Research article

Identification, Epidemiology and Seasonal Variation of *Neisseria meningitidis* in Al-Nasiriya City, South of Iraq

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Abstract

The study involved 219 meningitis patients registered at AL-Hussein Teaching Hospital over a two-year period to determine the prevalence of *Neisseria meningitidis* in AL-Nasiriya city and the impact of sociodemographic parameters on infection (from the beginning of 2015 to the end of 2016). A technician extracted cerebrospinal fluid samples from the research population, and then transferred them directly to the laboratory for the identification of bacterial pathogens. The findings revealed that 57 patients (26.02%) were afflicted with *Neisseria meningitidis*. Twenty-nine cases (50.87%) were in 2015 and 28 cases (49.13%) were in 2016. Our studies showed that the incidence of *Neisseria meningitidis* was slightly higher in males than in females and in the age group of 20-44 years old. Over the study period, seasonal variation was also shown. This study concluded that meningococcal meningitis infection was affected by sociodemographic influences, which appeared to be prevalent in the long warm seasons of Iraqi weather, with summer having the highest percentage of *N. meningitidis* infections, followed by fall.

Keywords

meningitis;

sociodemographic factors;

Neisseria meningitidis;

seasonality

1. Introduction

A certain number of pathogenic organisms cause meningitis to become inflammatory (brain and spinal cord coverage) and remain an important cause of injury and death [1]. Infections with this disease might happen due to bacterial infections including *Streptococcus pneumoniae, Haemophilus influenzae, Neisseria meningitidis,* Streptococci, in addition to some viruses. Other possible factors are fungi, physical injuries, cancer and some kinds of drugs, but there are few reports of such factors. Viral meningitis is usually less severe than that resulted from bacterial pathogens [2].

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Neisseria meningitidis is a fastidious encapsulated aerobic, oxidase positive, gram-negative diplococcus. Genome sequence typing (ST), is currently augmented by phenotypic meningococcal categorization, which was dependent on structural variations in lipopolysaccharide, outer membrane protein, and capsular polysaccharide. The severe and often fatal, meningococcal meningitis, with an average 10% death rate, was found among patients without antibiotic treatment [3]. According to the World Health Organization (WHO), *N. meningitidis* infections are responsible for about 0.5 million cases and 50,000 yearly-deaths worldwide, especially in children and young adults [4].

Meningitis' epidemiological profile differed in various population groups due to flexible transferred genome as well as the existence of certain capsule-based serologic types A to C, W-135, Y and X, besides the expression of non-capsular antigens, over time. Infections caused by serogroups (A, C, Y, and W) can be prevented by using meningococcal vaccine. Moreover, protection against infection by serogroup B could be achieved by different obtainable meningococcal vaccine. Even with promising new vaccines, both developed countries continue to log meningococcal infection, with no universal coverage, and an ever-greater spread of antibiotic resistance [5]. Meningitis clinical characteristics are frequently unspecific and might interfere with other diseases. Approximately 90% of cases caused by virus are associated with common enterovirus; other viruses such as measles, herpes, and the West Nile are severe and infrequent. Fungal-caused meningitis rarely infects humans, commonly due to fungal dissemination through the bloodstream to the spinal cord. *Cryptococcus* is the main cause for fungal meningitis [6]. In 2002, an estimated 1.2 million cases of bacterial meningitis were recorded worldwide, with an additional 173,000 deaths, the majority of which occurred in children in underdeveloped nations [7].

The aims of this study were to report the meningitis incidence in the center of Thi-qar province during two years (2015 and 2016), as well as to determine the distribution of meningitis by age, gender and seasonality.

2. Materials and Methods

2.1 Study group and sample size

This study included 219 patients, aged 1 to 66 years, with age categories divided into childhood, adolescence, youth or maturity, and old age. It also included both sexes, and those who had symptoms and were suspected of having meningitis by a licensed physician, and who had attended AL-Hussein Teaching Hospital for two consecutive years (beginning of 2015 to the end of 2016). All of them were subjected to a clinical examination for bacterial meningitis by bacteriological procedure for isolation and identification of bacterial species from the cerebrospinal fluid (CSF). Socio-emographic informations including gender, age, time of presentation were pointed. During the study period, all patients with bacterial meningitis who presented to AL-Hussein Teaching Hospital and met the research requirements were identified as the study population.

2.2 Sampling

A technician took CSF samples from the study participants by and immediately transferred to the laboratory for bacterial infection testing.

Bacteriology: CSF samples were inculcated on chocolate agar and blood agar and incubated at 37°C under 10% (v/v) CO_2 using anaerobic jar for 24 h. *Neisseria meningitidis* is a fastidious organism that grows on blood agar plates (BAP) and chocolate agar plates (CAP), which are enriched differential media used to isolate fastidious organisms. BAPs contain mammalian blood (generally sheep or horse), as well as meat extract, tryptone, sodium chloride, and agar at a concentration of 5-10%. Blood that has been heated to release substances that aid in the growth of fastidious bacteria, is contained in CAPs. Classic clinical symptoms of the patients (fever, confusion, poor nutrition, physical inactivity, vomiting, headache, photophobia, neck stiffness, indications of meningeal irritation), isolation of bacterial pathogens in one or more CSF cultures, gram staining to identify gram-negative diplococci (*N. meningitides*), selecting single growing colonies from cerebrospinal fluid cultures, and submitting them to bacterial species detection utilizing (VITEK® 2 NH ID card) performed by BioMérieux (France) procedures are all standard criteria for bacterial meningitis diagnosis [8]. Patients infected with another type of meningitis such as tuberculous, fungal, or viral meningitis, or patients with another illness such as cerebral malaria or any other central nervous system lesion, were excluded from the study.

The Health Board's Administrative Ethics Committee granted permission to conduct this study under the administrative order number 7/18/5 in 23/6/2020. Samples were collected under the supervision of public health technicians in compliance with the principles described and applicable defined scientific norms.

2.3 Statistical analyses

The data of two years (2015-2016) were analyzed using SPSS software package version 20. To evaluate statistical significance, a p-value ≤ 0.05. was employed. Data were analyzed using statistical tests such as Chi-square, frequency, and percentage.

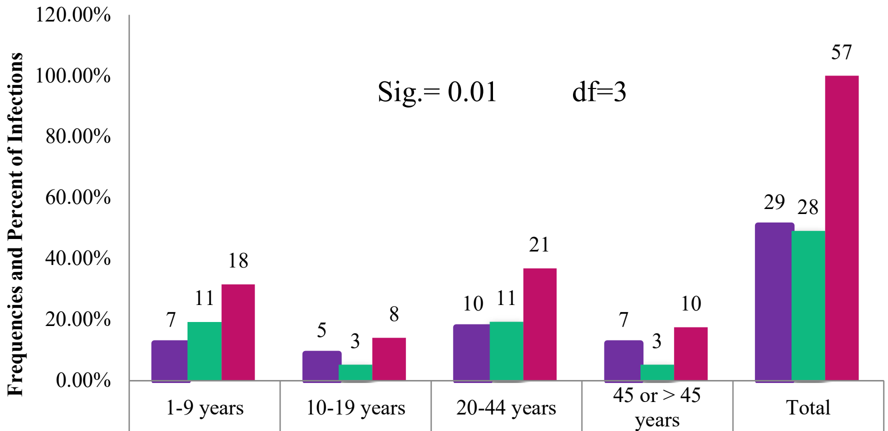
3. Results and Discussion

The increase of bacterial meningitis is linked to a decline in environmental, household, and personal hygiene standards [9]. Coughing, sneezing, kissing, chewing on toys, and even sharing a supply of fresh water can spread *N. meningitidis* through saliva and respiratory secretions. The progression of the disease or mortality, as well as the effectiveness of immunization campaigns, served to reduce the outbreak of the disease. In terms of the prevalence of *N. meningitidis* in the Iraqi community, the previous study showed that 4% of children tested positive with meningitis [10]. During the two years (2015 and 2016), 57 (26.02%) patients were identified to be infected with *N. meningitidis*, according to our findings. Twenty-nine cases (50.88%) were recorded over the year 2015, while 28 cases (49.12%) cases were recorded during 2016, as presented in Table 1. The male sex (56.14%) was found to be infected at significantly higher proportion than females (43.86%) (Table 1). This meant that males might be at high risk of getting *N. meningitides* infection than females at the time when the study was conducted. These results are consistent with those investigated in Bangladesh in 2009 where the male to female proportion was 2.5:1 [11]. The fundamental systems that might clarify this discovery are probably multifactorial and include a mind-boggling mix of social, behavioral, and organic elements. Females have stronger cellular and humoral immune immunities to antigenic threats than males, leading to decreased vulnerability to numerous infectious illnesses [12]. However, improved invulnerable reaction can likewise have negative consequences as a result of an excessive inflammatory response [13].

The results showed that patients aged 20-44 years old displayed the highest percentage of *N. meningitidis* infection, with frequencies of 36.84% for both years, and 17.54% for 2015 and 19.30% for 2016 (Figure 1). The second highest percentage of infection was found in the children aged between 1-9 years old followed by elder patients aged 45 or older than 45 years old (31.58% and 17.54%, respectively) (Figure 1). Furthermore, with a p-value less than 0.05 in both years, the data revealed that the patients' age had a significantly predictive influence in relation to

Table 1. Total number and percentage of meningitis infection according to sex

	Year			
Gender	**2016**	**2015**	**Total**	
	No (% of Total Number)	No. (% of Total Number)		
Male	15 (26.32%)	17 (29.82%)	32(56.14%)	Sig = 0.04
Female	14 (24.56%)	11 (19.30%)	25(43.86%)	Df=1
Total	29 (50.88%)	28 (49.12%)	57(100%)	



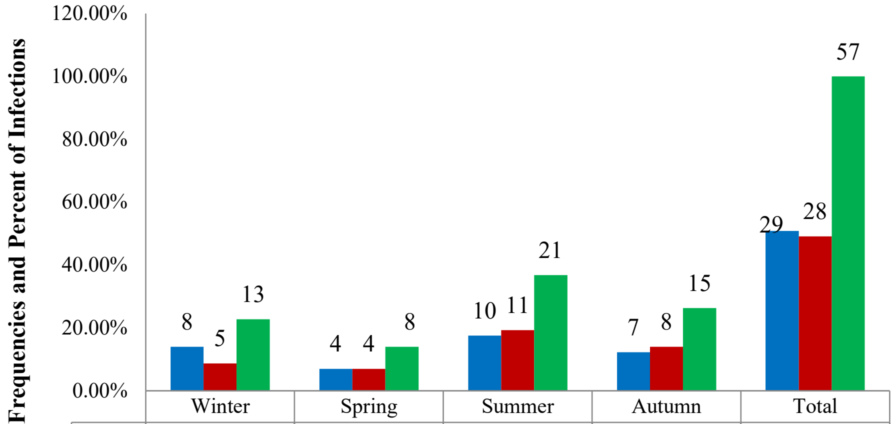
	1-9 years	10-19 years	20-44 years	45 or > 45 years	Total
2015	12.28%	8.77%	17.54%	12.28%	50.88%
2016	19.30%	5.26%	19.30%	5.26%	49.12%
Total	31.58%	14.04%	36.84%	17.54%	100%

Figure 1. The age-related percentage of meningitis infection

meningitis complications (Figure 1). Our findings are consistent with those findings of other researchers [14-17].

Generally, the risk of meningitis infection is associated with a number of factors including; (1) ages: babies and kids are more vulnerable than other age groups because their immune systems are not fully formed and maternal passive immunity fades with time; and (2) infectious trends; infection appears to spread more rapidly among larger numbers of people with poor immune systems. Smoking, secondhand smoke, and living in cramped quarters also raise the risk of meningitis. Adolescents and young adults have the highest prevalence of carriage, with conjugate vaccinations having a 75% efficacy against carriage in these age ranges [18]. Another study showed that young adults and adults (25-44 years of age) have the highest rate of Men C cases, while serogroup Y is typically found in people over 65 years old [19].

Figure 2 illustrates that most *N. meningitidis* infections, 21 total cases (36.84%), occurred during the summer, 10 cases (17.54%) in 2015, and 11 cases (19.3%) in 2016. The total number of infections then decreased to 15 total cases (26.32%) in fall, 7 cases (12.28%) in 2015, and 8 cases (14.04%) in 2016, and continued to decrease to 13 total cases (22.81%) during the winter, 8 cases (14.04%) in 2015, and 5 cases (8.77%) in 2016. Finally, the spring was found to show the lowest frequencies of *N. meningitidis* infection, demonstrating in 8 cases (14.04%), 4 cases (7.02%) in 2015 and 2016, respectively. It seemed that *N. meningitidis* favored the hot weather. Seasonal changes in meningitis infection, on the other hand, were not significant.



	Winter	Spring	Summer	Autumn	Total
2015	14.04%	7.02%	17.54%	12.28%	50.88%
2016	8.77%	7.02%	19.30%	14.04%	49.12%
Total	22.81%	14.04%	36.84%	26.32%	100%

Seasonality of meningitis in both of 2015 and 2016 years

Figure 2. Comparison of meningitis infection between years according to seasons

Furthermore, we discovered that males were highly infected by *N. meningitidis* throughout 2015, with the exception of summer (Figure 3). Meningitis infection was prevalent in patients aged 20 to 44 years old throughout the year, with the exception of winter (Figure 4). Throughout 2015, these seasonal links of meningitis infection with sex and age were statistically insignificant.

In the same way, during 2016, meningitis infection was found at a higher incidence in males than in females in all seasons (Figure 5). These data, however, did not show any statistically significant changes. Otherwise, as shown in Figure 6, the percentage of meningitis cases grew significantly in patients aged 1 to 9 years old throughout the summer and fall in 2016 (p-value = 0.009) and then patients aged 20 to 44 years old, who were primarily infected during the winter and spring.

During the study period, we noticed that the occurrence of meningococcal meningitis varied substantially according to the Iraqi's four seasons, and there were also significant differences across seasons according to the patients' ages and sexes. Summer had the highest prevalence of *N. meningitidis* infection, followed by fall, winter, and finally spring, which had the least prevalence. Summer lasts four months and is characterized by a hot, dry climate with temperatures ranging between 21-40℃. The temperature decreases in the fall to 30-35℃ with moderate humidity. In the spring, our country is characterized by moderate temperature (20-28℃) while the winter climate is cold, rainy and humid with temperatures ranging between 5-18℃. Occasionally, other varieties of meningococcal meningitis occur; however, this happening with other bacterial meningitis agents is less common [20]. In some countries like Iraq, the dry season is marked by dusty winds and chilly nights. When these disorders are combined with respiratory illnesses that affect the oropharyngeal tract, they are likely to enhance the risk of meningococcal infection. Meningococcal epidemics have historically been reported in the beginning of the dry season from June and lasting until September [4]. Low humidity, high temperature, and dust have all been suggested as factors that can help increase the likelihood of meningococcal infections as they can cause direct damage to mucosal barriers or mucosal inhibitors that offer protection against infection [21]. Despite this, in

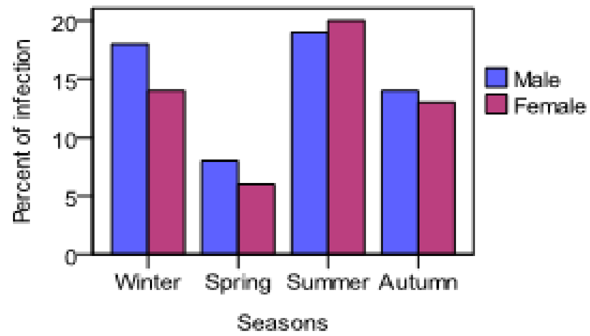


Figure 3. The study group data for seasonality of meningitis infection according to sex in 2015

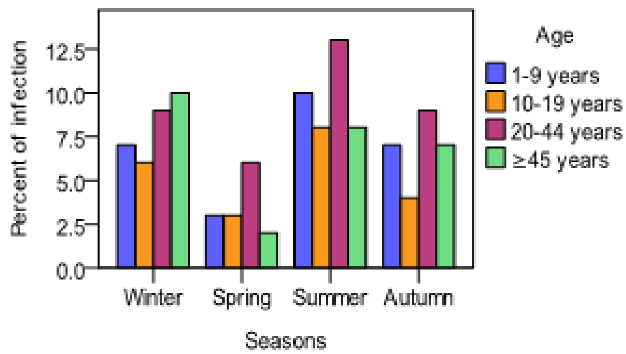


Figure 4. The study group data for seasonality of meningitis infection according to age in 2015

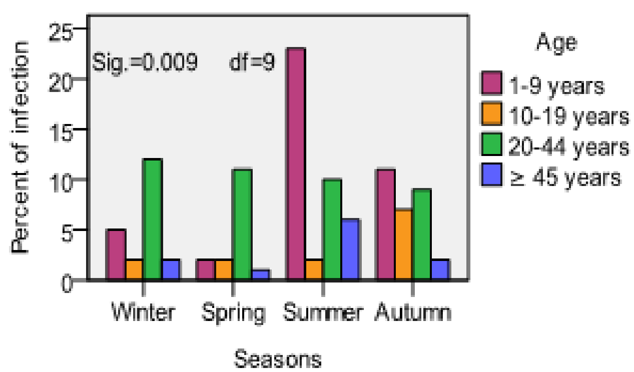


Figure 5. The study group data for seasonality of meningitis infection according to sex in 2016

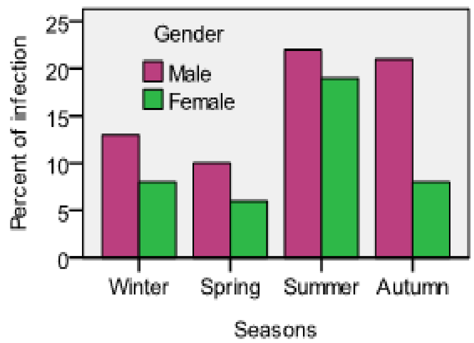


Figure 6. The study group data for seasonality of meningitis infection according to age in 2016

many regions of the world, the temporal patterns of bacterial meningitis, including seasonality, inter-annual variability, and social trends, are poorly characterized. As a result, many people are worried about the disease's ecology. The first and most significant step towards understanding the complex interplay of behavioral, economic, immunological, sociological, and some other factors which influence such patterns, is to thoroughly investigate the dynamic behavior of bacterial meningitis [22]. On the other hand, other studies showed that late winter and spring incidence rates were the highest [23]. Meningitis risk factors include: loss of immunity due to infection of other pathogens at young age, recent colonization with bacterial pathogenesis, near contact with individuals with N-invasive diseases (in the household, and at daycare centers and college dormitories), CSF leakage, and head injury penetration (HI VHI, asplenia, complementarity deficiency, immunoglobulin deficiency, lymphocyte deficiencies and malignancy) [13, 24].

4. Conclusions

The male sex was found to be substantially related with meningitis. Patients with *Neisseria meningitidis* were predominantly between the ages of 22 and 44 as well as children under the age of 9 years old. The dry seasons (summer and fall) were found to be strongly linked with the occurrence of meningococcal meningitis. Differences in the patients' ages and genders influenced the seasonal connection.

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