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Challenges in studying neuroanatomy in sub-Saharan Africa: The case of Cameroon

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ABSTRACT

Introduction: Quality education is key in addressing the skilled neurological workforce gap in Africa. However, many medics are scared of the neurological sciences because of the challenges faced in medical schools in studying the neurosciences. Understanding its state and educational challenges is crucial for fostering interest in neurosurgery and related specialities on the continent.
Research question: What are the current state, challenges, and solutions to improve neuroanatomy education in Cameroon, Africa in miniature?
Materials and methods: A cross-sectional study using an 11-item electronic survey was conducted among medical students from all nine medical schools in Cameroon. Data were analysed using descriptive statistics and independent t-tests, with significance set at $p < 0.05$.
Results: Among 220 respondents, 40.1 % and 35.0 % respectively, reported cranial nerves/brainstem and neurovascular anatomy to be the most challenging, with a mean comprehension score of 5.83/10. Faculty predominantly relied on PowerPoint lectures (83.2 %), while most students supplemented learning with YouTube videos (77.7 %). 63.9 % of the respondents perceived classroom teaching alone to limit their understanding of neuroanatomy, and 85.8 % of students reported the time allocated for neuroanatomy teaching to be inadequate. The usage of cadaver dissection (69.5 %), and neurosimulation practicals (66.4 %) were the most recommended tools by students to improve neuroanatomy teaching.
Discussion and conclusion: Challenges in neuroanatomy education in Cameroon are perceived to arise from insufficient hands-on learning, time constraints, and limited access to specialised faculty. These suggest interactive teaching, increased curriculum time, and diverse resources as potential improvements, though further research is needed to assess their effectiveness and ultimately improve understanding, fostering a stronger neurological workforce.

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Abbreviations

CAMSA	Cameroon Medical Students' Association
CHERRIES	Checklist for Reporting Results of Internet E-Surveys
UDM Bagante	Université des Montagnes Bangante
FMBS-Garoua	Faculty of Medicine and Biomedical Sciences of the University of Garoua
FHS-UB	Faculty of Health Sciences of the University of Buea
FHS-UBa	Faculty of Health Sciences of the University of Bamenda
FMBS-Yaounde 1	Faculty of Medicine and Biomedical Sciences of the University of Yaounde 1
FMPS-Dschang	Faculty of Medicine and Pharmaceutical Sciences of the University of Dschang
FMPS-Douala	Faculty of Medicine and Pharmaceutical Sciences of the University of Douala
ISTM	Higher Institute of Medical Technology Nkolondom, Yaoundé.
SHMS	School of Health and Medical Sciences of the Catholic University of Cameroon

1. Introduction

The burden of neurosurgical diseases in Africa is substantial, with Africa alone accounting for 15 % of its global volume (Cheyuo and Hodaie, 2022). Yet access to neurosurgical care remains limited, with African neurosurgical patients having access to less than 1 % of skilled neurosurgeons. Multiple initiatives have been put in place to increase this workforce deficiency in this region, among them improving the quality of neurosurgical education and training (Ahmed et al., 2024).

Human anatomy remains one of the most challenging courses in medical school (Designing courses in anatomy, 2025). This is worse in developing countries such as Cameroon, where access to modern learning resources is limited (Shah et al., 2023). Anatomy education has witnessed significant improvement from white and black images in textbooks during the 19th century to present-day YouTube videos and even life models available at the disposal of medical students of the 21st century (Hulme et al., 2017). Despite these significant advances, not every section of human anatomy seems so easy to medical students (Hall et al., 2018).

While the nervous system is regarded as the most organized human system, neuroanatomy is regarded as complex by many students, who often express difficulty with assimilation. Therefore the name "Achille's Heel of Medical Students" (Sotgiu et al., 2020). Jozefowicz first used the term "neurophobia" to refer to the fear of neural sciences and neurology among medical students and non-specialist doctors (Matthias et al., 2013). Despite acknowledging the influence of neurophobia in understanding neuroscience courses, many other factors are known to influence mastery of human neuroanatomy amongst medical students (Triepels et al., 2018).

Given the importance of neuroanatomy in nurturing students' interest and developing the neurological and neurosurgical workforce, it is therefore essential to understand in detail the challenges faced by medical students in receiving neuroanatomy education in this region.

In Cameroon, there have been reports on challenges in pursuing a neurosurgery career and education (Dada et al., 2022; Kanmounye et al., 2022). But to the best of our knowledge, no prior study has examined the current state of neuroanatomy in the Cameroon medical curriculum or the challenges faced by medical students in neuroanatomy knowledge acquisition.

2. Study aim

This study evaluated the current state, challenges, and solutions to improve neuroanatomy education from the perspective of Cameroon medical students.

3. Materials and methods

3.1. Study design

Our study was an online cross-sectional study design approved by the Cameroon Medical Students' Association (CAMSA). The study was conducted in accordance with the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) (Eysenbach, 2004).

3.2. Study setting

Cameroon is a sub-Saharan African country with a population of about 28 million people, a GDP per capita of US$1563.5, and a density of 56/km^2 as of 2022 (World Bank Open Data [Internet]). It has one of the highest surgical preparedness indexes (81 ± 12.5) in central Africa (Elective surgery system strengthening, 2022). According to the latest estimates, Cameroon has a neurosurgery workforce density of 0.09 per 100,000 population (Kanmounye et al., 2020). Cameroon has nine medical schools, with each having a CAMSA representative on campus. Medical training in Cameroon follows a seven-year cycle divided into preclinical (Levels 1–3) and clinical training (Levels 4–7).

3.3. Data collection tool

We designed a standardised anonymous survey using Google Forms (Google, USA) in Cameroon's official languages (English and French). Following a pilot and validation by the senior author (IE), the final survey contained a combination of 11 questions featuring a combination of multiple-choice, Likert-scale, and short-text questions. The questions were organised into 3 main sections: (i) study characteristics; (ii) personal assessment and challenges with neuroanatomy education; and (iii) proposed solutions to improve neuroanatomy education (supplementary material).

3.4. Data collection

The final survey was administered by the CAMSA Campus Coordinator in collaboration with the CAMSA representatives of each of the 9 Cameroonian medical schools. A convenient sampling method was used to recruit our study participants, and the survey was administered via the WhatsApp social media platforms of level 2 to level 7 medical students participating in the survey. To increase the response rate, the survey link was sent both in the WhatsApp groups and privately. Data from the survey was collected anonymously, and stored on Google Drive (Google, USA) accessible only by the investigators.

3.5. Statistical analysis and visualisation

Survey data was collected and processed into a Google Sheet. The collected data was analysed in SPSS v26 (IBM, USA). The question assessing the sufficiency of curriculum time dedicated to learning neuroanatomy was converted as follows prior to analysis. "Yes, enough" and "Yes, quite much" were converted to "Adequate", and "Not enough" and "Very little" converted to "Inadequate". Summary descriptive statistics were generated as counts with the respective percentages for categorical variables and means with the respective standard deviations for continuous variables. The independent samples *t*-test was used to perform comparisons of means between selected groups. The threshold of significance was set at $p < 0.05$. Tableau Public (Salesforce, Mountain View, CA, U.S.A.) was used for interactive visualisation.

4. Results

A total of 220 level two to seven medical students from the 9 medical faculties in Cameroon completed the survey. Université des Montagnes Bangante (UDM Bagante) had the largest participation (n = 57, 25.9 %),

followed by the Faculty of Medicine and Biomedical Sciences of the University of Garoua (FMBS-Garoua) (n = 29, 13.2 %) (Fig. 1). The majority of the participants were in their clinical years of study (n = 121, 55 %) (Fig. 1).

Generally, the anatomy of the head and neck was the most challenging section of anatomy (n = 161, 73.2 %) (Fig. 2). Overall, about 40.1 % (n = 88) of participants considered the study of cranial nerves/brain stem to be most difficult, and this was followed closely by the neurovascular anatomy (n = 77, 35.0 %) (Fig. 3).

The mean score for the level of understanding of neuroanatomy by respondents to the survey was 5.83/10 ± 1.56. There was no statistically significant difference in the mean knowledge of neuroanatomy amongst students when grouped across the stage of training (preclinical vs clinical), type of institution (private vs public), and between French and English-speaking medical schools (Table 1).

PowerPoint lectures were the most widely used to teach neuroanatomy by the faculty (n = 183, 83.2 %), and cadaver dissection was used in 4.9 % (n = 9) of the cases (Fig. 4). YouTube videos, followed by anatomy websites/apps and textbooks, were the most common resources used by students to complement classroom neuroanatomy teaching (n = 171, 77.7 %; n = 93, 42.3 %) (Fig. 5). 63.9 % (n = 108/168) of the participants perceived faculty teaching alone to limit their understanding of neuroanatomy. Also, participants who did not perceive the faculty teaching to limit their understanding of neuroanatomy had a slightly higher mean score for understanding neuroanatomy than the opposite group (6.07/10 vs 5.77/10) (p = 0.242) (Table 1).

85.8 % (n = 187/218) of students reported the time allocated for neuroanatomy teaching to be inadequate. The usage of cadaver dissection (n = 153, 69.5 %), and neurosimulation practicals (n = 146, 66.4 %) were the most recommended tools by students to improve on neuroanatomy teaching (Fig. 6). Also, multiple textbooks were recommended as being efficient in gaining neuroanatomy knowledge (supplementary material).

5. Discussion

Learning and mastering neuroanatomy by medical students is essential to building the deficient skilled neurological and neurosurgical workforce in Africa. With the current efforts to improve on the workforce domain of global neurosurgical systems, investigating the teaching paradigm of neuroanatomy is of utmost importance. The present study used a survey to outline the perceived current state of neuroanatomy education in Cameroon and challenges faced by medical students. Our respondents were from all nine medical faculties in Cameroon, both preclinical and clinical years, and private and public institutions.

Generally, the anatomy of the head and neck was reportedly the most challenging. Neuroanatomy and the anatomy of the head and neck are widely considered the most challenging sections of anatomy (Hall et al., 2018; Javaid et al., 2018). Both intrinsic and extrinsic factors can influence the perception of neuroanatomy amongst students (Javaid et al., 2018). The top five (all intrinsic) from a large survey in Ireland included complexity of the topic, understanding clinical aspects of neuroanatomy, visualisation of CNS structures, appreciation of 3D relationships, and memorisation of neuroanatomical terminologies. Hall et al. (2018), also reported the volume, detail-orientated, and 3D nature of neuroanatomy as determinants of learning difficulties amongst second-year medical students in the United Kingdom (Hall et al., 2018). Among the extrinsic factors, the time spent in the dissection room and lecture duration were the most reported to influence perceptions of neuroanatomy. In our study, the majority of the participants reported underutilisation of cadaver dissections and inadequacy of the time allocated to neuroanatomy. Given the link of the aforementioned extrinsic factors to understanding neuroanatomy, these findings may explain the challenge expressed in the head and neck sections of anatomy reported in this survey. Moreover, according to the 2015 harmonised medical program in Cameroon, neuroanatomy is taught almost entirely in the first semester of the first year of medical training in the course "HEAD AND NECK". Given the widely reported challenge with this course, introducing this course too early in the curriculum may add to the aforementioned challenges. This may suggest a possible need to look into the educational approach to dispensing neuroanatomy in Cameroon medical schools and beyond.

An in-depth assessment of the difficulties perceived in studying neuroanatomy found that few students reported all sections of neuroanatomy to be equally challenging. There were variations in what sections were difficult and easy to understand. The cranial nerves and neurovascular anatomy predominated in terms of difficulty, while the peripheral nervous system and function of the brain and nerve fibres pathways were the least difficult. These findings suggest specific contributors to neurophobia within the Cameroon anatomy curriculum. These areas of difficulties identified could inform where to focus attention when designing future educational programs to enhance access to quality neuroscience education in Cameroon and other countries with a similar curriculum.

Most of our participants reportedly had an average understanding of neuroanatomy and found the time allocation for studying it insufficient. The recommended teaching hours for neuroanatomy taught in medical schools can vary, and this variation reflects the diversity in approaches to teaching anatomy across different medical schools and countries (Newman et al., 2021). In Cameroon, neuroanatomy is taught almost entirely in the course "HEAD AND NECK", and expects all students to attend 45 h of classroom lectures, 15 h of tutorials, and 30 h of practicals, giving a total of 90 h dedicated to neuroanatomy. During this course, students are taught all aspects of neuroanatomy as per the school schedule in the first semester of the first year. The average understanding reported by most participants in this survey probably reflects the difficulties in understanding the head and neck anatomy. This could also be associated with the fact that the neuroanatomy contact hours

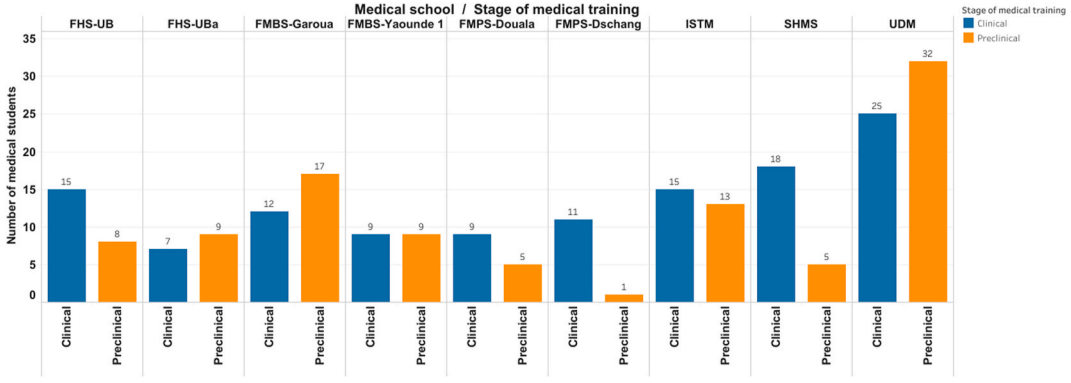

Fig. 1. Distribution of students who participated in the survey per medical school and stage of medical training. To explore the interactive figure: click here.

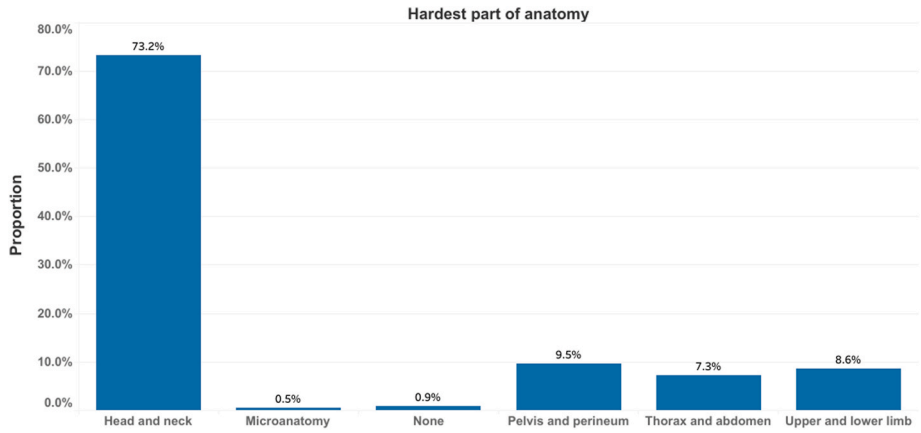

Fig. 2. The most difficult part of anatomy expressed as a percentage of study participants (N = 220). To explore the interactive figure on the difficulties of anatomy per medical school and stage of medical training: click here.

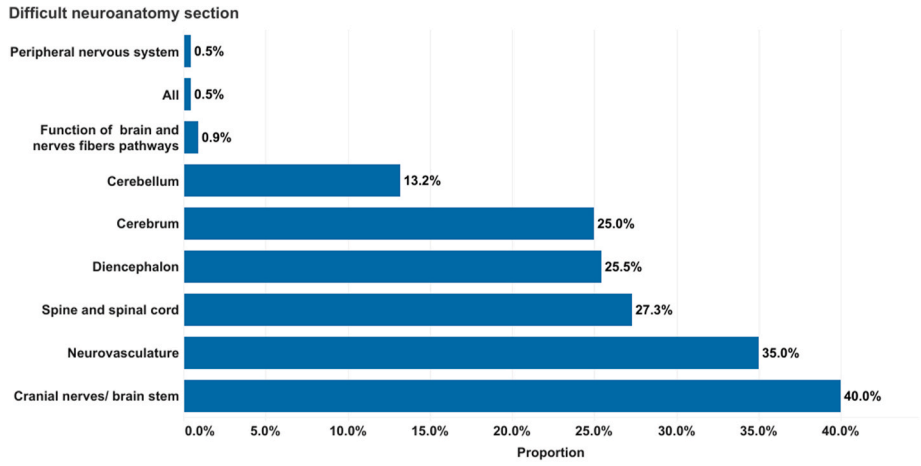

Fig. 3. The most difficult section of neuroanatomy expressed as a percentage of study participants (N = 220). To explore the interactive figure on the difficulties of neuroanatomy per medical school and stage of medical training: click here.

Table 1
Comparison of Neuroanatomy Understanding Amongst Cameroonian Medical Students Based on Training Stage, Training Language, Institution Type, and Perception of teaching tool (N = 220)
*= (*N = 169*).

Variable	Category	Count (n)	Mean ± Standard Deviation/10	P-value
Stage of training	Preclinical	99	6.05 ± 1.574	0.060
	Clinical	121	5.65 ± 1.537	
Language of training	French	158	5.84 ± 1.574	0.881
	English	62	5.81 ± 1.545	
Institution type	Private	108	5.67 ± 1.629	0.124
	Public	112	5.99 ± 1.486	
Teaching tool alone limits understanding of neuroanatomy*	Yes	108	5.77 ± 1.586	0.242
	No	61	6.07 ± 1.569	

may not be fully respected or underutilised, as reported in previous studies (Gogalniceanu et al., 2009; Dekesel et al., 2022; Smith et al., 2022). These therefore may have a great impact on the understanding of neuroanatomy by these students. The reported reasons for this phenomenon include scheduling conflicts with other courses in the curriculum and competing demands on the lecturer's time for research, clinical duties, and in some cases administrative obligations (Lochner et al., 2016). The latter is a real problem in Cameroon, where there is a scarce and uneven distribution of recommended neuroanatomy lecturers (neurosurgeons, neurologists, and anatomists). For example, it was reported that there are only 25 neurosurgeons for 26.5 million Cameroonians in 2020, with 76 % located in the same regions as 33 % of the medical schools (Kanmounye et al., 2020). Similarly, Cameroon was estimated to have 1.11 neurologists per million inhabitants in 2015 (Mateen et al., 2016). Given this disproportionate burden, medical students are taught neuroanatomy by non-neurological specialists. This can result in students not having a full grasp of the clinical relevance and importance of neuroanatomy (Matthias et al., 2013; Hernando-Requejo, 2020).

The lack of enthusiasm or confidence from the instructor can negatively influence students' interest in neurosurgery/neurology and ultimately lead to neurophobia. Additionally, students may not receive adequate exposure to complex neuroanatomy and the high-level spatial reasoning skills required. Furthermore, non-specialists may also lack the clinical experience to prioritise the most relevant neuroanatomy adapted to the context. Increasing the number of contact times for neuroanatomy is a proven solution to reduce neurophobia among medical students (Hall et al., 2018). Also, refresher lectures and practical sessions during case-based learning and bedside teaching, especially in the clinical years, can be beneficial in optimising neuroanatomy knowledge among these students. Moreover, in medical schools lacking neurological faculty, invited or guest lectures online or on-site from faculties affiliated with a different medical school may be considered. Global collaborations with experts and organisations dedicated to

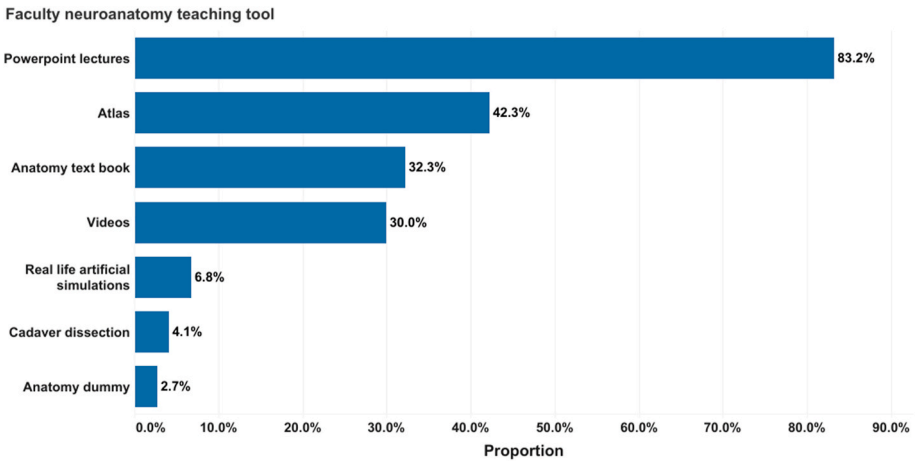

Fig. 4. Distribution of the various teaching tools used by the faculty to teach neuroanatomy in Cameroon expressed as percentage of study participants (N = 220). To explore the interactive figure on the various teaching tools across each medical school: Click here.

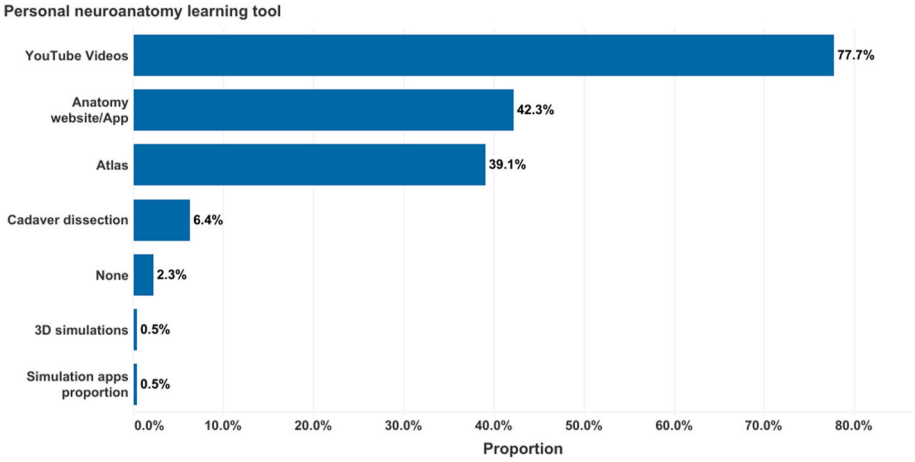

Fig. 5. Distribution of the various personal tools used by Cameroon medical students to acquire neuroanatomy knowledge (N = 220). To explore the interactive figure on the various personal learning tools used across each medical school, and stage of medical training: Click here.

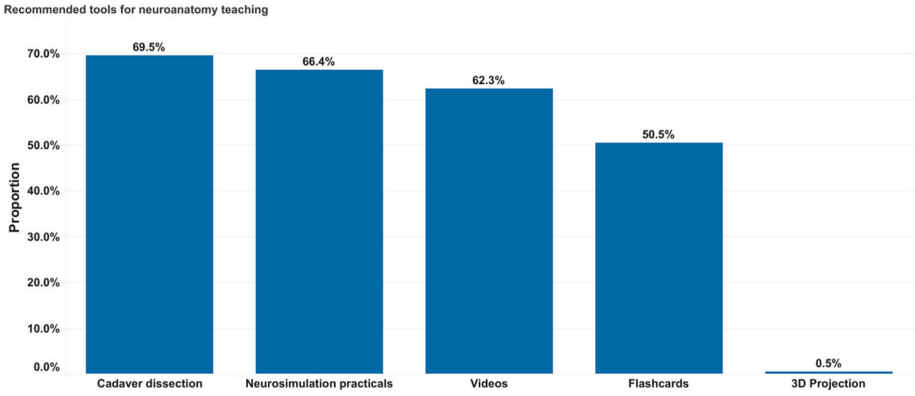

Fig. 6. Recommended tools to improve on neuroanatomy teaching (N = 220).

advancing neuroanatomy teaching, such as the International Association of Neuroanatomy, could facilitate access to expertise, resources, and innovative teaching strategies tailored to resource-limited settings.

In Cameroon's medical curriculum, there is an equal distribution of time allocated for neuroanatomy classroom lectures, practicals and tutorials. The reported predominance of PowerPoint lectures as a mode of teaching and the scarcity of cadaver dissections add more arguments to support that the number of contact hours allocated for neuroanatomy may not be respected owing to the scarce and unevenly distributed workforce (Kanmounye et al., 2020; Mateen et al., 2016). Estai and Bunt (2016) reported that the use of lecture-based teaching as a tool to teach neuroanatomy has become particularly attractive over cadaver dissection, which is now considered outdated, costly, time-consuming and a potentially hazardous approach (Estai and Bunt, 2016). Nevertheless,

this mode of teaching has some limitations. PowerPoint slides may not adequately convey the true complexity of neuroanatomy, over-simplifying complex neuroanatomical concepts (Dorji et al., 2021). It also fails to engage students and promote active understanding, thus making it less effective for long-term learning and memory retention. Lastly, it does not provide the hands-on practice and spatial reasoning skills needed to truly master neuroanatomy. The same limitations apply to anatomy atlases and textbooks, which were most frequently used after PowerPoint lectures by faculty in neuroanatomy teaching.

Cadaveric dissection is traditionally a recommended means to encourage active learning and promote long-term retention of neuroanatomy. The reported scarcity of this mode of teaching can be explained by the fact that in Cameroon and other parts of Africa, cadaveric laboratories are limited, and the few available are faced with funding, ethical, cultural, and infrastructure barriers (Takoutsing et al., 2023). This therefore suggests a burning need for medical students to explore other means, such as recommended online resources and neurosimulation, among others (Javaid et al., 2018; Takoutsing et al., 2023). In this study, YouTube videos were mostly used to complement classroom teaching by medical students. This finding is similar to many studies in both developing and developed nations (Zargaran et al., 2020; Gayef and Çaylan, 2021; Shoufan and Mohamed, 2022). YouTube videos can be an effective supplement to traditional teaching methods. It provides access to a wide variety of neuroanatomy video resources that can help students visualise complex structures and concepts, allowing students to review the teaching material at their own pace (Gayef and Çaylan, 2021). However, YouTube videos alone may not substitute hands-on learning through cadaver dissections and clinical exposure. There are also concerns about the quality and accuracy of the content delivered. As recommended by the majority of students in this study, neurosimulation is a tool to improve neuroanatomy teaching (Arantes et al., 2018). This allows for interaction and appreciation of the 3D relationships between neuroanatomical structures and develops spatial reasoning skills, similar to the cadaver experience, which is scarce in Africa. Recently, the development of non-cadaveric neurosimulation models has been proven to mimic accurately the human body (Chawla et al., 2022). Following a training with these models in Cameroon, medical students express the desire for such forms of teaching to be incorporated into the official medical curriculum (Takoutsing et al., 2023). Similarly, augmented and virtual reality models have been implemented and have shown benefits in transmitting neuroanatomy knowledge, especially in parts of the world with limited body organ donations (Gurses et al., 2024; Trandzhiev et al.)

While the challenges in neuroanatomy education identified in our study—including the perceived complexity of this part of neuroscience, reliance on PowerPoint lectures, and preference for cadaveric dissection, among others may be similar to those faced in high-income countries, the educational context in Cameroon which is similar to other African nations introduces additional constraints (Ahmed et al., 2024; Olabode and Calistus, 2021). Unlike in settings where neuroanatomy instruction is supplemented with cadaver-based learning and simulation technologies, most Cameroonian medical students have limited access to these resources. The reported shortage of trained clinical neuroanatomy faculty and the early placement of neuroanatomy in the curriculum may further exacerbate learning difficulties. These findings underscore the possible need for curriculum adjustments and investment in alternative teaching modalities such as neurosimulation and virtual and augmented realities, particularly in resource-limited settings.

6. Limitations

Our study had a few limitations. Firstly, our sample size may not be reflective of the number of medical students in Cameroon. However, participants in the survey were from all nine medical schools in this nation, and both clinical and preclinical-level students participated in the study. Secondly, our results may be subject to reporting bias on the part of the participants in the survey. To reduce this, our questionnaire was anonymised and a representative of the CAMSA known by all students in the various schools ensured its distribution. This helped ensure confidence and ensure truthful filling of the questionnaire by those who consented to participate in the survey. Non-response bias was possible given the use of online questionnaires. Students without access to internet facilities, smartphones, or computers may have hindered their participation in the survey. Language barriers may also have led to non-response bias. To reduce this, questionnaires were distributed in the two official languages of Cameroon, and the choice was given to choose which is convenient. Lastly, recall bias may have predisposed study participants to provide false responses. This may be true for participants in the clinical years of study who have completed the "HEAD AND NECK" course at least three years prior to our survey. Nevertheless, we had almost equal participation from both clinical and preclinical students and some of our results didn't show any statistically significant difference in the responses between these groups. Also, first year medical students were not surveyed to ensure only those who were taught neuroanatomy filled the questionnaire.

7. Conclusion

Mastering neuroanatomy is critical for developing the skilled neurological and neurosurgical workforce needed in Cameroon and Africa at large. However, neuroanatomy is the most challenging section of anatomy in Cameroon. The perceived challenges faced by Cameroon medical students vis-à-vis neuroanatomy are both intrinsic and extrinsic. The predominant use of PowerPoint lectures and the underutilisation of cadaver dissections, combined with insufficient time allocation and the scarcity of specialised faculty, are perceived to significantly impact students' understanding and retention of neuroanatomy.

To improve neuroanatomy education, medical faculties in Cameroon may consider integrating more hands-on and interactive teaching methods, reassessing the timing and adequacy of neuroanatomy instruction, and expanding access to diverse educational resources and specialised faculty. While prior research suggests that such interventions could enhance neuroanatomy comprehension and reduce neurophobia, our study did not directly evaluate their effectiveness. Future research should explore the impact of these educational modifications through interventional studies assessing student performance and confidence in neuroanatomy. Beyond research, collaborative efforts between medical institutions, policymakers, and international partners could facilitate curriculum reform, faculty development, and the integration of cost-effective simulation tools to enhance neuroanatomy training in resource-limited settings.

Author contributions

KN: conception, design, data collection, data curation, writing, reviewing and editing, and project administration. NK: conception, design, data collection, writing, reviewing and editing.

BT: data analysis, data curation, writing, reviewing and editing. ERBA, JN, JN, NC, AEN, SK, KY, RN, EN, JEN, MM, VE, NG: writing, reviewing and editing. IE: conception, design, reviewing and editing, supervision. All authors contributed to the article and approved the submitted version.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bas.2025.104259.

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