

LETTER TO THE EDITOR

ADDRESSING THE ALARMING SURGE OF NAEGLERIA AND OTHER WATER-BORNE DISEASES IN KARACHI: A CALL FOR URGENT ACTION

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Naegleria fowleri, a thermophilic, free-living organism causes a life-threatening condition called primary amoebic meningoencephalitis (PAM). *Naegleria* thrives in warm freshwater but the rising number of cases in Karachi has raised concerns about the quality of the city's domestic water supply. Pakistan has dealt with numerous healthcare burdens in the past, including outbreaks of diseases such as diphtheria, and cholera, and is persistently dealing with the challenge of polio. Moreover, bacterial contamination and improper water infrastructure pose a significant public health risk to several other water-borne diseases, prevalent in the city. Furthermore, the surge in cases of *Naegleria* adds to these ongoing health concerns. This brain-eating amoeba has the potential to spread beyond its current location, posing a significant threat to the nation's healthcare system. While the world is struggling to find an effective treatment for PAM, implementing preventive measures to improve water management, and surveillance can save lives and lessen the burden. The addition of chlorine to the water supply of the city by KWSB is a crucial step toward keeping this infection under control.

Keywords: *Naegleria fowleri*; Primary Amoebic Meningoencephalitis; Water quality; Water-borne diseases; Karachi

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INTRODUCTION

Naegleria fowleri also known as “brain-eating amoeba” is a thermophilic, free-living amoeba, well-recognized as the causative agent for an acute, lethal brain infection called Primary Amoebic Meningoencephalitis (PAM) It is characterized by fever, headache, nausea, vomiting, stiff neck, and in an advanced stage; lack of attention, loss of balance, hallucinations, and seizures leading to death within 7–10 days, if left untreated, accounting for 98% mortality rate.¹ The amoeba resides in hot springs, ponds, rivers, and freshwater lakes and has also been identified in untreated swimming pools, thermal waters, untreated drinking water, and water parks. A total of 39 countries have reported cases of *N. fowleri* infections, however, the United States of America (USA), Pakistan, Mexico, Australia, the Czech Republic, and India have been the most affected countries owing to the warm climatic conditions and increased use of contaminated water.¹

In 2008, Karachi faced a turning point in its public health history with the emergence of the first recorded case of *Naegleria fowleri*. From a total of about two reported cases in 2008 to thirteen cases in 2011 and more in later years,² this unfortunate increase in the number of cases has translated into a growing number of lives lost. According to one of the

reports, the number of cases in Karachi from 2008 to Oct 2019 (146 cases) has crossed the number of cases reported in the U.S. in the last half a century (142 cases).³ From six deaths in 2017, followed by seven in 2018 and eleven fatalities in 2019, six in 2021 and 2022, the upward trend has persisted in subsequent years.⁴ According to the data obtained from the Sindh Health Department's *Naegleria* monitoring and inspection team in 2022, forty-seven fatal outcomes were reported in the past six years.⁵

While the past surge in cases of brain-eating amoeba in Karachi provided valuable insights, it is the current situation that demands our immediate attention. As of May 31st, 2023, the Sindh health department has confirmed three deaths from *Naegleria fowleri* infection within a short span of one week. What's alarming is that none of the three victims had a previous record of swimming, suggesting that the infection likely resulted from the use of unchlorinated, contaminated tap water.⁶ In Karachi, another fatality was reported in July; the victim had exposure to the public swimming pool. Nevertheless, the emergence of the first case of *N. fowleri* has been identified in Lahore for the first time, posing a significant public health risk. In response, the Karachi Water and Sewerage Board (KWSB) has started adding chlorine to the water, as the standard set by the World Health

Organization (WHO), to inhibit the growth of organisms in tap water.⁷

Another crucial factor contributing to increasing cases of PAM is the warm weather. The Karachi Health Department had issued a warning for a possible heatwave in June, with temperatures likely to range between 44 to 46 degrees Celsius and could go up as far as 50 degrees.⁸ Since *Naegleria fowleri* is a thermophilic organism and thrives in a hot climate and warm water, this is an alarming situation for the residents of Karachi, where the average temperature during summers usually remains above 91 °F.

The management of *Naegleria fowleri* infection poses critical challenges and concerns. Owing to its extreme resemblance with meningitis, it is often misdiagnosed and wrongly treated for bacterial or viral infection,⁹ and the rapidly progressive nature of this protozoa further narrows the window of survival. The detection of this test cannot be done by ordinary lab techniques and requires advanced techniques like PCR, which are sometimes expensive and difficult to find in far-flung areas. Further, Pakistan has an underdeveloped healthcare infrastructure, with limited access to resources along with financial constraints. Thus, due to poor reporting and a lack of facilities, many cases of PAM go undetected and unreported in Pakistan, thus compromising the true extent of the disease. Additionally, effective treatment for PAM, with different antimicrobials including Amphotericin B, Fluconazole, Rifampin, Dexamethasone, and Miltefosine relies on the early diagnosis of the infection. Despite several trials, there is no medically approved vaccine available for this pathogen, posing a significant challenge to immune individuals against this deadly pathogen. The researchers hypothesize that the *N. fowleri* strain present in Pakistan has acquired resistance to saline water or is different from strains reported in the rest of the world, further posing a serious challenge for its effective management. Adequate chlorination of water is the crucial step for preventing this outbreak, the chlorination level of Karachi's municipal water supply has failed to meet the WHO's recommended threshold of 0.5ppm². This shortfall in chlorination is a concerning factor in fostering the spread of this infection, not just in Karachi but in other cities of Pakistan as well.

Despite the challenges faced in the management of *N. fowleri*, one of the major challenges is the quality of drinking water in Karachi. Karachi, a metropolitan city, has been the victim of many waterborne disease outbreaks owing to its contaminated water supply. It has been reported that over 70% of the households in Pakistan drink bacterially contaminated water. A study reported 20%, 43%, and 23% of human adenovirus, enteroviruses,

and rotaviruses in tap water samples in Karachi, with no sample free of bacterial contamination, indicating an alarming situation for the residents of Karachi.¹⁰ Unsafe drinking water accounts for 50% of all diseases and 40% of the mortalities in the country, posing a significant threat to the public health system, further compromised by scarce water supply, lack of proper sanitation, and the leakage in sewage pipelines leading to infiltration of sewage into the drinking water, creating a possible reservoir for *Naegleria fowleri* and setting the stage for various other waterborne diseases like diarrhoea, cholera, and typhoid infections. However, the Karachi Water and Sewerage Board (KWSB) has started adding chlorine to the water, as the standard set by the World Health Organization (WHO), to inhibit the growth of organisms in tap water.⁷ but the provision of chlorinated water supply to all the areas in the city to combat *Naegleria* in such settings is far from reach. Nevertheless, the city still lacks proper monitoring of water quality and surveillance and future planning for the provision of a safe and abundant water supply.

Pakistan, a developing nation, grappling with restricted infrastructure and healthcare resources has faced a cascade of outbreaks in the past. In addition to the staggering count of 335 cases of XDR typhoid reported in the southern province of Sindh in 2023, epidemiologically, Pakistan is classified as a moderate malaria-endemic country, with 43, 587 confirmed cases as of May 2023. Further, the sudden spike in diarrhoea to 372 cases within 10 days in July, along with the rise in cholera cases points to the graving situation of the current water quality in Karachi.

While battling to find an effective treatment for PAM, the occurrence of the resistant strain of *Naegleria* can pose an enormous strain on the country's healthcare system. It is critical to enhance the monitoring and surveillance system of drinking water quality in the country that regularly tests and analyzes samples from various sources across the country. Awareness drives should emphasize the importance of clean, safe water and the use of boiled water for ablution should be promoted. The condition of the water pipelines should be assessed for leakage and prompt measures should be taken to prevent sewage water from contaminating the pipelines of drinking water. The relevant authorities should invest in upgrading the infrastructure improving the water quality standards and ensuring proper levels of chlorination in the water supply. Lastly, future trials should focus on the development of more effective drugs and vaccines to reduce the mortality rate caused by PAM.

In short, the recent surge of *Naegleria fowleri* and other water-borne diseases highlights the pressing need for improving water management and quality

control measures. Collective efforts of the government, organizations, and the community are promptly needed to improve water quality and mitigate the risks of *Naegleria* and other water-borne diseases.

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