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Public Knowledge, Attitudes, and Perceptions of Meningitis and Vaccination in Southeastern Nigeria: A Review of Epidemiological Evidence

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Abstract

Meningitis remains an important public health concern in Nigeria, with recurrent outbreaks contributing to substantial morbidity, mortality, and socioeconomic burden. Vaccination is one of the most effective strategies for preventing meningitis and controlling outbreaks; however, its success depends largely on public knowledge, attitudes, perceptions, and acceptance. This review examines existing epidemiological evidence on public knowledge, attitudes, and perceptions of meningitis and meningitis vaccination in Southeastern Nigeria. Relevant literature was reviewed to assess community awareness of meningitis causes, symptoms, modes of transmission, prevention, and vaccination, as well as factors influencing vaccine acceptance and utilization. Available evidence indicates that although awareness of meningitis exists among many populations, important knowledge gaps persist regarding transmission, risk factors, early symptoms, and the protective benefits of vaccination. Attitudes and perceptions are influenced by educational level, access to reliable health information, previous vaccination experiences, socioeconomic conditions, cultural beliefs, and trust in healthcare institutions. Concerns about vaccine safety, misinformation, accessibility, and perceived susceptibility to meningitis may also contribute to vaccine hesitancy. The review highlights the need for sustained community-based health education, improved risk communication, accessible vaccination services, and collaboration between healthcare providers, government agencies, and community leaders. Strengthening public understanding and confidence in meningitis vaccination is essential for improving vaccine uptake and reducing the burden of meningitis in Southeastern Nigeria.

Keywords: Meningitis, Vaccination, Public Knowledge, Vaccine Hesitancy, Southeastern Nigeria

Introduction

Meningitis is an acute inflammation of the membranes surrounding the brain and spinal cord (called the meninges), most often due to bacterial or viral infections [1]. The outer layer of the meninges is called the dura mater, followed by the arachnoid mater

and the pia mater. The two inner layers (arachnoid and pia mater) are also called the leptomeninges and are separated by the subarachnoid space, which contains cerebrospinal fluid (CSF). *Neisseria meningitidis*, a bacterial meningitis, is the most severe, leading to death or long-term disability if not treated early [2]. Neisseria meningitidis (meningococcal meningitis) is the primary cause of these epidemics, especially serogroups A, W, C, and X (NmA, NmW, NmC, and NmX respectively). However, according to Kohil *et al*. [1], viruses, fungi, and drugs (such as nonsteroidal anti-inflammatory drugs and antibiotics) can also induce meningitis. The authors further report that pathogens can access the CSF through hematogenous spread by two pathways: (1) by infecting immune cells, which then transport the pathogen to the nervous system, and (2) by crossing blood capillaries and entering the CSF as free pathogens [3]. Viral meningitis is the most common type of aseptic meningitis, with enteroviruses being the leading causes of viral meningitis.

Meningitis is endemic to Northern Nigeria, and indeed many regions in SSA, forming the "meningitis belt," where periodic outbreaks pose significant public health challenges [4]. The public health significance of meningitis in this region is underlined by recurring outbreaks that pose substantial burden on healthcare systems, leading to high morbidity and mortality [2]. Vaccination is the most effective preventive measure against bacterial meningitis, particularly the polysaccharide and conjugate vaccines targeting the prevalent serogroups [5, 6].

Globally, meningitis accounts for alarmingly high morbidity and mortality, especially in children and young adults [7]. According to the WHO, there is a yearly estimate of 1.2 million cases of bacterial meningitis globally, with 1 in every 10 persons dying, despite the availability and proven efficacy of vaccines. This burden is especially high in LMICs— a region typified by limited access to healthcare and vaccines [8]. According to Soertes *et al*., (2019), the global yearly incidence of bacterial meningitis is estimated at 2 – 5 cases per 100, 000 population. However, this figure is considerably higher in regions within Africa's meningitis belt (Benin, Burkina Faso, Cameroon, the Central African Republic, Chad, the Democratic Republic of the Congo, Ethiopia, Ghana, Ivory Coast, Mali, Niger, Nigeria, Togo, and Senegal). The CFR for meningitis, globally, can be as high as 1 death in every 5 cases, with survivors suffering chronic disabilities such as neurological damage, deafness, or cognitive impairment [9].

In SSA, the regions within the meningitis belt suffer the most burden of meningitis worldwide. This area is vulnerable to seasonal epidemics of meningococcal meningitis, especially between December and June, when there is dry season characterized by dust and windy nights. Nigeria, is at high risk of this epidemic, experiencing repeated outbreaks over the years, especially in its northern regions. In 1996, Nigeria experienced one of the largest meningitis outbreaks worldwide, with over 100, 000 cases and an 11% mortality rate. There were similar high meningitis-related morbidity and mortality rates in 2009 [10] and 2017 [11]. Viviani [12] reports that, in Nigeria, NmA, NmC, and NmW contribute to the largest proportion of bacterial meningitis cases, although there has been a decrease in NmA following the introduction of MEnAfriVac vaccine. The incidence rate during major meningitis outbreaks has ranged from 10 – 20 cases per 100, 000 population, with Northern Nigeria being the most affected due to limited healthcare access, geographical constraints, and insurgencies such as the incessant Boko Haram attacks. These factors contribute to the high meningitis prevalence in the region [13].

There is evidence showing vaccination as the most effective meningitis preventive method, especially *Neisseria meningitidis* and *Streptococcus pneumoniae*. The availability of vaccines has substantially lowered the global burden of meningitis, particularly in vulnerable regions [14]. In the meningitis belt, large-scale vaccination programs have effectively addressed NmA in several countries. However, a similar study Ngo *et al*., [15] highlights that there are gaps in vaccination uptake, especially in war-torn regions, which persist as a public health problem. In response to this issue, the WHO has implemented a strategy with the aim to curtailing meningitis by the year 2030, with particular focus on lowering incidence and enhancing access to vaccines and treatment [16].

Despite the reported effectiveness of vaccination programs such as MenAfriVac, there is need for more efforts targeting other serogroups, enhancing vaccine coverage, and ensuring timely access to medical care during outbreaks. The global and regional burden of meningitis accentuates the need for sustained vigilance, research, and investment in public health infrastructure to mitigate the debilitating effects of this epidemic.

Public knowledge and awareness of meningitis

A study reporting an overview on viral meningitis Kohil *et al*. [1] stresses that a good public health knowledge of meningitis, including its causes, symptoms, and transmission, is critical in disease prevention and control. This puts meningitis at great risk, regions of limited knowledge, as it leads to misdiagnosis or late treatment, thus increasing risk of complications. Similarly, Baloyi *et al* [17] reiterate that a poor knowledge of meningitis symptoms such as fever, nausea, phonophobia, and headaches can delay timely health-seeking behavior. In Northern Nigeria, a range of factors including poor education, misinformation, and dependence on cultural beliefs shape people's understanding and preventive action toward meningitis. Balint *et al*., [18] reveal that cultural beliefs, especially concerning the causes of illness, often conflict with biomedical explanations, undermining efforts to enhance awareness on meningitis. The following section details the other causes of meningitis.

Causes of meningitis

Meningitis is caused by the inflammation of the meninges, the membranes protecting the brain and spinal cord. This disease condition is exacerbated by various infectious agents, including bacteria, viruses, fungi, and parasites, as well as non-infectious causes such as NSAIDs and cancers. The most common and serious forms of meningitis are those caused by bacterial and viral infections.

Bacterial meningitis

Bacterial meningitis is the most severe and most debilitating form of meningitis. A failure to seek immediate medical intervention would result in the bacteria invading the bloodstream and crossing the blood-brain barrier, causing the meninges to swell [19]. *Neisseria meningitidis* (Meningococcal Meningitis) is a leading cause of meningitis globally, but more so in the meningitis belt of SSA [20]. This form of meningitis is highly communicable, transmitted through

respiratory droplets, and can cause widespread outbreaks. There are multiple serogroups of meningococcal meningitis (A, B, C, W, X, Y), with serogroup A being the most common in the African meningitis belt. Secondly, the Streptococcus pneumoniae is the most common cause of bacterial meningitis worldwide, with children and older adults being the most vulnerable. This form often occurs following pneumonia and infections such as sinusitis [21]. Additionally, Hib, once a leading cause of meningitis in children, especially in LMICs, has been mitigated due to widespread vaccination [22]. The other two causes of bacterial meningitis include listeria monocytogenes and group B streptococcus. The former, often transmitted via contaminated food, primarily affects neonatals, pregnant women, older adults, and individuals with low immunity [23]. The latter is transferred from infected mother to newborn [24].

Viral meningitis

This is a less severe form of meningitis, even though it is more common than bacterial meningitis. This form usually resolves without need for any treatment and is caused by viruses communicable through direct contact with an infected person or contaminated surfaces. Enteroviruses account for the largest proportion of viral meningitis cases, particularly in children [1]. They are often transmitted via close contact, respiratory droplets, or infected surfaces. The herpes simplex virus mostly affects newborns and adults with a reactivation of a latent infection. Furthermore, the Varicella-Zoster virus that causes chickenpox and shingles can also lead to viral meningitis, especially in people with low immunity. Finally, HIV-positive populations are at significant risk of viral meningitis due to immunosuppression.

Fungal meningitis

A less common form, fungal meningitis may appear in individuals with compromised immune systems, such as those with HIV/AIDS, cancer, or organ transplant recipients. This form develops slower than bacterial or viral meningitis. Cryptococcus neoformans is the predominant causative factor of fungal meningitis, mostly affecting HIV-positive populations [25]. This fungus is often present in soil and bird droppings, and if inhaled, can cause lung infections that affect the brain. Also, *Candida*, the fungus responsible for yeast infections, can also lead to fungal meningitis, particularly in premature infants and immunosuppressed individuals [26].

Parasitic meningitis

Parasitic infections are the least common cause of meningitis [27]. However, Tunali and Korkmaz [28] reveal that the condition can be life-threatening when it occurs. The *Naegleria fowleri*, also referred to as "brain-eating amoeba" and commonly occurring in warm freshwater, can reach the brain via the nasal passages. This could occur when humans encounter contaminated water during activities such as swimming [29].

Non-infectious causes

Meningitis can be caused by non-infectious factors. There is evidence associating drugs such as NSAIDS and antibiotics with the exacerbation of meningitis (Davis *et al*., 2021) [49]. Similar studies highlight that cancers of metastatic which spread to the brain or spinal cord, can lead to neoplastic meningitis (Molina and Penas-Prado, 2022) [73]. Finally, trauma to the head could lead to meningitis, if the meninges are compromised.

A comprehension of the varied causes of meningitis is key to appropriate diagnosis and treatment. Timely medical treatment is necessary for bacterial meningitis, while viral meningitis is less damaging, but still necessitates supportive care. It is imperative for public health efforts such as vaccination and education to target regions such as Northern Nigeria, to prevent outbreaks in this high-burden area.

Symptoms of meningitis

Meningitis manifests with a range of symptoms that can be categorized into general, specific, and progressive, based on the causative agent and the person's age and immune status. Studies recommend that early identification of these symptoms be made, to aid diagnosis, as the symptoms could exacerbate the condition, leading to debilitating effects.

The most common symptoms of meningitis, often referred to as the "triad of meningitis" include fever, neck stiffness, and headache (Iftiyastuti *et al*., 2024) [60]. Fig 1 illustrates the triad of meningitis:

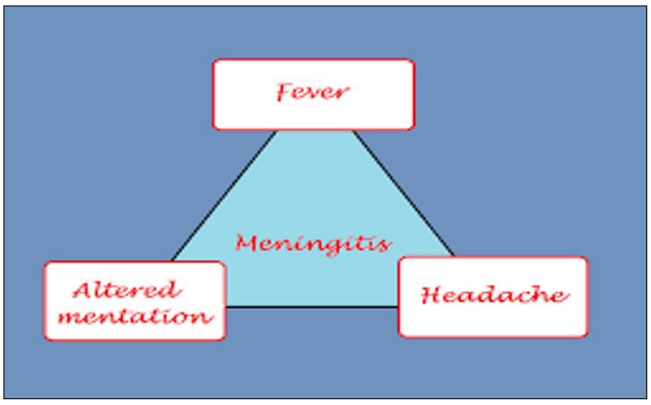

Fig 1: The Triad of Meningitis

According to Kohil *et al*. [1], fever occurs in 9 of every 10 meningitis cases. This is corroborated by the Hasbun (2022) [58] review, which reveals sudden high fever as a primary symptom of meningitis, often seen in bacterial meningitis. Furthermore, Scanferla *et al*., (2022) associate meningitis with neck stiffness, highlighting that the sufferer usually experiences pain while trying to turn their neck. This is most common in adults and is due to an irritation of the meninges and occurs in 7 out of every 10 cases (Petersen *et al*., 2023) [86]. Severe throbbing headaches, due to elevated intracranial pressure, are also common in meningitis [1]. These symptoms occur in 90% of adult patients, especially for bacterial meningitis. It is worth noting however, that the full triad does not manifest in all patients, particularly infants and old adults, which makes early diagnosis more difficult (Malik *et al*., 2024) [68]. The authors also add that the manifestation of meningitis symptoms differs with age, with some symptoms more prominent in children and others in older individuals. In children, for instance, irritability and high-pitched crying, low interest in feeding, weakness, and a bulging fontanelle are common symptoms. Symptoms more common in adults and young people include photophobia, drowsiness, coma, and seizures.

Studies also reveal that symptoms could manifest according to the causative agent. Bacterial meningitis manifests with acute and severe symptoms due to the rapid onset of

inflammation and progression of the disease. These symptoms present by day 1 and proceeds to worsen the condition. Some of the symptoms (apart from the triad discussed earlier in the section) include a purplish rash, present in half to three-quarters of cases (Silva *et al*., 2021) [98]. McEntire *et al*., (2021) [69] also associate the disease condition with severe neurological symptoms such as coma and intracranial palsies. On the other hand, symptoms of viral meningitis are less severe and go away without any intervention. The symptoms could include fever, headache, and photophobia. Similarly, meningitis causes by enteroviruses lead to gastrointestinal problems such as nausea, emesis, and diarrhea (Rao, 2020). Fungal meningitis typically develops gradually over weeks and majorly affects immunocompromised individuals (such as in HIV/AIDS). Some of the symptoms include chronic headaches and confusion. Finally, parasitic meningitis manifests with more severe symptoms such as rapid onset of severe headache, vomiting, fever, and neurological deficits, ultimately causing death within days if untreated [28]. A timely identification of key symptoms, such as the meningitis triad is critical for proper diagnosis and treatment. A lack of early treatment could result in more severe forms of this disease, accentuating the need for public awareness and timely medical attention. Future studies should look into symptom variability across various populations and pathogens.

Transmission of meningitis

Meningitis transmission differs according to the causative agent, whether bacterial, viral, fungal, or parasitic. Understanding the transmission routes is crucial to developing effective prevention strategies, particularly in regions with high disease burden, such as Northern Nigeria. The mode of transmission also influences outbreak potential and public health interventions, such as vaccination campaigns and hygiene practices. Table 1 shows the transmission of various meningitis forms according to the pathogens causing them.

Table 1: Types of meningitis, causes, mode of transmission, and risk factors

Type of meningitis	Causative agent	Mode of Transmission	Risk factors
Bacterial meningitis	Neisseria meningitidis, Streptococcus pneumoniae, Hib	Person-to-person through respiratory droplets, close contact, coughing, or sneezing.	Close living quarters (e.g., dormitories), weakened immune system, crowded conditions, lack of vaccination.
Viral Meningitis	Enteroviruses, Mumps virus, Herpes Simplex Virus	Fecal-oral transmission (for enteroviruses), respiratory droplets (for mumps and herpes viruses).	Poor hygiene, close contact with infected individuals, exposure to contaminated surfaces or food.
Fungal Meningitis	Cryptococcus spp., Candida spp.	Inhalation of fungal spores from the environment (usually soil or bird droppings).	Weakened immune system (e.g., HIV/AIDS, cancer treatments), prolonged use of immunosuppressive drugs.
Parasitic Meningitis	Amoeba (Naegleria fowleri)	Entry of parasites through contaminated water, often via the nasal passages during swimming or water sports.	Exposure to warm, freshwater bodies (e.g., lakes, rivers) in areas where the parasite is found, poor water safety.
Non-infectious Meningitis	NSAIDs, cancers	Not contagious. Often triggered by drug reactions, cancers, or other medical conditions.	Autoimmune conditions, drug reactions, exposure to certain medical treatments (e.g., surgery, chemotherapy).

Public perception of meningitis and vaccination

How the public perceives meningitis and vaccination is a key indicator of health-seeking behavior and vaccine acceptance (Aksnes *et al*., 2021) [37]. Perception entails beliefs regarding the severity of the disease, the effectiveness of preventive measures, and the safety of vaccines. Vaccine decision-making can be illustrated by health behavior models such as the Health Belief Model (HBM; Ahn and Oh, 2021) [36] which views vaccination behaviors as a function of an individual's perceptions of both a disease and its associated vaccine. These constructs especially involve individual's perceived susceptibility or susceptibility to the disease, their comprehension of disease severity (e.g., disability and death), perception of the potential benefits of vaccination, and barriers to vaccination (financial cost and side effects; Zahari *et al*., 2022). Similarly, a study investigating perception of meningitis among caregivers, (Mahmoud *et al*., 2022) [67] identifies socio-cultural and religious factors that shape these perceptions. Firstly, the population in Nigeria perceive meningitis as a deadly disease. However, many communities relate meningitis occurrence with spiritual causes, resulting in a dangerous dependence on non-medical treatment (Olu *et al*., 2021) [81]. This relationship could undermine timely treatment-seeking.

To provide further context into the perception of meningitis as a function of witchcraft, di Fazio *et al*., (2021) [50] reported that respondents likened the operation of witches to an insect sucking away all the liquid in a groundnut seed if left in an enclosure. Considering this parallel, Northern Nigerian populations opine that witchcraft causes the "*Yinrun yinrun*" illness and commonly afflicts people through foul wind (Mahmoud *et al*., 2022) [67]. Similarly, "*Djinn*" is another community perception of meningitis aetiology. Unlike witchcraft, Muslims view Djinns as spirit creatures thought to dwell amongst humans. While largely considered harmless, there is also the belief that bad Djinns exist, which can afflict human beings with insanity, illness, or death, by attacking an individual via foul wind. The authors also reveal that individuals believe these creatures to target vulnerable demographics, if they encroach their territory— a view responsible for their perception on meningitis' severe symptoms. The severity of these symptoms is hence, a reflection of how much the Djinn has taken over the victim's body and the degree to which the native doctor's intervention is expunging the body of this creature.

On the back of this explanation, treatment is reliant on the patient's family traditions and common practices and often involves native doctors who are widely revered across regions in SSA (Mahmoud *et al*., 2022) [67]. Most healers suggest that if an individual demonstrates severe symptoms, it is important to identify the specific cause of that issue before the person can recover. More often than not, the person so plagued, would neglect a biomedical health practitioner in favour of their belief in supernatural forces as the main cause of that illness. Despite the evidence supporting their beliefs in spirits and witchcraft, there is a dearth in ethnographic and socio-behavioral research integrating local beliefs of sickness into preventive efforts for meningitis.

Furthermore, studies cite vaccine hesitancy as a major barrier to meningitis preventive efforts in most regions of Northern Nigeria (Agbede *et al*., 2024) [35]. The authors identify misinformation about vaccine side effects, distrust in health authorities, and the influence of community leaders as factors undermining vaccination rates in some regions. A comprehension of these perceptions is crucial for developing effective public health programs. Moreover, Wagner *et al*., (2017) associate vaccine uptake with demographic

characteristics such as residency and urbanicity. For instance, rural-urban migrants have limited access to governmental entitlement programs than indigenes (Ismail, 2019) [61].

Similarly, Blagden *et al*., (2017) [45] conducted a cross-sectional study regarding the uptake of a new meningitis vaccination program among adolescents. The study revealed the highest bacterial meningitis burden in adolescents and young adults with one-quarter of the respondents being infected, but showing no symptoms. The authors attribute this high burden in young people to their inclination to living close to areas that promote bacterial transmission through droplet and aerosol routes. In addition, meningococcal carriage at adolescence and young adulthood promotes transmission of MnW across the population, with MnACWY vaccination initiative developed with the aim of generating herd immunity. Likewise, Millar *et al*., (2017) [72]'s school-based study investigating vaccination uptake in Northern Ireland revealed that uptake reduced from 90% to 39% among adolescents and younger adults. This finding is in tandem with Turner *et al*., (2017) [104], a university-based study evaluating the uptake of MnACWY vaccination, which reported a 70% vaccine uptake, compared to 31% who had been vaccinated prior to admission into the institution. Interestingly, however, the paper identified a near 45% decline by the unvaccinated population, even though free vaccination was offered upon arrival at the university. These findings suggest a pressing need for public health programs to key into understanding the factors that influence vaccination among this demographic.

Health-seeking behavior and access to vaccination

The health-seeking behavior of individuals is affected by their understanding of disease symptoms, access to healthcare services, and perceptions of the quality of care (QoC) provided. With regard to meningitis, delayed healthcare seeking due to a lack of knowledge or dependence on traditional remedies is common, often exacerbating the condition. This persists as a problem in Northern Nigeria, especially in rural areas. The distance to health facilities, poor road network, costs, and perceived QoC are all contributory factors to determining health-seeking and vaccine-adoption behaviours. It is imperative thus, to reinforce healthcare infrastructure, enhancing service delivery, and improving public awareness, in order to promote better health-seeking behaviour in the region. Gidado *et al*., (2023) [56] carried out an investigation on health-seeking patterns among internally displaced persons (IDPs). IDPs are groups of persons forced to abandon their homes, due to a range of factors such as armed conflict, man rights violation, and disasters— issues endemic to Northern Nigeria. This abandonment forces IDPs to take refuge in camps, tents, and makeshift homes with little or no basic amenities. These settings are typified by population congestion, overcrowded shelters, poor water, sanitation, and hygiene, and reduced food security. These conditions make IDPs more susceptible to communicable diseases, with high morbidity and mortality (Hammer, 2017) [57]. Furthermore, non-vaccination of eligible children against these diseases exacerbates outbreaks of vaccine-preventable diseases in these settings (Cantor *et al*., 2021) [46]. In Northern Nigeria, an armed rebellion by terrorist groups triggered a complex human emergency in the region. These emergencies displaced more than two million persons, mostly women and children (Gidado *et al*., 2023) [56]. Expectedly, this has also weakened health systems, affected healthcare delivery and undermined disease response. This is reflected by the state of communicable disease outbreaks with significant morbidity and mortality, especially among IDPs in the area (Abubakar *et al*., 2019 [30]; Ngwa *et al*., 2020).

Factors such as poor housing conditions and overcrowding have also received scholarly justification as major meningitis risk factors. This assertion is illustrated in the works of Umaru *et al*., (2023) [105], a study based in urban Kaduna, Nigeria, assessing the association between built environment with meningitis incidence. The study reported that environmental factors played a significant role in propagating meningitis spread, especially through poor housing conditions, deprived settlements, and household overcrowding. The study also added that the absence of overcrowded settlements permitting proper ventilation are also significant risk factors for the disease. This is common in LMICs, where inflow and outflow of ventilation are often absent. This finding is in tandem with Yaka *et al*., (2008) [111], a UK-based study, associating high spread of *Meningococcal meningitis* disease with the overcrowded settlement in Burkina-Faso. According to Umaru *et al*., (2023) [105], the built environment comprises housing conditions, transportation patterns, land use, urbanization, housing density, building arrangements, road and park networks. The built environment is related with public health; one of such ways is via individual transportation choices and environmental exposures that are a consequence of various built environment patterns. Furthermore, there are neighbourhoods within the region that are faced with a lack of facilities and services. Low-income earners in the community often choose (out of necessity) to reside in such places due to lower rent and affordability of services. These neighbourhoods, often described as high-density settlements are typified by poor housing conditions, with mass movement and clustering predisposing this demographic to greater meningitis incidence risk.

Socio-cultural and religious barriers to vaccine uptake

Socio-cultural norms and religious beliefs are crucial determinants of vaccine acceptance and uptake in many regions, including Northern Nigeria. This section discusses these critical factors and how they influence community attitudes, perceptions, and behaviors, either facilitating or hindering vaccination efforts.

The role of community and religious leaders

Community and religious leaders hold influential positions in Northern Nigeria, often serving as gatekeepers of public opinion and mediators between healthcare providers and local populations. According to Gidado *et al*., (2019), a Zamfara-based case study, community leaders and religious leaders who actively supported vaccination campaigns aided to dismiss misperceptions and distrust in vaccines. Consequently, leaders who were involved in sensitization efforts produced substantial advancements in vaccine coverage in the area. Similarly, Dutta *et al*., (2021) [51] reported that vaccine endorsement from faith-based organizations proved effective in countering misinformation and promoting participation during meningitis outbreaks. Their efforts were especially successful when they proffered faith-based justifications for vaccination, presenting it as their moral obligation to protect the community. In contrast, other literature presented a case of resistance to vaccination. According to Ukah (2023), vaccine hesitancy persisted in

some areas of Northern Nigeria where leaders distrusted government intentions and adhered to conservative interpretations of religious teachings. This occurrence is not new, but instead dates back to decades back, where leaders kicked against polio vaccination in the area, off the perception that the government intended to make inhabitants sterile and other anti-Islamic notions (Taylor *et al*., 2017) [102]. This perhaps provides a cautionary example as polio prevalence spiked in the region leading to widespread morbidity and mortality. It is thus, imperative for research to integrate health education initiatives aimed at dispelling the misperceptions of vaccination being a foreign imposition or a means to undermine cultural values.

Influence of cultural beliefs and practices

Cultural norms, including traditional healing practices, communal decision-making, and gender roles are all significant influencing factors in vaccine acceptance. In rural regions, dwellers often take traditional healers as their primary healthcare provider. In a study by Agbede *et al*., (2024) [35], the authors reported that traditional healers sometimes hindered vaccination by promoting alternative remedies for meningitis. This highlights the need to integrate traditional healers into vaccination campaigns and training them to be at the forefront lowering resistance and broadening outreach. Furthermore, the impact of communal decision-making is implicated in Schmidt, 2017. The authors stressed the relevance of communal agreement in health-associated decisions. The more in disagreement to vaccination, their thought leaders were, the higher the likelihood of community members resisting adoption. On the other hand, communities undertaking a concerted approach to supporting healthcare interventions most likely accept vaccination. Other literature associate gender dynamics with vaccine uptake. For instance, a study in Wong *et al*., (2020) [109] detailed that women in traditional societies required spousal approval to access healthcare services, including vaccination. This is consistent with context to Northern Nigeria, where men's input and decision-making concerning health are crucial, thus proving their relevance in vaccination uptake. This is consistent with an older study based in Nigeria (Antai, 2013), attributing their strong influence to household financing and decision-making. There are studies highlighting the negative influence of misinformation and myths on vaccine uptake in the community. Several regions hold the misperception regarding vaccine safety, efficacy, and side-effects. For instance, Mupandawana and Cross (2016) [74] observed that misperceptions linking meningitis vaccines with sterility or chronic health problems, were highly influential in lowering adoption rates. In another study (Ukah, 2023), there are persistent claims that vaccines were a means of foreign intervention in controlling population or leading anti-religious efforts. It is worth noting that these myths easily spread through channels such as social media and large community fellowships, undermining public health campaigns.

Addressing socio-cultural/religious barriers

To conduct successful interventions to scale socio-cultural/religious barriers, public health programs must be adapted to local contexts. Studies (Shen *et al*., 2023) [95] advocate for the integration of faith-based organizations (FBOs) in delivering pro-vaccine messages in ways that appeal to the public culturally and locally, and also in improving trust and adoption. A similar study Edberg *et al*., (2016) [52] emphasized the effectiveness of tailored health education campaigns in assuaging socio-cultural challenges by delivering content in local easy-to-understand languages and via trusted channels, such as community health extension workers (CHEWs) and women leaders. This feeds into Michau *et al*., (2015) [71], which underscores the importance of empowering women as health thought leaders and involving youth groups that can aid counter patriarchal norms. In addition, offering unambiguous information regarding vaccine development, safety, and efficacy is vital to reducing mistrust and combatting misinformation.

Theoretical review

To adequately understand the KAP concerning meningitis and its associated vaccination in South-East Nigeria, it is imperative to examine the relevant theoretical underpinnings and concepts in public health. This section highlights the frameworks that form the basis for this study's objectives, and their applications to the present research.

Health belief model (HBM)

The health belief model is a psychological framework employed to understand and predict health-related behaviors, especially preventive health efforts such as vaccination (Shmueli, 2021) [97]. The HBM involves the interplay of multiple constructs to influence individual decision-making regarding health behaviors:

1. Perceived susceptibility

This construct highlights individuals' beliefs concerning their risk of contracting meningitis. In the context of this study, young adults' understanding of meningitis transmission and vulnerability to infection will shape their perceived susceptibility. A high perception of meningitis risk is directly proportional to vaccine adoption. This is particularly relevant to objective 1 of the present study as investigating baseline knowledge regarding meningitis will offer insights into participants' awareness of their susceptibility.

2. Perceived severity

This construct investigates beliefs regarding the seriousness of meningitis, encompassing possible complications, impact, and mortality. A high perception of severity promotes preventive actions. Conversely, if individuals fail to recognize/trivialize the severity of meningitis, they are less likely to prioritize vaccination. This is relevant, in particular to objective 2 of the present study as the assessment of public attitudes regarding meningitis vaccination could be indicative of people's understanding of the potential severity of the disease.

3. Perceived benefits

This aspect investigates individuals' beliefs about the effectiveness of vaccination in preventing meningitis. Individuals' perspectives on vaccination as a trustworthy and safe measure are directly related with their likelihood to undertake vaccine. On the other hand, misconceptions about vaccine efficacy can significantly impede uptake. As reflected in objective 3 of the current research, identifying socio-cultural and religious barriers will highlight issues impeding understanding and adoption of the benefits of vaccination.

4. Perceived barriers

Barriers to vaccination encompass cultural beliefs, financial costs, accessibility, or distrust in the healthcare system. A comprehension of these barriers is key to developing

effective interventions. In context of the study objectives 3 and 4, the exploration of socio-cultural and religious aspects, as well as demographic factors, will identify the barriers impeding vaccine adoption.

5. Cues to action

External factors, such as public health initiatives, education interventions, or recommendations from community/thought leaders, can motivate health-promoting behaviors like vaccination. This is relevant to objective 5 of the study as the research seeks to develop evidence-based strategies, including tailored interventions, to serve as cues to action.

6. Self-efficacy

This construct highlights individuals' confidence in their capacity to achieve the desired health behavior, e.g., vaccination uptake. For instance, individuals may require information on where and how to access vaccines, or reassurance that the process is simple and affordable. By addressing barriers and offering accessible solutions, this research can improve self-efficacy among participants, aligning with objectives 3 and 5.

Social ecological model (SEM)

The SEM provides a multi-level framework for understanding the complex interplay of individual, interpersonal, community, and systemic factors that influence health behaviors (Salihu *et al*., 2015) [91]. This model is appropriate for addressing the socio-cultural and structural determinants of meningitis vaccination in South-East Nigeria.

1. Individual level

This aspect is concerned with personal factors including KAP and demographic characteristics (e.g., age, gender, employment status, educational level). It operates on the premise that individual factors shape how people perceive meningitis and the vaccine. In tandem with objective 4, the statistical analysis of demographic data will identify the relationship between individual characteristics and KAP of meningitis and its associated vaccination.

2. Interpersonal level

This level explores dynamics with family, friends, and peers who can shape health behaviors. For instance, parents or peers (who are often decision makers in the household) advocating for vaccination can positively affect others' decisions. This feeds into objective 3 of this study, which seeks to engage community leaders in order to reinforce positive interpersonal influences on vaccine uptake.

3. Community level

This examines the role of social norms, cultural practices, and the influence of community and religious leaders. In South-East Nigeria, community and religious leaders (popularly referred to as *Onye Isi*) are heavily involved in decision-making, which often influences public perceptions and addresses vaccine hesitancy (Mahmoud *et al*., 2022) [67]. As reflected in objective 3 of this research, identifying socio-cultural and religious factors requires understanding community-level influences that encourage or impede vaccination.

4. Organizational level

At this level, the study examines the role of institutions, such as healthcare facilities and schools, in providing vaccination services and information. Poor healthcare infrastructure or inadequate vaccination programs can be significant barriers (Bangura *et al*., 2020) [40]. According to objective 5 of the present study, evidence-based strategies must bridge gaps at organizational level to improve access to vaccines.

5. Policy/systemic level

This level emphasizes the broader structural factors, such as healthcare policies, governmental support, and funding for vaccination campaigns. As demonstrated in (Baum *et al*., 2020) [42] inadequate policies or a lack of political input can undermine public health efforts. This is consistent with the study's fifth objective which informs that recommendations from this research can inform policy interventions to reinforce vaccination programs in South-East Nigeria.

Interplay between HBM and SEM

The models adapted for this study complement each other by addressing micro- and macro-level influences on meningitis vaccination. While the former describes individual decision-making processes, the latter focuses on the environmental and systemic factors that promote or impede behavior change. A successful incorporation of these models in this research provides a holistic approach to understanding and addressing meningitis-related KAP in South-East Nigeria.

Conceptual review

1. Conceptual overview

This study's conceptual framework is designed to analyze the interrelationship between KAP regarding meningitis and its vaccination, influenced by socio-cultural, religious, and demographic factors. The framework integrates the theoretical underpinnings (HBM and SEM models) to provide a multi-layered understanding of the determinants and barriers to vaccine uptake.

2. Core constructs of KAP

In context of the study, the aspect of knowledge encompasses awareness of the disease (including causes, symptoms, transmission, and prevention), understanding of vaccine benefits and potential risks, channels for disseminating information (including health campaigns, health education programs, community leaders, social media, healthcare providers). Attitudes, according to this study, involves perceptions about the severity and susceptibility to meningitis. Beliefs regarding vaccine effectiveness and safety, and socio-cultural/religious norms affecting vaccine adoption. The study contextualizes practices to include willingness to receive or advocate for meningitis vaccination, health-seeking behaviours concerning meningitis symptoms, and community efforts (such as participation in sensitization programs).

The KAP are shaped by various influencing factors derived from the HBM and SEM (explained in section 2.2 of the present study). The demographic characteristics of the study population serve as moderating variables that influence KAP and its determinants. Shown in Fig 2, these variables include age, gender, educational status, income level, and religious inclination. Also included are urban versus rural dwellers, which affect access to healthcare and exposure to misinformation.

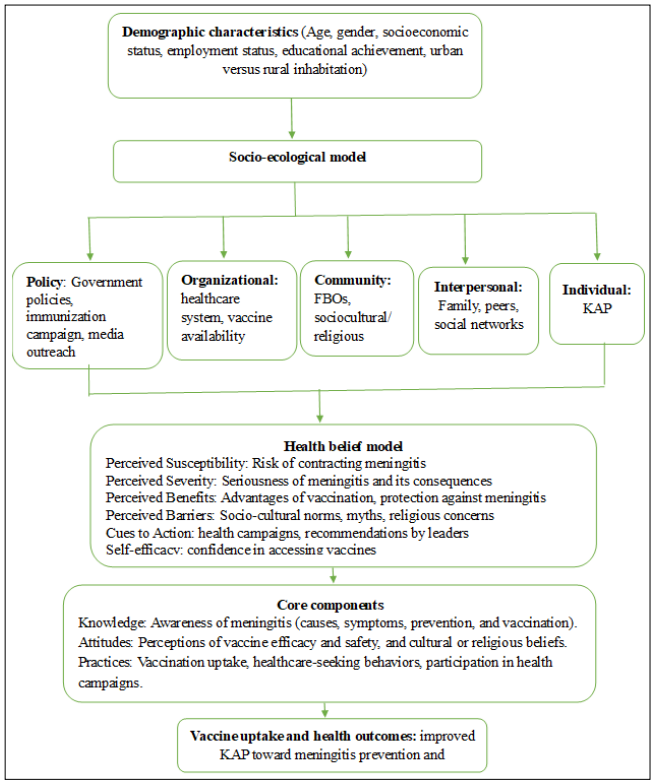

Fig 2: The demographic characteristics of the study population serve as moderating variables that influence KAP and its determinants

Conclusion

Improving public knowledge, attitudes, and perceptions of meningitis and vaccination is essential in Southeastern Nigeria. Strengthening health education, addressing misinformation, building vaccine confidence, and improving access to vaccination services can enhance uptake, prevent outbreaks, reduce meningitis-related complications, and ultimately improve community health outcomes.

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