






Clinicians' and Students' Perceptions and Attitudes Regarding the Anatomical Knowledge of Medical Students

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Background: In both the preclinical and clinical sciences, anatomy is considered as the foundation of medical education. Anatomy education serves as a foundation for clinical application and future practice of medicine. Health practitioners and students are interested in the adequacy of anatomical knowledge in clinical years since it has a direct impact on medical education and professional clinical practice.

Objective: To examine the opinions and attitudes of medical students and clinicians regarding the preclinical and clinical years' teaching of anatomy and anatomical knowledge to medical students.

Methods: Participants in the study, including clinicians and medical students, were required to answer an 8-question, 5-point Likert scale questionnaire to assess their attitudes regarding anatomical knowledge. The maximum score was 40, and the higher the score, the more the positive attitude towards anatomical knowledge. The difference in the mean attitude score between males and females was investigated using the Independent sample *t*-test.

Results: A total of 327 clinicians and 423 students participated in the study. Clinicians and students showed moderately high positive attitude towards anatomical knowledge. The mean statements score for clinicians' attitudes was 31.4(±3.4). There was no significant difference between total attitude score means for clinicians and students, $p=0.83$. Attitude statements attained a significantly higher percentages and were in favor to clinicians in comparison to students, particularly for clinical significance of anatomical knowledge to students in the clinical years, the importance of anatomical knowledge to surgical and non-surgical specialties, and re-teaching special anatomy for students in the clinical years would improve their clinical background. Both clinicians and students expressed low agreement regarding anatomical educational style and quality of study materials.

Conclusion: Teaching anatomy to medical students is a continuous process. Therefore, we recommend reforming the anatomy curriculum by vertical integration of anatomy into the clinical rotations, clerkship, and specialist training.

Keywords: anatomy, medical education, clinicians, students, Saudi Arabia

Introduction

Anatomy is “a contraction of two Greek words, ana- (up) and temnein (to cut), therefore anatemnein (to cut up or dissect)”.¹ The publication of the primary opera by Andrea Vesalius (von Wesel), the true father of modern anatomy, marks the beginning of the scientific era of human anatomy.² Regardless of country, racial background, or the system of medical school, anatomy has always been a cornerstone in medical education.³ Medical students gain their first “idea” of the structure of the human body through learning gross anatomy, which is the foundation for understanding pathophysiological and clinical problems. Furthermore, the relevance of teaching anatomy to undergraduate and graduate students cannot be underestimated.³ Recently, traditional anatomy education, which focused on topographical structural anatomy

taught in lectures and gross dissection classes, has been replaced by a variety of study modules, including computer-assisted learning, plastic models, and curriculum integration.^{3–5}

Anatomy knowledge is also essential for communicating effectively with colleagues, completing a medical examination, and making a diagnosis. Competent clinicians require a thorough understanding of anatomy for safe clinical practices.⁶ Human anatomy is a fundamental subject in medical school. Typically, it takes place during the first year of medical school. However, the students do not apply the course outcomes until several years following the final anatomy exams.⁷ At the same time, curricula modifications around the world have resulted in a reduction in both gross anatomy instruction hours and context, which could have an impact on the safety of their medical practices in the long run.^{8–10}

According to Franciska Koens, “the type of curriculum will influence medical students’ attitudes about the perceived relevance of basic science for physician training”.¹¹ Newly qualified doctors were questioned on the appropriateness of anatomy teaching in a survey conducted at the University of Nottingham Medical School in the United Kingdom, with the results revealing that 44.2% of physicians believed they were not taught enough anatomy in medical school.¹² Clinicians and anatomists were unsatisfied with the students’ anatomical knowledge, according to a study conducted at the University of Aberdeen, with radiologists (82%) and surgeons (72%) expressing the most concerns.¹³ As a result, clinicians and students argued for the continuation of anatomy education beyond the basic years of medical school in order to maintain and improve safe and efficient medical practice.¹⁴ A previous study by Farey et al investigated factors associated with medical students’ self-reported confidence in their knowledge of anatomy in advance of clinical practice. This research revealed that the male gender, anatomy education prior to medical school, exposure to dissection, adequate assessment of anatomy, integration of anatomy with other basic sciences and clinical teaching were significant factors that increased self-reported confidence in anatomy knowledge. Additionally, medical students in their clinical years reported having less faith in their understanding of anatomy.¹⁵ Another study by Lunn-Collier et al demonstrated how beneficial clinically relevant anatomy is to students in the eyes of physicians. Some believe that this is currently not being given in an efficient manner. Clinical technologies could potentially be integrated into anatomical pedagogy, according to clinicians.¹⁶

Medical students’ anatomical knowledge is not well examined in Saudi Arabia during the clinical part of their careers. There are limited studies in the Middle East region in general and in Saudi Arabia that explore clinicians’ and students’ perceptions and attitudes towards the anatomical knowledge of medical students. Therefore, this study aimed to examine clinicians’ and students’ perspectives and attitudes concerning medical students’ anatomical knowledge in Saudi Arabia. The findings of this study are likely to aid in a better understanding of the existing medical curriculum’s usefulness and comprehensiveness in regard to the anatomy disciplines. They might also come up with new ways to reimagine the gross anatomy curriculum to make it more practical and therapeutically focused, in order to boost anatomical understanding and medical students’ interest in the topic.

Materials and Methods

Study Design

This is a descriptive cross-sectional survey study that was conducted for the duration between October 2020 and November 2021 to explore physicians’ and students’ perspectives and attitudes concerning medical students’ anatomical knowledge in Saudi Arabia.

Hypothesis

H⁰: We hypothesized that participants demographic characteristics will not influence their attitudes towards anatomical knowledge.

Study Population and Settings

This study involved two populations of interest to explore the study aim: the first population included clinicians who are responsible for medical students’ teaching process at King Abdullah bin Abdulaziz University Hospital, King Salman

Hospital, King Saud Medical City, and Prince Mohammed bin Abdulaziz Hospital. The second population included medical students enrolled in all public universities in Riyadh, Saudi Arabia.

The study was open to all medical students at Imam Muhammad Ibn Saudi Islamic University, King Saud University, King Saud bin Abdulaziz University for Health Sciences, and Princess Nourah Bint Abdul Rahman University. Students in their third, second, and first year were excluded as they have not experienced clinical courses yet. All clinicians who met the inclusion criteria in the participating sites were invited to participate in the study.

Questionnaire Tools

The questionnaire tools used in this study were developed by the research team based on an extensive literature review for studies that explored perspectives and attitudes concerning anatomical knowledge.

Students' Questionnaire Tool

Students in the study were asked to complete a structured questionnaire (11-items) that asked them about their gender, specialty of interest, their own assessment of their anatomical knowledge, and attitude toward anatomical knowledge (8-items on a 5-point Likert scale format ranging from 1 to 5). Based on this the maximum attainable attitude score is 40. The higher the score, the more positive attitude towards anatomical knowledge.

The attitude section asked the participating students about their attitudes concerning the importance of anatomical knowledge during clinical years; importance of anatomical knowledge for surgery specialty and non-surgical specialty; the adequacy of education style and quality of study material for anatomy; attitude towards increasing the content of anatomical knowledge and specifying more time for practical sessions in preclinical years; re-teaching special anatomy for each clinical course and its role in helping in the improvement of students' understanding of clinical knowledge; and redesigning the final exams in clinical years to make more weight for anatomy to help improve students' anatomical background and understanding of clinical knowledge. In addition, the students were asked one open-ended question to explore their recommendation regarding the improvement of anatomical education.

Clinicians' Questionnaire Tool

The clinicians in the study were asked to complete a structured questionnaire that asked them about their gender, specialty, duration of experience in their specialty, and attitude toward the importance of anatomical knowledge for medical students during their clinical years (8-items on a 5-point Likert scale format ranging from 1 to 5). The same questions that were administered to explore students' attitudes were administered to the clinicians to explore their own perception concerning medical students and interns. A similar scoring procedure was applied as that for the clinicians' population, with a maximum attainable score of 40.

Questionnaires Piloting

Healthcare experts in Saudi Arabia who work in academia reviewed the questionnaire tools for clarity and comprehensibility, and they affirmed that, based on their experience, they would be clearly understood by the two research populations (students and clinicians).

The questionnaire tools were then used in a pilot study on a small group of students and clinicians from the collaborating sites who met the study's inclusion criteria. Students and clinicians were asked about the questionnaire's clarity and comprehensibility, as well as whether any of the questions were difficult to understand. They were asked if they thought any of the questions were inappropriate. They confirmed that the questionnaire was simple to comprehend and complete. Cronbach's alpha test was used to explore the internal consistency of the two questionnaires. Cronbach's alpha measure for students' scale was 0.725 and for clinicians' scale was 0.64, which reflect acceptable internal consistency.

Sampling Strategy

A convenience sampling technique was employed in this study to distribute the questionnaire tools to the study participants. The questionnaire tools were distributed to medical students using an online survey link (google form),

which was sent to their email address. Besides, they were invited to participate in the study through social media websites, at which they gather to share their feedback concerning their medical courses and communicate. Another procedure that was employed to increase the number of participants was to distribute the questionnaire tool using paper-based copies. A similar procedure was followed to invite the clinicians from the participating sites (both using an online questionnaire and a paper-based tool).

Ethical Approval

The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Committee of Imam Mohammad Ibn Saud Islamic University (IMSIU), under IRB number 91-2020. Informed consent was obtained from all subjects involved in the study as they were made aware that submitting the questionnaire is considered as giving their consent to part in the study.

Statistical Analysis

The Statistical Package for Social Science (SPSS) software version 27 was used to analyse the data for this study. Categorical variables were presented as frequencies and percentages. Continuous variables were presented as the mean (standard deviation). A Parsons's Chi-square test was used to compare proportions across the two study populations. An independent Sample-test was used to explore the difference in the mean attitude score between males and females. The p-value was set at 0.05.

Results

Characteristics of the Participating Clinicians

Of the 400 clinicians, 327 (81.7%) responded and returned the survey. [Table 1](#) shows the characteristics of the participating clinicians. More than half of them (63.6%) were males. Family physicians, internal medicine physicians, ophthalmologists, pediatricians, and orthopedic surgeons constituted the highest percentage of our sample. Nearly half of

Table 1 Characteristics of the Participating Clinicians

Variable	Frequency	Percentage
Gender		
Males	208	63.6%
Specialty		
Paediatrics	54	16.5%
Orthopedic surgery	48	14.7%
Family medicine	41	12.5%
Internal medicine	38	11.6%
Ophthalmology	29	8.9%
Others	117	35.8%
Experience		
Less than 5 years	163	49.8%
5–10 years	78	24.0%
10–15 years	41	12.5%
16 years and over	45	13.7%

the participating clinicians (49.8%) had less than five years of experience. Table 1 describes the characteristics of the participating clinicians.

Characteristics of the Participating Students

Out of 470 students, 423 (90%) responded to the survey. Less than half of them (47.3%) were males. The vast majority of the participating students (86.3%) were from Princess Nourah Bint Abdul Rahman University. When the students were asked about their future specialty of interest, the most commonly reported were surgery and family medicine, with 18.2% and 7.3%, respectively. Table 2 describes the characteristics of the participating students.

Clinicians and Students' Attitude Towards Anatomical Knowledge

Overall, the participating clinicians showed a moderately positive attitude towards anatomical knowledge with a mean attitude score of 31.4 (± 3.4) (representing 78.3% out of the maximum attainable score, which is 40). There was no statistically significant difference in the clinicians' attitudes based on gender ($t = 3.3$; $P = 0.06$) or years of experience ($F = 1.1$; $p = 0.3$).

For students' attitudes, the mean overall attitude score was 30.7 (± 4.4) (representing 76.7% out of the maximum attainable score). Similarly, there was no statistically significant difference in the mean attitude score between male and female students ($t = 3.5$; $p = 0.06$). Table 3 shows that there was no statistically significant difference in the total attitude score between the two study populations (clinicians and students) ($p = 0.83$).

Table 4 describes the percentages of clinicians and students who showed positive agreement with different attitude statements after combining the two categories: strongly agree and agree. Attitude statements had a significantly higher percentage and were more favorable to clinicians than students. In particular, the clinical significance of anatomical knowledge to students in clinical years, the importance of anatomical knowledge to surgical and non-surgical specialties, and re-teaching special anatomy for students in clinical years would improve their clinical background. Students had a negative attitude toward their anatomical knowledge background; clinicians also expressed a significantly less negative attitude toward students' anatomical background (31.7% vs 19.9%, respectively). Both clinicians and students expressed

Table 2 Characteristics of the Participating Students

Variable	Frequency	Percentage
Gender		
Males	200	47.3%
University		
Princess Nourah Bint Abdul Rahman University	365	86.3%
King Saud University	46	10.9%
Imam Muhammad ibn Saud Islamic University	12	2.8%
Future specialty of interest		
Surgery	77	18.2%
Family medicine	31	7.3%
Others	315	74.4%

Table 3 Means of Total Attitude Score for Clinicians and Students

Clinicians' Total Attitude Score Mean	Students' Total Attitude Score Mean	P-value
31.4 \pm 3.4	30.7 \pm 4.4	0.83

Table 4 Distribution of Attitude Statements for Clinicians and Students

Clinician's Attitude	No (%)	Student's Attitude	No (%)	P-value
Do you think that understanding anatomical knowledge and knowing its clinical significance is important for students in clinical years?	311 95.1%	Do you think that understanding anatomical knowledge and knowing its clinical significance is important for students in clinical years?	374 88.4%	0.001
Regarding the educational style and quality of study material for anatomy that is adapted in the current curriculum, do you think it is adequate and enough?	196 59.9%	Regarding the educational style and quality of study material for anatomy that is adapted in the current curriculum, do you think it is adequate and enough?	261 61.7%	0.61
Regarding the anatomical knowledge of medical students attending your department, rate your opinion on it:	65 19.9%	Regarding your anatomical knowledge, rate your opinion on it:	134 31.7%	0.000
Do you think that anatomical knowledge is important regarding surgical specialties, ? Rate your thoughts about it:	305 93.3%	Do you think the anatomical knowledge is important regarding surgical specialties,? Rate your thoughts about it:	374 88.4%	0.02
Do you think anatomical knowledge is important regarding non-surgical specialties,? Rate your thoughts about it:	274 83.8%	Do you think the anatomical knowledge is important regarding non-surgical specialties,? Rate your thoughts about it:	319 75.4%	0.005
Do you think that increasing the content of anatomical knowledge and specifying more time for practical sessions in preclinical years will help in improvement?	250 76.5%	Do you think that increase the content of anatomical knowledge and specifying more time for practical sessions in preclinical years will help in improvement?	299 70.7%	0.07
Do you think that re-teaching special (regional) anatomy for each clinical course would help improve students' level and understanding of clinical knowledge?	267 81.7%	Do you think that re-teaching special anatomy for each clinical course would help improve students' level and understanding of clinical knowledge?	312 73.8%	0.01
Do you think redesigning the final exams in clinical years to make percentages for anatomy will help improve students' anatomical background and understanding of clinical knowledge?	180 55%	Do you think redesigning the final exams in clinical years to make percentages for anatomy will help improve students' anatomical background and understanding of clinical knowledge?	211 49.9%	0.15

an undesirable attitude regarding anatomical educational style, the quality of study materials, and redesigning the final exams in clinical years, yet there was no significant difference ($p \leq 0.05$).

Discussion

Anatomy is the cornerstone of medical education, providing a background knowledge that is essential for all medical careers.¹⁷ In our study, clinicians and students showed moderately high positive attitudes towards anatomical knowledge with a mean score of 31.4 (± 3.4) and 30.7 (± 4.4), respectively, representing 76.7% to 78.3%. Besides, there was no statistically significant difference between males and females in terms of their attitude towards anatomical knowledge among the two study populations. In addition, clinicians' years of experience did not affect anatomical knowledge significantly ($p \geq 0.05$).

According to our findings, most of the students recognize the significance of anatomy in becoming a good physician. This is consistent with the findings of a previous study, which demonstrated that senior medical students, compared to junior students, appreciate the importance of the anatomy taught in the preclinical years and its relevance to clinical medicine.¹⁸ According to a previous study, the majority of doctors believe that medical students' current anatomical education is insufficient and falls short of what is required for safe medical practice.¹⁹ The examination of a patient, the development of a diagnosis, and the dissemination of these findings to the patient and other medical personnel are all supported by anatomical knowledge.¹³ Human anatomy will undoubtedly not change throughout the length of a doctor's career, contrary to claims that many areas of basic science will. This precludes their inclusion in a "core curriculum".¹³

It offers a foundation of knowledge appropriate for all medical occupations. On the other hand, a previous study reported that most residency program directors thought new graduates were unprepared for jobs in anatomy. However, around half of the respondents (56%) stated that there had been no significant change in graduates' anatomical knowledge over a 10-year period, which was also observed in the survey.⁷ The majority of respondents who took part in the survey felt that medical students lacked an adequate understanding of anatomy. The majority of the participants reported that fresh medical school graduates lack the basic anatomical understanding that might jeopardize patient safety. Anatomy's significance in the medical curriculum has also been hotly debated in the medical literature. On the other hand, some of the participants reported that the quality of the anatomical knowledge of recent medical graduates has declined.²⁰ In another previous research, participants from all groups reported that learning anatomy was an essential element of the medical school curriculum. Clinicians were unsure whether anatomy education had an impact on their ability to perform well in a clinical setting. This may also help to explain why they do not think anatomy education has had a significant impact on professional competence. Physicians' reported modest levels of agreement with claims that learning anatomy improves professionalism, teamwork, communication skills, and critical thinking. In a study by Prince et al,²¹ thirteen anatomy specialists, clinicians, clerks, and fresh graduates were asked to establish a pass/fail criteria for an anatomy test at the beginning of clinical training. The judges who just graduated (failing only 26%) were by far the most lenient judges, yet students imposed the highest standard (failing 64%) (58% and 42%, respectively). Researchers found that because they had more clinical experience and a better understanding of how much they had learnt during their clerkship, study participants were more forgiving to fresh graduates. It is not immediately clear why students set such high standards for themselves when they are first beginning their clinical training. In a 2013 study, students said that anatomy was taught in regions, with some sections taking months to understand. As a result, they were unable to depict the human body and its functions clearly on a drawing.²² Several junior students have also expressed worries about this problem and its possible clinical repercussions. Additionally, it was noticed that students struggled to apply what they had learned in class while assessing and diagnosing patients or interpreting radiological images in the clinic.

The results of our research suggest that a significant number of physicians are curious about what goes on in the anatomy department and frequently want to be engaged. Clinicians believe that medical schools are not adequately preparing students for a future in medicine by teaching them enough anatomy. Both of our study populations, "clinicians and students" showed moderately high positive attitudes towards anatomical knowledge. Although these results are promising and better than other findings from other countries, we recommend that this positive attitude should be maintained and even enhanced. One dimension that should be considered by decision makers who develop medical school curricula is to solve the problem of anatomical knowledge retention, which has been frequently reported in previous literature.²³ So, there should be some kind of continuous medical education that emphasizes anatomical knowledge refreshment for final year students. Another approach is conducting anatomy review sessions during the clinical third year using prosected cadavers in two half-day session.²⁴ Additionally, it is advised to repeat and reinforce key concepts to help students remember and retain them.²⁵ This may also have a significant impact on how clinical and diagnostic thinking are developed in medical students early in their training.

This study has several strengths. To the best of our knowledge, this is the first study in Middle Eastern Arabic-speaking countries to investigate clinicians' and students' perspectives and attitudes concerning medical students' anatomical knowledge. Our study population included clinicians from all specialties, which increases the generalisability of these findings. However, there are some limitations. The study design itself, a cross-sectional survey design, limited our ability to identify causality between study variables. The use of convenience sampling technique is not free from bias. No prior study had been conducted in the Middle East exploring clinicians' and students' perspectives and attitudes concerning medical students' anatomical knowledge, which prevented us from comparing our findings with Arabic-speaking countries of a similar healthcare environment and culture.

Conclusion

Clinicians and students showed a positive attitude towards anatomical knowledge in Saudi Arabia regardless of their gender or clinicians' years of experience. Our findings could be a step toward reforming the anatomy curriculum in our

medical school and its clinical rotations. Multiple actions should be implemented in order to maintain and improve this positive attitude towards anatomical knowledge. We recommend vertical integration of anatomy into our curriculum starting in the first year and continuing through the clerkship and specialty training to increase the retention of clinically pertinent anatomical knowledge. Additionally, to encourage closer integration of the basic and clinical domains, specialty-specific anatomy courses could be provided during the clerkship.

Abbreviation

IMSIU, Imam Mohammad Ibn Saud Islamic University.

Ethical Approval

The protocol was approved by the ethics review board of the Faculty of Medicine, Imam Mohammad Ibn Saud Islamic University (IMSIU), Saudi Arabia. Approval No. 23-2020

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Koens F, Mann KV, Custers EJ, Ten Cate OT. Analysing the concept of context in medical education. *Med Edu.* 2005;39(12):1243–1249. doi:10.1111/j.1365-2929.2005.02338.x
2. Vesalius A, Park K. *De humani corporis fabrica*. Basel: Rippol Klassik; 1998.
3. Papa V, Vaccarezza M. Teaching anatomy in the XXI century: new aspects and pitfalls. *Scientific World J.* 2013;2013:1–6. doi:10.1155/2013/310348
4. Staden HV. *Herophilus: The Art of Medicine in Early Alexandria*. USA: Cambridge University Press, Cambridge, Mass; 2004.
5. Porter RS. *Blood and Guts: A Short History of Medicine*. WW Norton & Company; 2002.
6. Estai M, Bunt S. Best teaching practices in anatomy education: a critical review. *Anatomischer Anzeiger.* 2016;208:151–157. doi:10.1016/j.aanat.2016.02.010
7. Staśkiewicz GJ, Walczak E, Torres K, et al. What do clinicians think of the anatomical knowledge of medical students? Results of a survey. *Folia Morphologica.* 2007;66(2):138–142.
8. Bergman EM, Prince KJ, Drukker J, van der Vleuten CP, Scherpbier AJ. How much anatomy is enough? *Anat Sci Educ.* 2008;1(4):184–188. doi:10.1002/ase.35
9. Craig S, Tait N, Boers D, McAndrew D. Review of anatomy education in Australian and New Zealand medical schools. *ANZ J Surg.* 2010;80(4):212–216. doi:10.1111/j.1445-2197.2010.05241.x
10. Older J. Anatomy: a must for teaching the next generation. *Surgeon.* 2004;2(2):79–90. doi:10.1016/S1479-666X(04)80050-7
11. Centre for Teaching Excellence. Self-directed learning: a four-step process; 2020. <https://uwaterloo.ca/centre-for-teaching-excellence/teaching-resources/teaching-tips/tips-students/self-directed-learning/self-directed-learning-four-step-process>. Accessed April 13, 2022.
12. Dettmer S, Tschernig T, Galanski M, Pabst R, Rieck B. Teaching surgery, radiology and anatomy together: the mix enhances motivation and comprehension. *Surg Radiol Anatomy.* 2010;32(8):791–795. doi:10.1007/s00276-010-0694-5
13. Turney BW. Anatomy in a modern medical curriculum. *Annals Royal Coll Surg Engl.* 2007;89(2):104–107. doi:10.1308/003588407X168244
14. Aljoudi SB, Alsolami SS, Farahat FM, Alsaywid B, Abuznadah W. Patients' attitudes towards the participation of medical students in clinical examination and care in Western Saudi Arabia. *J Family Community Med.* 2016;23(3):172–178. doi:10.4103/2230-8229.189133
15. Farey JE, Bui DT, Townsend D, Sureshkumar P, Carr S, Roberts C. Predictors of confidence in anatomy knowledge for work as a junior doctor: a national survey of Australian medical students. *BMC Med Educ.* 2018;18(1):1–8. doi:10.1186/s12909-018-1280-5
16. Lunn-Collier R, Layman-Lemphane JI, Baatjes KJ, Correia J. Clinicians' opinions on the clinical relevance of anatomy education at Stellenbosch University. *Anat Sci Educ.* 2022;15:745–753. doi:10.1002/ase.2175
17. Nabil N, AlMously N, AlWathnani S, Abduldaiem A, Allssa H. Medical students perception on anatomy knowledge relevance and retention during clerkship. *J Contemporary Med Educ.* 2014;2(3):1. doi:10.5455/jcme.20140928035119

18. Cottam WW. Adequacy of medical school gross anatomy education as perceived by certain postgraduate residency programs and anatomy course directors. *Clin Anat.* 1999;12(1):55–65. doi:10.1002/(SICI)1098-2353(1999)12:1<55::AID-CA8>3.0.CO;2-O
19. Waterston S, Stewart I. Survey of clinicians' attitudes to the anatomical teaching and knowledge of medical students. *Clin Anat.* 2005;18:380–384. doi:10.1002/ca.20101
20. Sbayeh A, Qaedi Choo MA, Quane KA, et al. Relevance of anatomy to medical education and clinical practice: perspectives of medical students, clinicians, and educators. *Perspect Med Educ.* 2016;5(6):338–346. doi:10.1007/s40037-016-0310-4
21. Prince KJ, Scherpbier AJ, van Mameren H, Drukker J, van der Vleuten CP. Do students have sufficient knowledge of clinical anatomy? *Med Edu.* 2005;39(3):326–332. doi:10.1111/j.1365-2929.2005.02096.x
22. Bergman EM, de Bruin AB, Herrler A, Verheijen IW, Scherpbier AJ, van der Vleuten CP. Students' perceptions of anatomy across the undergraduate problem-based learning medical curriculum: a phenomenographical study. *BMC Med Educ.* 2013;13:1–11. doi:10.1186/1472-6920-13-152
23. Jurjus RA, Lee J, Ahle S, et al. Anatomical knowledge retention in third-year medical students prior to obstetrics and gynecology and surgery rotations. *Anat Sci Educ.* 2014;7(6):461–468. doi:10.1002/ase.1441
24. Drake R. A unique, innovative, and clinically oriented approach to anatomy education. *Acad Med.* 2007;82:475–478. doi:10.1097/ACM.0b013e31803eab41
25. Feigin D, Magid D, Smirniotopoulos J, Carbognin S. Learning and retaining normal radiographic chest anatomy: does preclinical exposure improve student performance? *Acad Radiol.* 2007;14:1137–1142. doi:10.1016/j.acra.2007.06.023

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