



## Knowledge of Nursing Students Regarding Brain Eating Amoeba: A Cross-Sectional Study

**Author Names:** Amrita A. Sivasanker PhD, RN<sup>1</sup>, Kanika\* PhD, RN<sup>2</sup>, Jigyasha Sharma MHN, RN<sup>3</sup>, Neha Brari OBG, RN<sup>4</sup>, Soumya Rajeswari Khuntia CHN, RN<sup>5</sup>, Alka Guleria MSN, RN<sup>6</sup>

<sup>1</sup> Professor, Sharda School of Nursing Science and Research, Sharda University

<sup>2,3,6</sup> Chitkara School of Health Sciences and Centre for Evidence Based practice in healthcare, Chitkara University, Punjab

<sup>4</sup> Associate Professor, Sharda School of Nursing Science and Research, Sharda University

<sup>5</sup> Senior Tutor, Sharda School of Nursing Science and Research, Sharda University

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### ABSTRACT:

**Introduction:** *Naegleria fowleri*, referred to as the brain-eating amoeba, is a thermophilic protozoan responsible for primary amoebic meningoencephalitis (PAM), an uncommon yet exceedingly lethal infection. The rising exposure to warm freshwater bodies and environmental conditions in Asian regions, particularly northern India, poses a considerable risk of illness. Awareness among healthcare practitioners, especially nursing students, is essential for early detection and prevention.

**Objectives:** This study aimed to evaluate nursing students' knowledge and awareness of *N. fowleri*, including its epidemiology, clinical presentation, diagnosis, and treatment.

**Methods:** A cross-sectional study was performed including 319 nursing students from a designated institution in northern India, utilising a structured and validated questionnaire. The instrument evaluated general awareness, symptoms, diagnostic techniques, and management of *N. fowleri*. Descriptive and inferential statistics were applied and the data were analysed with SPSS version 25.0.

**Results:** Approximately 49.8% of nursing students exhibited good knowledge, whereas 35.4% possessed average knowledge, and 14.7% shown inadequate understanding. Students demonstrated heightened awareness of general information (70.5%) and symptoms (74%) in contrast to diagnosis (48.9%) and management (42.9%). Knowledge scores had a significant correlation with gender ( $p=0.035$ ), year of study ( $p<0.001$ ), and swimming practices ( $p=0.013$ ). Although knowledge levels are quite high, substantial deficiencies were observed in essential areas, including diagnostic and treatment methods.

**Conclusions:** The study emphasises the urgency and necessity for focused educational initiatives to improve nursing students' comprehension of *N. fowleri* infection. Integrating rare yet significant illnesses such as PAM into the nursing curriculum and promoting awareness through seminars and clinical exposure is advised to reduce morbidity and mortality linked to this fatal infection.

### 1. Introduction

*Naegleria fowleri*, sometimes termed the "brain-eating amoeba," is a free-living, thermophilic protozoan responsible for an uncommon yet inevitably lethal infection called primary amoebic meningoencephalitis (PAM).<sup>[1]</sup> The amoeba is generally located in warm freshwater habitats, including lakes, rivers, and hot springs, where it flourishes at temperatures reaching 45°C. With the exception of Antarctica, nearly every continent has been found to harbor *N. fowleri*, indicating its widespread distribution.<sup>[2]</sup> The WHO has identified PAM as the second leading cause of morbidity and mortality globally. PAM incidents have been documented in numerous countries, including the United States, Australia, Hong Kong, Thailand,

Taiwan, and China, linked to recent activities including swimming in warm waters or direct contact with polluted tap water.<sup>[3]</sup>

Within a span of 7 – 10 days of acute fulminating infection which is caused by the parasite, Primary Amoebic Meningoencephalitis (PAM). Infection transpires when water harbouring *N. fowleri* forcibly infiltrates the nasal passages, frequently throughout swimming or diving endeavours. The amoeba traverses the olfactory nerve to the brain, resulting in necrotising hemorrhagic meningoencephalitis.<sup>[4]</sup>

Most susceptible population are children and immunocompromised people especially after history of contact with infected water body with



amoeba. As, the illness is rare the mortality rate is 98%. Only early identification can improve the prognosis to some extent. But little is known about the pathophysiology of the illness because of low morbidity. Frequently, the cases of PAM are unreported or confused for bacterial or viral disease for its non-specific symptoms.<sup>[5]</sup> Prolonged delays in precise diagnosis and therapy significantly deteriorate patient outcomes.<sup>[4]</sup>

The clinical signs of PAM closely resemble those of acute bacterial meningitis, complicating the differentiation between PAM and other forms of bacterial meningitis. The consequent delayed diagnosis of PAM is a primary factor contributing to elevated mortality rates. Encephalopathic patients exhibiting a triad of symptoms—fever, nausea, and a low ESR—should be promptly referred for a lumbar puncture to get a verified diagnosis.<sup>[6]</sup>

While *Naegleria* is a widely acknowledged disease in many developed nations, the incidence of infections caused by *Naegleria* species remains largely undocumented in much of Asia. Over 150 confirmed cases of PAM have been recorded from Asia, predominantly from southern Asia, including Pakistan, India, and Thailand.<sup>[7]</sup> In Asian nations, where numerous areas encounter warm weather and possess plentiful freshwater resources utilised for recreational or ritualistic activities, there exists a possible risk of exposure to *N. fowleri*.<sup>[8]</sup> So far, India has documented only 17 instances of PAM, out of which, seven were effectively treated.<sup>[9]</sup>

Northern India is a warm area with temperature exceedingly more than 45-50 degree Celsius easily in summers. It poses a threat to residents where people often go for swimming in public pools, open ponds etc. Nursing students, a vital component of the future healthcare profession, require comprehensive understanding of the epidemiology, clinical characteristics, and preventative measures for *N. fowleri* infection.

A knowledgeable nursing community can mitigate morbidity and death by identifying early illness indicators and executing preventive strategies.<sup>[10]</sup>

Furthermore, awareness initiatives and comprehensive nursing curriculum that focus on rare but deadly infections are essential for enhancing public health outcomes. Nevertheless, there is a paucity of evidence regarding nursing students' comprehension of PAM, especially in areas where environmental and climatic conditions may heighten the risk of infection. Little knowledge and awareness about this disease in the public makes the diagnosing and treatment quite difficult for healthcare workers.

## 2. Objectives

Thus, this study aims to assess the knowledge of emerging healthcare professionals- nursing students related to *N. fowleri* infection, its spread, diagnosis as well as treatment especially in northern region of the country. Results from this study may guide curriculum creation and specialised training initiatives that tackle significant deficiencies in knowledge and practice.

## 3. Methods

A quantitative research approach with cross sectional study design was selected and the data was collected during September- November 2024. Nursing students studying in selected educational institution of northern India were selected using convenience sampling technique. A total of 350 survey questionnaires were disseminated, of which 319 students completed the survey. The inclusion criteria comprised nursing students who were present during data collection and consented to participate in the study. Questionnaires that were incomplete were omitted from the study.

A self-structured knowledge questionnaire was used to collect the data in the study. The survey comprises two sections. The initial section pertains to the socio-demographic factors of the study participants and has 10 questions.

The second section of the tool was a structured, validated (CVI=0.86) knowledge questionnaire having 22 questions related to general awareness about *N.fowleri* (*seven questions*), signs and symptoms related to *N.fowleri* (*five questions*),



diagnosis of *N.fowleri* infection (four questions) and management of *N.fowleri* infection (six questions). The reliability of the tool was calculated by test-retest method and was found to be reliable ( $r=0.82$ ). A google form was created and was circulated to the students after obtaining their consent.

The ethical consideration was also sought and the study was approved (CU/PB/CSHS/DON/RC/2024-2025/007).

The analysis was conducted with SPSS version 25.0. Descriptive and inferential statistics were employed for the analysis.

#### 4. Results

**Table 1: Demographic Information of students**  
N=319

S. No.	Variable	f(%)
<b>1. Age (in years)</b>	17-22	<b>308 (96.55)</b>
	23-28	<b>8 (2.50)</b>
	>28	<b>3 (0.95)</b>
	<b>2. Gender</b>	
	Female	<b>241 (75.50)</b>
	Male	<b>78 (24.50)</b>
<b>3. Programme of Study</b>	B.Sc. Nursing	<b>312 (97.80)</b>
	Post Basic B.Sc. Nursing	<b>4 (1.30)</b>
	M.Sc. Nursing	<b>2 (0.60)</b>
	GNM	<b>1 (0.30)</b>
<b>4. Year of Study</b>	1 <sup>st</sup>	<b>68 (21.3)</b>
	2 <sup>nd</sup>	<b>193 (60.50)</b>
	3 <sup>rd</sup>	<b>37 (11.6)</b>
	4 <sup>th</sup>	<b>21 (6.6)</b>
<b>5. Area of residence</b>	Home	<b>137 (42.90)</b>
	Hostel	<b>124 (38.90)</b>
	Other	<b>27 (8.50)</b>
	PG	<b>31 (9.70)</b>

#### 6. Presence of any stagnant water body around your residence

Yes **57 (17.90)**  
No **262 (82.10)**

#### 7. Do you go for swimming?

No **235 (73.70)**  
Sometimes **58 (18.20)**  
Yes **26 (8.20)**

#### 8. Attended any lectures or workshops on parasitic infections?

Yes  
No

A total of 319 respondents participated in the survey, primarily in the age group of 17-22 years (96.55), with a very few in the age group of 23-28 (2.5). There were a total of 75.5% female participants and 24.5% male participants, indicating a notable gender skew. The majority of participants were enrolled in B.Sc. Nursing (97.8%). The distribution of study years indicated that 60.5% of participants were in their 2nd year, followed by those in the 1st, 3rd, and 4th years, respectively. Approximately 43% of the students lived at home, 39% in hostels, while some occupied PG or alternative accommodations. Furthermore, 17.9% indicated the presence of stagnant water near their residence, which could be pertinent for the analysis of environmental risk factors. (Table 1)

**Table 2: Knowledge of Naegleria fowleri Infection among students**

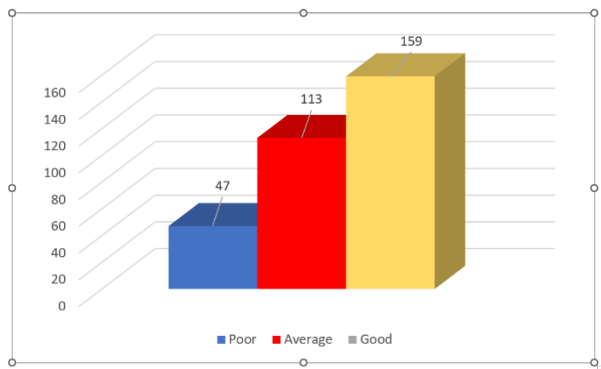
N=319			
Variable	Rang	f(%)	Mean ±SD
Knowledge	Poor	0-7	47 (14.70)
	Average	8-14	113 (35.40)



<b>Good</b>	15-	159
	22	(49.80)

<b>Diagnosis</b>	0-2	163 (51.10)
	3-4	156 (48.90)
<b>Management</b>	0-3	182 (57.05)
	4-6	137 (42.95)

The data given in the **Table 2** and **Figure 1** depicts that nearly 49.8% of the students had good knowledge followed by average (35.4%) and poor (14.7%) with a mean knowledge score of  $13.85 \pm 5.26$ . This pattern of distribution reveals that although a significant number of participants possess sufficient awareness, a considerable segment still necessitates further education regarding the infection.



**Figure 1. Knowledge of Naegleria fowleri Infection among students**

Most of the students had greater awareness regarding the general information (70.53%) and signs and symptoms (74%) of Naegleria fowleri infection whereas less understanding was observed in the areas of diagnosis and management, thereby highlighting the necessity for increased emphasis on these essential areas in educational interventions. (Table 3)

**Table 3: Area-wise knowledge of Naegleria fowleri Infection among students**

N=319		
Area	Range of Score	f(%)
<b>General Awareness</b>	0-3	94 (29.47)
<b>Symptoms</b>	4-7	225 (70.53)
	0-2	83 (26.00)
	3-5	236 (74.00)

The knowledge scores of the students were significantly associated with their gender [ $X^2 = 6.721$ ; p-value=0.035]; programme [ $X^2 = 23.121$ ; p-value=0.03] and year of study [ $X^2 = 47.171$ ; p-value=0.000] and swimming habits [ $X^2 = 12.632$ ; p-value=0.013]. (Table 4)

**Table 4: Factors associated with Knowledge of students**

N=319						
S. No.	Variab le	Level of knowledge	Chi square value	d f	p value	
	<b>Age (in years)</b>	<b>Po or</b>	<b>Aver age</b>	<b>Go od</b>		
	17-22	43	111	15	<b>5.0</b>	<b>4 2.8</b>
	23-28	3	1	4	<b>33</b>	<b>4</b>
	>28	1	1	1		
	<b>Gende r</b>					
	Female	30	82	12	<b>6.7</b>	<b>2 0.0</b>
	Male	17	31	30	<b>21</b>	<b>35*</b>
	<b>Progra mme of Study</b>					
	B.Sc. Nursin g	44	111	15	<b>23.</b>	<b>8 0.0</b>
	Post Basic B.Sc. Nursin g			7	<b>121</b>	<b>3*</b>
	M.Sc. Nursin g	3	1	0		
		0	0	2		



S. No.	Variable	Level of knowledge	of	Chi square value	d f	p-value
	<b>Year of Study</b>					
	1 <sup>st</sup>	3	11	54	<b>47.1</b>	<b>0.00*</b>
	2 <sup>nd</sup>	34	76	83	<b>171.0</b>	<b>0.00*</b>
	3 <sup>rd</sup>	7	20	10		
	4 <sup>th</sup>	3	6	12		
	<b>Area of residence</b>					
	Home	19	43	75	<b>8.06</b>	<b>0.237</b>
	Hostel	16	47	61	<b>08</b>	<b>37</b>
	Other	8	10	9		
	PG	4	13	14		
	<b>Presence of stagnant water around your residence</b>					
	Yes	9	25	23	<b>2.709</b>	<b>0.259</b>
	No	38	88	13	<b>09</b>	<b>59</b>
	<b>Do you go for swimming?</b>					
	No	29	77	12	<b>12.9</b>	<b>0.013*</b>
	Sometimes	10	25	23		
	Yes	8	11	7		
	<b>Attended any lectures or</b>					

S. No.	Variable	Level of knowledge	of	Chi square value	d f	p-value
	<b>works on parasitic infections?</b>					
	Yes	14	31	43	<b>0.12</b>	<b>0.933</b>
	No	33	82	11	<b>39</b>	<b>33</b>
				6		

## 5. Discussion

The study results showed that female participants exhibited markedly superior knowledge scores compared to their male counterparts, aligning with prior research that suggests females in healthcare professions typically have enhanced awareness of infectious diseases. Other studies have also revealed that female nursing students demonstrated superior awareness and knowledge of infection control measures relative to male students.<sup>[11,12]</sup>

Further, a notable correlation between the nursing program, particularly the B.Sc. Nursing, and enhanced knowledge aligns with findings from analogous studies, which indicate that students in more demanding or clinically focused programs exhibit superior comprehension of infection-related material. **Silvia Rossini et al. (2021)** observed that B.Sc. Nursing students, owing to a more comprehensive curriculum on infectious diseases, generally get higher knowledge scores compared to students in less rigorous programs such as General Nursing and Midwifery.<sup>[13]</sup> A significant association of knowledge and students' academic year corresponds with findings by **Tayade & Latti (2021)**, which indicate that clinical exposure and advanced coursework considerably enhance knowledge over time, with senior students exhibiting better comprehension of infectious disease material due to augmented training.<sup>[14]</sup>

The gender distribution in the present study shows a significant predominance of female participants



(75.5%) compared to males (24.5%). These findings contradict with the study conducted by **Younus et al. (2023)** with males comprising 41.3% and females 58.8%.<sup>[15]</sup> The results of the present study emphasise that nearly 49.8% of the students possessed good knowledge about *Naegleria fowleri*. This indicates a relatively favorable level of awareness within the student population, potentially due to their access to formal education or targeted awareness programs. In contrast, the study conducted in Karachi, Pakistan revealed that a significant majority (78.5%) of the general population had never heard of *N. fowleri*.<sup>[15]</sup>

#### Domain-Specific Knowledge Deficiencies

Consistent with this study's findings, previous literature suggests that healthcare students typically exhibit a strong foundational awareness however possess insufficient expertise in certain domains such as diagnosis and management. **Ghasemi MR (2020)** observed that the nursing students often possess a strong comprehension of symptoms but exhibit limited knowledge regarding the clinical management of diseases, implying a need for more focused teaching in these areas.<sup>[16]</sup>

A significant association of awareness levels of students with their swimming practices aligns with research carried out on aquatic illness, in which the behaviours associated with the risk of exposures correspond with level of awareness regarding the infection. The present study revealed that non-swimmers exhibited more awareness, maybe indicating an increased vigilance regarding infections among those who refrain from water exposure. A study finding revealed that those who avoided high-risk activities exhibited enhanced infection awareness, which the authors linked to proactive avoidance behaviour.<sup>[16]</sup>

The study revealed no substantial difference in infection knowledge between those who attended seminars/workshops and those who did not, contrary to previous studies that indicated a positive effect of workshops. This outcome corresponds with the observations of **Robertson B et al. (2020)**, who indicated that lecture-only formats may be deficient in the involvement required to significantly enhance knowledge levels.<sup>[17]</sup> The authors determined that interactive or experiential learning approaches frequently enhance information retention and understanding.

#### Conclusion

The study concludes that less than half of the nursing students possess good level of knowledge regarding brain amoeba and this paves the way for future researches in this area and also to develop and administer specific educational interventions to improve the awareness of students about this infection.

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