

MEDICAL STUDENTS' PERCEPTION OF NEUROLOGY

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Abstract

Background: As neurophobia (fear related to neurology) seems to be a problem seen worldwide, we were interested in assessing whether neurophobia existed among medical students at the Faculty of Medicine in the University of Tetovo. This study aims to assess the attitudes of medical students towards Neurology in relation to perceived interest, difficulty, knowledge and confidence in learning the neurology subject compared to four other medical subjects. **Methods:** During the study period (January-March 2025), general medicine students in the 2013-2020 and 2021-2025 academic years were invited to respond to an anonymous questionnaire, using Google forms distributed on the Internet. **Results:** Total, 125 students answered the anonymous questionnaire 83 female (66.4%) and 42 males (32.6%). The most favorites subject among medical students were Internal medicine (26.4%) and Neurology (24%), respectively, while Dermatovenerology was ranked third (6.4%). The current level of knowledge among medical students was most for subject Internal medicine (16%), Neurology (9.6%), Infectiology (4.8%), Dermatovenerology 5 (4%), while Epidemiology (3.2%) was ranked fifth. The most difficult subject for majority of medical students (27.2%) was Neurology. Among medical students, most participants were less confident when dealing with patients with headaches (19.2%), dizziness (10.4%), and leg numbness (5.6%) when compared to other non-neurological complaints. **Conclusions:** Neurophobia is also widespread among students of general medicine at the University of Tetova and the findings of the first survey on neurophobia in this study sample are consistent with those of similar studies. Further studies are required to identify the extent of the problem.

Keywords: Neurology, Neurophobia, Medical students

Introduction

Neurological disorders account for a large and increasing health burden worldwide, as shown in the Global Burden of Diseases Study 2016 (GBD, 2016) and remaining an ongoing global epidemiological transition (GBD, 2021).

The data of such information is of interest for greater attention by health authorities for the prevention and care of neurological diseases and the need for clinicians specialized in neurology.

Neurologic diseases are largely incurable, lead to decreased life expectancy, and cause a multitude of signs and symptoms that negatively affect quality of life. Caregivers for those with neurologic diseases also have high rates of distress and Burnout syndrome (Boersma et al., 2014; Conti et al., 2021).

It is calculated that neurological disorders represent the leading cause of disability-adjusted life-years worldwide and the second leading cause of death globally, particularly as a result of population growth and ageing GBD 2015; Feigin et al., 2017; Feigin et al., 2019; Huang et al., 2023; Safdieh et al., 2019).

The increasing need for neurologists in a decade of aging is driven by the rising prevalence of neurological diseases in older adults. As the population ages, the number of individuals at risk for neurological disorders increases, placing a greater demand on specialized neurological care (Dall et al., 2013; Freeman et al., 2013; Harrigan et al., 2024; Racette et al., 2014).

In this context, including a wide spectrum of palliative care in neurological disease, neuropalliative care is an emerging interprofessional field (of neurology and palliative

medicine) that is increasingly becoming an established part of medical care, aims to improve communication through the holistic assessment and management approach of the person and quality of life for all people affected by severe neurological diseases (Oliver, 2022; Wiblin, 2024).

Likewise, the perception of classical neurology practice, research, and the way age-related conditions are viewed has changed, while medical education remains core to the future of neurology (Stancu et al., 2024; Mustafa et al., 2024; Osgood et al., 2024).

In the context of medical education, studies have found that insufficient or inadequate instruction hindering student learning and future clinical practice has contributed to disengagement and lack of interest in neurology, which may negatively affect the clinical competence and skills of future physicians (Fantaneanu et al., 2014; Han et al., 2023; Zinchuk et al., 2010).

Besides this, the World Health Organization (WHO) predicts a global shortage of 4.3 million physicians by 2030, with the largest deficits in developing and conflict-affected regions, including low-income countries (Qayumi et al., 2024).

A growing burden of neurological disease means medical students and doctors are likely to encounter patients with neurological diseases during their training and practice (Feigin et al., 2019; Feigin et al., 2004), yet neurology is considered a difficult subject by medical students (Schon et al., 2002; Zinchuk et al., 2010; Fantaneanu et al., 2014).

Current medical educational theory encourages the development of competency-based curricula (McElligott et al., 2025; Merlin et al., 2014; Sakai et al., 2013), whereas clinical neurology teaching is conducted in the clinical years, while focusing on the clinical symptoms and signs associated with neurological disease (Gelb et al., 2021). Different studies have been reported that gap between preclinical and clinical learning is a challenge (Surmon et al., 2016).

People often use the terms “fear”, “anxiety”, and “phobia” interchangeably. However, all three medical entities are natural, human feelings that are experienced differently by everyone, vary in intensity, and have similar emotional and/or bodily responses; Fear is a response to an imminent real or perceived threat, whereas anxiety is a response to a worry about a threat that has not yet occurred, or may never occur, i.e. an anticipated future threat. So, fear is inevitable, it can arise from almost anything. (Bateson et al., 2011; Garcia, 2017; Hudson, 2006; Ropeik, 2004; Weisberg, 2009; Merikangas et al., 2010).

Actually, pathological anxiety can develop from adaptive states of fear (Kellet & Kokkinidis, 2004; Rosen & Schulkin, 1998), but when the irrational fear of something becomes debilitating and affects an individual's daily life, it is considered a phobia. Phobias are a type of anxiety disorder that provokes excessive, persistent, and extreme fear that can arise from almost anything, some seeming stranger than others, also it is common for someone to have or develop specific fears or phobias. So that, different types of fear (specific phobia) have been described with various definitions including fear of flying (aerophobia), fear of heights (acrophobia), fear of spiders (arachnophobia), fear of enclosed spaces (claustrophobia), fear of social interactions (social phobia), fear of death (thanatophobia), fear of driving (vehophobia), fear of developing a disease (nosophobia), fear of doctors (iatrophobia), fear of neurology or neurological diseases or as a “fear of neural sciences and clinical neurology” known as neurophobia among medical students (Ausín et al., 2020; Anwar et al., 2015; Merikangas et al., 2010; Tarolli & Józefowicz, 2018; Józefowicz, 1994).

These types of fear (specific phobia) and other usually go away on their own, but some affect the quality of daily life and are a major public health challenge in terms of epidemiology, fear management and health care costs, affecting people throughout life and starting in childhood.

Based on diagnostic interview data from National Comorbidity Survey Adolescent Supplement, prevalence of specific phobia among U.S. adolescents aged 13-18, 19.3% of adolescents had specific phobia (Merikangas et al., 2010).

Over the last few decades, a fear of neurology termed neurophobia by Ralph Jozefowicz in 1994 (Jozefowicz, 1994; Anwar et al., 2015) or termed pathological fear of neurology (according Fuller, 2012) is fear or anxiety of any topic related to neurology due to failure to integrate basic science knowledge to clinical situation by medical professionals when interacting with patients suffering from neurological disorders (Hudson, 2006).

Earlier Jozefowicz defined neurophobia as “a fear of neuroscience and clinical neurology that is due to students' inability to apply their basic science knowledge to clinical situations” (Jozefowicz, 1994). The resulting negative attitudes toward neurology as a subject have been well documented since the 1950s among medical students in various countries around the world, and today the definition of neurophobia is not uniform across differently studies. Although there are different ways to approach this issue, the Likert-type scales developed in 1932 by Rensis Likert (Likert, 1932) and used by many researchers from different disciplines, often used in medical education and medical education research can serve as an example of the neurophobia assessment instrument (Norman, 2010; Sullivan & Artino, 2013).

There is also evidence that neurophobia begins early in medical school (Shiels et al., 2017), whereas neurophobia experienced by medical students during the course of their medical training (Conway & Tubridy, 2018) may play a role in choosing neurology as a career option and contribute to the shortage of neurologists at a time when, with an aging population, the burden of neurological disease is intensifying (Conway & Tubridy, 2018; Dall et al., 2013; Freeman et al., 2013; Racette et al., 2014).

Evidence-based treatments over the past two decades have revolutionized the clinical management and design of neurological services, increasing the need for neurologists to provide modern patient care. There are so many more treatments modalities now than there was in the past (Pereira et al., 2025; Mustafa et al., 2024; Harrigan et al., 2024; Osgood et al., 2024).

Because neurology cases are commonly complex and challenging to manage (Bartolo et al. 2010), the limited exposure to the cases could have limited the opportunity for students to be challenged in term of knowledge and skills, as well as confidence level. More opportunities to handle neurology cases and sufficient duration of practice are needed before students can adequately reflect on their skill in implying patient care and satisfaction (Mc Colgan et al.2013; Mc Gee et al.2014).

Now, the relationship between neurophobia (with its four dimensions of difficulty, self-confidence, knowledge and interest) and the shortage of neurologists (as in the case of the United Kingdom according to Nitkunan et al., 2020), when “one in six Americans is currently affected by neurologic disease” according to Dao and co-workers (2015) has aroused considerable research interest, given reports in the literature.

Resultant negative attitudes toward neurology as a subject have been well documented and frequently reported among medical students, potentially impacting their academic confidence and clinical performance.

Based on some studies, neurophobia is a recognized problem (Devoy et al., 2022) that influences both medical students (Han et al., 2024; Han et al., 2023; Flanagan et al., 2007) and postgraduate trainees” (Han et al., 2024), general practice trainees (McCarronet al., 2014), doctors (Flanagan et al., 2007), non-specialist doctors (Matthias et al., 2013) as well as to medical students towards neurological education (Zinchuk et al., 2010) and is described as “a global issue” (Zinchuk et al., 2010), “a global phenomenon” (Murphy et al., 2024), “a global and under-recognized phenomenon” (McGee al., 2014) or “fear of neurology among medical students” (Anwar et al., 2015), “fear of neurology experienced by medical students” (Conway & Tubridy, 2018), “fear of neurosciences held by medical students and doctors” (Matthias et al., 2013), “fear of neurological diseases” (Szirmai, 2012), “a chronic illness that begins early in medical school” (Shiels et al., 2017) as well as pathological fear of neurology which “should probably be considered a natural state for medical students and doctors” (Fuller, 2012).

Nowadays, evidence based on various studies has accumulated that medical students and junior doctors as well as new specialists in the field of neurology find neurology difficult (Flanagan et al., 2007) because they are unable to apply their basic neurology knowledge at the patient's bedside. According to statistics, every second student suffers from the neurophobia (Szirmai, 2012).

The prevalence of the neurophobia has been studied predominantly in medical students and junior doctors (Saldaña-Inda et al., 2023) and resident trainees (Han et al., 2023). Estimates of the prevalence of neurophobia in medical students vary substantially from 26% (Shiels et al., 2017), 34.1% (Lambea-Gil et al 2023), 47.5% (Kam et al., 2013), 58.9% (Jukna et al., 2023) to 66.1% (Han et al., 2023). A recent systematic review and meta-analysis recently showed that among medical students, the overall prevalence of neurophobia was 43%, while among postgraduate doctors, it was 49% (Han et al., 2024).

To illustrate estimates of the prevalence of neurophobia, Nitkunan and colleagues (2020) show that the United Kingdom has the lowest number of neurologists per population in Europe and a possible contributing factor is the prevalence of neurophobia.

Reports in the literature have attributed medical student neurophobia to an inability to apply knowledge of the basic science to clinical situations. So that a teaching and learning initiative called case-based teaching was designed to help medical undergraduates integrate clinical neurology with the neuroscience that underpins it (Hudson, 2006).

For this reason, we sought inspiration from student feedback, their experience, and current practices in the medical education sphere to investigate if neurophobia, not as a medical condition, but as a professional phenomenon (according to Jozefowicz, 1994) or as a “natural state for medical students and doctors” (according to Fuller, 2012) is present among medical students at the Faculty of Medicine in the University of Tetovo and to assess the attitude of medical students toward neurology compared to other medical subjects.

Methods

Study design and sample

During the study period from January to March 2025, students in the medical education program of general medicine in the academic years 2013-2020 and 2021-2025 were invited to answer an anonymous questionnaire, using Google forms distributed on the Internet.

Each questionnaire administered to medical students was accompanied by an informed consent and information leaflet, which explained the details of the study to the participants as well as the rights of the participants before they were enrolled in the study and responses were recorded directly per computer.

By assigning a unique code to each student, the study author was able to track the activities and responses received for each questionnaire. All students were given two weeks to collect as many responses as possible. Responses were then filtered for any duplicates by the study authors. Finally, the data of each questionnaire was processed and analyzed presenting their data as a presentation in this study anyway commenting on their results.

The study instrument was an anonymous questionnaire based on modified qualitative interpretation of 5-point/response Likert scale measures. In this cross-sectional survey, the questionnaire included demographic data and statements to examine attitudes toward neurology and four medical subjects (Epidemiology, Dermatovenerology, Infectiology, Internal medicine) that are heard in the fourth year of studies, using a Likert scale, as well as the willingness to choose neurology as a career. The confidentiality of the responses was fully assured. There were no wrong or right answers. the student was asked to answer in the way that best reflects his thoughts.

Participants were defined as having neurophobia if they had a difficulty score calculated on a Likert scale from possible responses related to difficulty in neurology and that score = 5 (i.e., very difficult), whereas values ≤ 4 were considered as absence of neurophobia.

Statistical analyses

For data analysis, the Statistical Package for Social Sciences (SPSS version 17.0.) was employed. Continuous variable such age was analyzed using mean and standard deviation, while categorical variable as gender and academic generation were summarized using frequencies and percentage by applying descriptive tables of the study cohort.

Results

Total, one hundred and twenty-five students with an average age of 24.08 years (SD = 1.599; ranging from 20 to 27 years) responded to the anonymous survey. Of these, 83 (66.4%) were female and 42 males (32.6%), while the female to male ratio was approximately 2:1, indicating a higher representation of female participants in the study. This gender distribution highlights the demographic composition of general medical students, with female forming the majority in this sample cohort.

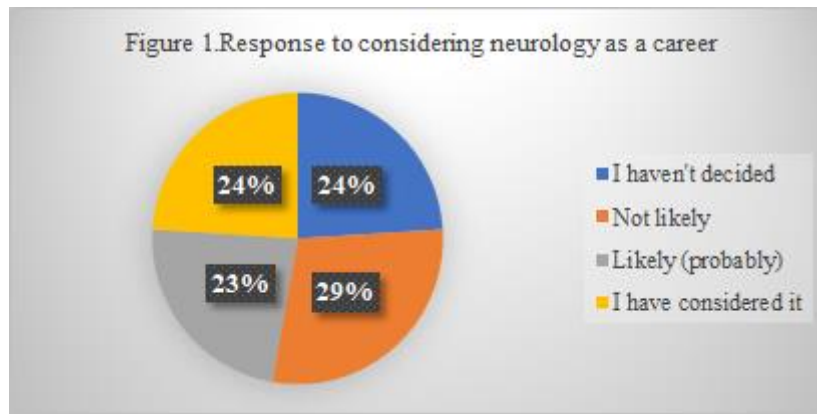
The sociodemographic characteristics of the study cohort (n = 125) are presented in Table 1.

Table 1. Sociodemographic characteristics of the study sample (n =125)

Sociodemographic factor	Category	n	(%)
Generation	2013	56	(44.8)
	2021	69	(55.2)
Age (y)	20-21	5	(4.0)
	22-23	48	(38.4)
	24-25	49	(39.2)
	>25	23	(18.4)
	Gender	Female	83
	Males	42	(32.6)

Sociodemographic variable with the categories shown in table 1 were analyzed according to the frequency distribution. The term age range by generation is not an official definition and means the years of the academic generation up to the academic years 2013/2025. Among the participants in the study, 69 of 125 (55.2%) were students of the generation in the academic years 2021-2025, while students of the generation in the academic years 2013-2020 were 56 (44.8%), were those with 24-25 years of age ranked first (39.2%). According demographic age groups, the age range distribution of the participants shows that most were in their early twenties, representing a relatively young sample of the typical cohort for undergraduate medical students.

Figure 1 shows the response to considering neurology as a possible career; 24% of students had not decided regarding their future career, also 24% selected neurology as their first possible choice.



Perceived difficulties with neurology were compared with four medical subjects that were analyzed, whereas table two present the assessment of medical students' attitudes towards neurology and four other medical subjects.

Table 2. Assessment of medical students' attitudes towards neurology and four other subjects

	Epidemiology	Dermatovenerology	Infectiology	Internal medicine	Neurology
<i>Preference ratings</i>					
1 = not a favorite at all	14 (11.2)	16 (12.8)	13 (10.4)	10 (8.0)	7 (5.6)
2 = least favorite	64 (51.2)	27 (21.5)	28 (22.4)	0	5 (4.0)
3 = favorite	30 (24.0)	40 (32.0)	52 (41.6)	13 (10.4)	20 (16.0)
4 = very favorite	14 (11.2)	24 (19.2)	22 (17.6)	48 (38.4)	42 (33.6)
5 = the most favorite	3 (2.4)	18 (14.4)	10 (8.0)	54 (43.2)	51 (40.8)
<i>Difficulty ratings:</i>					
1 = very easy	10 (8.0)	1 (0.8)	1 (0.8)	0	0
2 = easy	46 (36.8)	27 (21.6)	27 (21.6)	3 (2.4)	2 (16.0)
3 = moderate	41 (32.8)	56 (44.8)	56 (44.8)	50 (40.0)	36 (28.8)
4 = difficult	25 (20.0)	30 (24.0)	30 (24.0)	62 (49.6)	54 (43.2)
5 = very difficult	3 (2.4)	11 (8.8)	11 (8.8)	10 (8.0)	33 (26.4)
<i>Knowledge ratings:</i>					
1 = very limited	13 (10.4)	24 (19.2)	7 (5.6)	4 (3.2)	10 (8.0)
2 = limited	40 (32.0)	32 (25.6)	39 (31.2)	13 (10.4)	24 (19.2)
3 = moderate	39 (31.2)	37 (29.6)	54 (43.2)	45 (36.0)	51 (40.8)
4 = good	29 (23.2)	27 (21.6)	19 (15.2)	43 (34.4)	28 (22.4)
5 = very good	4 (3.2)	5 (4.0)	6 (4.8)	20 (16.0)	12 (9.6)
<i>Confidence ratings:</i>					
1 = very uneasy	8 (6.4)	28 (22.4)	20 (16.0)	12 (9.6)	34 (27.2)
2 = uneasy	23 (18.4)	36 (28.8)	28 (22.4)	29 (16.8)	33 (26.4)
3 = moderately confident	50 (40.0)	41 (32.8)	47 (37.6)	37 (29.6)	39 (31.2)
4 = confident	24 (19.2)	13 (10.4)	20 (16.0)	30 (24.0)	11 (8.8)
5 = very confident	19 (15.2)	7 (5.5)	10 (8.0)	25 (20.0)	8 (6.4)

Details regarding provided self-reported information on opinions and attitudes on current challenges in studies in the sample of medical students showed that most favorites subject among medical students were Internal medicine (43.2%) and Neurology (40.8%), respectively, while Dermatovenerology was ranked third (14.4%).

According to the students' perception, despite the fact that internal medicine was considered the most preferred subject by medical students and neurology the least preferred subject than internal medicine, neurology is considered to be the most difficult subject compared to internal medicine and the other three subjects.

From the study, on the Likert Scale, 2 of the respondents (16%) perceived neurology as an easy subject, while 54 of the respondents (43.2%) perceived neurology as a difficult subject, whereas 33 of the respondents (26.4%) perceived neurology as a very difficult subject.

From the overall assessment of the participants were determined three possible main reason why perceived neurology as a very difficult subject: the overly theoretical lectures implying a large number of neurological disorders (63.2%), lack of sufficient knowledge from the field of neuroanatomy (50.4%), and limited patient exposure during practical exercises (37.6%) including difficulties in clinical (24%) and neurological examination (33.6%).

The current level of knowledge among medical students was very good for subject Internal medicine (16%), Neurology (9.6%), Infectiology (4.8%), Dermatovenerology 5 (4%), while Epidemiology (3.2%) was ranked fifth.

The knowledge assessments were reflected in the confidence assessments so that students were very confident in the field of Internal medicine (20%) and less so in the field of other subjects. So, among medical students, most participants were less confident when dealing with patients with headaches (19.2%), dizziness (10.4%), and leg numbness (5.6%) when compared to other non-neurological complaints.

Discussion

To our knowledge, this study is the first anonymous electronic survey in the Republic of North Macedonia (RNM) that medical students filled out a questionnaire using the Likert scale with answer scores ranging from 1 to 5 to evaluate their perceptions of neurology and four other medical subjects, to capture a general view of the factors behind neurophobia among medical students. Unlike our country, studies of neurophobia in relation to difficulty and belief, and experiences of fear of neurology were mainly conducted among medical students, junior doctors and primary care doctors in different countries like in the European, American, Asian and African countries (Abulaban et al., 2015; Anwar et al., 2015; Conway & Tubridy, 2018; Devoy et al., 2022; Flanagan et al., 2007; Han et al., 2024; Han et al., 2023; Matthias et al., 2013; McCarronet al., 2014; McGee al., 2014; Murphy et al., 2024; Szirmai, 2012; Shiels et al., 2017; Zinchuk et al., 2010).

Nowadays, evidence based on various studies has accumulated that medical students and junior doctors find neurology difficult (Flanagan et al., 2007; Zinchuk et al., 2010) because they are unable to apply their basic neurology knowledge at the patient's bedside.

According to Szirmai (2012), every second student suffers from neurophobia and its main symptom is that medical students and young doctors are not able to utilize their basic neurological knowledge at the bedside. In his original article, Ralph Josefowicz (1994) attributed neurophobia to the lack of integration between basic neurosciences and clinical neurology, and claimed that 50% of medical students at some stage have neurophobia.

The study results show that a quarter (24.6%) of respondents perceived neurology as a difficult subject to learn and reported low perception of self-efficacy, similar to medical students in different studies. These results are consistent with the predictions of the purpose of this study. And, these findings of high perceptions of difficulty and low confidence are some of the hallmarks of neurophobia as described in studies of neurophobia in medical students (Abulaban et al., 2015; Anwar et al., 2015; Conway & Tubridy, 2018; Devoy et al., 2022; Flanagan et al., 2007; Han et al., 2024; Han et al., 2023; Matthias et al., 2013; McCarronet al., 2014; McGee al., 2014; Murphy et al., 2024; Szirmai, 2012; Shiels et al., 2017; Zinchuk et al., 2010).

Compared with several studies, the prevalence of neurophobia in medical students was similar to the prevalence estimate of neurophobia in the study of Shiels and co-workers (2017), lower than the prevalence estimates of neurophobia in the studies of Lambea-Gil and co-workers (2023), Kam and co-workers (2013), Jukna and co-workers (2023) and Han and co-workers

(2023), or lower than the estimate of the overall prevalence of neurophobia according to Han and co-workers (2024).

This difference in study prevalence may be related to the small study sample or medical education system, reflecting how medical students' attitudes toward neurology were assessed. In addition, this study did not address teaching method preferences for learning and ways to improve neurological education.

To date, patient care has been dominated by evidence-based medicine (Fernandez et al., 2015), and now, medicine is moving from a population-based model of clinical care to a model of “personalized” medicine based on the individual or individualized patient care (Horwitz et al., 2018).

Medical universities in the Republic of North Macedonia use student-centered teaching methods, with theoretical-practical bases based on evidence-based medicine. Teaching during the first years (pre-clinical phase), has a more theoretical focus with limited integration of clinical exposure, and clinical exercises during the final years (clinical phase) may exacerbate neurophobia due to a lack of theoretical-practical grounding in the complexities of neurology. Didactic lectures have been the gold standard and the most common method of traditional teaching and learning practice, but interactive teaching styles are more popular than didactic lecture (Costa et al., 2007; Miller et al., 2014). Current medical education theory encourages the development of competency-based curricula, as translational medicine moves to the forefront of medical research and clinical practice (Merlin et al., 2014).

Activity-based learning, case-based discussion, and problem-based learning, are laying the foundation for this modern era of teaching (Mishra et al., 2023). Different studies have reported that the gap between preclinical and clinical learning is a challenge (Surmon et al., 2016), including malpractice fear (Johnston et al., 2014) which also affect the attitudes of neurologists (Brilla et al., 2006). For more, students must acquire critical thinking skills to evaluate the medical literature and incorporate it into their clinical practice.

Scientific medicine, conventional medicine, evidence-based medicine, modern medicine, holistic medicine, integrative medicine, all of them are different and are considered medical systems that were developed years ago and have only recently become known to share a number of common elements (Yeung, 2018). For example, by all medical systems, it is considered that each person or each patient is unique.

The definition of evidence-based medicine comes from Sackett and co-workers (1996) who stated that it is the “integration of the best research evidence with clinical expertise and patient values to make clinical decisions” and the notion that clinical judgments should be based on the best available research is not new.

Evidence-based medicine in the form of the scientific method has underpinned medical practice for decades and requires continuing education. At its core, evidence-based medicine is a systemic approach to utilizing the best scientific information to make decisions regarding diagnosis and treatment for individual patients. It involves learning a set of skills to access and evaluate the medical literature and select the most accurate information for use in clinical decision-making. In fact, students and new physicians attempting to practice evidence-based medicine may become frustrated with the process when they are unable to find any useful information to answer their clinical questions. In some cases, medical information is available, but the evidence may be inconclusive or contradictory. Fortunately, the amount of medical information available to medical students and physicians continues to grow. Regardless, more research studies should be used to assess the scientific knowledge to evaluate the outcomes of each major clinical problem with the evidence-based medicine approach.

Evidence-based medicine uses the scientific method to organize and apply current data to improve health care decisions and generate evidence for patient care, whereas evidence-based practice is the process of applying current, best evidence (external and internal scientific

evidence), patient perspective, and clinical expertise to make decisions in relation to the care of the individuals being treated (Horwitz et al., 2018).

The Horwitz and Singer article (2017) argues that while evidence-based medicine has been successful in strengthening the evidence base for population health, it has failed to answer the specific questions of individual patient care. They propose “medicine-based evidence” as a better approach, which focuses on individual patient profiles and uses data from various sources to personalize treatment decisions.

Meanwhile, the emerging concept of integrating the details of biology and biography is a goal of “precision medicine” while recent advance in techniques for biomarker identification and innovations in digital sensors to monitor physiological and behavioral features, have rich biological and clinical data that describe each patient (Lobitz et al., 2019).

This may lead to more motivation to learn how to replace neurophobia with “neurophilia” (Fuller, 2012).

Defensive medicine is becoming increasingly prevalent in the in western cultures (Baungard et al., 2022; Borgan et al., 2020; Guthorn 1968; Garcia-Retamero & Galesic, 2014) and the concept of defensive medicine is closely related to the issue of medical errors (Kakemam et al., 2022). The term defensive medicine (Guthorn, 1968) is defined as “doctors who deviate from sound medical practice due to fear of reasonable claims and lawsuits” (Garcia-Retamero & Galesic, 2014).

Defensive medicine occurs when doctors prescribe unnecessary tests, procedures, or specialist visits (positive defensive medicine), or avoid high-risk patients or procedures (negative defensive medicine). Physicians practice defensive medicine to reduce their exposure to medical malpractice lawsuits (Borgan et al., 2020; Johnston et al., 2014; Kakemam et al., 2022; Panella et al., 2017). The fear of litigation and defensive medicine also affect the attitudes of neurologists (Brilla et al., 2006). There are also assessments of students' experiences with preventive medicine (Johnston et al., 2014; O'Leary et al., 2012), due to a perceived threat of liability through insurance behaviors (including providing additional services of minimal clinical value) or avoidance behaviors (including withholding services that are, or avoiding patients who are perceived as high risk) (O'Leary et al., 2012).

The development of modern medicine in many countries is slowly progressing towards a more holistic and individual approach to healing, where part of this progress is the integration between Western and alternative forms of medicine, a concept that has been described as “integrative medicine” (Li et al., 2024). This approach to health care incorporates the patient's mind, spirituality, and sense of community into the healing process (Gannotta et al., 2018).

Integrative medicine is a new way of designing health care that brings conventional and complementary approaches together in a coordinated manner by emphasizing multimodal interventions, which are two or more interventions such as conventional health care approaches (such as medication, physical rehabilitation, psychotherapy) and complementary health approaches (such as acupuncture, yoga, and probiotics) in various combinations, with an emphasis on treating the whole person (holistic approach) rather than, for example, an organ system (Li et al., 2024).

According to the recommendations of the main international neurological societies, during the medicine undergraduate degree, the students must learn the clinical ability to perform a meaningful clinical and neurological examination, and acquire the clinical skills to initiate appropriate investigations and management of the most frequent, urgent or treatable neurological illnesses (Bermejo-Pareja & Hernandez-Gallego, 2007; Hernando-Requejo, 2020; Lambea-Gil et al 2023).

There are authors (Flanagan et al., 2007) who explained the disparity between difficulty and knowledge/interest by the fact that students perceive that they have to struggle more at neurology to gain knowledge. The results of this study showed that along with current

theoretical and practical knowledge in the field of neurology, low levels of neurophobia were associated with students' willingness/expectation to pursue a career in neurology. Today there is a lot of information due to technological development in more fields of medicine and according to evidence-based medicine, the evidence of this information must be verified, while for every student this is a big challenge and this challenge is widely reported in contemporary literature.

Anyway, there are data that neurological semiology is often considered by medical students as particularly difficult to learn, whereas finding alternative teaching methods may improve students' motivation and understanding of this field (Zeidan et al., 2022).

From all that we said above, it is not surprising why students and young doctors around the world complain of fear of neurology (neurophobia), or resident physicians perceive their knowledge of neurology and neurological emergencies as possible causes for said fear (Saldaña-Inda et al., 2023) which may contribute to a reduced number of trained neurologists (Tarolli & Józefowicz, 2018) especially in the lowest number of neurologists (Nitkunan et al., 2020).

The elements that contribute to the development of neurophobia we're not the main purpose of this study, therefore they are discussed in part.

From the overall assessment of our participants were determined three possible main reason why perceived neurology as a very difficult subject were the overly theoretical lectures implying a large number of neurological disorders, lack of sufficient knowledge from the field of neuroanatomy, and limited patient exposure during practical exercises, including difficulties in clinical and neurological examination.

Students also reported low confidence in neurology compared to internal medicine. These findings are likely to have important implications for medical education in how medical students practice. In terms of educational resources, the complexity of neurology is widely recognized as one of the primary contributors to major reason why neurology was perceived as a difficult clinical specialty (Flanagan et al., 2007). Meanwhile, this perception by medical students (Conway & Tubridy, 2018) is exacerbated by too theoretical lectures (Lambea-Gil et al., 2023; Saldaña-Inda et al., 2023) driven by an intimidation of the complex nature of neuroanatomy and neuropathology (Murphy et al., 2024), inadequate exposure to practical and insufficient training during both preclinical and clinical education (Matthias et al., 2013; McCarron et al., 2014; Loftus et al., 2016; Kam et al., 2014), due to poor teachings of neurology (Flanagan et al., 2007), the necessary understanding of neuroanatomy (Dao et al., 2015) and complex neurologic examination (Matthias et al., 2013; Youssef, 2009), a low degree of confidence when confronted with patients presenting with neurologic symptomatology (Zinchuk et al., 2010) as well as due to the lack of a practical basis in the complexities of neurology (Han et al., 2024). Learning neurology and neurological examination is an art in itself and like any art, it requires knowledge, awareness, patience and sensitivity, which is emphasized in more studies (Dao et al., 2015).). A teaching and learning initiative called case-based teaching (Hudson, 2006) is designed to help medical undergraduates integrate clinical neurology with the neuroscience that underpins it.

Similar to the mentioned studies (Matthias et al., 2013; McCarron et al., 2014; Loftus et al., 2016; Kam et al., 2014; Han et al., 2024), it is likely that the difficulty in the theoretical and practical learning of neurology among the participants of this study contributed to the lack of confidence regarding neurology, especially among those who felt less confident in the treatment of complaints related to neurological symptoms and/or signs, a very important reason for 39.4% of students.

Based on diagnostic interview data from National Comorbidity Survey Adolescent Supplement, prevalence of specific phobia among U.S. adolescents aged 13-18, 19.3% of adolescents had specific phobia (Merikangas et al., 2010).

Generally, the word “fear” is used in two ways, one to describe the emotional response to something that seems dangerous and the other to name something that a person often feels afraid of.

Fear is a normal and healthy part of life and one of the most basic human emotions, which is programmed into the nervous system and functions as an instinct. Fear is a response the brain has learned in an attempt to protect the person as physical responses (Mochcovitch et al., 2014). In fact, fear plays an important role in preventing the individual from entering harmful situations and helping him decide when to get out of situations that are not necessarily better, whereas, fear appeals are persuasive messages that attempt to arouse fear by emphasizing the potential danger and harm that will befall individuals if they do not adopt the messages’ recommendations (Tannenbaum et al., 2015; Ropeik, 2004).

It is well understood due to extensive research that the neurobiological basis of normal and pathological innate and learned fear reactions refers to brain mechanisms involved in processing and regulating the emotion of fear, particularly those involving the amygdala (Garcia, 2017) and its connections to the frontal cortex (perirhinal cortex, ventrolateral prefrontal cortex, anterior insula) considered (Mochcovitch et al., 2014). Also, the amygdala and other fear-related neurocircuitry may share a similar neuroanatomy to anxiety neurocircuitry (Mochcovitch et al., 2014). The amygdala contributes to fear indirectly but is not an innate fear center out of which fear percolates (LeDoux, 2000).

The main function of fear and anxiety is to act as a signal of danger, threat, or motivational conflict, and to trigger appropriate adaptive responses (Steimer, 2002). Furthermore, many authors justify a clear distinction between fear and anxiety where although both are alarming signals, they seem to prepare the body for different actions. So, anxiety as a natural adaptive reaction is a generalized response to an unknown threat or internal conflict, while fear focuses on known external danger (Barlow, 2000; Craig et al., 1995).

Fear or anxiety result in the expression of a range of adaptive or defensive behaviors, which are aimed at escaping from the source of danger or motivational conflict (Steimer, 2002).

These behaviors depend on the context and three familiar examples have been proposed to understand the development and maintenance of coping if the anxiety response goes beyond normal fear and leads to avoidance behavior. First, the active strategies are mediated predominantly by sympathetic activation (hypertension, tachycardia), known as the fight-or-flight response, originally described by Cannon (1915).

Secondly, passive coping strategies, such as immobilization or freezing, are usually characterized by autonomic inhibition (hypotension, bradycardia), and a more pronounced increase in the neuroendocrine response (activation of the hypothalamopituitary-adrenal axis and increased glucocorticoid secretion), known as the conservation-withdrawal strategy, originally described by Engel and Schmale (1972).

And thirdly, the concept of alternative (active/passive) strategies itself owes much to the work of Henry and coworkers (1977) where specific brain circuits appear to mediate distinct coping reactions to different types of stressors (Bandler et al., 2000; Keay & Bandler, 2001; Sinha et al., 2016; Mochcovitch et al., 2014).

Conclusion

Neurophobia is also widespread among students of general medicine at the University of Tetova and the findings of the first survey on neurophobia in this study sample are consistent with those of previously published studies.

According to the students' perception, despite the fact that internal medicine was considered the most preferred subject by medical students and neurology the least preferred subject than

internal medicine, neurology is considered the most difficult subject compared to internal medicine and the other three subjects on the Likert scale.

Given that recognition of the multifactorial nature of neurophobia is critical to designing effective interventions, further studies are required to identify the extent of the problem. Since the elements that contribute to the development of neurophobia we're not the main purpose of this study, they will therefore be analyzed and fully presented in a future study.

Limitations

Four specific limitations are worth mentioning. First, as introduced in the introduction, the results of the present study are concerned with the perception of fear from neurology (neurophobia) and not with innate fear. That is, our analysis did not compare students who were subjectively fearful to students who were not subjectively fearful, but we compared students who were more or less exposed to fear-inducing neurology content. Consequently, all levels between the five medical subjects and comparisons of student attitudes should be interpreted as effects of exposure to levels of fear of neurology (neurophobia) rather than effects of fear per se. Finally, a small sample of all medical students may limit the generalizability of these results, but there were 125 respondents in this survey and the sample was assumed to be representative and therefore the results are presented similarly to other studies.

Contributions

Author BK was responsible for the study conception, which was refined by co-author DK. Both authors analyzed the raw data obtained from the anonymous questionnaires. BK wrote the manuscript and both authors reviewed and approved the final manuscript.

Conflict of interests

The authors declare that they have no competing interests.

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