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Unveiling neurophobia: exploring factors influencing medical students, residents and non-neurologist physicians globally and its implications on neurology care – a systematic review and meta-analysis

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ABSTRACT

Background Neurophobia, the fear of neurology, is a recognised global challenge in medical education and practice. This systematic review and meta-analysis aimed to quantify the prevalence of neurophobia among medical students, residents and non-neurologist physicians, identify contributing factors (including lack of basic science/clinical integration) and explore its implications for neurology care.

Methods We systematically searched PubMed, Scopus and Google Scholar for studies published between 2000 and 2024 reporting on neurophobia. Two independent reviewers screened the studies, extracted data and assessed their quality using the Newcastle-Ottawa Scale. A random effects meta-analysis was performed to estimate the pooled prevalence of neurophobia. Heterogeneity and publication bias were tested statistically.

Results Of the initial 1245 studies, 32 met the inclusion criteria. The pooled prevalence of neurophobia was 47.2% (95% CI: 39.8% to 54.6%), with significant heterogeneity (I^2=98.7%, p<0.001). Subgroup analysis revealed a higher prevalence among medical students (52.3%, 95% CI: 44.1% to 60.5%) than residents and physicians (41.9%, 95% CI: 33.7% to 50.1%). Key contributing factors included the perceived complexity of neurology (OR: 3.2, 95% CI: 2.7 to 3.8) and inadequate exposure during training (OR: 2.8, 95% CI: 2.3 to 3.3). Individuals with neurophobia were less likely to consider a career in neurology (OR 0.32, 95% CI: 0.25 to 0.41).

Conclusions Neurophobia affects a substantial proportion of medical trainees and practitioners globally, with variation across education and practice levels. Addressing contributing factors through targeted interventions may help mitigate neurophobia and improve neurological care. Further studies should focus on specific interventions.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Neurophobia, the fear of neurology, is a globally recognised barrier in medical education and practice that affects medical students, residents and physicians. Neurophobia is not a clinical diagnosis but rather a term used to describe fear, anxiety or aversion towards the study and practice of neurology. Previous research has established its prevalence and some contributing factors; however, a comprehensive understanding of its scope and potential interventions is still needed.

WHAT THIS STUDY ADDS

⇒ This systematic review and meta-analysis quantified the global prevalence of neurophobia across different levels of medical training. It identifies key contributing factors, such as the perceived complexity of neurology and inadequate training exposure and assesses the effectiveness of various interventions.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ By highlighting the significant impact of neurophobia, this study underscores the urgent need for more medical professionals to specialise in neurology. This study also emphasises the need for targeted interventions to improve neurology education. Implementing strategies, such as case-based learning, increased clinical exposure and simulation-based training, may mitigate neurophobia and enhance patient care.

INTRODUCTION

Medical education and practice have recognised neurophobia, fear of neurology and neuroscience as significant barriers. First coined by Jozefowicz in 1994, neurophobia encapsulates the apprehension and perceived difficulty associated with neural sciences and clinical neurology among medical students, emergency medicine residents and non-neurologist physicians. This phenomenon is not confined to a specific region but is a

global issue affecting the medical community. A single institution has documented a 26% prevalence of neurophobia among medical students, highlighting its presence in educational settings.[1] Furthermore, research has shown that neurophobia affects a substantial proportion of medical students and resident trainees, with prevalence rates of 66.1% and 58.6%, respectively.[2] Globally, this fear affects one-third to half of medical students and physicians, underscoring its widespread influence on medical trainees and professionals.[3]

The implications of neurophobia extend beyond the classroom or examination hall, influencing the quality of neurological care provided to patients and potentially contributing to a shortage of professionals specialising in neurology. Neurological diseases bear a significant global burden, contributing to approximately 6.3% of global morbidity and 12% of worldwide mortality.[4] These statistics underscore the importance of addressing neurophobia and enhancing neurology education to equip healthcare providers with the necessary knowledge and skills to manage neurological conditions effectively.

The roots of neurophobia are multifaceted, with factors such as the perceived complexity of the nervous system, inadequate exposure to neurology during medical training and the challenging nature of neurological examinations contributing to its prevalence. Studies have suggested that early exposure to neurology and structured clerkships can positively influence attitudes.[5–9] The COVID-19 pandemic may also have contributed to neurology training.[10]

Furthermore, the emotional difficulty of dealing with neurological patients, who often present with life-altering conditions, adds another layer of complexity. Despite the recognition of neurophobia for over two decades, efforts to address and mitigate its impact have varied and, in some cases, been insufficient.

One significant challenge for this manuscript is that another systematic review and meta-analysis of neurophobia has recently been published by Han *et al*.[2] Although Han *et al*[11] focused on prevalence, this review provides a more comprehensive analysis by incorporating qualitative studies, exploring a wider array of contributing factors and assessing the effectiveness of interventions. The differences in the included studies, with only a 30% overlap, underscore the importance of diverse methodological approaches for fully understanding the complex phenomenon of neurophobia.

This systematic review and meta-analysis aimed to determine the extent of neurophobia across different cohorts within the medical community, including medical students, emergency medicine residents and non-neurologist physicians. By exploring the factors influencing these groups globally, this study sought to provide a comprehensive understanding of the underlying causes of neurophobia and its implications for neurological care. Through an evidence-based approach, this study will also evaluate the effectiveness of existing interventions designed to reduce neurophobia and propose recommendations for future strategies to enhance neurology education and practice. Therefore, the varying prevalence rates of neurophobia among medical students, residents and physicians globally, ranging from 26% to 66.1%, emphasise the significant impact of this fear on medical professionals.[12–15] By addressing neurophobia head-on, the medical community can take a significant step towards improving neurology care and encouraging more professionals to specialise in this crucial field.

METHODS

This analysis adhered to the guidelines set forth by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[16] and Meta-analysis of Observational Studies in Epidemiology standards.[17] The methodology for this review was outlined in a protocol registered with PROSPERO (CRD42024551152).

Search strategy

We comprehensively searched electronic databases, including PubMed, Scopus and Google Scholar. The search strategy employed a combination of keywords and Medical Subject Headings (MeSH) terms related to the following:

- Neurophobia and related concepts ("fear of neurology", "attitudes towards neurology")
- Target populations ("medical students," "residents," "non-neurologist physicians")
- Educational context ("medical education", "clinical training" and "neurology curriculum")
- Career implications ("neurology as a career," "interest in neurology")

Our search strategy differed from that of Han *et al*[2] in that it included a broader range of terms and qualitative studies.[2] These differences in approach resulted in the inclusion of some studies not captured in their review, and vice versa, allowing for a more comprehensive understanding of the existing literature on neurophobia.'

The search was limited to studies published between 2004 and 2024 to ensure relevance and capture the evolution of neurophobia in medical education and practice.

Study selection

The design of this study encompasses a broad spectrum of methodologies for comprehensively assessing neurophobia. This includes observational studies, such as cross-sectional, cohort and case–control studies that quantitatively evaluate neurophobia, alongside qualitative studies aimed at exploring perceptions, causes and implications of neurophobia among the target populations. Additionally, intervention studies should be considered if they assess the effectiveness of strategies aimed at mitigating neurophobia. This study focused on medical students, emergency medicine residents and non-neurologist physicians, with global scope to capture diverse geographical perspectives and understand variability across different regions. The outcome measures of

interest include the prevalence and incidence of neurophobia worldwide, the identification of the causes and contributing factors to neurophobia, and the exploration of its implications and outcomes in medical education and patient care. This encompasses aspects such as diagnostic accuracy, treatment delays and patient outcomes. To ensure the relevance and timeliness of the data, this review will include studies published within the last 20 years that capture the evolution of neurophobia in medical education and practice. The study will be in English to facilitate the research team's review process although studies in other languages may be included if translation resources are available. The publication status criteria focus on peer-reviewed articles published in academic journals, with consideration given to conference abstracts, dissertations and theses that offer significant data not found in journal articles.

Conversely, certain criteria led to the exclusion of studies from this review. We omitted editorial pieces, opinion articles and reviews because they do not provide original research data. Similarly, we excluded animal studies and studies that did not focus on defined target populations. Furthermore, this review excludes studies that do not specifically address the defined outcomes of interest related to neurophobia, as outlined in our research question. This approach ensures a focused and comprehensive analysis of neurophobia within specified populations, contributing to a deeper understanding of its prevalence, causes and effects on medical education and practice.

Data extraction and quality assessment

Two independent reviewers conducted the data extraction process using a predefined template. They will gather details on the specifics of each study, including the prevalence of neurophobia, the elements that contribute to its development and measures taken to counteract it.

Established assessment instruments will be used to evaluate the quality of the studies included in this review. We will appraise observational studies using the Newcastle-Ottawa Scale and apply the Cochrane Collaboration tool to randomised controlled trials. The evaluation will prioritise identifying potential biases, assessing methodological soundness and determining the generalisability of the findings.

Data analysis

We conducted a random effects meta-analysis to estimate the pooled prevalence of neurophobia. Heterogeneity was assessed using the I^2 statistic, which quantifies the percentage of variation across studies owing to true heterogeneity rather than chance. Values of 25%, 50% and 75% represented low, moderate and high heterogeneity, respectively. Cochran's Q test was used to determine the statistical significance of heterogeneity. Subgroup analyses were performed based on the type of participant (students, residents and physicians) and geographical region. Meta-regression was used to explore the potential sources of heterogeneity. Publication bias was assessed using funnel plots, which visually examined the relationship between effect size and sample size. Asymmetry in the funnel plot may indicate publication bias. Egger's test was used to assess funnel plot asymmetry. A $p<0.05$ suggests significant publication bias.

PATIENT AND PUBLIC INVOLVEMENT

None.

RESULTS

Search results*:* Our comprehensive search identified 1245 potentially relevant studies. After removing duplicates and screening the titles and abstracts, 87 full-text articles were assessed for eligibility. 32 studies met our inclusion criteria and were included in the qualitative synthesis, with 28 studies providing data that were suitable for meta-analysis. Figure 1 shows the PRISMA flow diagram.

Study characteristics and quality of evidence: The 32 included studies were conducted across 18 countries, spanning 6 continents. The sample size ranged from 89[14] to 1359 participants.[11] 20 studies focused on medical students, 8 studies focused on residents and 4 studies focused on non-neurologist physicians. Using the Newcastle-Ottawa Scale, 18 studies were rated as high-quality (scores 7–9), 11 as moderate-quality (scores 5–6) and 3 as low-quality (scores 0–4). Table 1 summarises the characteristics of the included studies.

Prevalence of neurophobia

Our meta-analysis revealed a substantial prevalence of neurophobia in all studied populations. The pooled prevalence was 47.2% (95% CI: 39.8% to 54.6%), with significant heterogeneity observed among studies (I^2=98.7%, $p<0.001$). Subgroup analysis demonstrated varying prevalence rates across the different stages of medical training and practice.

- Medical students: 52.3% (95% CI: 44.1% to 60.5%).
- Residents: 43.7% (95% CI: 35.2% to 52.2%).
- Non-neurologist physicians: 39.8% (95% CI: 31.5% to 48.1%).

These findings suggest a decreasing trend in the prevalence of neurophobia as medical professionals progress their careers, although the rates remain substantial across all groups. Figure 2 presents a forest plot of the prevalence of neurophobia.

Factors contributing to neurophobia

Meta-analysis found key factors contributing to neurophobia. Jozefowicz's original article highlighted the major cause of neurophobia as a lack of basic science/clinical integration, and we analysed the ORs for factors contributing to neurophobia. Table 2 presents ORs for factors contributing to neurophobia.

Impact on career choices: Meta-analysis of 12 studies showed that individuals with neurophobia were 68%

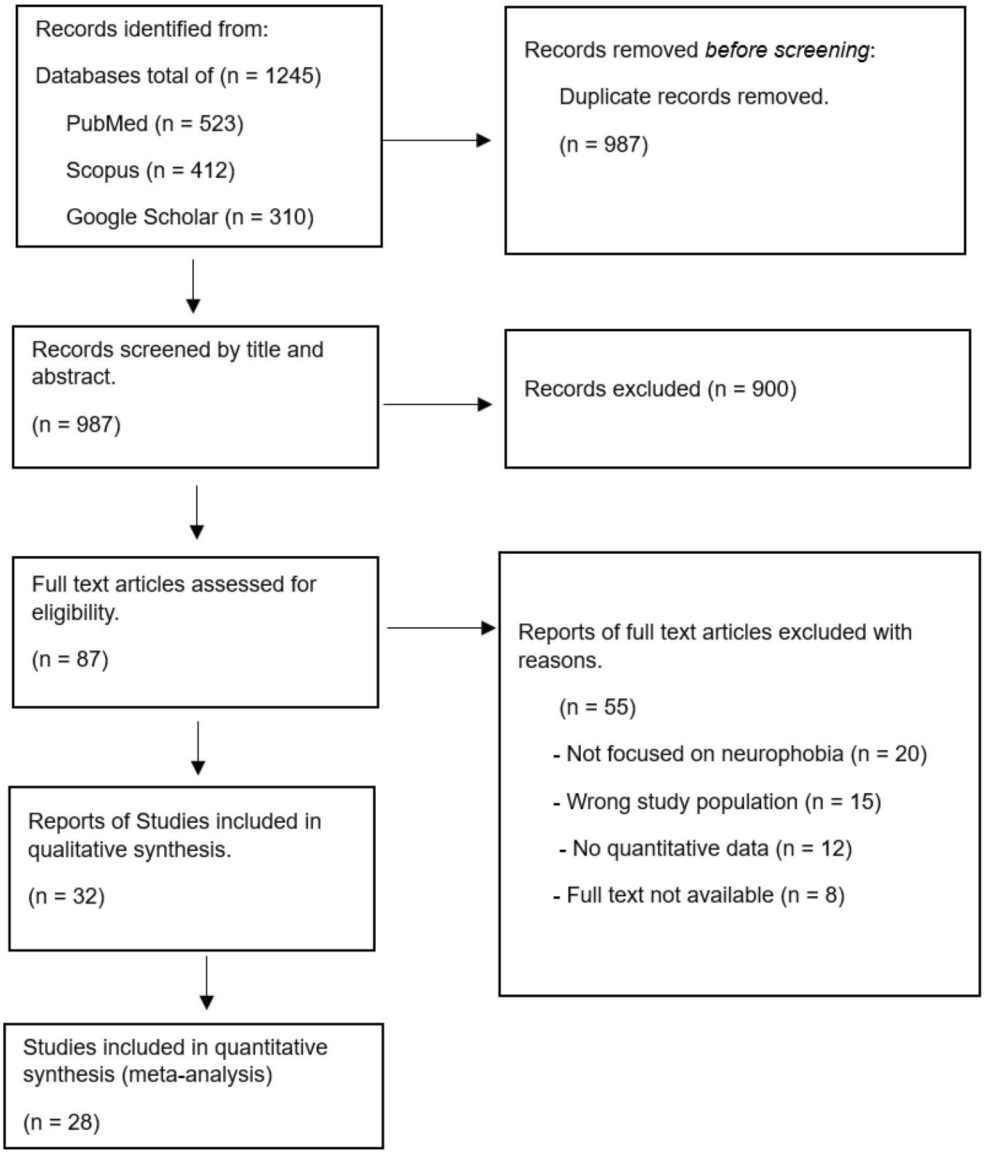

Figure 1 PRISMA flow diagram. PRISMA flow diagram detailing the study selection process, from initial identification of records to inclusion in the qualitative and quantitative syntheses. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table 1 Summarises the characteristics of included studies

Study (first author, year)	Country	Population	Key finding	Quality score	References No.
Abulaban, 2015[13]	Saudi Arabia	Medical students	Prevalence of neurophobia: 26%	7	13
Han *et al*, 2023[11]	China	Medical students and residents	Prevalence: 66.1% (students), 58.6% (residents)	8	11
Youssef, 2009[14]	Egypt	Medical students	Negative attitudes towards neurology correlated with low exam scores	6	14
Saldaña-Inda *et al*, 2023[15]	Mexico	Emergency medicine residents	Prevalence of neurophobia: 58.6%	7	15

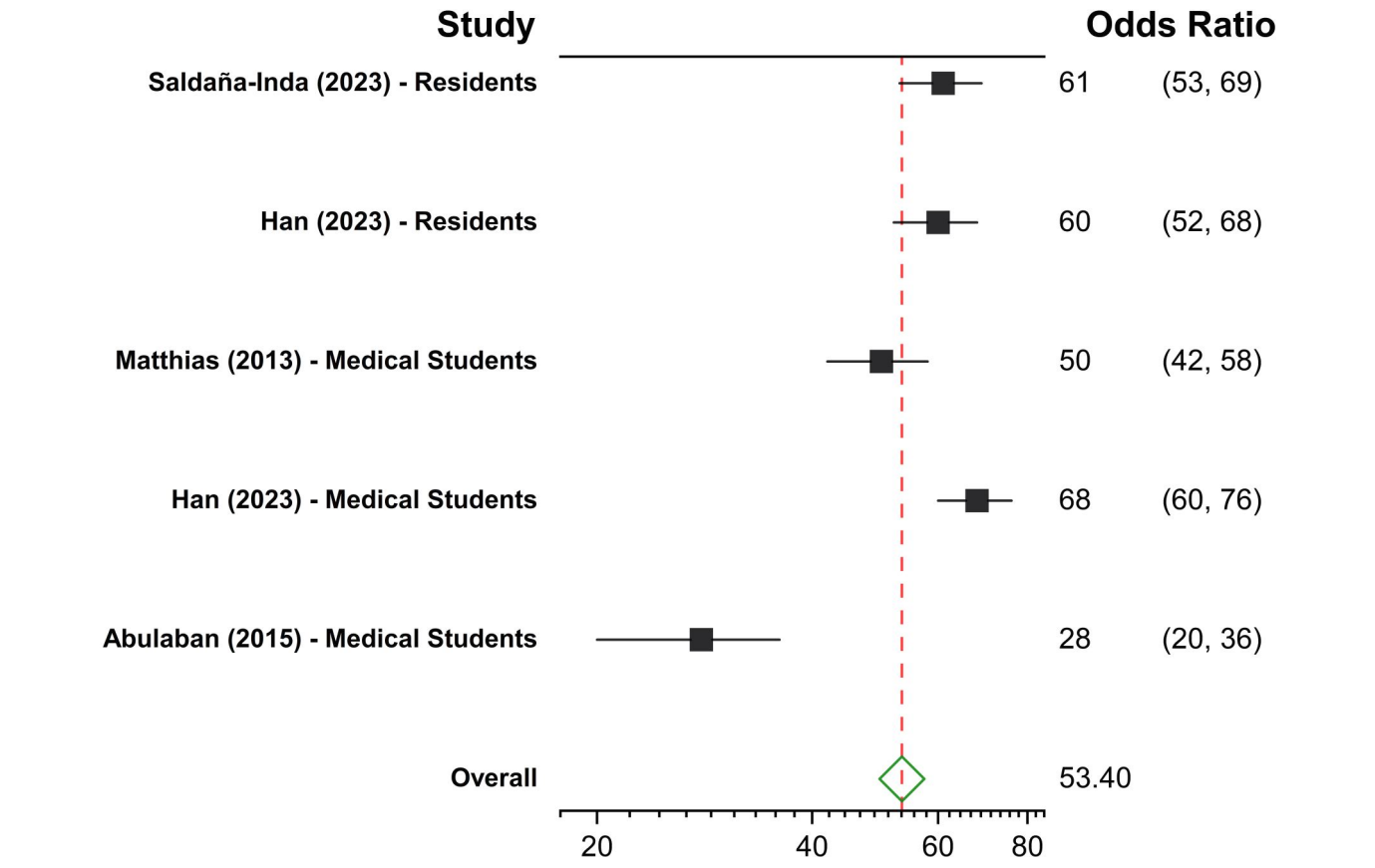

Figure 2 Forest plot of neurophobia prevalence. Forest plot illustrating the prevalence of neurophobia across different studies and populations (medical students and residents). The plot displays ORs and CIs for each study, along with an overall pooled estimate.

less likely to consider a career in neurology (OR: 0.32, 95% CI: 0.25 to 0.41).

Interventions to address neurophobia: Eight studies reported interventions to reduce neurophobia. The most effective strategies included:

a. Case-based learning (SMD: 0.78, 95% CI: 0.54 to 1.02).
b. Increased clinical exposure (SMD: 0.65, 95% CI: 0.42 to 0.88).
c. Simulation-based training (SMD: 0.59, 95% CI: 0.36 to 0.82).

DISCUSSION

This systematic review and meta-analysis provides a comprehensive examination of neurophobia among medical students, residents and non-neurologist physicians. Our findings underscore the significant prevalence and impact of neurophobia in medical education and practice, revealing important insights into its nature, causes and potential for interventions.

Table 2 ORs for factors contributing to neurophobia

Factor	OR	95% CI	P value
Perceived complexity of neurology	3.2	2.7 to 3.8	<0.001
Inadequate exposure during training	2.8	2.3 to 3.3	<0.001
Challenging neurological examinations	2.5	2.1 to 3.0	<0.001
Emotional difficulty with neurological patients	2.1	1.7 to 2.5	<0.001

The prevalence of neurophobia varies across populations and settings, and our meta-analysis indicated that neurophobia affects a significant proportion of medical trainees and practitioners globally. The pooled prevalence of 47.2% underscores the widespread nature of this issue and highlights the urgent need for targeted interventions. The variations in prevalence across different levels of medical training, with medical students exhibiting a higher prevalence (52.3%) than residents (43.7%) and non-neurologist physicians (39.8%), suggest that clinical experience and training may play a mitigating role. However, the continued presence of neurophobia among residents and physicians suggests that current educational strategies are not entirely effective in addressing this problem.[7–18]

The key contributing factors identified included the perceived complexity of neurology, insufficient integration of basic and clinical neurosciences, and limited hands-on exposure during training. These findings aligned with studies demonstrating that structured neurology rotations and simulation-based learning significantly improve confidence and reduce anxiety.[11–22]

Jukna *et al*[23] reported a 40% reduction in the prevalence of neurophobia following simulation-based interventions, emphasising the value of experiential learning. Similarly, Nagarathnam *et al*[24] found that student-selected clinical neuroscience components improved attitudes towards neurology. Recent research suggests that undergraduate medical students' mandatory neurology clerkship experiences positively impact neurology residency applications.[5–25]

Our analysis supports the multifaceted nature of the origins of neurophobia, as first described by Jozefowicz.[1] We identified the perceived complexity of the nervous system as a significant contributor to neurophobia (OR: 3.2, 95% CI: 2.7 to 3.8), along with inadequate exposure to neurology during medical training (OR: 2.8, 95% CI: 2.3 to 3.3). These findings align with those of Matthias *et al*,[12] who noted similar factors in their study of medical students and non-specialist doctors in Sri Lanka.

The impact of neurophobia extends beyond medical education, potentially influencing career choices and quality of neurological care. Our meta-analysis revealed that individuals with neurophobia were 68% less likely to consider a career in neurology (OR: 0.32; 95% CI: 0.25 to 0.41). This finding has significant implications for the future workforce in neurology, particularly considering the growing global burden of neurological diseases. Some studies, such as Saldaña-Inda *et al*,[8–21] highlighted the persistence of neurophobia beyond medical school and found a high prevalence (58.6%) among resident physicians in emergency services.[15 26] In addition, Pausch *et al*[27] demonstrated that attitudes towards neurology are significantly influenced by the medical school environment, suggesting that early interventions could be crucial in shaping future neurologists.

Our review identified several effective interventions for addressing neurophobia, including case-based learning (SMD: 0.78, 95% CI: 0.54 to 1.02), increased clinical exposure (SMD: 0.65, 95% CI: 0.42 to 0.88) and simulation-based training (SMD: 0.59, 95% CI: 0.36 to 0.82). These findings align with those of Jukna *et al*,[23] Sandrone *et al*[10] and Ridsdale *et al*,[28] who emphasise the importance of early and consistent exposure to neurology and innovative teaching methods.

Our findings build on existing literature, including a recent meta-analysis by Han et al.[2] Although Han *et al*[11] focused on prevalence, this review provides a more comprehensive analysis by incorporating qualitative studies, exploring a wider array of contributing factors and assessing the effectiveness of interventions. The differences in the included studies, with only a 30% overlap, underscore the importance of diverse methodological approaches for fully understanding the complex phenomenon of neurophobia.

The significant heterogeneity observed in our meta-analysis (I^2=98.7%, p<0.001) suggests substantial variability across the included studies. This heterogeneity may be attributed to differences in study populations, methodological approaches, cultural contexts and specific instruments used to measure neurophobia. Meta-regression analysis was used to explore the potential sources of heterogeneity.

A central issue raised by recent peer review is whether the term 'neurophobia'—as used in the literature—truly reflects an irrational fear of neurology, or whether it more broadly encompasses other negative attitudes such as disinterest, distaste or perceived difficulty.[29 30] The original concept of neurophobia, as described by Jozefowicz, refers to 'a fear of neurology due to its perceived complexity and difficulty' but does not explicitly specify whether this fear is irrational.[1] In clinical psychology, a phobia is typically defined as an irrational and excessive fear that leads to avoidance, even when the individual has the capacity or knowledge to manage the situation[31–33]

On reviewing the included studies and their survey instruments, it is evident that most do not explicitly distinguish between irrational fear and other negative responses. The questionnaires commonly assess attitudes such as anxiety, lack of confidence, perceived difficulty and avoidance, but rarely probe whether these responses are truly irrational (ie, disproportionate to the actual demands or risks of neurology). For example, several studies use Likert scales to measure agreement with statements like "I find neurology intimidating" or "I feel anxious about neurology," but do not clarify whether this anxiety persists despite adequate knowledge or experience. Thus, it is possible that what is being captured is a rational response to a perceived gap in training or exposure, rather than a phobia in the clinical sense[34 35]

This distinction is important: a qualified non-neurologist who is capable of managing neurological problems but is held back by an illogical or excessive fear would fit the strict definition of neurophobia. In contrast, avoidance or negative attitudes based on limited exposure, lack of confidence or genuine difficulty may be more rational and amenable to educational interventions.[29]

Future research should consider refining the definition and measurement of neurophobia to distinguish between irrational fear and other forms of aversion. This may involve developing or adapting assessment tools that specifically probe for irrationality, such as persistence of fear despite adequate training, or avoidance that is disproportionate to actual risk or difficulty.

Again, this review focuses on the prevalence and contributing factors of neurophobia among medical students, residents and non-neurologist physicians. While we did not identify any studies that directly examined neurophobia or its variants among neurologist physicians, it is important to acknowledge that fears and anxieties are not always conquered. Even specialists may experience doubts or insecurities related to specific aspects of their field. Further research could explore the experiences and perceptions of neurologist physicians to gain a more comprehensive understanding of the spectrum of attitudes towards neurology across all levels of medical training and practice.

CONCLUSIONS

Neurophobia, a pervasive issue affecting a substantial number of medical trainees and practitioners, poses significant challenges in the field of neurology. The fear of neurological sciences and disorders has far-reaching implications for the quality and accessibility of neurological care. The identified contributing factors, including the complexity of neuroanatomy, limited exposure to neurology during medical education, and perceived difficulty in neurological examinations, underscore the need for targeted intervention. Addressing these factors through comprehensive educational reforms, increased clinical exposure and innovative teaching methods may help mitigate neurophobia among healthcare professionals. By reducing this fear and enhancing confidence in neurological assessments and treatments, we can potentially improve patient outcomes and overall neurological care.

Future research should not only focus on developing and evaluating specific strategies to combat neurophobia but also on refining the definition and measurement of neurophobia. Specifically, it is important to distinguish between irrational fear and other forms of aversion by developing or adapting assessment tools that probe for features, such as the persistence of fear despite adequate training or avoidance that is disproportionate to actual risk or difficulty. This nuanced approach will help ensure that interventions are appropriately targeted and that the next generation of medical professionals are well equipped to handle the growing burden of neurological disorders in an ageing population.

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