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Prevalence of neurophobia among medical students and young doctors: a systematic review and meta-analysis

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Abstract

Background Neurophobia is a global phenomenon, that influences both medical students and postgraduate trainees. We aimed to analyze the prevalence of neurophobia by conducting a systematic review and meta-analysis of studies on neurophobia, and potential associated risk factors.

Methods The search was done in the PubMed, EMBASE, and Scopus databases for studies reporting neurophobia among medical students and young doctors for the period up to March 18, 2024. The overall prevalence and scores of four subcomponents of neurophobia were pooled. The potential heterogeneity was tested through meta-regression/subgroup analyses/influence analysis.

Results Twenty-four studies from 30 countries met the inclusion criteria and involved 10,395 responding individuals. The estimated overall pooled prevalence of neurophobia was 46% (95%CI, 35-57%; $I^2 = 98\%$). The result of the meta-regression revealed that geographic region was significantly associated with the prevalence ($p = 0.006$). The pooled scores of the four subcomponents of neurophobia were: difficulty 3.79 (95%CI, 3.47–4.12, $I^2 = 99\%$), confidence 2.81 (95%CI, 2.39–3.24, $I^2 = 99.5\%$), interest 3.22 (95%CI, 2.84–3.61, $I^2 = 99.6\%$), and knowledge 2.73 (95%CI, 2.39–3.06, $I^2 = 98.1\%$).

Conclusions Neurophobia was widely prevalent among medical students and young doctors. The high prevalence and severity highlight the need for targeted interventions to reduce neurophobia.

Keywords Systematic review, Meta-analysis, Neurophobia, Prevalence, Neurology education

Introduction

The term neurophobia was coined in 1994 by Ralph Jozefowicz to describe "a fear of the neural sciences and clinical neurology that is due to students' inability to apply their knowledge of basic sciences to clinical situations" [1]. The author claimed that 50% of medical students at some stage have neurophobia. Since the concept was introduced, multiple studies have reported on the prevalence and risk factors of neurophobia, while also attempting to explore potential solutions. Based on these studies, neurophobia seems to be a pervasive phenomenon, that influences medical students, residents, primary care

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physicians, and general practitioners. However, there are differences in the conclusions of these studies across different countries and regions, and there have not been studies to systematically summarize the prevalence of neurophobia among medical students and young doctors.

As the population ages, the burden of neurological diseases is intensifying. Neurophobia may play a role in choosing neurology as a career option, and contribute to a shortage of neurologists at a time when brain disorders have become major contributors to disability and death worldwide [2, 3]. A study in 2017 [4] revealed significant correlations between students' perceived knowledge in neurology, their self-confidence in diagnosing and managing neurological patients, and their likelihood of specializing in neurology. This confirms the link between neurophobia and the shortage of neurologists.

To address the gaps in the existing literature and to gain a global understanding of the current situation, this study undertakes a systematic review and meta-analysis to determine the prevalence of neurophobia among medical students and young doctors. By doing so, we aim to offer a more holistic view of neurophobia across a range of demographics and geographical regions. Additionally, we will delve into the associated risk factors and assess strategies to mitigate and potentially overcome neurophobia.

Methods

Ethics approval and informed consent were not applicable because all data used in this study were collected from previous published studies and anonymous. We followed the PRISMA 2020 guideline to report this study [5]. The protocol for this review was registered on PROSPERO.

Search strategy

We searched the terms, neurophobia, or neurophobic up to 18 March 2024 in the following databases: PubMed, EMBASE, and Scopus. The search strategy for all databases was provided in the supplementary material 1. We also screened the references of related publications to identify additional relevant studies. Two researchers (F.H. and D.Z.) searched the databases independently.

Eligibility criteria

The inclusion criteria of eligible studies were as follows: (1) studies investigating the population of medical students, interns, residents, junior doctors, primary care physicians, or family medicine trainees; (2) studies reporting neurophobia among the aforementioned population; (3) studies provided data on at least one of the following aspects: the prevalence of neurophobia, Likert scale ratings for at least one of the four dimensions of neurophobia: difficulty, confidence, interest, and knowledge [6], and (4) cross-sectional study designs.

Studies were excluded if they (1) were qualitative studies; (2) only reported the effectiveness of measures to reduce neurophobia; (3) were reviews, comments, editorials, notes, letters, replies, case reports, or books chapters.

Selection process

Endnote 20 (Clarivate PLC, Jersey, UK) was used to manage the records imported from each database. Duplicated publications were initially removed by the same DOI number and then verified manually. Studies were first screened by reviewing the titles and abstracts. The potentially eligible studies subsequently underwent full-text reviews. Two researchers (F.H. and D.Z) independently selected studies and any disagreement was discussed or considered by a third researcher (J.N.)

Data extraction

Study information was extracted, including author information, year of publication, study period, settings, centers, and survey response rate. The following information was extracted from the investigated population: specialty, level, total number of respondents, definition of neurophobia, number of neurophobia, the prevalence of neurophobia, quantitative scores of difficulty, confidence, interest and knowledge. We converted the scoring from the studies proportionally to the following Likert scale standards: Difficulty: 1=very easy, 2=quite easy, 3=moderate, 4=quite difficult, 5=very difficult; Confidence: 1=very uneasy, 2=uneasy, 3=averagely competent, 4=confident, 5=very confident; Knowledge: 1=little or none, 2=some, 3=moderate, 4=fair, 5=great; Interest: 1=little or no interest, 2=some interest, 3=moderate interest, 4=quite interested, 5=very interested. These standards clearly reflect the different ratings given by participants regarding the four dimensions of neurophobia, thereby facilitating further pooled analysis. Two researchers (F.H. and D.Z.) independently collected data and discussed disagreements.

Risk of bias assessment

Studies were evaluated for risk of bias by using a modified tool for prevalence studies as previously reported [7]. The tool consists of 10 items that address four domains of bias: selection bias, nonresponse bias, measurement bias, and bias related to analysis (supplementary material 2). The tool also includes a summary risk of bias assessment. The domains and items are designed to evaluate the external and internal validity of the studies included in systematic reviews on the prevalence study. When a checklist item was not reported or unclear, it was identified as high-risk. The risk of bias was graded as low (score 0–3), moderate (4–6) and high (7–10). Each study was independently assessed for bias by two researchers (F.H.

and D.Z.) and given a score out of nine. Discrepancies were discussed in consultation with a third researcher (J.N.).

Statistical analysis

The prevalence of neurophobia and the scores of four neurophobia subcomponents, difficulty, confidence, interest, and knowledge, were pooled and presented in a forest plot. The pooling model was a random effects model if $I^2 \geq 50\%$ (heterogeneity was significant); otherwise, a fixed-effects model was adopted. The pooled estimates of the outcomes are expressed as percentages or scores with 95% confidence intervals (CI). The subgroup analysis was performed based on whether the participants were undergraduate medical students or postgraduate doctors, the geographic region, the survey respondent rate, sample size, and the definition used to evaluate neurophobia. A meta-regression was conducted to determine if there were any independent risk factors for neurophobia. The difference was considered significant when a two-sided p value was less than 0.05. Sensitivity analysis was used to identify studies that significantly affected the overall effect. Influence analysis by leaving out one study at a time was performed to the pooled prevalence and scores to assess its robustness. Publication bias was assessed using funnel plots and Egger's regression tests when at least ten studies were included. All analyses were performed with the statistical software Stata 12.0.

Data availability

Data not provided in the article because of space limitations (such as raw statistical data) may be shared (anonymized) at the request of any qualified investigator for purposes of replicating procedures and results.

Results

Study selection

We identified a total of 430 records from PubMed ($n=104$), EMBASE ($n=202$), and Scopus ($n=124$). There were 238 duplicates removed. The remaining 192 records went through title and abstract reviews. A total of 164 records were excluded owing to the following reasons: reviews ($n=32$), letters ($n=6$), studies only on interventions ($n=53$), studies on neuroanatomy teaching ($n=32$), and studies on unrelated topics ($n=41$). Therefore, 28 records were considered eligible when evaluated by full-text reviews. Five records were excluded with reasons of insufficient data. One additional paper was found by screening the reference lists of the included studies. Ultimately, 24 studies were included in the current analysis (Fig. 1) [4, 6, 8–26]. Risk of bias was assessed as low in 18 studies, and moderate in the other 6 studies (supplementary material 2).

The selected studies were conducted in 30 countries (supplementary material 3), covering the period from 2002 to 2023. Nine studies were conducted in Europe [6, 8, 15, 17, 18, 23, 27–29], 7 studies in Asia [4, 12–14, 21, 25, 30], 4 studies in Latin America [16, 19, 20, 22], 2 in Africa [10, 24], 1 in the United States [11], and 1 in the Middle America [9]. A total of 10,395 medical students and postgraduate doctors completed a questionnaire regarding their perceptions of neurology and other specialties including cardiology, endocrinology, respiratory medicine, gastroenterology, geriatrics, nephrology, psychiatry, etc. The details of the 24 eligible studies have been summarized in Table 1 and supplementary material 4.

Respondent characteristics

Eleven of the included studies sampled medical students, five studies sampled postgraduate doctors, and eight studies sampled both medical students and postgraduate doctors. Sample sizes ranged from 41 to 2877. The median response rate was 68.4% (range: 7-100%). Twenty-three studies showed the specific number of medical students and postgraduate doctors, including undergraduate medical students ($n=6992$,76.3%), physiotherapy and rehabilitation students ($n=391$, 4.3%), and postgraduate doctors ($n=1779$, 19.4%). Among the 10,395 respondents, the mean ages range from 21 to 32 years (online suppl. material 4). Nine studies provided the number of males and females, with a pooled male percentage of 41% (95% CI 34%-48%, $I^2=96.7\%$).

Prevalence of neurophobia

Ten studies reported the prevalence of neurophobia (Table 1). In three studies, neurophobia was defined and calculated according to Kam et al. scores of items relating to difficulty and confidence (supplementary material 5) [12, 25, 27]. This measure varied from scores of 2 to 10, and neurophobia was defined as a score of ≤4 (i.e., low confidence and high difficulty). Three additional studies defined neurophobia in a less strict manner, characterizing it as a strong or relatively strong agreement that neurology is difficult, or the experience of fear towards neurology [21, 24, 29]. The other four did not give the exact definition [19, 22, 28, 30].

The included studies reported 1904 subjects of neurophobia. The estimated overall pooled prevalence was 46% (95% CI, 35-57%; $I^2=98\%$) (Fig. 2-A). Among medical students, the overall prevalence of neurophobia was 43% (95% CI, 20-65%; $I^2=99\%$), while among postgraduate doctors, it was 49% (95% CI, 32-65%; $I^2=99\%$) (Fig. 2-B). Figure 2-C showed according to the geographic area where the study was conducted (grouped by continents), the overall prevalence of neurophobia in studies from Asia was 54% (95% CI, 45-63%; $I^2=95.6\%$), from

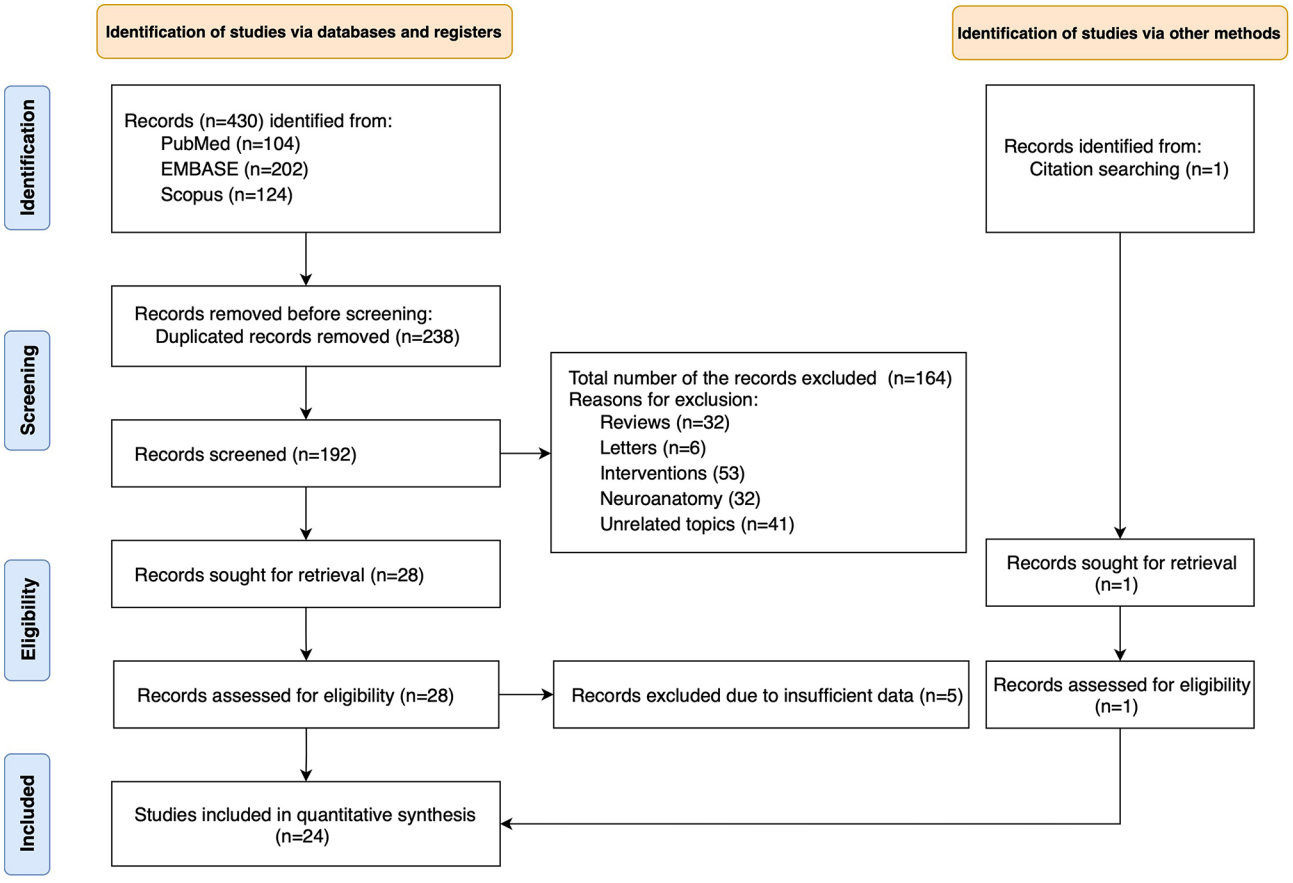

Fig. 1 PRISMA flow chart of study screening

Europe was 31% (95% CI, 25-38%; I^2=47.3%), from Latin America was 29% (95% CI, -17-76%; I^2=97.8%). Online supplementary material 6 showed the subgroup analysis separated by sample size (<100 and ≥100) and the survey response rate (<50% and ≥50%). The pooled prevalence was 54% (95% CI, 45-63%; I^2=89.5%) in only included studies [12, 25, 27] using the Kam [12] definition of neurophobia. The outcome of the meta-regression reflected that factors explaining the heterogeneity of neurophobia prevalence were the geographic region (β=-0.192, 95%CI -0.305 to -0.079, p=0.006) and sample size (β=-0.443, 95%CI -0.831 to -0.056, p=0.031) (supplementary material 7). Influence analysis revealed that the value was not significantly changed by omitting one study at a time (supplementary material 8). The results of Egger's linear regression test showed no evidence of publication bias for the prevalence of neurophobia (p=0.893).

Scores of subcomponents of neurophobia

Ten of the 24 studies reported scores of at least one of the four subcomponents of neurophobia. Most of them applied the Schon test [6] among its participants, which consists of four questions using the Likert scale with answer scores ranging from 1 to 5 to evaluate the perception of difficulty of neurology (n=8), the clinical confidence when treating patients with neurological complaints (n=7), the interest (n=5) and level of knowledge (n=8) in neurology.

Eight studies reported scores of perceived difficulty, with a pooled value of 3.79 (95%CI, 3.47–4.12, I^2=99%); seven studies reported scores of confidence, with a pooled value of 2.81 (95%CI, 2.39–3.24, I^2=99.5%); five studies reported scores of interest, with a pooled value of 3.22 (95%CI, 2.84–3.61, I^2=99.6%); eight studies reported scores of knowledge, with a pooled value of 2.73 (95%CI, 2.39–3.06, I^2=98.1%). The forest plots of scores for each subcomponent are presented in Fig. 3. Online supplementary material 9 to 12 presented the results of subgroup analysis for each subcomponent. The influence analysis showed that the heterogeneity of the pooled scores of the four subcomponents did not significantly change by leaving out a study (supplementary material 13 to 16). Publication bias analysis was not conducted because the number of studies to pool the overall effect was less than 10.

Table 1 The measure and prevalence of neurophobia of the included studies ($n = 24$)

Study	Setting	Participants	Response rate	No	Prevalence of neurophobia	Difficulty[a]		Confidence[a]		Interest[a]		Knowledge[a]	
						Mean	SE	Mean	SE	Mean	SE	Mean	SE
Schon 2002	United Kingdom	UG + PG		345		3.80		2.70		3.30		2.40	
Flanagan 2007	Ireland	UG + PG		457		4.00							
Youssef 2009	Trinidad & Tobago	UG	65%	167		3.89	0.07			2.56	0.01	2.32	0.08
Zinchuk 2010	United States	UG + PG	44%	152		3.70	0.10	2.60	0.10			2.70	0.10
Sanya 2010	Nigeria	UG	94%	302								2.40	
Kam 2013	Singapore	UG	63.50%	158	47.47%								
		PG	73.20%	131	36.64%								
		UG + PG	67.50%	289	42.56%								
Matthias 2013	Sri Lanka	UG	100%	148		3.46	0.06					2.53	0.06
		PG	98.70%	100		3.33	0.07					2.59	0.07
		UG + PG	99.20%	248						2.36	0.22		
Lukas 2014	China	UG	100%	41				2.98	0.01			2.78	0.94
Pakpoor 2014	United Kingdom	UG	7%	2877		3.47	0.02	2.96	0.02				
Zambrano 2015	Ecuador	UG	78.30%	401		4.01	0.05	3.01	0.06			2.96	0.06
Loftus 2016	United Kingdom	PG		76		4.04		2.33		3.43		3.07	
Lukas 2017	China	UG	94%	145				2.38	0.09			2.28	0.08
Midik 2017	Turkey	PG		384		2.82	0.07	3.80	0.02	2.83	0.02		
Morinigo 2017	Paraguay	PG		56	53.57%								
Santos 2018	Brazil	UG	55.10%	486		4.00		2.97		2.78		2.49	
Chua 2020	Malaysia	PG	69.20%	415	66.02%								
Diaz 2020	Peru	UG		112	6.25%								
McDonough 2022	15 countries of Africa	UG + PG		294	54.08%	4.60	0.06			4.46	0.07	3.85	0.06
Abasiyanik 2022	Turkey	UG		391		4[b]		3[b]		4[b]		3[b]	
Subir 2023	India	UG + PG		1227	42.05%								
Saldana 2023	Spain	PG		134	27.61%	4.00				3.50			
Han 2023	China	UG	72.20%	218	66.06%	4.30	0.05	2.25	0.05	3.47	0.07	2.63	0.05
		PG	71.90%	133	58.65%	4.32	0.06	2.51	0.08	3.68	0.08	2.63	0.08
		UG + PG	72.10%	351	63.25%								
Lambea 2023	Spain	UG	29.60%	320	34.06%	4.60		2.60		3.60			
Jukna 2023	Lithuania	UG	20.50%	725	58.90%								

UG, undergraduate; PG, postgraduate; SE, standard error

[a]Likert scale 1–5. Difficulty: 1 = very easy, 2 = quite easy, 3 = moderate, 4 = quite difficult, 5 = very difficult; Confidence: 1 = very uneasy, 2 = uneasy, 3 = averagely competent, 4 = confident, 5 = very confident; Interest: 1 = little or no interest, 2 = some interest, 3 = moderate interest, 4 = quite interested, 5 = very interested; Knowledge: 1 = little or none, 2 = some, 3 = moderate, 4 = fair, 5 = great

[b]Median was used

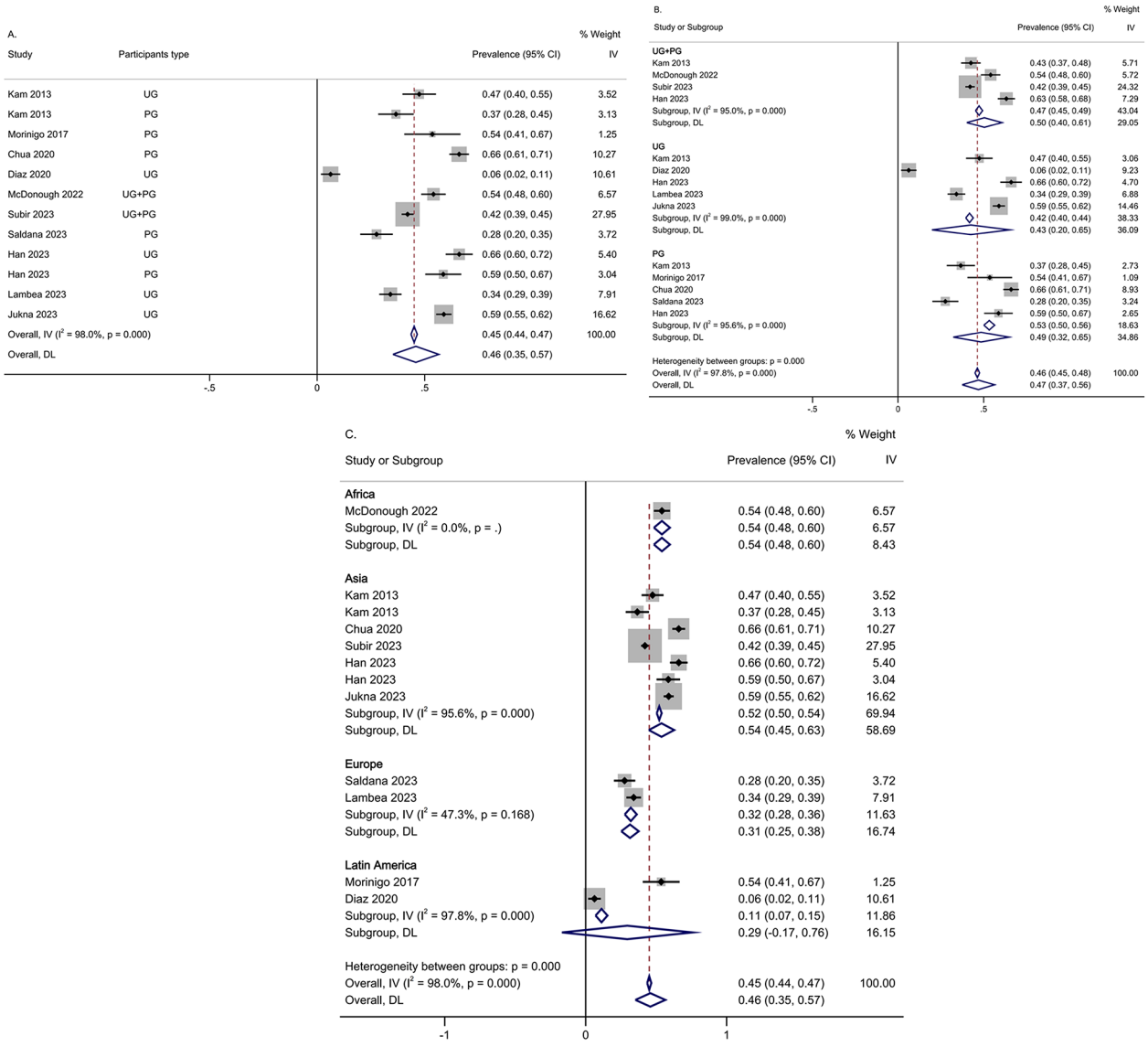

Fig. 2 (**A**) Forest plot of the overall prevalence of neurophobia. (**B**) Pooled prevalence of neurophobia related to type of participants. (**C**) Pooled prevalence of neurophobia related to geographic regions. UG, undergraduate; PG, postgraduate

Reasons of neurophobia

Sixteen studies reported the reasons participants found neurology a difficult subject, primarily obtained through responses to open-ended questions. There was a significant association of difficulty with complexity of neuroanatomy, the needs to know basic neuroscience, insufficient teaching, and limited exposure to neurological patients. Other relevant factors include the complex clinical examination, too many difficult and rare diagnoses, and the poor integration of preclinical and clinical neurological teaching.

Improving neurology teaching

Out of the 24 selected papers, 20 have addressed methods for improving neurology teaching, with a focus on summarizing participants' feedback obtained from open-ended questions. More teaching and bedside tutorials, greater integration of pre-clinical neurology to clinical years were considered the most helpful methods for improving teaching in most studies. Other methods included more significant exposure to patients, case discussions, and more online resources for self-learning.

Discussion

To the best of our knowledge, this study is the first systematic review and meta-analysis to provide a summary of the prevalence of neurophobia, and to capture a global view of factors behind neurophobia among medical students and young doctors. Besides, the preference of

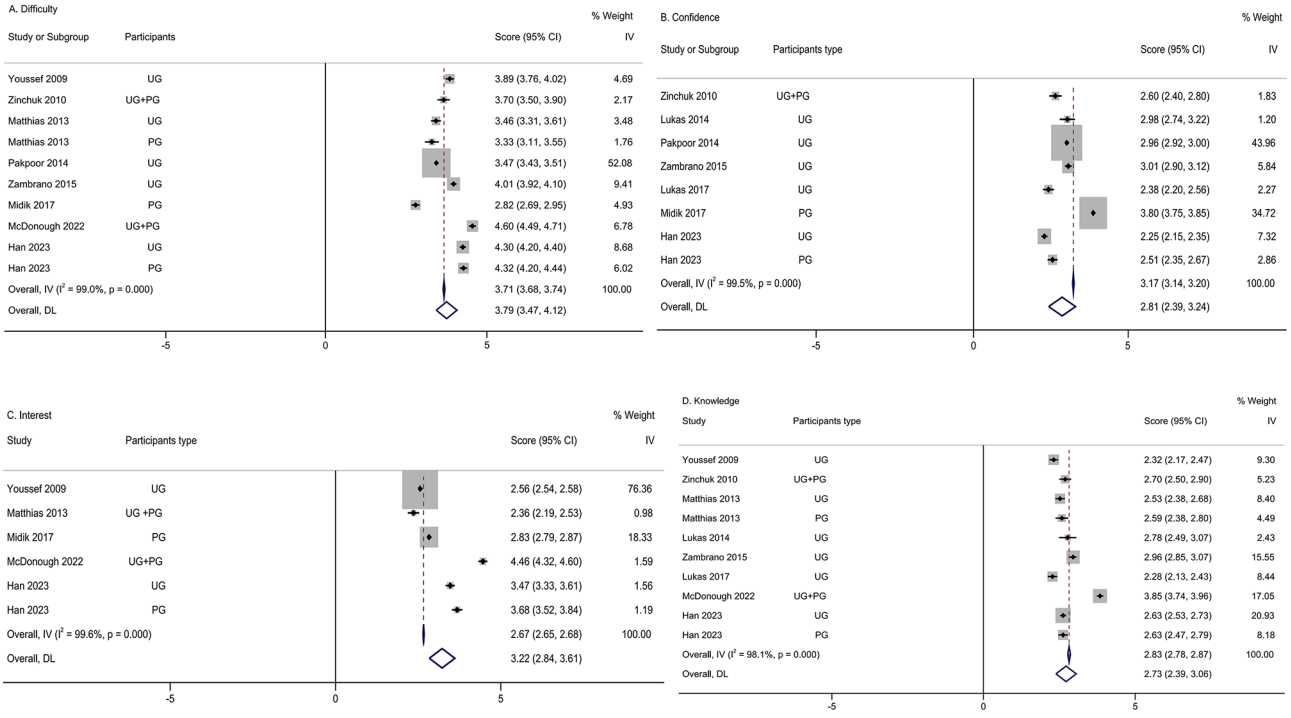

Fig. 3 The forest plots of scores for each subcomponent of neurophobia (**A**) Difficulty; (**B**) Confidence; (**C**) Interest; (**D**) Knowledge. UG, undergraduate; PG, postgraduate

teaching methods for learning and ways for improving neurology education were addressed.

The overall neurophobia prevalence was determined to be 46%. This study incorporated data from countries across Europe, the Americas, Latin America, Asia, and Africa. Despite the differences in educational systems among these regions, we have found that neurophobia is a common phenomenon worldwide. According to the subgroup meta-analysis, the prevalence of neurophobia among Asian and African medical populations is similar, both at 54%, significantly higher than that in Europe at 31%. This geographic difference may be related to the differences of medical education systems, reflecting the historical, cultural, economic development levels, and health care needs of their respective regions. Firstly, medical curricula in Asia and Africa often have a more theoretical focus during the early years, with limited integration of clinical exposure, which might exacerbate neurophobia due to the lack of practical grounding in neurology's complexities. In contrast, European and American medical schools frequently employ student-centered teaching methods such as problem-based learning. The integration of basic sciences with clinical practice and early exposure to clinical settings can help reduce fear. Moreover, in developing countries, although some top medical colleges have modern clinical training facilities, resource allocation may be uneven, leading to inconsistent quality of clinical training in different areas, and the specialty training systems may be in development, with variations between different countries and regions. Therefore, it is particularly important to pay attention to neurology teaching programs in developing countries and propose targeted solutions based on specific national conditions and education systems. It would also be important to compare approaches to education and training for medical students and postgraduate trainees across different country and of cross-cultural study.

The findings using the Likert scale in questionnaires to quantify perceived difficulty, confidence, knowledge and interest in neurology was collected and summarized in this review. Neurology was ranked as the most difficult medical specialty in a theoretical context due to the complexity of neuroanatomy, too many rare diagnoses, and limited exposure to neurological patients. Also, knowledge level consistently scored lower than other medical disciplines. Difficulty in learning neurology and the low level of knowledge in participants, contribute to the lack of confidence concerning neurology, especially in medical students, general practitioners, and non-neurology residents who felt the least confident in dealing with neurologically related complaints. Despite of the limited understanding and a relative lack of self-confidence among learners, they maintained a keen interest in neurology. Morinigo and Santos reported that neurology was rated as one of the most interesting sub-specialties by medical students and non-neurology residents [19, 20].

It is widely recognized that interest serves as the most potent catalyst for learning, and therefore, it is feasible and hopeful to change the current situation of neurophobia in the future.

An effective program that integrates the basic neurosciences with clinical neurology, enhances bedside teaching and difficult conversation training [31], may make learning more enjoyable for the student. In the European and American countries, specific organizations such as the American Academy of Neurology and the Association of British Neurologists have respectively developed recommendations for an undergraduate neuroscience and clinical neurology curriculum, emphasizing a system-based approach to achieve clear educational objectives [32, 33]. In those countries, as well as some Asian and African countries, undergraduate neuroscience and neurology courses are taught through problem-based learning methods, preceding the clinical teaching in later years [34–37]. The courses primarily employ small-group active learning techniques, including modified case-based and problem-based studies, as well as team-based active learning methods like team-based learning and flipped classroom lectures. It has been confirmed by randomized controlled trials that combination of team-based, problem-based and lecture-based learning is acceptable to students and produces better learning outcomes than either method alone in neurology education, which showed greater improvement in knowledge scores and interest [38, 39]. This may lead to more motivation in learning the workings of the nervous replaced by "neurophilia".

The strength of this study is the inclusion of large samples research from multiple countries across different continents of the world. However, our systematic review is not free of limitations. Firstly, some of the included studies had low response rates and lacked comparisons between respondents and non-respondents. This could result in a respondent bias since neurophobia is self-reported. Secondly, the included studies differed in their methodologies, sample sizes, and participant characteristics, which may influence the results. The definition of neurophobia is not uniform among studies, and it brings the need to standardize the neurophobia diagnostic method to achieve more accurate prevalence measurements in the future. Utilization of the neurophobia definition, as delineated and quantified by Kam et al., which is predicated on the assessment of difficulty and confidence metrics, is objective and quantifiable [12]. Thirdly, the analysis was constrained by the availability and quality of the data reported in the original studies, limiting the depth and breadth of pooled analysis. Most studies lack data on the specific prevalence of participants in each academic year, which could affect neurophobia levels due to varying exposure and knowledge. This should be considered in interpreting our results.

Conclusions

We reported that the overall prevalence of neurophobia among medical students and young doctors was as high as 46%, which was higher in Asian and African countries. This study enabled us to picture a complete, global overview of such a widespread phenomenon. The high prevalence and severity highlight the need for targeted interventions to reduce neurophobia among the medical populations.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-024-06303-3.

Supplementary Material 1

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Author contributions
F.H. and J.N. conceived and designed the study. F.H., DD.Z., and Y.Z. carried out literature retrieval, data extraction and performed the statistical analysis. F.H. and D.Z. completed the article writing. J.N., LX.Z, and YC.Z reviewed the manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Conflict of interest
No potential conflict of interest was reported by the authors.

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