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ABSTRACT

Background and objectives: This study aimed to evaluate students' perspectives on the relevance of anatomy education to clinical practice throughout their studies at the Faculty of Medicine in Skopje.

Materials and methods: The study was designed as a cross-sectional, questionnaire-based investigation and took place at the Faculty of Medicine in Skopje at the University of "Ss Cyril and Methodius", R. North Macedonia. The questionnaire form included demographics, five-point Likert items, and open-ended questions. Questionnaire data were collected from volunteer students participants, currently and not currently involved in anatomy education, consisting of 134 first-year and 87 fourth- and fifth-year students during March and April 2024.

Results: Junior students agreed that their anatomy education helped them achieve some important goals for clinical practice, such as adopting and applying medical terminology and the ability to visualize a three-dimensional human body map. Senior students were less convinced that the structures and concepts acquired during anatomy education were relevant to clinical practice, helped them acquire clinical knowledge and skills effectively, and

understand the principles of evidence-based medicine. Both junior students and their senior colleagues disagreed that anatomy education succeeded in developing their self-confidence, teamwork, and communication skills.

Conclusions: Both groups of students had similar preferences and suggestions for redesigning anatomy courses to focus on essential elements that are functionally and clinically relevant. This can be achieved through traditional and modern teaching methods, small group work, and the establishment of learning outcomes within clinically relevant contexts.

Keywords: medical education, anatomy education, clinical practice, questionnaire; survey, medical faculty

INTRODUCTION

Anatomy has been an essential component of medical education for many years. While current trends may indicate a reduced emphasis on teaching anatomy, it continues to be a crucial aspect of preclinical medical education, with clinical anatomy becoming increasingly significant [16, 22]. Introducing clinically focused anatomy topics during lectures and utilizing various teaching methods can contribute to developing well-prepared doctors for modern clinical practice. Clinicians emphasize the need for customized anatomy education to equip students for effective participation in clinical practice. The perspectives of clinicians whose specialties are closely associated with a strong understanding of anatomy are centered on high-quality and clinically oriented anatomical education. However, students may not always appreciate the significance of anatomy in cultivating professional and teamwork skills [21]. There is an ongoing discussion about the depth and breadth of anatomical knowledge required and the most effective teaching approaches [10, 23]. Nonetheless, there is consensus that anatomy topics should have clinical relevance, and a combination of teaching methods is most effective. The optimal approach to teaching anatomy is to integrate multiple complementary pedagogical resources [8]. The modern anatomy curriculum faces a significant challenge in preparing students for safe medical practice, especially those in later years of study who may have been distanced from anatomy for some time. This raises the question of whether they are adequately prepared to begin safe medical practice and if the existing anatomy curricula meet their needs and prepare students for safe and modern medical practice. Survey studies have revealed differing opinions on the role of anatomy education among students, staff, and clinicians [17, 26]. Questionnaire-based survey studies,

designed for medical students, can provide valuable data for the improvement of anatomy education. This survey was based on a questionnaire for medical students, evaluating the level of agreement with statements regarding the role of anatomy education in clinical practice, along with open-ended questions allowing students to formulate their suggestions and recommendations. The survey included different groups of students currently and not currently involved in anatomy education, aiming to evaluate their perspectives on the relevance of anatomy education throughout their medical studies. The responses of the two student groups will differ due to variations in their motivation, personal experiences, and expectations.

The investigation aimed to assess students' perspectives on the relevance of anatomy education to clinical practice in medical school throughout their medical studies.

MATERIALS AND METHODS

The study was designed as a cross-sectional, questionnaire-based investigation and took place at the Faculty of Medicine in Skopje at the University „Ss Cyril and Methodius”, R. North Macedonia. It included 221 volunteer medical undergraduates who responded to an online call during the 2023–2024 academic year. The study sample consisted of 134 (67%) first-year students participating in anatomy education and 87 (43.5%) fourth- and fifth-year medical students who had already been involved in clinical practice as part of their medical studies. Approval for the study was obtained from the institutional Research Ethics Committee (No.03-4422/7; 19.09.2024). The educational programs at the Faculty of Medicine are nationally accredited by the “Higher Education Accreditation and Evaluation Board” from the Agency for Quality in Higher Education of the Republic of North Macedonia (AQHE) ([https://www.enqa.eu/membership-database/heaeb-higher-education-accreditation-andevaluation-board/Decision no. 08–74/4 from 19th of July 2024](https://www.enqa.eu/membership-database/heaeb-higher-education-accreditation-andevaluation-board/Decision%20no.%2008-74/4%20from%2019%20of%20July%202024)). In our Medical Faculty, anatomy education is provided to students during the first two years of their undergraduate medical studies, which covers the first three semesters through an integrated curriculum. The curriculum integrates theoretical lectures, practical cadaver-based teaching through dissection activities, and the use of prosecuted and plastinated specimens. Additionally, students and educators have access to radiologic anatomy using medical imaging and computer-based learning. During the first semester, students are introduced to anatomy, focusing on the locomotor system, including the systematic and topographic anatomy of the upper and lower extremities. In the second semester, students learn about the systematic and topographic anatomy of the thoracic, abdominal, and pelvic cavities. Finally, in the third semester, the

systematic and topographic anatomy of the head and neck, along with the central nervous system are covered.

To develop the questionnaire about the relevance of anatomy education to clinical practice, we followed a three-phase process: **Phase I:** Needs analysis and planning; **Phase II:** Questionnaire development, and **Phase III:** Validation and reliability evaluation [2]. The questions were formulated following detailed consultations with the faculty's anatomy education staff. We also sought feedback from student delegates, considering their input, whether positive or negative, during the preparation of the questionnaire. The questionnaire for first-year medical students focuses on their expectations, as they have not yet started clinical practice. However, the questionnaire for senior students allows them to express their agreement with statements based on their own experiences and readiness for clinical practice. The statements and open-ended questions were prepared in Macedonian. Most of the survey statements used a Likert scale response format, where respondents rated their level of agreement on a scale of 1 to 5. The questionnaire's first section requested general demographic data, while the second section consisted of statements for students to rate their agreement. The third section included open-ended questions for students to express their opinions on the negative aspects of the anatomy curriculum and to suggest improvements, Table 1. Students were encouraged to answer the open-ended questions, and the questionnaire was tested in a pilot study with a small number of students, with revisions based on the feedback received. The first-, fourth-, and fifth-year medical students were all informed about the questionnaire, with a text that included an explanation of the study's purpose, the voluntariness of participation, and the safety of the data collected. The questionnaire data was collected digitally in March and April 2024 from the first-year students, and in April 2024 from the fourth and fifth-year students. Google Forms was used to administer the questionnaire. The data was then exported from Google Forms to Microsoft Excel (Microsoft Corp., Redmond, WA, USA), and the Statistical Package for Social Sciences SPSS V 26 (IBM Corp, Armonk, NY, USA) for analysis. Descriptive statistics (frequencies and percentages) were used to present the results. For analyzing Likert-item-based categorical data, Chi-square analysis supported by Monte Carlo simulation was used, with a statistical significance level of 0.05. The internal consistency of the items in the second section was measured using Cronbach's alpha. For analyzing the qualitative data in the third section of the questionnaire, the thematic analysis method was utilized. This involved identifying and grouping themes in the data, based on the responses to open-ended questions. The researchers read the responses multiple times and noted key themes in each participant's response. These

key themes were then grouped into final categories, with each participant's response included in the appropriate category.

RESULTS

The study included 200 first-year students and 200 fourth- and fifth-year students from the Faculty of Medicine in Skopje. A total of 134 (67%) first-year and 87 (43.5%) fourth- and fifth-year medical students participated in the questionnaire. The average age of the first-year students was 19.63 [standard deviation (SD): 1.2, Min: 18, Max: 26], and the average age of the fourth- and fifth-year students was 23.6 (SD: 1.43, Min: 21, Max: 29). Demographic details of the participants are presented in Table 2. Gender demographic characteristics of the participants are in accordance to the students' population at the faculty of Medicine in Skopje.

The students' level of agreement with the statements

The Cronbach's alpha value obtained was 0.6 for the first-year medical students. The results of the second section of our questionnaire, which pertains to first-year medical students, are presented in Table 3 and Fig. 1. The students' level of agreement with the statements is summarized based on the results of the statistical analysis as follows.: St 2.1.1: It was found that anatomy theoretical and practical lessons help first-year medical students to adopt and apply medical terminology, which is particularly important for their future clinical practice ($p = 0.000$). St 2.1.2: The majority of the students thought they could always visualize a three-dimensional map of the anatomic structures of the human body ($p = 0.000$). St 2.1.3: The students' opinions were opposed to the statement that anatomy education improved their self-confidence, their teamwork, and communication skills; the majority of them disagreed or were neutral to this statement ($p = 0.007$). St 2.1.4: The majority of the first-year medical students disagreed or were neutral to the statement that forgotten anatomical knowledge could come back easily with a small amount of repetition ($p = 0.000$). St 2.1.5: The majority of the junior students agreed with the statement that they could see clearly that anatomy would be a part of their clinical practice from the beginning of the medical studies ($p = 0.000$). St 2.1.6: Additionally, the majority of them thought that their knowledge and interest in anatomy would influence their future career choice ($p = 0.000$).

The Cronbach's alpha value for the group of fourth- and fifth-year medical students was 0.806. The results from the responses of the students to the second section of our questionnaire are presented in Table 4 and Fig. 2. The students' level of agreement with the

statements is summarized below: St. 2.2.1: Students held opposing opinions about the relevance of the anatomical structures and concepts they learned to their clinical practice ($p = 0.157$); St. 2.2.2: The majority of the students believed that anatomy education helped them connect basic to clinical medicine ($p = 0.003$); St. 2.2.3: The majority of students agreed that they began to realize the importance of anatomy in clinical practice during their fourth and fifth years of medical studies ($p = 0.000$); St. 2.2.4: The majority of senior students agreed that they have forgotten a lot of the anatomy they learned in the first years of their studies ($p = 0.000$). St 2.2.5: The majority of students had self-confidence in their ability to visualize a three-dimensional map of the anatomical structures of the human body ($p = 0.000$); St.2.2.6: Senior students stated that forgotten anatomical details come back easily with a little reminder ($p = 0.005$); St.2.2.7: Senior students stated they often use their knowledge of anatomy to effectively acquire clinical knowledge and skills, but many were undecided about this statement ($p = 0.002$); St.2.2.8: The majority of senior students agreed that the topics of anatomy related to their clinical practice are permanently remembered ($p = 0.000$); St.2.2.9; Students had opposing opinions regarding the statement that anatomy education enhanced their understanding of the principles of evidencebased medicine and the ability to think critically and analytically ($p = 0.007$); St.2.2.10; The majority of senior students, similar to their first-year colleagues, disagreed with the statement that anatomy education has improved their self-confidence, teamwork, and communication skills ($p = 0.084$).; St.2.2.11: Students in the final years of medical studies disagreed that anatomy education would affect their future career choice ($p = 0.033$).

The students' responses to open- ended questions

The responses to open-ended questions in the Questionnaire from the first-year medical students were analyzed and grouped based on the topics they covered. The results were presented in Table 5 for question Q3.1.1 (What are the major deficiencies in anatomy education from your perspective?) and in Table 6 for question Q3.1.2 (What suggestions or ideas do you have for enhancing and progressing anatomy education?). The rate of response for Q3.1.1 was 30.6%, with 41 students answering, and for Q3.1.2, it was 93.3%, with 125 students answering. The comments for the question "What are the major deficiencies in anatomy education from your perspective?" are shown in Table 5a. These comments covered five main themes, with the most numerous comments focusing on the extensive and highly detailed material to learn, as well as the demanding and long-lasting practical lessons requiring prior studying of the topics. Students were more inclined to provide suggestions for

improving the anatomy curriculum. The majority of these suggestions involved integrating practical lessons with theoretical lectures, conducting small group work, and using different teaching practices to make lessons more engaging and effective. Many junior students also emphasized prioritizing clinically relevant topics over unnecessary details, along with recommending greater use of 3D anatomy platforms and video recordings.

The open-ended responses from the Questionnaire form for fourth- and fifth-year medical students were analyzed and categorized based on themes. The findings were summarized in Table 7 for the question “What are the major deficiencies in anatomy education from your perspective?” and Table 8 for the question “What suggestions or ideas do you have for enhancing and progressing anatomy education?”. The response rate for the question “What are the major deficiencies in anatomy education from your perspective?” was 46%, with 40 students answering. For the question “What suggestions or ideas do you have for enhancing and progressing anatomy education?”, the response rate was 90%, with 78 students answering. 64 comments were given for the question “What are the major deficiencies in anatomy education from your perspective?”. The comments were categorized into three themes. The most common themes included comments about extensive and detailed learning material, as well as comments about the numerous knowledge assessments and the detailed, and stressful nature of exams. Many senior students offered suggestions covering diverse topics to improve the anatomy curriculum. Most of the suggestions were related to integrating practical lessons with theoretical lectures, replacing theoretical teaching with practical interactive teaching, and conducting teaching in small groups. Also, many senior student comments highlighted the importance of avoiding unnecessary details and focusing on essential clinically relevant topics. Suggestions such as continuous use of 3D anatomy platforms and video recordings, as well as changing the way anatomy is examined, were also noted by the students. Some senior students recommended incorporating clinical anatomy in the final years of integrated medical studies.

DISCUSSION

The study aimed to collect information from early and final-year medical students about the long-term nature of anatomical education and its outcomes throughout medical studies. In the first year of studies, learning anatomy is fundamental, while in the final years, applying anatomy knowledge during clinical practice dominates. As students’ progress through their studies, they build a solid foundation of anatomical knowledge, followed by processes of forgetting and storing data in their long-term memory. They eventually apply this knowledge

in clinical settings. The anatomy knowledge gained in the early years provides the basis for clinical training and practice. This knowledge is restructured throughout medical studies, and clinically important topics are reinforced and appropriately applied during clinical practice. To develop a modern and effective anatomy curriculum, it is important to consider the perspectives of medical students, educators, and clinicians. Previous studies have focused on the perspectives of individual categories (e.g., students or educators), while others have compared the views of diverse groups involved in anatomy education [9, 15, 20]. In this study, the perspectives of two groups of students (first and final-year medical students) were evaluated to understand the process of acquiring and applying anatomy knowledge from their point of view. To analyze anatomical education in terms of its clinical relevance, the study considered the different cognitive factors influencing the perceptions of the two groups of students. The first group's perceptions were based more on expectations, while the second group's perceptions were primarily based on individual experiences. The voluntary participation rate of first-year medical students in the applied questionnaire was 67%, while the participation rate of fourth and fifth-year students was 43.5%. Junior students currently involved in anatomical education showed a greater need to share their ideas and thoughts. Junior students found that anatomy education helped them learn and apply medical terminology. Both junior and senior students gained self-confidence from using 3D anatomy platforms, especially in the ability to visualize 3D maps of the human body's structures. Although there is no evidence showing that computer-based learning is superior to traditional dissection methods, it is a useful supplement for visualizing anatomical structures [6, 14, 24]. Anatomy practical laboratory sessions involve cadaver dissection and prosection (pre-dissected specimens), which enhance students' understanding of topographical anatomy and provide a three-dimensional visualization of structures. A cross-sectional study involving 250 undergraduate medical students who participated in cadaveric dissection during their first year found that the majority felt that dissection deepened their understanding (91.8%) and offered a three-dimensional perspective of anatomical structures (92.4%) [13]. Furthermore, the dissection experience contributed significantly to anatomy knowledge retention and long-term memory. During the dissection process, students experienced the practical application of their anatomical knowledge, which instilled in them a sense of responsibility as future physicians. Junior and senior students in our study had mixed or negative views on whether anatomy education improved their self-confidence, teamwork, and communication skills. This suggests a need for a student-centered curriculum that emphasizes small group work and problem-based learning to enhance interactivity, communication, and teamwork skills.

Problem-based learning requires students to apply critical thinking, collaborate with colleagues, and gain self-respect and satisfaction from solving problems. Many publications recommend problem-based courses to produce confident, practically-minded physicians [1, 25]. However, reduced public funding for higher education hinders the implementation of these changes. Our students expressed a strong preference for practical anatomy laboratory lessons, even suggesting that anatomy lectures be integrated into anatomy practical sessions. The atmosphere in the anatomy laboratories appeared to be much more conducive to student engagement, allowing material to be presented through various teaching methods. This approach enabled more students to receive feedback and participate actively, fostering a more personalized learning experience. Universal Design for Learning (UDL) is a pedagogical framework developed by the Center for Applied Special Technology (CAST) in the United States during the 1990s. It aims to transform and design curricula to be inclusive for all types of learners within a single teaching environment. A study conducted at a single institution in Ireland found that 91% of first-year undergraduate healthcare students — majoring in medicine, dentistry, occupational therapy, and speech and language therapy — believed that UDL had been implemented in the anatomy laboratory sessions. However, only 52% felt that UDL had been effectively applied in the anatomy lectures [7]. In the current study, senior and junior students offered different perspectives on the impact of anatomy education. According to this study, most senior students were undecided about anatomy education improved their understanding of evidence-based medicine and enhanced their critical thinking skills. They agreed that forgotten anatomical details were easily retrieved. On the other hand, junior students were undecided or disagreed on this point. This could be because these students are still learning and have not stored a lot of information in their long-term memory yet. The study also highlighted the need to improve anatomical knowledge among students, as poor understanding of anatomical variations could lead to increased risks during medical procedures and misinterpretation of results [11]. Additionally, while junior students felt that anatomy would influence their future career choices, senior students did not share the same opinion, as they believed that other factors and experiences would play a greater role in shaping their professional decisions. Overall, both groups of students recognized the importance of anatomy as the foundation for clinical examination in an integrated medical curriculum. Cadavers, skeletons, preserved specimens, x-rays, CT scans, MRI, and multimedia programs are valuable resources used in anatomy courses to enhance students' understanding of the anatomical basis for clinical examination. To achieve these goals using multimodal teaching approaches can be a valuable supplement to existing educational tools.

A cross-sectional study involving 250 first-year medical students enrolled in a neuroanatomy course examined the effectiveness of stained versus unstained brain sections in helping students identify specific neuroanatomical structures. The results showed a strong preference among participants for stained brain sections. Thematic analysis of the open-ended responses revealed several reasons for this preference, including enhanced visual distinction, improved spatial understanding, and increased confidence, engagement, and interest [18]. Teaching methods that boost student interest and enhance self-confidence and engagement can have a long-term impact on clinical performance and the application of anatomical knowledge.

Studies have suggested that greater emphasis on clinical anatomy education in the gross anatomy curriculum leads to improved performance in final examinations [28]. The senior students in the current study expressed a need for the anatomical structures and concepts learned to be more relevant to clinical practice. It is crucial to emphasize clinically relevant topics to enhance the modern anatomy curriculum. According to senior students, knowledge of anatomy is frequently utilized in acquiring clinical knowledge and skills while examining the cardiovascular, respiratory, abdominal, and urogenital systems through inspection, palpation, percussion, and auscultation. In addition to physical examination, anatomical knowledge is essential for interpreting radiological images, establishing diagnoses, performing clinical and surgical procedures, and understanding anatomical pathology [17, 27].

The senior students often forgot most of the anatomy they had learned in their first years of study but stated that anatomy topics related to clinical practice were permanently remembered. The longitudinal nature of anatomy education is presented in preclinical and clinical studies. An anonymous cross-sectional survey conducted in Poland assessed the recognition of anatomical structures among undergraduate medical students and physicians. The results revealed that anatomical knowledge significantly declines over time, with anatomical structure recognition being up to 25% lower in highly trained physicians compared to pre-clinical medical students [12]. To address this issue, it would be beneficial to provide senior students with thematically tailored anatomical education that runs parallel to the other courses during the clinical phase of their medical studies.

Students' views in the open question section match those of students in the second section of the applied questionnaire in our survey. The method of thematic analysis was used to evaluate open-ended questions in the third section of the questionnaire [5]. The answers were organized concerning the topics covered. The main flaws for both groups of students were the extensive and detailed material to be learned during the theoretical and practical courses in

anatomy. According to students' opinions, knowledge assessment was done by numerous exams, the preliminary tests being particularly stressful for students. To overcome student fears during exams, students often participate in practice exams and quizzes to strengthen learning and to help assess understanding of anatomy concepts. Many online platforms offer anatomy quizzes. Modern trends favor anatomical examinations aimed at assessing topographic and/or applied anatomy knowledge, including visual resources such as body specimens or images, radioactive images, and/or clinical photographs [19].

The recommendations of the students for improving and developing the anatomy curriculum were almost identical in both groups of students. Recommendations for a complete fusion of theoretical and practical courses, their performance in practical course laboratories, and the application of different teaching practices in small groups (3D anatomy platforms, video recordings, cadavers, prosecuted specimens). Recommendations for restructuring anatomy's theoretical and practical courses and knowledge assessment, to reduce unnecessary details and focus on essential elements of clinical practice. Higher students stressed the importance of vertical anatomy integration in clinical studies and suggested the integration of clinical anatomy into the clinical subjects. In addition to the tendency of medical faculties to reduce anatomy courses over the last decade, anatomy remains a fundamental subject in the process of training physicians and their support in clinical practice. Highly detailed and extensive anatomy courses should develop into clinically relevant courses, reducing unnecessary detail. How much basic anatomy knowledge do students need to know and assimilate? This problem is a challenge for anatomists and medical professionals. The core anatomy knowledge for general practitioners may be insufficient for some specialists, such as surgeons and radiologists. Access to anatomy training should be provided to students and residents during the clinical training and practise. This vertical integration into the clinical medical curriculum can result in better, more competent, and safer physicians [3]. Some medical careers require a more detailed knowledge of anatomy and a more detailed training in anatomy. Adapting anatomy education thematically and methodologically to meet the needs of residents and medical professionals at all stages of their careers could enhance their proficiency and efficiency in this critical area.

Modern teaching methods provide better results than traditional teaching methods and, according to current research, stimulate great interest among students. Traditional teaching methods should not be suppressed because they are old-fashioned; on the contrary, they are compatible with computer-based learning and provide numerous benefits for students. The solution is to integrate all these resources to complement each other [4]. Various teaching

methods should be used following the criteria of how much their use helps students acquire essential and effective anatomy knowledge. The reduction in teaching staff and resources and the reduction of contact teaching hours requires efforts to optimize the management of teaching time and maximize students' learning results.

Limitations

The study analyses and discusses only students' perceptions at the Faculty of Medicine in Skopje. Integrating students from other Medical faculties in our country into multi-center research will produce more comprehensive results. Multi-center research can provide a more detailed understanding of students' views on the relationship between anatomy education and clinical practice and advanced statistical analysis. In research and analysis, factors that may affect students' answers, such as students' success presented during assessing anatomy knowledge and socio-economic factors, have not been considered. The statements were adjusted and formulated separately for each group of students, relating to the differences in the experiences and knowledge between the junior and senior students. There were no comparisons between student groups. The response rate of senior students was lower than that of their junior colleagues. This is probably due to their busy schedule and the distance between anatomy education in preclinical medicine and current medical education in clinical medical studies

CONCLUSIONS

The study included first-year medical students who learned anatomy and fourth- and fifth-year students who used anatomy knowledge in their clinical practice. The junior students felt that their anatomy education helped them achieve important objectives for clinical practice, such as understanding medical terminology and 3D visualization of the human body. However, senior students were less convinced that the anatomy knowledge was relevant for clinical practice. Both groups agreed that anatomy education should focus on essential elements and be taught using a mix of traditional and modern methods, in small groups, and in a clinically relevant context.

They also felt that the course should help develop critical thinking and analytical skills and improve self-confidence, teamwork, and communication skills. Understanding the process of acquiring and applying anatomy knowledge from students' points of view will contribute to the development and adaptation of modern anatomy curriculum relevant to clinical practice.

ARTICLE INFORMATION AND DECLARATIONS

Data availability statement

Data is contained within the article or supplementary material. The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

The study was conducted following the Declaration of Helsinki and approved by the Ethics Committee for Research for studies involving humans at the Faculty of Medicine in Skopje, No. 03-4422/7; 19.09.2024.

Author contributions

Niki Matveeva — conceptualization, writing. Julija Zhivadinovikj Bogdanovska — resources, formal analysis. Biljana Zafirova — validation. Elizabeta Chadikovska — software. Ace Dodevski — methodology. Biljana Trpkovska — supervision. Biljana Bojadzieva Stojanoska — formal analysis. Anamarija Paunkoska — investigation.

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Conflict of interest

The authors declare no conflict of interest.

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Table 1A. Questionnaire forms for assessing students’ perceptions of the relevance of anatomy education to clinical practice throughout their medical studies; **B.** Questionnaire form for fourth- and fifth-year medical students.

(a). Questionnaire form for first-year 1 contents	
medical students	
Section 1.1 (S1.1). Demographic data	Q. 1.1.1: Gender Q. 1.1.2: Age
Section 2.1 (S2.1) Statements 2.1	St. 2.1.1: Anatomy theoretical and practical lessons have helped me adopt and apply medical terminology. St. 2.1.2: I have a three-dimensional map of the human body in my mind that I can always visualize. St. 2.1.3: Anatomy education has improved my self-confidence, teamwork, and communication skills. St. 2.1.4: Forgotten anatomical details are easily retrieved with a little reminder. St. 2.1.5: It is evident to me that anatomy will be an integral part of my clinical practice from the start of my medical studies. St. 2.1.6: My knowledge of and interest in anatomy will influence my future career choice.
Section 3.1 (S3.1). Open-ended questions	Q. 3.1.1: What are the major deficiencies in anatomy education from your perspective?

Q. 3.1.2.: What suggestions or ideas do you have for enhancing and progressing anatomy education?

(b). Questionnaire form for fourth-, and fifth-year medical students

	Contents
Section 1.2 (S1.2). Demographic data	Q. 1.2.1: Gender Q. 1.2.2: Age
Section 2.2 (S2.2) Statements 2.2	St.2.2.1: The anatomical structures and concepts we have learned are relevant in scope and content to my clinical practice. St.2.2.2: Anatomy education has helped me connect basic to clinical medicine. St.2.2.3: I have begun to realize the importance of anatomy for clinical practice in the final years of my studies. St.2.2.4: I have forgotten much of the anatomy I learned in the first years of my studies. St.2.2.5: I have a three-dimensional map of the human body in my mind that I can always visualize. St.2.2.6: Forgotten anatomical details are easily retrieved with a little reminder. St.2.2.7: I frequently use my knowledge of anatomy to effectively gain clinical knowledge and skills.

St.2.2.8: The anatomy topics that are relevant to clinical practice are remembered permanently.

St.2.2.9: Anatomy education has enhanced my understanding of the principles of evidence-based medicine and my ability to think critically and analytically.

St.2.2.10: Anatomy education has improved my self-confidence, teamwork, and communication skills

St.2.2.11. My knowledge and interest in anatomy will influence my future career choice.

Section 3.2 (S3.2). Open-endedperspective?
questions

Q. 3.2.1: What were the major deficiencies in anatomy education from your

Q. 3.2.2.: What suggestions or ideas do you have for enhancing and progressing anatomy education?

Table 2. Demographic parameters of student participants by gender.

Year of medical studies	Gender		Total N
	Males N [%]	Females N [%]	
First-year Students	32 (23.9)	102 (76.1)	134 (100)
Fourth- and fifth-year students	24 (27.6)	63 (72.4)	87 (100)
Total	56 (25.3)	63 (72.4)	221 (100)

Table 3. Distribution of first-year medical students' agreement levels with statements (St. 2.1.1–S2.1.6) in Section 2 (S 2.1) of the questionnaire form (n = 134)

2.1	Statements	Strongly disagree % (n)	Disagree % (n)	Neither agree nor disagree % (n)	Strongly Agree % (n)	Agree % (n)	Total	p**
					38.1		100 (134)	0.00
	St 2.1.1	0.7 (1)	8.2 (11)	21.6 (29)	(51)	31.3 (42)	100 (134)	0
	St 2.1.2	0.7 (1)	6 (8)	16.4 (22)	39.6	37.3 (50)	100 (134)	0.00
	St 2.1.3	11.26	20.1 (27)	26.9 (36)	(53) 27.6	14.2 (19)	100 (134)	0.00
	St 2.1.4	(15) 9 (12)	24.6 (33)	20.1 (27)	(37) 34.3	11.2 (15)	100 (134)	7 0.00

St 2.1.5	3 (4)	6 (8)	16.4 (22)	49.3	25.4 (34)	100 (134)	0	0.00
St 2.1.6	3.7 (5)	11.9 (16)	21.6 (29)	35.1	27.6 (37)	100 (134)	0	0.00
				(46)			0	
				(66)			0	
				(47)			0	

*S —statement ** Chi — square test with Monte Carlo
 Section; St ; simulation

Table 4. Distribution of fourth-and fifth-year medical students' agreement levels with statements (St.2.2.1–S2.2.11) in Section 2 (S 2.2) of the questionnaire form (n = 87).

Statements	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total	P
2.2							0.15
St. 2.2.1	13.8 (12)	20.7 (18)	27.6 (24)	24.1 (21)	13.8 (12)	100 (87)	7
St. 2.2.2	5.7 (5)	17.2 (15)	23 (20)	32.2 (28)	21.8 (19)	100 (87)	0.00
St. 2.2.3	5.7 (5)	26.4 (23)	25.3 (22)	31 (27)	11.5 (10)	100 (87)	3 0.00
St.2.2.4	1.1 (1)	10.3 (9)	28.7 (25)	23.0 (20)	36.8 (32)	100 (87)	0
St.2.2.5	2.3 (2)	12.6 (11)	19.5 (17)	31 (27)	34.5 (30)	100 (87)	0.00
St.2.2.6	8 (7)	14.9 (13)	21.8 (19)	33.3 (29)	21.8 (19)	100 (87)	0 0.00
St. 2.2.7	5.7 (5)	20.7 (18)	33.3 (29)	23 (20)	17.2 (15)	100 (87)	5 0.00
St. 2.2.8	3.4 (3)	12.6 (11)	18.4 (16)	34.5 (30)	31 (27)	100 (87)	2 0.00
St.2.2.9	10.3 (9)	23 (20)	32.2 (28)	23 (20)	11.5 (10)	100 (87)	0 0.00

								0.08
St.2.2.10	26.4 (23)	26.4 (23)	20.7 (18)	10.3 (9)	16.1 (14)	100 (87)	4	
St.2.2.11	21.8 (19)	32.2 (28)	18.4 (16)	16.1(14)	11.5 (10)	100 (87)	0.03	

*S — Sectionstatement; square test with Monte Carlo
St — **Chi-simulation.

Table 5. Distribution of first-year medical students' answers to question Q3.1.1 in Section 3.1 (S 3.1) of the Questionnaire form (n = 134).

Themes	Comments count (N)
1. The material to learn is very extensive and highly detailed, essential elements of clinical significance should take priority.	10
2. Large amount of material to process during the long practical lessons.	9
3. The course is very intensive and demanding, leaving insufficient time to prepare for colloquiums and exams.	8
4. Sometimes, there is a lack of alignment between the theoretical and practical courses.	8
5. The preliminary tests are stressful and difficult, with an excessive focus on unnecessary details.	7

Table 6. Distribution of first-year medical students' answers to question Q3.1.2 in Section 3.1 (S 3.1) of the Questionnaire form (n = 134).

Themes of the recommendations	Comments count (n)
1. The integration of theoretical and practical anatomy courses through interactive teaching methods and working in small groups.	47
2. Emphasis on clinically important subjects and fundamental elements in theoretical and practical anatomy courses.	16
3. Providing continuous support for theoretical and practical anatomy courses through medically proven 3D anatomy platforms and video recordings.	15
4. Focusing anatomy knowledge assessment on understanding the material and developing logical and analytical thinking. Avoid unnecessary and stressful preliminary tests.	13
5. Remodeling the anatomy curriculum to increase learning time and to ensure that teachers and laboratories are always available to students.	9

Table 7. Distribution of fourth- and five-year medical students' answers to question Q3.2.1 in Section 3.2 (S 3.2) of the Questionnaire form (n = 87).

Themes	Comments count (n)
1. The learning material is very extensive and highly detailed, but it does not highlight clinically relevant topics.	22
2. There are numerous stressful assessments of anatomy knowledge, including tests, oral exams, and practical examinations. The preliminary tests are hard and highly detailed.	11
3. Sometimes, there is a lack of alignment between theoretical and practical courses, as well as insufficient communication with the students.	8

Table 8. Distribution of fourth- and five-year medical students' answers to question Q3.2.2 in Section 3.2 (S 3.2) of the Questionnaire form (n = 87).

Themes of the recommendations	Comments count (n)
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1. The integration of theoretical and practical anatomy courses, using problem-based learning and small group sessions. 26
 2. Theoretical and practical anatomy courses should be revised to emphasize essential elements and their clinical relevance. 20
 3. Providing continuous support for theoretical and practical anatomy courses through medically verified 3D anatomy platforms, video recordings and medical images accessible to students. 14
 4. Adjusting the assessment of anatomy knowledge to emphasize understanding of material, logical and analytical thinking. 14
 5. Introducing clinical anatomy in the fourth or fifth year of medical studies. 6
-

Figure 1. Distribution of first-year medical students' agreement levels with statements (St. 2.1.1–S2.1.6) in Section 2 (S 2.1) of the questionnaire form (n = 134).

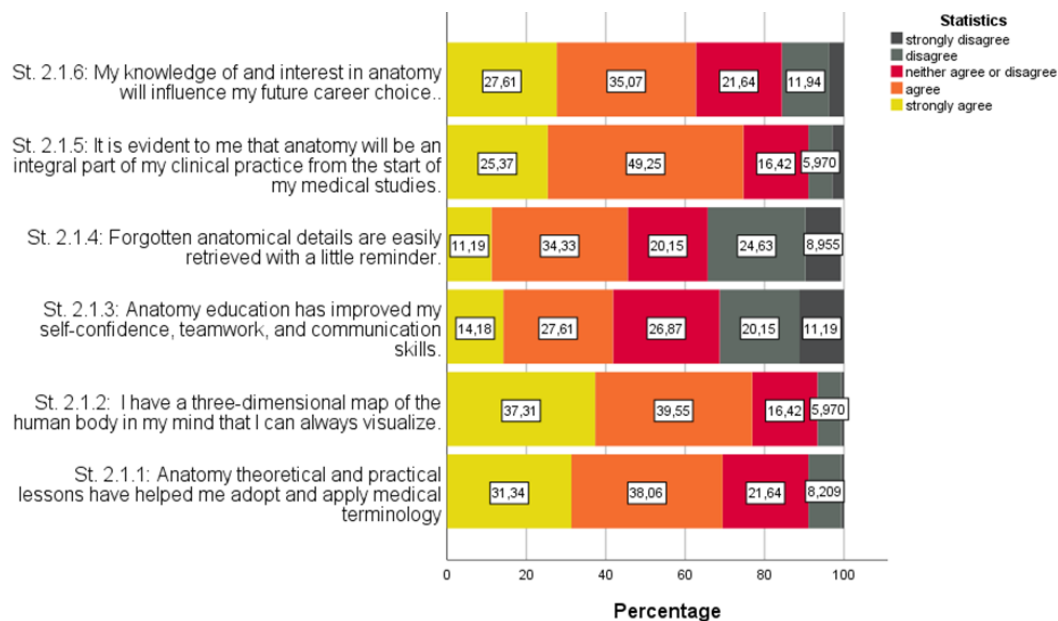


Figure 2. Distribution of fourth-and fifth-year medical students' agreement levels with statements (St.2.2.1–S2.2.11) in Section 2 (S 2.2) of the questionnaire form (n = 87).

