (0.9-1.8)	82	3.24 (2.5-3.9)	34	23.26 (15.4-31.1)	48	2.01 (1.4-2.6)
2017	35	1.38 (0.9-1.8)	15	10.24 (5.1-15.4)	20	0.84 (0.5-1.2)	57	2.25 (1.7-2.8)	24	16.38 (9.8-22.9)	33	1.38 (0.9-1.9)
2018	38	1.49 (1.0-2.0)	16	10.89 (5.6-16.2)	22	0.92 (0.5-1.3)	71	2.79 (2.1-3.4)	27	18.38 (11.4-25.3)	44	1.84 (1.3-2.4)
2019	49	1.92 (1.4-2.5)	14	9.51 (4.5-14.5)	35	1.46 (1.0-1.9)	64	2.51 (1.9-3.1)	16	10.86 (5.5-16.2)	48	2.00 (1.4-2.6)
2020	14	0.55 (0.3-0.8)	7	4.74 (1.2-8.3)	7	0.29 (0.1-0.5)	17	0.66 (0.3-1.0)	7	4.74 (1.2-8.3)	10	0.42 (0.2-0.7)
2021	15	0.59 (0.3-0.9)	0	0.0 (0.0-0.0)	15	0.62 (0.3-0.9)	22	0.86 (0.5-1.2)	0	0.0 (0.0-0.0)	22	0.91 (0.5-1.3)
Total	404	16.28 (14.7-17.9)	148	103.10 (86.5-119.7)	256	10.95 (9.6- 12.3)	653	26.32 (24.3-28.3)	218	151.85 (131.7-172.0)	435	18.61 (16.9-20.4)

Note. CI: Confidence interval.

statistically significant ($P>0.05$). In the population under 5 years, the best model also had one breakpoint in 2019. The cumulative incidence increased during 2011-2019 with an APC of 1.22% (95% CI: -19.60 to 117.80), then sharply decreased between 2019 and 2022, with an APC of -66.46% (95% CI: -93.60 to 11.30). These changes were not statistically meaningful ($P>0.05$). Models without any breakpoints were selected for the population over 5 years old. The cumulative incidence showed a consistent decreasing trend over the entire study period (2011-2022), with an AAPC (the same as APC) of -2.46% (95% CI: -12.16 to 7.43), which was not statistically significant ($P>0.05$).

Regarding the cumulative incidence of fever and neurological symptom syndrome, a joinpoint model with a breakpoint in 2018 was chosen for all ages. The cumulative incidence revealed a significant decrease during 2018-2022, with an APC of -37.45% (95% CI: -63.04 to -17.00, $P<0.05$). Before 2018, the trend was increasing, with an APC of 3.76% (95% CI: -2.92 to 17.97), which was not significant. Among children under 5 years, the model similarly had a breakpoint in 2018,

with a significant decreasing trend post-2018 (APC: -54.03%, 95% CI: -92.51 to -20.00, $P<0.05$). Before 2018, there was an increasing but not significant trend (APC: 5.66%, 95% CI: -3.02 to 37.54). For the population over 5 years, a breakpoint was identified in 2015. After 2015, the cumulative incidence significantly decreased, with an APC of -14.40% (95% CI: -59.12 to -3.16, $P<0.05$). Before 2015, the trend was increasing but not significant (APC: 15.84%, 95% CI: -5.36 to 142.71). In addition, the AAPC values were calculated for the years 2011-2014, 2015-2019, 2020-2022, 2011-2019, and for the entire period, the results of which are presented in Table 4 and Figure 2 (a-b).

The cumulative incidence of meningitis in different districts of the province confirmed that the districts of Lahijan, Langarud, Masal, Astaneh-ye Ashrafiyeh, and Rasht had the highest incidence of meningitis in Guilan, respectively. Moreover, the highest incidence was reported in Astaneh-ye Ashrafiyeh, Lahijan, Rudsar, Rasht, and Siahkal districts for the age group under 5 years, and in the districts of Masal, Lahijan, and Langarud for the age group over 5 years. The related data are plotted in Figure 3 (a-c).

Discussion

This study provided a comprehensive epidemiological assessment of fever and neurological symptom syndrome and meningitis cases in Guilan Province from 2011 to

Table 4. Analysis of the Cumulative Incidence by Group Age During 2011-2022

Age Group	Year	APC	2011-22	2011-14	2015-19	2020-22	2011-19
		APC (95% CI)	AAPC (95% CI)	AAPC (95% CI)	AAPC (95% CI)	AAPC (95% CI)	AAPC (95% CI)
Meningitis (confirmed and probable cases) Cumulative Incidence							
All ages	2011-2019	1.36 (-14.70, 106.60)	-11.52 (-26.98, 7.41)	1.36 (-14.67, 61.04)	1.36 (-18.80, 11.51)	-48.62 (-81.40, 4.12)	1.36 (-9.55, 14.28)
	2019-2022	-48.62 (-81.40, 4.12)					
Under 5 years	2011-2019	1.22 (-19.60, 117.80)	-18.84 (-40.98, 8.60)	1.22 (-18.52, 68.87)	1.22 (-24.11, 14.13)	-66.46 (-93.55, 11. 31)	1.22 (-12.49, 16.40)
	2019-2022	-66.46 (-93.60, 11. 30)					
Over 5 years	2011-2022	-2.46 (-12.16, 7.43)	-2.46 (-12.16, 7.43)	-2.46 (-12.16, 7.43)	-2.46 (-12.16, 7.43)	-2.46 (-12.16, 7.43)	-2.46 (-12.16, 7.43)
Fever and neurological symptoms syndrome: Cumulative Incidence							
All ages	2011-2018	3.76 (-2.92, 17.97)	-10.86 (-18.56, -3.97)*	3.76 (-2.92, 17.54)	-8.57 (-17.58, 2.33)	-37.45 (-63.04, -17.0)*	-2.60 (-7.56, 3.50)
	2018-2022	-37.45 (-63.04;-17.00)*					
Under 5 years	2011-2018	5.66 (-3.02, -37.54)	-17.68 (-39.92, -3.47)*	5.66 (-3.02, 36.56)	-14.18 (-28.65, 3.48)	-54.03 (-92.51, -20.00)*	-4.78 (-13.38, 7.59)
	2018-2022	-54.03 (-92.51, -20.00) *					
Over 5 years	2011-2015	15.84 (-5.36, 142.71)	-3.37 (-18.21, 9.28)	15.84 (-5.36, 80.56)	-14. 38 (-25.79, 0.90)	-14.38 (-59.12, -3.16)*	-0.41 (-8.40, 15.10)
	2015-2022	-14.40 (-59.12, -3.16)*					

Note. * $P<0.05$. AAPC: Average annual percent changes; APC: Annual percent changes; CI: Confidence interval.

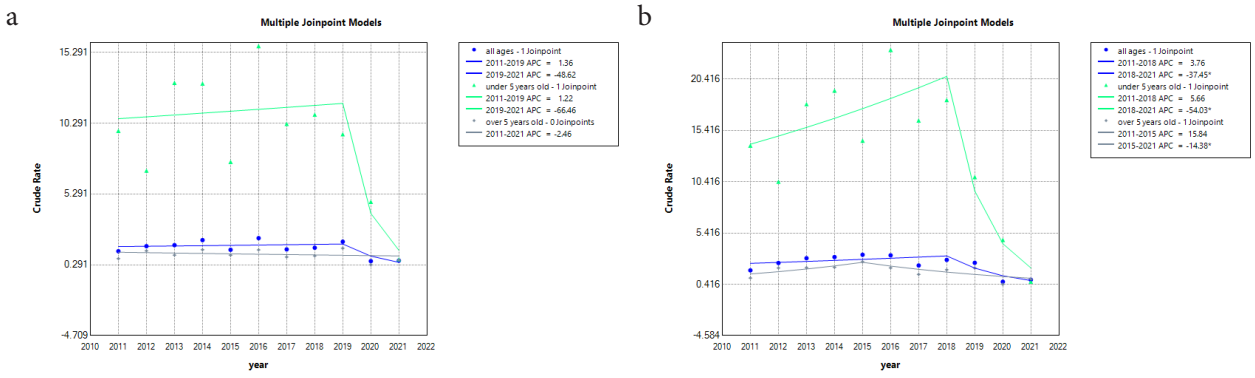

Figure 2. The Trend of the Cumulative Incidence of Meningitis in Guilan by Age Groups During 2011-2022: **(a)** Meningitis and **(b)** Fever and Neurological Symptoms Syndrome

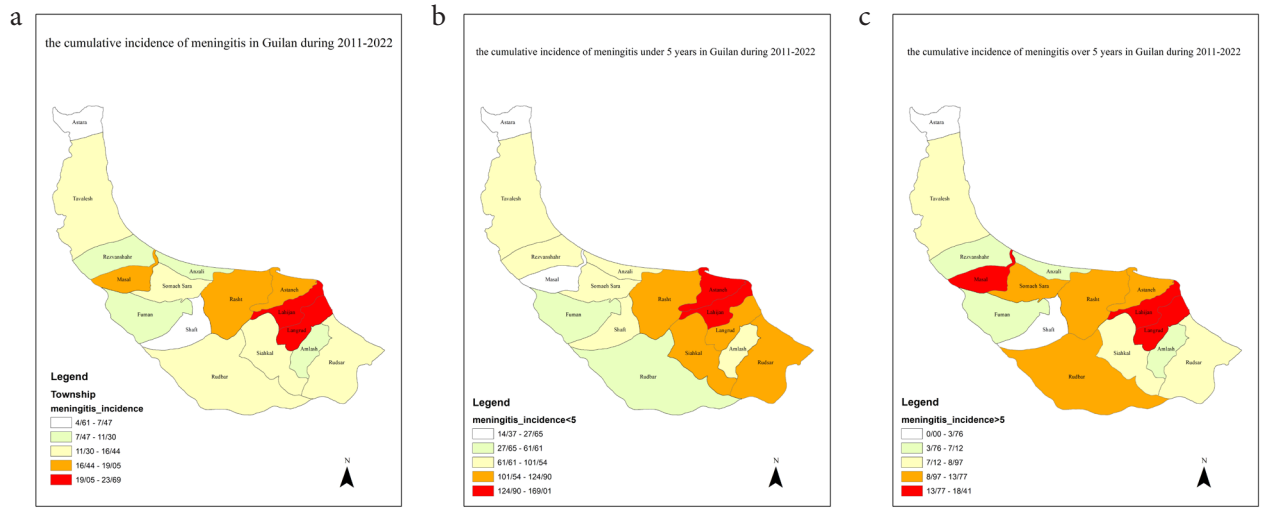

Figure 3. Distribution of the Cumulative Incidence of Meningitis per 100,000 in Guilan in 2011-2022: **(a)** All Ages, **(b)** Under 5 Years, and **(c)** Over 5 Years

2022. Due to inherent limitations in laboratory diagnostic methods, this study reported the incidence of meningitis by incorporating both confirmed and probable cases to provide a more comprehensive assessment of disease burden. A total of 653 cases of fever and neurological symptoms were reported, of whom 61.87% were confirmed or probable meningitis cases. Notably, 36.63% of meningitis patients were children under 5 years, with a predominance of male patients (63.12%). The incidence trends of meningitis, fever and neurological symptom syndrome demonstrated distinct temporal and age-related patterns. In addition, significant decreasing trends were observed in the incidence of fever and neurological syndrome after 2018 across all age groups, particularly among children under 5, and in individuals over 5 years after 2015. However, meningitis incidence trends exhibited non-significant declines, with a breakpoint identified in 2019 for all ages and children under 5 years. Spatial analysis identified Lahijan, Langarud, Masal, and Astaneh-ye Ashrafiyeh as high-incidence districts.

Most patients in our study were male, which is consistent with the results of other studies.[3,6,14,20-22] Biological or social factors can justify the high rate of disease in men.[2] In line with another study,[6] the age of the majority of patients was less than 5 years in our study, reflecting age-related vulnerability.

The majority of patients in our study lived in the city, which conforms to the findings of other studies,[6,14,20] indicating that they potentially had better access to healthcare and reporting systems.

Most cases were observed across the four seasons: autumn, summer, spring, and winter. Similarly, the highest incidence of the disease was reported in summer, spring, winter, and autumn, respectively, in another study.[6] In one study, the majority of meningitis cases also occurred in autumn, followed by summer, winter, and spring seasons.[22] The highest frequency of cases belonged to August and September, which contradicts another study's results in Iran, where most meningitis cases were reported in June and May during 2010-15.[20] These disparities may result from regional climatic differences influencing pathogen transmission dynamics, as hot and dry conditions have been associated with elevated risk of respiratory infections risk.[8,23]

The result of this study regarding the incidence cases of the syndrome is in line with those of a study conducted in Iran during 2010-15, and the incidence of the disease in the province was lower than the average incidence in the whole country.[20]

The incidence trend of meningitis revealed an increasing pattern until 2019 and then decreased at all ages, and in the population under 5 years, although it was not statistically significant. Although a reduction 2.5% was observed for age groups over 5 years at all the investigated periods, it was not statistically significant.

Likewise, the incidence trend of fever and neurological symptom syndrome decreased at all ages, and in both age groups in 2011-19, although it was not statistically meaningful.

Our results confirmed a significant decrease in disease incidence in the post-COVID period. The highest decrease was related to the age group under 5 years, with an AAPC of -54%. This decline in the incidence of fever and neurological symptom syndrome post-2018, particularly among children under five, may be related to public health measures and preventive measures against the COVID pandemic, in addition to underreporting.

Based on our findings, death occurred in 11.5% of confirmed cases and 6.3% of all reported cases. This finding does not match that of another study in Iran, where the outcome of death was observed in 2% of patients.[20] This contradiction may be partly explained by the demographic structure of the province, marked by a relatively larger elderly population who are more vulnerable to severe outcomes.[24] In another study conducted in Southern Vietnam, the outcome of death was reported in 1.2% of

probable cases and 8.2% of confirmed cases.[3]

Recognizing high-risk areas helps us to reduce the incidence of meningitis. In this study, spatial analysis identified Lahijan, Langarud, Masal, and Astaneh-ye Ashrafiyeh as areas with the highest incidence, reflecting geographic heterogeneity in disease distribution likely influenced by differences in healthcare access, reporting quality, and environmental factors. Such clustering underscores the necessity of targeted interventions and strengthened epidemiological surveillance in these places. Moreover, due to underreporting and the lack of reporting of cases in some districts, there is a need for intervention measures in order to strengthen the syndromic care system. This study benefits from a long-term surveillance dataset spanning 11 years, enabling in-depth trend analysis across critical healthcare events (e.g., the introduction of vaccines and the COVID-19 pandemic).

However, several limitations should be acknowledged. A considerable proportion of cases were classified as "other pathogens," reflecting incomplete etiological data. Additionally, some outcome data were missing, which may bias mortality estimates. Despite observed trends, the incidence of meningitis did not demonstrate statistically significant changes. This lack of significance may be due to the limited sample size, potential underreporting, or temporal variability in surveillance accuracy. Therefore, the findings should be interpreted with caution. Eventually, future research involving larger datasets and improved methodologies is needed to confirm these trends and support more definitive conclusions.

Conclusion

According to the results of the study, the incidence of meningitis in Guilan Province was lower than the average incidence in the whole country, but the case fatality rate was higher. The cumulative incidence of fever and neurological symptoms confirmed a significant decreasing trend during 2018-2022, at all ages, children under 5 years, and the population over 5 years. Based on geographical distribution, Lahijan, Astaneh-ye Ashrafiyeh, and Masal were areas with the highest incidence at all ages, for those under 5 years old and over 5 years old, respectively.

These results underline the need for sustained efforts to enhance preventive measures, improve case reporting systems, and strengthen epidemiological surveillance.

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Competing Interests

The authors declare that there is no conflict of interests.

Ethical Approval

The study protocol was reviewed and approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences (ethical code IR.SSU.SPH.REC.1402.118).

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