زانکۆی سەلاحەدین - هەولێر
Salahaddin University-Erbil

Types, Risk Factors, Clinical symptoms and Diagnostic Tests of Acute Meningitis in Sulaimani Province During 2019-2023

Research Project

Submitted to the Department of (Biology) in partial fulfillment of the requirements for the degree of **BSc.** in **Biology**

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CERTIFICATE

This research project has been written under my supervision and has been submitted for the award of the **BSc.** degree in **Biology** with my approval as a supervisor.

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DEDICATION

Our parents who have always supported us and helped us and to all the teachers and students of the biology department and our classmates and to the readers and those who write research after us.

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SUMMARY OR ABSTRACT

Meningitis is a medical emergency condition that requires prompt diagnosis and treatment and otherwise associated with serious morbidity and mortality. Since the epidemiological, clinical and experimental characteristics of meningitis are different for various locations, this study was conducted to investigate the characteristics of meningitis patients admitted to hospitals of Sulaymaniyah Provence in the 2019 to mid-June 2023. In this cross-sectional and descriptive study, all 457 patients with meningitis were considered. The type of sampling method was census and data were analyzed with SPSS-25 using descriptive statistics (frequency, and percentage), and Chi-square and fisher exact test were performed for nominal variables. The data were collected from patients' files using special forms that were designed for this purpose before done by hospital. In this study, 285 men (62.36%) and 156 women (34.13%) were considered. Among the patients, 64 people (14.00%) were under one-year-old, 130 people (28.44%) were between five to nine-year-old, and 16 people (3.50%) were over 65 years. Among 457 patients, 162 ones (35.44%) and 295 ones (64.55%) were hospitalized with a diagnosis of bacterial meningitis and aseptic meningitis respectively. The percentage of leukocytes, the amount of CRP and the protein of cerebrospinal fluid in bacterial and aseptic meningitis was not significantly different. While the amount of glucose level between two groups were significantly different with p-value (0.0453). Continuous surveillance of meningitis is necessary in Iraq, and can only be achieved through improved detection methods. The incidence of meningitis in Iraq warrants improved vaccination programs.

Keywords: Meningitis, *Neisseria meningitides*, *Streptococcus pneumonia*, Viral meningitis, CSF.

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CRP: a protein present in blood serum in various abnormal states (such as inflammation or neoplasia).

CSF: Cerebrospinal fluid a colorless liquid that is comparable to serum, is secreted from the blood into the lateral ventricles of the brain, and serves chiefly to maintain uniform pressure within the brain and spinal cord.

CNS: Central nervous system is made up of the brain and spinal cord. It is part of the nervous system.

ICP: Intracranial pressure is the pressure inside the skull, in brain tissue and in the cerebrospinal fluid.

PCR: The polymerase chain reaction is a method widely used to make millions to billions of copies of a specific DNA sample rapidly, allowing scientists to amplify a very small sample of DNA sufficiently to enable detailed study.

AIDS: A disease in which there is a severe loss of the body's cellular immunity, greatly lowering the resistance to infection and malignancy.

LP: Lumbar puncture, also known as a spinal tap, is a medical procedure in which a needle is inserted into the spinal canal, most commonly to collect cerebrospinal fluid for diagnostic testing.

CT: A computed tomography scan is a medical imaging technique used to obtain detailed internal images of the body.

MRI: Magnetic resonance imaging is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes inside the body.

1. INTRODUCTION

Meningitis was first described in the 1020s in Avicenna's The Canon of Medicine and again more accurately by Avenzoar of al-Andalusia in the 12th century. symptoms of the disease were also noted in 1805 by the Swiss Gabinetto Vieusseux (a scientific-literary association) during an outbreak in Geneva- Switzerland in 1887, Dr. Anton Weichsel Baum (1845- 1920) of Vienna became the first to isolate the specific germ meningococci (Julián-Jiménez and Morales-Casado, 2019). Meningitis is the inflammation of leptomeningeal membranes, and is divided into septic and aseptic groups. Septic meningitis is caused by bacteria and includes acute and chronic varieties. Acute bacterial meningitis is the purulent infection of CNS, and *Streptococcus pneumonia* is the most common causing agent, especially in people older than 50 years of age (Goldman and Schafer, 2012). Other types of microorganisms include *Neisseria meningitides*, Beta-streptococcus group, and *Haemophilus influenza* (Kasper *et al.*, 2015). Chronic bacterial meningitis is another bacterial form of meningitis that occurs with clinical and inflammatory CSF symptoms for four weeks or longer (Goldman and Schafer, 2012). Aseptic meningitis is caused by viral or non-viral agents with similar clinical signs and inflammatory responses. This type of meningitis has acute and subacute forms, which are categorized according to duration of disease and cellular responses in CSF. Most cases of aseptic meningitis are caused by viruses, especially Enteroviruses (Goldman and Schafer, 2012). Studies report the incidence rate of 1.1 cases per 100,000 patients in America (Brouwer *et al.*, 2010). In another study in Paris, the prevalence of pneumococcal meningitis in ICU was 1.5% (Auburtin *et al.*, 2002). The results of a study in Italy revealed the prevalence of bacterial meningitis 3.7 per 100,000 cases (Giorgi Rossi *et al.*, 2009). In a study conducted in Central Child Teaching Hospital in Baghdad, Iraq, from 1st of October 2017 until 28th of February 2018. The important finding that most common cause is the bacterial source among children. Among 117 patients 73 (62%) were male and 44 (37%) were female. The incidence of bacterial meningitis is highest among children

younger than 1 year of age (Jarad, 2019). Based on review of available literature, there are several risk factors associated with meningitis such as age, gender, otitis or sinusitis, neurosurgery, alcoholism, diabetes mellitus, pneumonaie, splenectomy, renal failure, chronic hepatitis with cirrhosis, endocarditis, cerebrospinal fluid (CSF) rhinorrhea, dural fistulas, head trauma, and impaired consciousness (Alavi *et al.*, 2010). The classic triad signs of meningitis include fever, headache, and neck stiffness. Drowsiness, nausea and vomiting, increased ICP, positive Kernig's signs, positive Brodzinski signs, photophobia, myalgia, seizure, cerebral oedema, and hydrocephalus, and hearing, motor and behavioral impairments were reported among other signs of this disease (Shakib and Khademi, 2022). Meningitis is diagnosed in different ways such as cell count, smear, culture and analysis of protein and CSF sugar, blood culture, skin biopsy, urinary antigen test, PCR, serum inflammatory markers and latex particle agglutination (Kastenbauer and Pfister, 2003). The main characteristics of bacterial and viral meningitis are summarized in (Figure 1). However, cerebrospinal fluid culture is the gold standard for diagnosis of meningitis (Kasper *et al.*, 2015). Acute meningitis is a medical emergency that requires immediate diagnostic and treatment procedures, otherwise it will have serious subsequent complications such as mental disorders, reduced psychomotor function, reduced sight, seizures, reduced hearing, and impaired walking. According to available databases, no detailed epidemiological study has been published on this disease in Sulaimani Province, so it was decided to design a study on types, risk factors, clinical symptoms and diagnostic tests of acute adult meningitis in patients admitted to hospitals affiliated to Sulaimani Province from 2019 to 2023, in order to raise awareness of healthcare providers, and to provide the context for preventive actions.

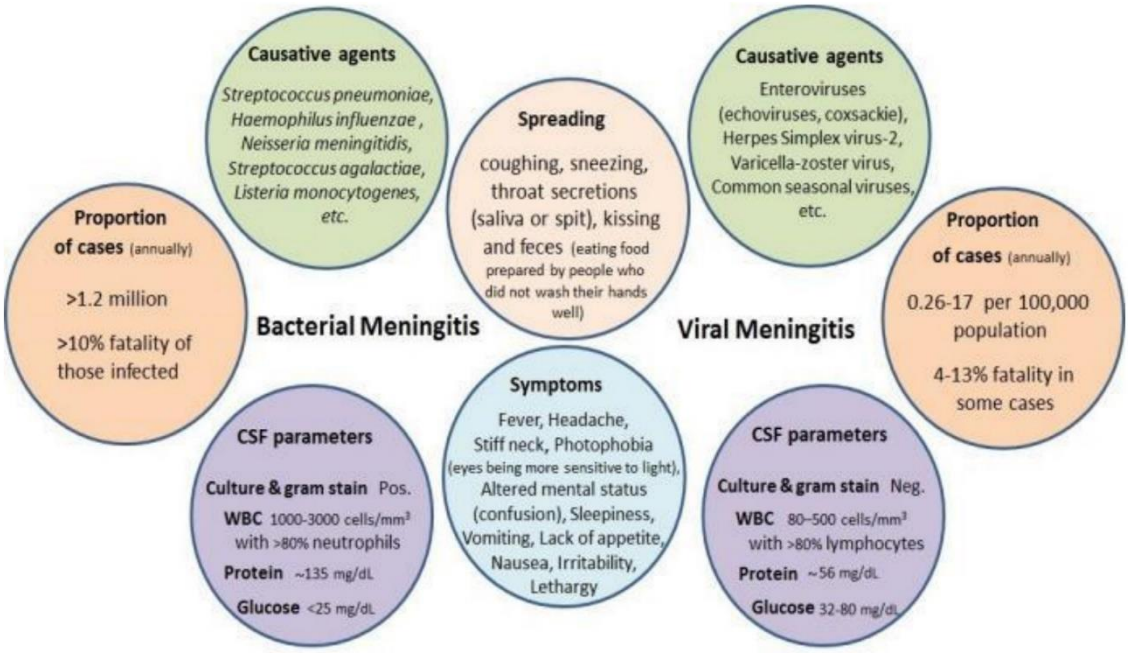

Figure 1: Characteristics of bacterial and viral meningitis (Jafari *et al.*, 2022).

2. METHODOLOGY & RESEARCH DESIGN

This is a retrospective descriptive study using existing data (Abdi *et al.*, 2006). It was performed on 457 patients who were admitted and diagnosed with acute meningitis from 2019 to mid-June 2023 from Sulaymaniyah Provenance and patients attending hospitals affiliated to Sulaymaniyah Provenance include (Kirkuk, Raparin, Halabja, and Garmian (Kalar)). Inclusion criteria included all patients from bellow 1 years to over 65 years of age, whose meningitis had been confirmed by performing lumbar puncture. Exclusion criteria included systemic diseases such as cancers, vascular collagen diseases, and AIDS which affect clinical symptoms and CSF analysis. Patient details were recorded using demographic questionnaire and medical findings done by Hospital. Variables studied included: age, gender, place of residence, diagnosis year, hospital meningitis type (bacterial and viral), risk, and clinical symptoms. In this study, data were collected by students and type of meningitis was determined using laboratory results by an infectious disease specialist in Hospitals. Data were analyzed with SPSS-25 using descriptive statistics (frequency and percentage). P value was calculated by chi-square test and fisher exact test and considered significant when it was less than 0,05.

3. RESULTS AND DISCUSSION

Patient demographics and characteristics

From 457 patients with meningitis who were included in this study were admitted to the hospitals from the Sulaymanyah Provenance from 2019 to mid-June 2023. Their ages ranged from bellow 1 year to over 65 years. Of the total suspected cases, 13.12 % were less than 1year old on hospital arrival, while 14.00% were between 1 and 4 years, 28.44% were aged between 5 and 9 years, 19.91% were aged between 10 and 14 years, 3.71% were aged between 15 and 19 years, 11.15% were aged between 20 and 44 years, 7.00% were aged between 45 and 64 years, and 3.50% were aged over 65 years old. Of the meningitis cases, only in 2023 from in total 247 cases from it 150 (60.72%) were reported in Sulaymaniyah fom 30th April, 72 (29.14%) in Halabja from 6th May, 23 (9.31%) in Garmian (Kalar) from 6th May, 2 (0.80%) in Kirkuk from 6th May, and 20 (8.09%) in Raparin from 14th June. (Table1-2).

Table 1: Shows Meningitis cases in the Sulaymaniyah Provenance Kurdistan Region of Iraq from mid-June 2023.

Governorates	**No. cases**	**Date**
Sulaymaniyah	150	30th April
Halabja	72	6th May
Garmian (Kalar)	23	6th May
Kirkuk	2	6th May
Raparin	20	14th June
Total cases	247	14th June

Table 2: The comparison of epidemiologic characteristics of the patients according to the types of meningitis.

Variable	**Categories of variable**	**Bacterial meningitis N(%)**	**Aseptic meningitis N(%)**	**Total N(%)**	**p-value**
Sex	Male	108 (23.63)	177 (38.73)	285 (62.36)	0.0001
	Female	54 (11.81)	102 (22.31)	156 (34.13)	
Residency	Urban	64 (14.00)	118 (25.82)	182 (38.82)	0.9999
Area	Rural	98 (21.44)	177 (38.73)	275 (60.17)	
Age	Bellow 1 year	25 (5.47)	35 (7.65)	60 (13.12)	0.0001
	Between 1-4 years	15 (3.28)	49 (19.72)	64 (14.00)	
	Between 5-9 years	25 (5.47)	105 (22.97)	130 (28.44)	
	Between 10-14 years	51 (11.15)	40 (8.75)	91 (19.91)	
	Between 15-19 years	7 (1.53)	10 (2.18)	17 (3.71)	
	Between 20-44 years	19 (4.15)	32 (7.00)	51 (11.15)	
	Between 45-64 years	10 (2.18)	22 (4.81)	32 (7.00)	
	Over 65 year	10 (2.18)	6 (1.31)	16 (3.50)	
Etiological	*Streptoccocus pneumonaie*	48 (10.50)	Unknown	48 (10.50)	
Agent	*Neisseria meningitides*	23 (5.03)	Unknown	23 (5.03)	
	Haemophilus influenza	12 (2.62)	Unknown	12 (2.62)	
	Others	79 (16.63)	Unknown	79 (17.28)	
CSF	Clear	69 (15.09)	118 (25.82)	187 (40.91)	0.8318
appearance	Turbid	43 (9.40)	88 (19.25)	131 (28.66)	
	Bloody	28 (6.12)	54 (11.81)	82 (17.94)	
	Unknown	22 (4.81)	35 (7.65)	57 (12.47)	

Distribution of meningitis cases over time

The lowest number of cases (N = 14) was recorded in 2020 this decrease in case admissions coincided with logistical issues that occurred during the COVID-19 pandemic. This increased to 247 cases in mid-June 2023 and the most affected patient were male. This increase may be return to the financial crisis and lack of salaries, health workers are boycotting their work in hospitals, which has become a severe threat to the spread of the disease (Figure 2).

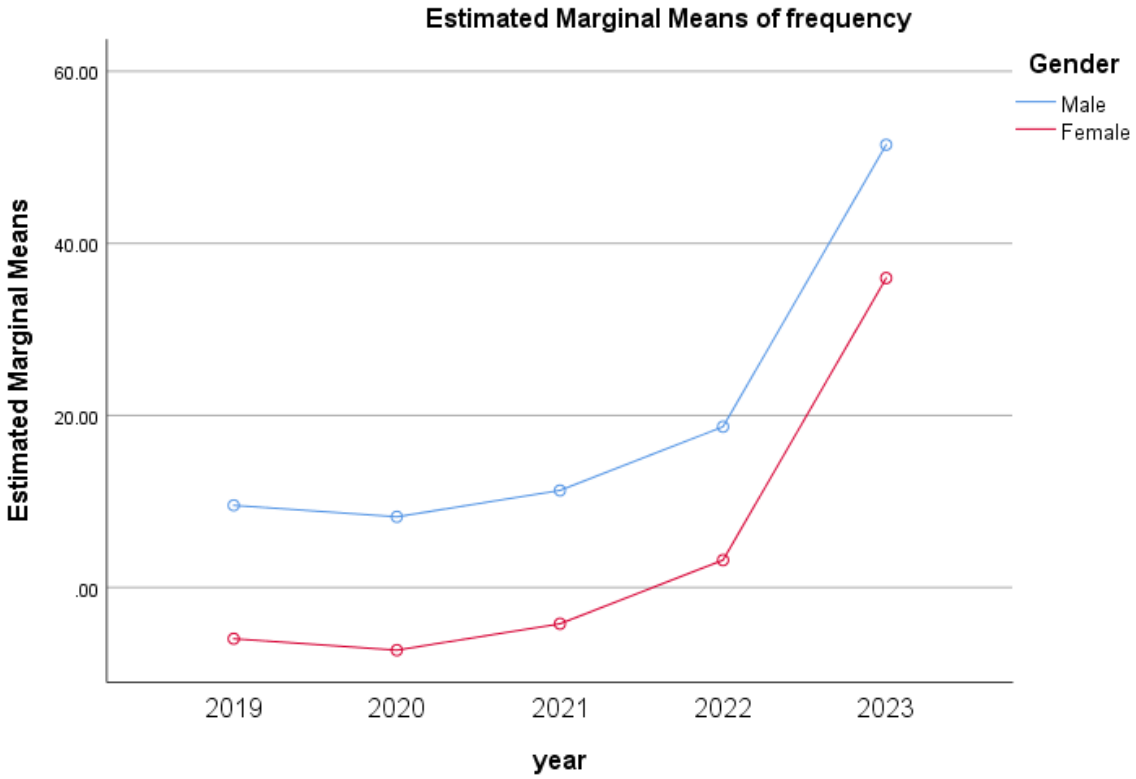

Figure 2: Line graph represent the outbreak of Meningitis in Sulaymaniayh Provence from 2019 to mid-June 2023.

285 (62.36) of the patients were men from which 108 (23.63) were bacterial meningitis, and 177 (38.74%) of the patients were aseptic meningitis. In contrast, in total 156 (34.13%) of female from which 54 (11.81%) were bacterial meningitis and 102 (22.31%) were aseptic meningitis with p-value (0.0001) were significant. Regarding the area of

residence affected population in rural place 1.5 time greater than urban place in term of infection with p-value (0.9999). In addition, according to age group the school age children between 4 to 9 years were the most group affected with aseptic meningitis (Figure 3). Almost half of the patients diagnosed with bacterial meningitis 162 (35.44%) from which 48 (10.50%) were *Staphylococcus pneumonia*, 23 (5.03%) were *Neisseria meningitidis* and 12 (2.62%) were *Haemophilus influenza*. Regarding CSF profile in both type of meningitis there were 187 patients (40.91%) with clear appearance of CSF and it was turbid in 131 patients (28.66%), while bloody CSF were 82 patients (17.94%) with p-value (0.8318). As we can see from (Table 2).

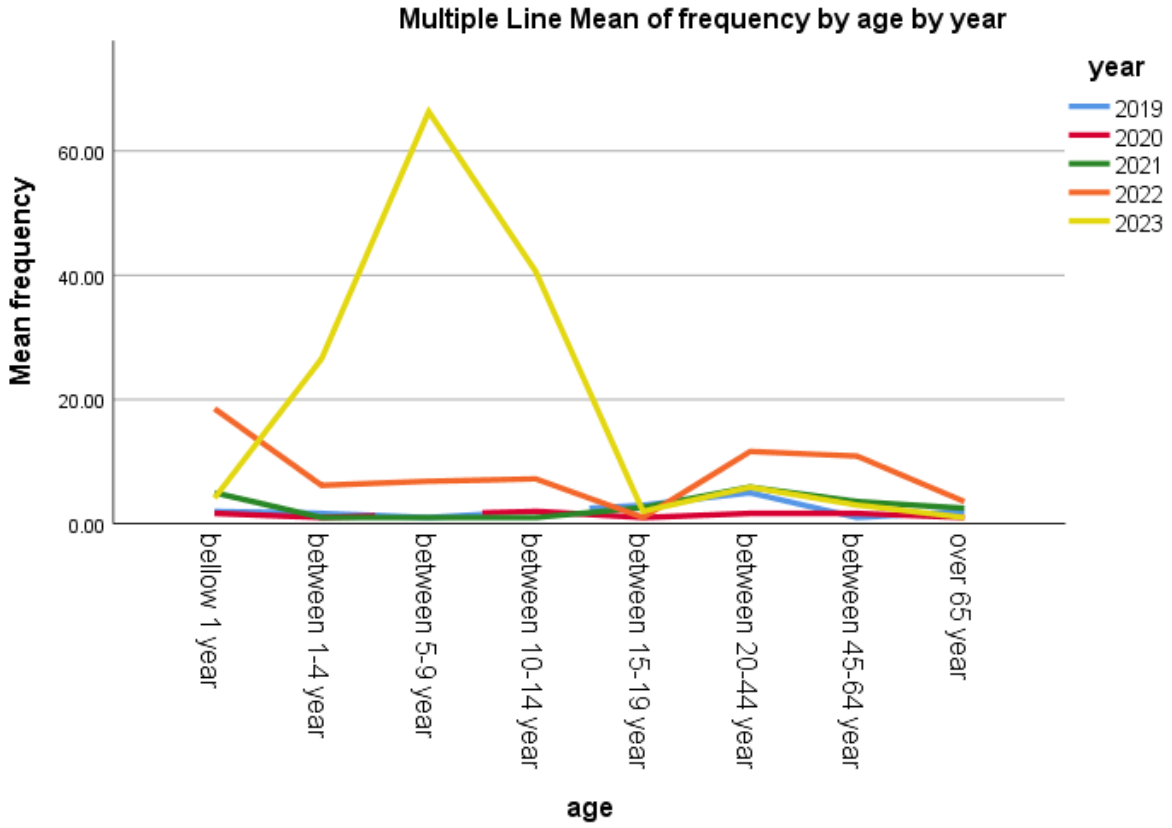

Figure 3: Distribution of confirmed cases of both type of meningitis according to age group and year, 2019 to mid-June 2023.

The distribution of the clinical symptoms for two types of bacterial and aseptic meningitis is listed in (Table & Figure 4). The most common symptoms in bacterial groups were fever and in aseptic meningitis were poor feeding. The majority of risk factors in patients were upper respiratory infection. Other risk factors included impaired renal function and head trauma.

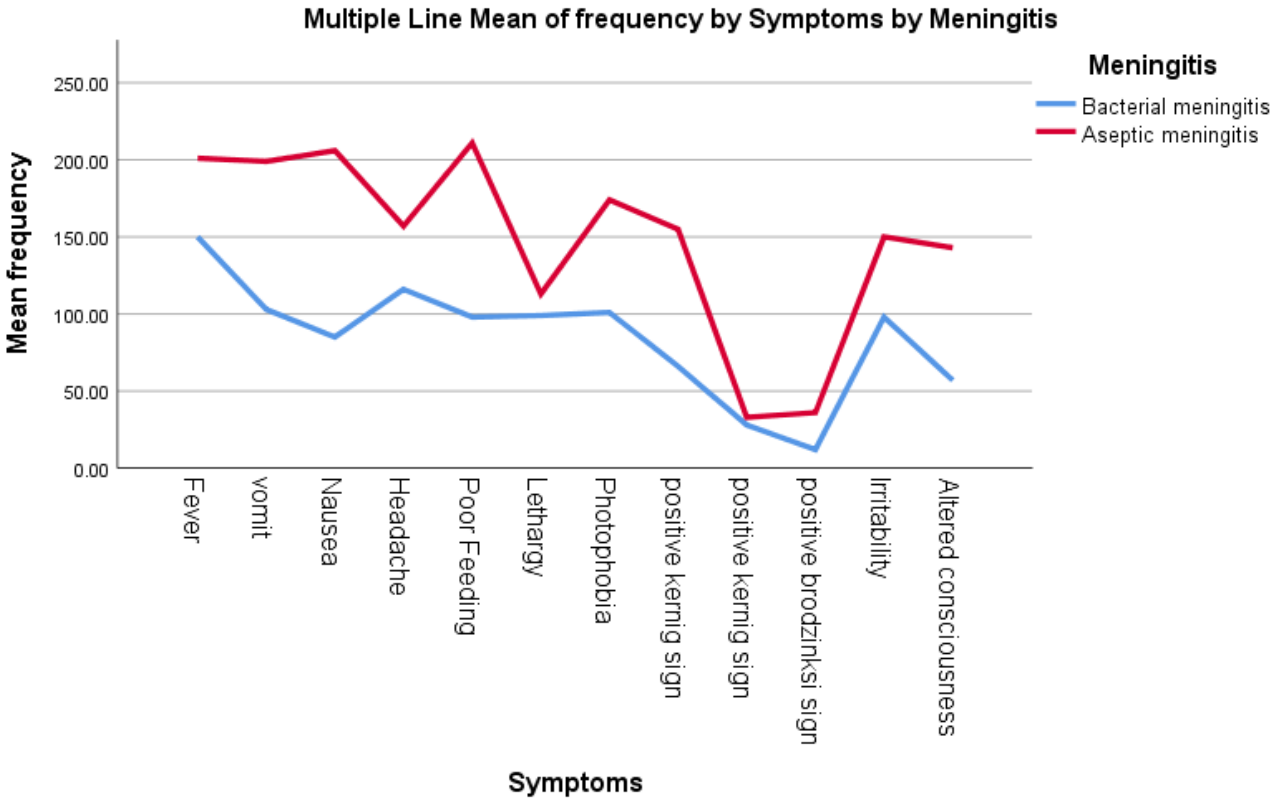

Figure 4: line graph shows distribution of confirmed cases of both type of meningitis according to symptoms.

Table 4 represents laboratory characteristics of cerebrospinal fluid in both of the bacterial meningitis and aseptic meningitis groups. The percentage of only the amount of glucose in both group were significantly different p-value (0.0453) and other laboratory finding leukocyte count, protein level, and C-reactive protein were not significantly different.

Table 3: Comparison the presence of clinical symptoms and risk factor according to the final diagnosis of meningitis.

Clinical Symptoms	**Bacterial N(162)**	**Viral N(295)**	**Total N(457)**	**P value**
fever	150	201	351	0.0001
vomit	103	199	302	0.3539
Nausea	85	206	291	0.0002
Headache	116	157	273	0.0002
Poor Feeding	98	211	309	0.0123
Lethargy	99	113	212	0.0001
Photophobia	101	174	275	0.6181
Neck stiffness	66	155	221	0.0145
Positive Kernig's signs	28	33	61	0.0849
Positive Brodzinski's signs	12	36	48	0.1131
Irritability	98	150	248	0.0377
Altered consciousness	57	143	200	0.005
Risk	**Bacterial N(162)**	**Viral N(295)**	**Total N(457)**	**P value**
Upper respiratory infection	12	15	27	0.4075
Impaired renal	9	6	15	0.0562
Head trauma	7	5	12	0.1265

Table 4: Comparison of laboratory parameters of cerebrospinal fluid according to the final diagnosis of meningitis.

Laboratory results		**Bacterial CSF N(%)**	**Aseptic CSF N(%)**	**p-value**
Leukocyte (Cell Count)	Less than 100	73 (15.97)	126 (22.57)	0.3963
	Between 100 – 1000	68 (14.87)	113 (24.72)	
	More than 1000	21 (4.59)	56 (12.25)	
Glucose level	Low	61 (13.34)	83 (18.16)	0.0453
	Normal	101 (22.10)	212 (46.39)	
Protein level	High	34 (7.43)	78 (17.06)	0.2123
	Normal	128 (28.00)	217 (47.48)	
CRP	Positive	98 (21.44)	198 (43.32)	0.1832
	Negative	64 (14.00)	97 (21.22)	

Evaluating the results, we found that meningitis have been seen more frequently in males than in females and more common in children age between 4-9 years, which are consistent with the published articles (Farag *et al.*, 2005, Kanani and Moradi, 2005, Logan and MacMahon, 2008, Sharifi-Mood *et al.*, 2015) and this may be explained by decrease antibodies production against polysaccharide capsular Ag in children resulting in increased susceptibility to *H. influenzae* and *S. pneumoniae* infection. While Dawood (2008), found majority of cases >1 year and this is may be due to different inclusion and exclusion criteria. Review of the data shows that the number of people suffering from viral meningitis was higher than the number of patients with bacterial meningitis and viral meningitis is more common in western countries (Sharifi-Mood *et al.*, 2015), and according to other studies, bacterial meningitis is more than viral, that does not match with our findings (Kyaw *et al.*, 2006). In the evaluation of cerebrospinal fluid leukocytes, we

came to the conclusion that this variable has high diagnostic value, and this value increases with age such that leukocytes was increased by 100% for the age group of above 7 years. This result is the same for both of the bacterial and non-bacterial meningitis.

In the present study, of the patients' records that were complete in terms of risk factors, the highest risk factors were upper respiratory infection, renal impair, and head trauma, respectively. In a study conducted in Kurdistan-Iran, head trauma, neurosurgery, and craniotomy were predisposing factors for meningitis (Kanani and Moradi, 2005). In Germany, Kastenbauer and Pfister (2003), regarded ear and sinus infections, dural fistula, diabetes and *pneumonaie* the most common causes of meningitis. In another study in France, dural fistula and sinusitis were proposed as meningitis risk factors (Auburtin *et al.*, 2002). Although in most of the above studies, similar risk factors have been proposed, risk factors and their percentages in the present study may differ due to incomplete data and small sample size. Furthermore, leukocyte values in bacterial meningitis were higher than 1000, which concurs with the results of other studies (Giorgi Rossi *et al.*, 2009). However, this value was also higher than 1000 in viral meningitis, which disagrees with (Alavi *et al.*, 2010) results. Cell count less than 100 is usually more common in patients with viral meningitis. But, since peripheral blood in CSF sample, following LP can increase white blood cells in cerebrospinal fluid (Mentis *et al.*, 2016), lumber puncture technique could have caused this abnormal rise.

4. CONCLUSIONS AND RECOMMENDATIONS

Kurdistan Region of Iraq is facing a severe meningitis outbreak that poses a grave challenge to public health, especially in conflict-affected regions. The disease is spreading rapidly, with limited transparency in reporting the exact numbers. Male gender, age between 4-9 years have more incidence of meningitis. Fever was the most common presenting symptom in bacterial meningitis and poor feeding in aseptic meningitis. The biggest risk factors include upper respiratory infection, impaired renal and head trauma, respectively. The most common clinical symptoms include headache with fever, nausea and vomiting, and stiff neck, and the most important diagnostic procedure include analysis, smear, and culture of cerebrospinal fluid. It can be recommended to perform a longitudinal study during the coming years on patients with meningitis. High index of suspicion for early diagnosis of meningitis when we have signs and symptoms suggestive for it. Also, improving laboratory work and availability of CT and MRI for early detection of complications. Further, careful follow up for patients to detect any possible complication and treat it accordingly. Finally, immediate actions are essential, including accurate data collection, well-equipped healthcare facilities, vaccination prioritization, public awareness campaigns, and international cooperation.

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