Review

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Meningitis in Niger Republic amidst COVID-19: current issues and novel recommendations

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Abstract

Amidst coronavirus disease 2019 (COVID-19), there has been a misplaced priority on meningitis in the Niger Republic, thus refocusing resources and attention away from the continuing meningitis campaign in the Niger Republic. The over-strained state of public health resources and staff has also led to decreased surveillance, postponed diagnoses, and constrained immunization efforts in Niger Republic. This review aims to bridge the gaps regarding meningitis amid COVID-19 in Niger Republic and offer recommendations to government to mitigate meningitis in the country, with the hope of finding a permanent solution to this debilitating disease. The authors reviewed 45 past and present pieces of literature on meningitis and COVID-19 from 2013 to 2023 in well-renowned scientific databases such as PubMed, ResearchGate, Google Scholar, African Journals Online, Medline, and Embase. Since 2015, Niger Republic has experienced multiple meningitis epidemics that have resulted in 20, 789 cases and 1, 369 deaths [a case fatality rate (CFR) of 6.6%]. A total of 231 cases of meningitis were reported from 1 November 2021 to 31 January 2022. And recently, 559 cases of meningitis (of which 111 are laboratory confirmed), including 18 deaths (overall CFR 3.2%), occurred in the Zinder region, southeast of Niger Republic, from 1 November 2022 to 27 January 2023. Meningitis remains a public health concern in the world, especially in Niger Republic, which could lead to serious long-term complications. Therefore, adequate and novel measures and therapeutic actions should be implemented by the Niger Government to lessen the burden of the disease in the country.

Keywords: epidemics, meningitis, Niger Republic, prevalence, public health measures

Introduction

Meningitis is a life-threatening disease caused by the infection of membranes that surround the brain and spinal cord, known as the meninges. Meningitis can be caused by a profusion of fungi, bacteria, or viruses. However, the infection is mainly caused by *Streptococcus pneumoniae*, *Neisseria meningitidis*, *Haemophilus influenzae* type b (Hib), group B Streptococcus (GBS), and *Listeria monocytogenes*, and less commonly by *Mycobacterium tuberculosis*[1]. Meningitis requires prompt medical attention. It is a disease that spreads by direct touch or through the exchange

HIGHLIGHTS

- Amidst coronavirus disease 2019 (COVID-19), there has been a misplaced priority for meningitis in Niger Republic, thus refocusing resources and attention away from the continuing meningitis campaign in Niger Republic.
- The overstretched state of public health resources and staff has also led to decreased surveillance, postponed diagnoses, and constrained immunization efforts in the Niger Republic.
- Since the year 2015, Niger Republic has seen multiple meningitis epidemics that have resulted in 20 789 cases and 1369 deaths [case fatality rate (CFR) of 6.6%]; 231 cases of meningitis were reported from 1 November 2021 to 31 January 2022.
- The Niger Government should take appropriate and successful measures to decrease the impact of the disease.
- The Ministry of Health and non-governmental organizations in Niger should strengthen their collaborations with the WHO and the United Nations International Children's Emergency Fund (UNICEF) in order to prioritize mass literacy and meningitis vaccination in every community in Niger.

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of respiratory and throat secretions (such as saliva or spit)[2,3]. Signs of bacterial meningitis are fever, headache, and meningismus (irritation and inflammation of the three layers around the brain)[4]. Another disease that spreads through airborne droplets is coronavirus disease 2019 (COVID-19). It was first discovered in Wuhan, China, in 2019, and to date, there have been more than 76 crore confirmed COVID cases worldwide, whereas more than 95 lakh confirmed cases in Africa, according to World Health Organization (WHO)[5]. The disease quickly spread to other parts of the world, including the Niger Republic, which is a West African country. This brought about lockdowns in many parts of the world. The first case of coronavirus disease in Niger Republic was on 19 March 2020, and it spread throughout the country leading to lockdown and a pause in the normal daily activities of life[6]. The Niger Republic is one of the largest inland countries in West Africa but is also among the least developed countries[6]. Treatment and management of COVID-19 cases in Niger were difficult due to the poor healthcare system, lack of healthcare workers, and inadequate training of healthcare workers[7]. Amidst COVID-19, there has been a misplaced priority for meningitis in the Niger Republic, thus refocusing resources and attention away from the continuing meningitis campaign in the Niger Republic. According to the WHO, other epidemics, including COVID-19, could be the cause of the spread of the meningitis outbreak in Niger Republic.

Niger Republic is among the 26 countries described as being within the meningitis belt. In Niger, there have been numerous meningitis epidemics; 10 000 individuals were infected in 2015, and 20 789 cases and 1369 deaths have been reported overall since 2015[8]. Meningitis in Niger was mostly caused by the serogroup A type of *N. meningitidis* bacteria, but since the administration of its vaccine, the main cause of meningitis in Niger has shifted to the serogroup C and W. Even though *N. meningitidis* is a major culprit of meningitis in Niger, *H. influenzae* and *S. pneumoniae* have also been reported to contribute significantly to the bacterial meningitis burden in Niger. The administration of the meningitis vaccine in Niger paused during COVID-19 as the country was in lockdown, and a maximum of 4% increase in meningitis caused by serogroup A is predicted to occur in the long term when there is a short-term pause of the vaccine in 5 years[9,10].

Niger's measures to control COVID-19 included training healthcare workers, national guidelines on COVID-19 management, and policy creation. However, problems like poor facilities were not considered. Many families were affected by COVID-19, and up to 270 000 persons were driven into poverty. It also affected the educational, psychological, and social aspects of the Niger population. The lockdown led to the shutdown of schools and businesses. It reduced access to healthcare services, which may have led to the pause in the administration of meningococcal vaccine.

Having identified some of the problems associated with meningitis outbreaks in Niger Republic, our present review aimed to bridge the gaps about meningitis and proffer novel recommendations and other possible public health measures for the Niger Government to mitigate meningitis in the country with the hope of finding an everlasting solution to this debilitating disease in the Niger Republic.

Methodology

We reviewed 45 past and present pieces of literature on meningitis and COVID-19 from the year 2013 to 2023 in different journals and different databases such as PubMed, Google Scholar, Medline, African Journals Online and Embase. Out of the 45 studies and articles, only 10 met our inclusion criteria. Our search was strictly based on the situation of meningitis amidst COVID-19 in the Niger Republic, the prevalence of meningitis in the Niger Republic, and the public health implications of the meningitis outbreak in the Niger Republic. Our inclusion criteria were meningitis outbreak, COVID-19, and Niger Republic.

Situation of meningitis amidst COVID-19 in Niger Republic

Niger Republic is one of the hottest countries in the world. Niger Republic, being a country with a vast plateau with an average elevation of 500 m, has a low local relief. This hot weather condition thus favours meningitis epidemics in Niger Republic. Meningitis is an endemic illness with a global spread and seasonal variations[11]. Meningitis epidemics, mostly brought on by the *N. meningitidis* bacterium, have plagued Niger Republic for decades[12]. However, COVID-19's emergence has altered public health priorities, refocusing resources and attention away from the continuing meningitis campaign. The overstretched state of public health resources and staff has led to decreased surveillance, postponed diagnoses, and constrained immunization efforts. Meningitis prevention and control services, such as disease surveillance, laboratory confirmation of cases, and outbreak investigations, were substantially interrupted by the pandemic, with meningitis control activities declining by 50% in 2020 compared to 2019[13]. This has led to the postponement of MenAfriVac vaccination campaigns in nations including Benin, Guinea, Guinea-Bissau, Nigeria, and Togo, which aim to shield 50 million children under the age of 12 from meningitis type A[14]. Additionally, meningitis is not the only disease where COVID-19 affects immunization programmes[10]. There are no worries regarding vaccine-preventable diseases because studies have revealed that the epidemic has interrupted routine children immunization coverage in nations like India[14]. Additionally, the pandemic has affected parents' views and behaviours towards immunizations, including meningococcal vaccination, which may result in lower vaccine uptake[15]. The effects have been devastating as meningitis continues to cost lives and affect people's health, particularly in those close to the 'meningitis belt', exacerbating an already precarious situation.

Meningitis belt is a group of 25 sub-Saharan nations that stretches from Senegal in the west to Ethiopia in the east and has a combined population of about 500 million[11]. States like Katsina, Sokoto, Kebbi, Niger, and Zamfara in Nigeria have frequently been the place of meningitis outbreaks due to dry and overcrowded areas. The majority of Niger Republic is situated in the African meningitis belt, where the seasonality and size of meningitis epidemics (which normally run from January to June) vary; also, seasonal epidemics differ in size from year to year[3]. *N. meningitides* serogroup C (NmC) was blamed for a significant meningitis outbreak in 2015 that affected around 10 000 people. Meningitis outbreaks brought on by *N. meningitidis* serogroups A (NmA) and X (NmX), respectively, were also documented in 2009 and 2006. *S. pneumoniae* and *H. influenzae* are two other

prominent pathogens that considerably increase the incidence of bacterial meningitis in Niger[7].

Meningitis is characterized by symptoms, such as stiffness in the neck, avoidance of bright light, high temperature, vomiting, confusion, and dizziness[16]. Studies have shown that early diagnosis and prompt treatment are not enough to save lives, as 5–10% of patients die within a day or two after the appearance of symptoms[3]. This is further worsened by the COVID-19 pandemic making an accurate diagnosis challenging. COVID-19 manifests a wide range of symptoms, including fever, headache, fatigue, decreased or loss of sense of smell, respiratory symptoms, and neurological symptoms, such as meningitis[17]. In addition to the similarity in presenting complaints, both meningitis and COVID-19 are contagious and can spread via respiratory droplets or person-to-person contact. Thus, these two diseases are often confused, leading to misdiagnoses[18]. Given its propensity to spread, robust strategies are required to prevent cross-border transmissions. These include screening at airports and checking the vaccination status of travellers.

Reasons for the recent outbreak of meningitis in Niger Republic

Epidemics of bacterial meningitis occur seasonally in the 'meningitis belt' of sub-Saharan Africa and are most commonly due to *N. meningitidis*[19–21]. Peak months for meningitis epidemics in Niger Republic are March and April when there is chronic low air humidity and high dust loading, which are thought to damage the pharyngeal mucosa and facilitate meningococci colonization of the nasopharyngeal epithelium[22]. The interconnectedness of other diseases like diphtheria, measles and COVID-19, insecurity, and population displacement can all contribute to the spread of the infection[3]. Data from an outbreak of meningococcal meningitis in Niger suggest that it is caused by *N. meningitidis* serogroup C1, as a result of clustering of households and communities[9,11]. In Niger Republic and throughout the meningitis belt, spatial clustering of cases[23,24] can be partly, but not fully, explained by variations in climatic factors, suggesting the role of the environment and transmission in driving epidemics[25]. Individuals in close contact with meningitis cases are at higher risk for carriage of *N. meningitidis* and invasive disease, among epidemic and non-epidemic settings.[26,27].

The humanitarian crisis amid the military coup in Niger Republic could further amplify the vulnerability of millions of Nigeriens to more problems like meningitis, in the Niger Republic[28]. It was revealed that the number of Nigeriens in need of humanitarian assistance has reportedly increased. More than 2 million children in Niger were reportedly impacted by the crisis in the country and need humanitarian assistance[28]. Thus, amid COVID-19, and the military coup in the Niger Republic, mitigating the further spread of meningitis in the country could be overwhelming.

Public health implications of meningitis outbreak in Niger Republic

Bacterial meningitis, a potentially life-threatening disease, is a leading cause of disability in lower- and middle-income countries. One can be affected by meningitis at any age, but the incidence is highest in infants and those between 16 and 23 years of age[29]. People who are in close contact with infected individuals, including caretakers and healthcare personnel, those with HIV or complement protein deficiency, dysfunctional or absent spleen, those on complement inhibitors, and those living in overcrowded areas such as college dormitories or military camps have an increased likelihood of developing meningitis[7].

Meningitis symptoms, such as fever, headaches, and respiratory distress, can resemble COVID-19 symptoms[7], making the diagnosis difficult and resulting in a delay in treatment. The meningitis outbreak in Niger during the COVID-19 pandemic has serious implications for the country's already feeble economy. Niger, a poor-resource country, faced numerous healthcare challenges amidst the COVID-19 pandemic, including a polio outbreak, malaria flare-up, and famine. This, combined with the meningitis outbreak, left the country economically crippled[30]. Niger's healthcare system is both understaffed and underfunded. The simultaneous attack by these two lethal diseases has overwhelmed the country's healthcare system, depleting already scarce resources.

A bacterial meningitis episode may have long-lasting repercussions on one in five survivors. In addition to scars and limb amputations following sepsis, these side effects also include hearing loss, seizures, limb weakness, and difficulty with vision, speech, language, memory, and communication. Loss of loved ones to these diseases significantly affected the mental health of the Niger population, making them prone to disorders such as anxiety and depression[17,31]. Moreover, the most affected population is healthcare workers, who are prone to two highly transmissible and deadly diseases. With inadequate resources, including personal protective equipment, they are at risk of contracting these diseases when dealing with affected individuals, also putting the lives of their families in danger.

Polysaccharide vaccines, which are known to provide only short-term immunity, have proven ineffective in young children. Conjugate vaccines have replaced the need for polysaccharide vaccines, as they are more effective in conferring immunity in younger populations and providing herd immunity. However, these vaccines, although highly effective, are too expensive to be afforded by low- and middle-income countries such as Niger[32]. Thus, the unmet need for an effective and affordable vaccine hampers the elimination of meningitis from Niger.

Results (prevalence trend)

We found that since the year 2015, Niger Republic has seen multiple meningitis epidemics that have resulted in 20 789 cases and 1369 deaths [case fatality rate (CFR) of 6.6%]. 231 cases of meningitis were reported from 1 November 2021 to 31 January 2022[3,7]. About 1252 of all suspected cases of meningitis are located in Jigawa state, Northwest Nigeria, near the borders of the Zinder region of Niger, where a meningitis outbreak has been noted since October 2022[21]; 53% of these cases are involving men. People under 20 years are the age group mostly affected by the outbreak ($n = 538$; 96.3%), with 202 cases (37.5%) reported in the 10–14 age group, followed by 153 cases (28.4%) in the 5–9 age group, 107 cases (19.9%) in the 15–19 age group, and 76 cases (14.2%) in the 0–4 age group[7]. See Figure 1: Showing the percentage distribution of cases of meningitis among under-20 in Niger, 2023.

Sadly, recently, the WHO through the Niger Ministry of Health reported 559 cases of meningitis (of which 111 are

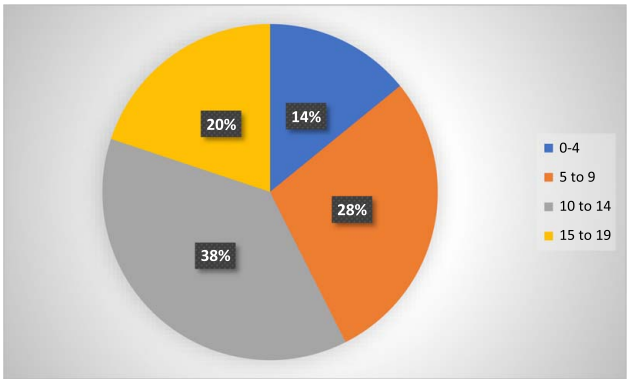

Figure 1. Showing the percentage distribution of cases of meningitis among under-20 in Niger, 2023.

laboratory confirmed), including 18 deaths (overall CFR 3.2%), from Zinder region, southeast of Niger Republic from 1 November 2022 to 27 January 2023, despite a total of 372 cases, including 12 fatalities (CFR 3%) that were reported during the most recent meningitis outbreak in the Zinder region during the 2021–2022 season[7].

Discussion

Even though a technical committee has been established in the Zinder region of Niger Republic to coordinate the response to the epidemic of meningitis in the country[7], the Niger population is still tense and worried about this debilitating disease. This might be so due to a lack of proper coordination and logistical issues from both the WHO medical team and the Niger epidemiologists. The WHO claimed that the meningitis response plan has been finalized and implemented. Unfortunately, this does not guarantee that there will not be a re-occurrence of meningitis in Niger Republic, especially, in the most affected parts; Dungass, Matamèye, Mirriah, Magaria, Zinder ville, and Gouré with (342 cases, 6 deaths), (98 cases, 3 deaths), (72 cases, 3 deaths), (38 cases, 5 deaths), (7 cases, 1 death), and (2 cases, 0 deaths), respectively[9] (Fig. 2).

This present review found that data from an outbreak of meningococcal meningitis in the Niger Republic is caused by *N. meningitidis* serogroup C1 and W[3], as a result of the clustering of households and communities[9,11]. This might be due to the lack of modern diagnostic kits to diagnose the other serotypes of meningitis, such as group Y and A, B strains, which are gaining more importance now and the lack of vaccination against the serotypes C and W with MenC or MenACWY. There are 13 serogroups of *N. meningitidis*: NmA, NmB, NmC, NmW, NmX, NmY, and other Nm (which includes non-groupable, non-encapsulated, NmE, NmE/Z, NmZ, polyagglutinable, and incompletely identified serogroups)[7]. Out of these 13 serotypes, six of them, A, B, C, W, X, and Y, are known to cause meningococcal meningitis epidemics[3]. Researchers found that the distribution of meningococcal serotypes has marked differences worldwide[7]. Meningococcal serogroups C and W accounted for substantial proportions of meningococcal disease in most of Africa, as the case in the Niger Republic, Nigeria, Ghana, Mali, etc. and Latin America, for example, Brazil, Colombia, Venezuela, etc., while serotype B was the predominant cause of meningococcal disease in many locations in Europe, Germany, Spain, France, etc., the Americas, for example, the United States and the Western Pacific[7]. Serotype Y also caused many cases of meningococcal disease in these regions, particularly in Nordic countries such as Denmark, Sweden, Finland, etc. Possible reasons for the geographical differences in serotypes of *N. meningitis* could include vaccine use and outbreaks of meningitis in different parts of the world[7]. For example, studies showed that either MenC or MenACWY, but not MenB vaccines, in the national immunization schedule predominate[33,34] in many countries in the European Region (EURO), Region of the Americas (AMRO), and Western Pacific Region (WPRO)[7]. For the case of the African Region (AFRO) where the Niger Republic lies, NmA has substantially decreased in that African Region after the introduction of a MenA conjugate vaccine after years of widespread epidemics in the meningitis belt[35,36]. See Table 1 below.

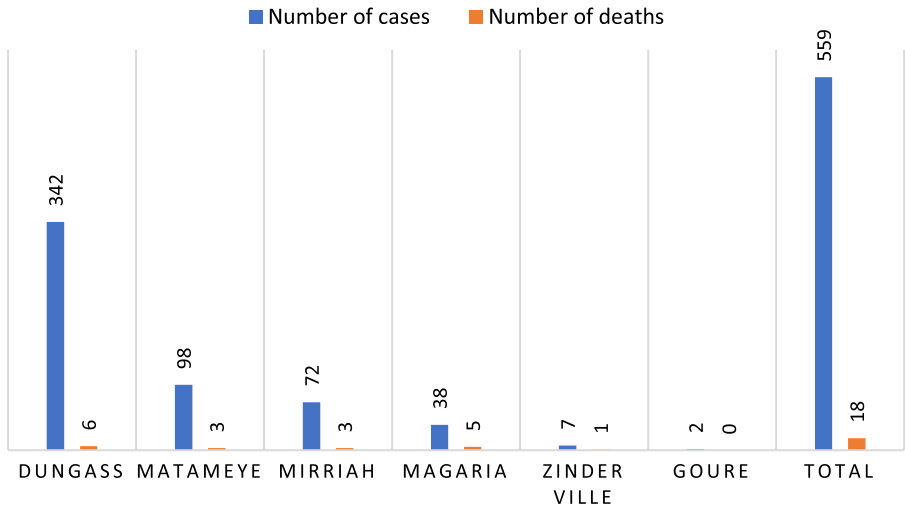

Figure 2. Showing the number of cases and deaths from meningitis in affected places in Niger.

Table 1

Serotypes of *Neisseria meningitidis* in Africa.

Country	Serotypes of *Neisseria meningitidis*
Niger	NmA, NmB, NmC, NmW, NmX, NmY, Other Nm
Algeria	NmA, NmB, NmC, NmW, NmX, NmY, Other Nm
South Africa	NmA, NmB, NmC, NmW, NmX, NmY, Other Nm
Benin	NmW and NmX
Burkina Faso	NmA, NmB, NmC, NmW, NmX, NmY
Cameroon	NmA, NmB, NmC, NmW, NmX, NmY
Central African Republic	NmA, NmB, NmC, NmW, NmX, NmY
Chad	NmA, NmB, NmC, NmW, NmX, NmY
Cote d'Ivoire	NmA, NmB, NmC, NmW, NmX, NmY
Ethiopia	NmA, NmB, NmC, NmW, NmX, NmY
The Gambia	NmA, NmB, NmC, NmW, NmX, NmY
Ghana	NmA, NmB, NmC, NmW, NmX, NmY
Guinea	NmA, NmB, NmC, NmW, NmX, NmY
Mali	NmA, NmB, NmC, NmW, NmX, NmY
Nigeria	NmA, NmB, NmC, NmW, NmX, NmY
Senegal	NmA, NmB, NmC, NmW, NmX, NmY
Togo	NmA, NmB, NmC, NmW, NmX, NmY
Morroco	NmB, NmC, NmW and NmY
Sudan	NmA, NmB, NmC, NmW, NmX, NmY

Nm, *Neisseria meningitidis*; NmA, *Neisseria meningitidis* A; NmB, *Neisseria meningitidis* B; NmC, *Neisseria meningitidis* C; NmW, *Neisseria meningitidis* W; NmX, *Neisseria meningitidis* X; NmY, *Neisseria meningitidis* Y.

Again, we found that the meningitis outbreak during COVID-19 in Niger had a significant impact on the nation's already fragile economy. The reason for this might be due to the Niger Republic has overwhelmed healthcare settings[37]. These healthcare settings could be overwhelmed due to more patients with meningitis amidst COVID-19, lack of healthcare personnel, lack of essential and comprehensive healthcare services, like drugs, medical equipment, laboratories, surgical theatres, etc., including social amenities, poor healthcare environment, as well as limited research studies. Such overwhelmed healthcare settings will not be able to effectively treat patients with some highly infectious diseases such as tuberculosis and COVID-19[37], including meningitis.

The COVID-19 pandemic also presented various healthcare issues for the Niger Republic, a resource-poor nation, including a polio outbreak, a flare-up of malaria, and famine[38,39]. The meningitis outbreak resulted in the nation's economic collapse. The reason for this could be poor socioeconomic status among the Niger population, interethnic wars, shortage of staff, including lack of political will by the Niger Government and corruption among the health authorities in Niger[34]. Also, the WHO revealed that with the COVID-19 pandemic, there is a high possibility of a delay in meningitis vaccination campaigns for more than 50 million children in Africa[13]. This delay in meningitis vaccination in Africa due to COVID-19 could, therefore, heighten the risk of outbreaks of meningitis type A in the Niger Republic. The COVID-19 pandemic would disrupt meningitis prevention and control services in Niger with disease surveillance, laboratory confirmation of cases, and outbreak investigations, all possibly reducing drastically in the country (Table 2).

Recommendations

The WHO advised widespread vaccination against *N. meningitidis* serogroup A meningitis, which 99% lessened the disease's burden. In the Niger Republic, the cause of meningitis has lately changed to different strains like serogroups NmC and NmW[3]. Researchers in Mali and the Gambia conducted a trial of a new meningitis vaccine (the immune response generated by the new pentavalent vaccine NmCV-5) against that of the licensed quadrivalent MenACWY-D vaccine in 1800 healthy 2–29-year-olds against meningococcal disease[44]. They found that this new vaccine is safe and induces a strong immune response across five strains of meningococcal bacteria: A, C, W, Y, and X. After 28 days, across all ages, the immune responses generated by a single dose of NmCV-5 were found to be generally higher than those generated by MenACWY-D. In addition, NmCV-5 induced a strong immune response to the emerging meningococcal X strain for which there is currently no licensed vaccine[44]. For this reason, we urge the Niger Government to collaborate with the

Table 2

Comparison of the clinical presentation and symptoms of meningitis and COVID-19[42–45].

Clinical symptoms	Meningitis	COVID-19
Causative agent	Bacteria (e.g. *Streptococcus pneumoniae*, *Neisseria meningitidis*), virus (e.g. enteroviruses)	SARS-CoV-2 virus[41]
Transmission	Respiratory droplets, direct contact	Respiratory droplets, contact, aerosols[41]
Incubation period	2–10 days	2–14 days[41]
Fever	Present, often high grade	Present, varying in intensity[42]
Headache	Severe, sudden onset	Common[42]
Stiff neck	Present	Rare[42]
Respiratory symptoms	Generally absent	Common (cough, shortness of breath)[43]
Cough	Absent	Common[43]
Sore throat	Uncommon	Possible[43]
Fatigue	May be present	Common[43]
Muscle/joint pain	May be present	Common[44]
Nausea/vomiting	Common	Possible[44]
Skin rash	Petechial rash in bacterial meningitis	Rare[44]
Gastrointestinal	May have diarrhoea	Possible[45]
Neurological symptoms	Confusion, altered mental status, seizures	Rare, possible in severe cases[45]
Loss of smell/taste	Rare	Common[45]
Incidence in children	More common, especially bacterial meningitis	Less severe cases compared to adults[43]
Vaccination availability	Vaccines available for some types of bacterial meningitis	COVID-19 vaccines available[43]
Severity and mortality	Can be severe, mortality rate varies	Generally milder, but severe cases can be life-threatening

researchers in Mali and the Gambia to administer this novel vaccine against meningitis to the Nigerien population, especially the vulnerable ones. Also, we recommend that there should be better laboratory capabilities for testing novel disease strains, more surveillance, and new vaccine development by pharmaceutical businesses in the Niger Republic[36].

Researchers in the Democratic Republic of Congo (DR Congo) made it known to us that both meningitis and COVID-19 are preventable diseases. They suggested that the stakeholders in DR Congo should focus primarily on the equitable distribution of vaccines, increasing the coverage in all the districts, and prioritizing 'catch-up' vaccines developed by the Centers for Disease Control and Prevention (CDC), particularly in children. The CDC recommended a catch-up vaccine against meningitis for children between the ages 13 and 15 years at 1 dose and booster dose at age 16–18 years (minimum interval: 8 weeks) while between the ages of 16 and18 years at 1 dose[45]. This is a novel recommendation that the Niger Government should adopt in the Niger Republic to tackle meningitis amid COVID-19. At the same time, more COVID-19 vaccines should be supplied across the country and should be administered together with the meningococcal vaccines. COVID-19 vaccines should be included in the National Programme of Immunization (NPI) schedule and should be given at the recommended doses according to the WHO[3,46] and the CDC[45].

In many African nations, including the Niger Republic, ceftriaxone, a highly efficient antibiotic, is the standard course of therapy for meningitis[47]. Sadly, there is limited availability of ceftriaxone in most African meningitis belts. This could result in less-than-ideal treatment plans against meningitis[48]. Ceftriaxone has been recommended for meningococcal and pneumococcal meningitis epidemics[48] with a dose of 2 g/day for 14–28 days. However, it is best to perform a lumbar puncture first since antibiotics may make it more difficult for germs to grow in spinal fluid[48]. Other antibiotics that could be administered include penicillin G (20 million U/day for 14–28 days), doxycycline (100 mg orally or IV every 12 h for 14–28 days), or chloramphenicol (1 g every 6 h for 14–28 days)[3,4,46,49]. For these reasons, it is a must that health authorities in Niger should provide abundant ceftriaxone and other alternative antibiotics against meningitis. These medications should be cost-effective for the treatment of meningitis in Niger. We also urge the health authorities in Niger to institute more chemoprophylaxis against meningitis in the country. Chemoprophylaxis has been recommended for close contacts in the meningitis belt in non-epidemic circumstances[46].

For several nations, including the Niger Republic, the meningitis scenario brought on by COVID-19 was a first. As a result, numerous activities, including vaccinations, were put on hold. It is important to look for creative solutions to the COVID-19 pandemic's worsening health situation and to establish rules for a variety of pandemic-related activities[50]. Although various publications provided varying recommendations for vaccination against common pediatric diseases, including meningitis, measles, tuberculosis, etc., during pandemics. Unfortunately, many nations, namely the Niger Republic, apply all these rules ineffectively. As a result, we also advise that mass vaccination against meningitis be implemented quickly in the Niger Republic, with full participation from all relevant corporate bodies, including weather forecasters, religious leaders, and health volunteers. It is impossible to overstate the importance of weather forecasts in preventing an outbreak of meningitis in the Niger Republic. The health authorities in the Niger Republic may use the assistance of weather forecasters to provide warning indications regarding unfavourable weather and climate conditions.

According to the recommendations in a research paper on the effect of COVID-19 on immunizations, health authorities should first evaluate the epidemiological risks, then consider the benefits of mass vaccination, if any, and then think about how an effective vaccination can be carried out while adhering to COVID-19 prevention protocols. Finally, health authorities should think about the COVID-19 prevention measures to put in place while beginning the vaccination[45,47]. Therefore, we implore the government of Niger to follow the aforementioned recommendations to eradicate meningitis there. Both meningitis and COVID-19 have significant effects on public health. Meningitis affects the entire family because it frequently affects youngsters, affects families' mental health, and may be fatal. The Niger Republic is a less developed nation with limited educational opportunities. We therefore urge the Niger administration to raise the country's citizens' educational standards. The standard of living and healthcare for the people of Niger should also be a top priority for the administration. In the Niger Republic, access to healthcare services ought to be a requirement, not a luxury. To combat any infections and prepare for any pandemics, the Niger health authorities should take steps to equip healthcare facilities and train the nation's healthcare staff. To reduce sickness in the Niger Republic as well, adequate infrastructure, including roads, primary healthcare facilities, electricity, and clean water, should be made available.

Many nations, including Niger, are working to implement the WHO's prediction that meningitis will be eradicated by 2030. An important component of this effort is vaccination, as well as giving meningitis and disability awareness a high priority at all levels[37]. To ensure that every kid in Niger is inoculated against meningitis, we implore the Niger Government to adopt and apply the novel mass vaccination methods in the nation. Healthcare professionals, including health students in Niger, should start community projects on meningitis, and sufficient healthcare services to treat meningitis should also be offered. This would go a long way to change the poor knowledge, poor attitude, and poor practices related to meningitis and COVID-19 in Niger, as many people in Africa attributed infectious diseases like meningitis and COVID-19 to witchcraft and demons[51,52].

Strengths and limitations of this review

The strengths of this present review are the comprehensive literature review and grey literature search to identify the prevalence and causes of meningitis in the Niger Republic amid the COVID-19 pandemic as well as the recent military coup in the country. With this review, the current clear picture of meningitis is known and novel recommendations are provided for the Niger Government and the international community. Additional strengths are the ability to discuss the prevalent serotypes of *N. meningitidis* in Niger and other parts of the world. Although past studies and reviews have reported discussions in expert panels and meetings regarding laboratory capacity for meningococcal surveillance[7,31,33–45,47,48,50,53–55]. However, only a few of these studies and reviews incorporated COVID-19 and the military coup in Niger. This makes our review unique.

However, this present review faced some limitations. We have not conducted any recent cross-sectional descriptive study about meningitis amid COVID-19 as well as issues like conflicts, war, and the military coup in the Niger Republic, especially on the knowledge, attitude, and perception about meningitis amid COVID-19 and humanitarian crisis in Niger. This could be a disadvantage to the policy-makers in Niger for them to have recent data for the affected population by the problems at hand. To overcome these limitations, we suggest further epidemiological studies by researchers and physicians be conducted regarding the current situation of meningitis amid COVID-19 in Niger.

Conclusion

Meningitis is a condition that can be fatal. It still poses a risk to the public's health due to its high CFR and potential for catastrophic long-term consequences. The Niger Government should therefore take appropriate and successful measures to decrease the impact of the disease. The Ministry of Health and non-governmental organizations in Niger should strengthen their collaborations with the WHO and the United Nations International Children's Emergency Fund (UNICEF) in order to prioritize mass literacy and meningitis vaccination in every community in Niger. We are hopeful that meningitis in the Niger Republic could be reduced if all of the aforementioned suggestions are put into practice.

Ethical approval

Ethical approval was not required for this review.

Consent

Informed consent was not required for this review.

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Author contribution

Conceptualization: M.O.O.; funding acquisition: A.A.; investigation: A.E.B. and H.W.P.; project administration: M.O.O.; resources: O.O.M.; software: A.A. and M.O.O.; supervision: M.O.O.; validation: A.-H.H.B.; visualization: FNU.F. and M.A.M.; writing – original draft: H.Q.A., U.O.A., A.-H.H.B., and K.F.; writing – review and editing: M.O.O., M.A.M., and FNU.F.; final approval of manuscript for publication: all authors.

Conflicts of interest disclosure

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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