Relevance of anatomical knowledge in first aid
A three-year study of medical students' perspective

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Abstract
Anatomy plays a vital role in medical education, serving as a fundamental basis for understanding various medical disciplines, conducting physical examinations, and interpreting medical imaging. Furthermore, a solid grasp of anatomy is essential for the effective implementation of first-aid procedures. The objective of this research was to investigate the relationship between medical students' performance in anatomy and first-aid courses, as well as to assess students' perspectives on the significance of anatomy in first-aid practices. Over the course of 3 academic years, 2 online surveys were administered to students prior to the commencement of the first-aid course. The 1st survey measured their knowledge of anatomy, while the 2nd evaluated their attitudes toward the relevance of anatomy in first aid. The attitude survey was subsequently readministered at the conclusion of the first-aid course. The findings revealed a significant correlation between the scores obtained in the anatomy knowledge test and those achieved in the first-aid course. While the initial attitude survey indicated a positive outlook among students, with a preference for higher response scales, the follow-up results showed a decrease in the selection of higher scales and an increase in the selection of lower scales. Although these shifts were not statistically significant, they suggest that the first-aid course may not have adequately emphasized the importance of anatomical knowledge. Despite students recognizing the relevance of anatomy in first aid, there is an opportunity to strengthen this connection more effectively within the framework of first-aid instruction.

Abbreviations: CI = confidence interval, COVID-19 = coronavirus disease 2019, CT = computed tomography, SD = standard deviation.

Keywords: anatomical knowledge, clinical integration, first-aid education, medical students

1. Introduction

A comprehensive understanding of human anatomy is fundamental for conducting clinical physical examinations and for the effective application of contemporary imaging techniques. This knowledge enables healthcare professionals to visualize the human body in 3 dimensions and to grasp its intricate structures and relationships, particularly in surgical contexts and emergency situations. Furthermore, a thorough understanding of anatomy is essential for the delivery of effective first aid, as it facilitates the accurate identification of injury sources and ensures the appropriate administration of medications.[1] Understanding anatomy is essential for healthcare professionals, as it provides critical insight into the functioning of the human body. This foundational knowledge is vital for conducting safe and effective clinical procedures, performing thorough physical examinations, and administering basic life support.

Furthermore, it enhances the ability to accurately identify and treat a wide range of injuries and illnesses.[2]

As technology has progressed, there has been a notable transformation in the delivery of human anatomy education within academic institutions. Advanced imaging techniques, including endoscopy, magnetic resonance imaging, and computed tomography scans, have unveiled a wealth of previously unrecognized insights for clinicians. These advancements emphasize the vital importance of a comprehensive understanding of gross anatomy, which is essential for accurate interpretation of imaging studies and for the continuation of high-quality patient care.[3–5]

The role of anatomical knowledge in clinical practice is well recognized; however, there has been a concerning reduction in the time dedicated to its instruction within medical education, particularly during the preclinical years. This trend merits

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careful consideration to ensure that future medical professionals are adequately prepared for their responsibilities in patient care.[6] Moreover, the use of cadaveric dissection in medical schools has gradually declined.[7]

The recent reduction has raised important concerns regarding the preparedness of medical students to effectively apply their anatomical knowledge in clinical settings. Additionally, it calls into question the extent to which they retain this knowledge throughout their ongoing clinical training.[4,8]

The challenges associated with anatomical education became particularly evident during the coronavirus disease 2019 (COVID-19) pandemic, which necessitated a transition to online learning modalities. This shift significantly restricted access to in-person cadaveric dissection laboratories, resulting in a notable reduction in hands-on learning opportunities and direct face-to-face instruction. Consequently, these limitations have impacted the development of students' practical skills and raised important concerns regarding their ability to fully comprehend complex anatomical concepts that are essential for effective clinical practice.[9,10]

Given the limited research on the impact of anatomical knowledge on first-aid performance, this study aims to assess the correlation between 1st-year medical students' understanding of anatomy and their performance in a first-aid course. Furthermore, the study will investigate the students' perspectives regarding the significance of anatomical knowledge in facilitating a thorough understanding of first-aid procedures.

2. Materials and methods

This study utilized a cross-sectional design involving 1st-year medical students from The Hashemite University in Zarqa, Jordan, during the summer courses of 2021, 2022, and 2023. In the earlier years of 2021 and 2022, the courses were delivered in an online format, while the 2023 course was conducted in person on campus. Learning first-aid is not a common practice in the schools or the community where the research was conducted. First-Aid is usually taught as part of the curriculum of colleges of medical specialties (faculty of medicine, nursery, and allied medical sciences). Students in all the cohorts came from various regions in Jordan and they all studied high school under the same educational system. All cohorts studied the same curriculum in their 1st year of medical school. Part of this curriculum was a course of General Anatomy taught in the 2nd term of the academic year (the term preceding the summer term during which the research was conducted). The first-aid course was taught by the same instructors to the 3 cohorts and under the same curriculum.

Prior to commencing the first-aid course, students were required to complete 2 online forms through the Microsoft Forms platform. The 1st form assessed the participants' anatomical knowledge pertinent to first aid, and the 2nd evaluated their attitudes regarding the importance of anatomy in first-aid training. Students were contacted and the link of the study was sent through the online First-Aid course group. The students were encouraged to participate, but participation was voluntary.

The anatomy test consisted of 22 multiple-choice questions designed by the anatomy and first aid instructors from the Faculty of Medicine at The Hashemite University, focusing on essential anatomical concepts relevant to 1st responders. Only face validity was considered. A sample of these test questions is provided in Table 1. The 2nd form was adapted from the research of Moxham and Plaisant,[11] anchored in Thurstone attitude measurement methodology.[12]

The attitude assessment instrument comprises 17 statements, as detailed in Table 2. Prior to commencing the first-aid course, participants were invited to evaluate their level of agreement with each statement on a scale ranging from 1 to 10, with 1

representing the lowest level of agreement and 10 denoting the highest. Upon completion of the course, participants were asked to reassess their agreement using the same instrument to identify any changes in attitude.

The mode, or the most frequently selected agreement value for each participant, was calculated and utilized as their attitude score for subsequent statistical analysis. Furthermore, the assessment of student progress in the first-aid course was conducted through 2 theoretical examinations: one administered during the course and the other at its conclusion. The maximum attainable score for the first-aid course was 100.

The study received approval from the Institutional Review Board of the Hashemite University. Prior to participation, all individuals provided written informed consent.

This was an exploratory, observational study and no formal sample size calculation was performed. The absence of a control group limits causal inference regarding the effect of anatomical knowledge on first-aid performance or perception.

Data were systematically compiled using Microsoft Excel and analyzed with International Business Machines (IBM) Statistical

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Table 1

Representative questions from the anatomy knowledge assessment.

Q) The radial pulse is felt as the radial artery passes:
   A) Against the neck of the radius
   B) Over the radius bone in the wrist
   C) Over the ulna
   D) Within the carpal tunnel
   E) Medially within the palms
Q) When examining an injured person, you suspect that there's a fracture of the 11th rib on the left side. Which of the following organs may also be injured in this condition?
   A) Liver
   B) Ascending colon
   C) Spleen
   D) Ileum
   E) Stomach

Table 2

Assessment tool for evaluating medical students' attitudes on the importance of anatomy in First Aid.

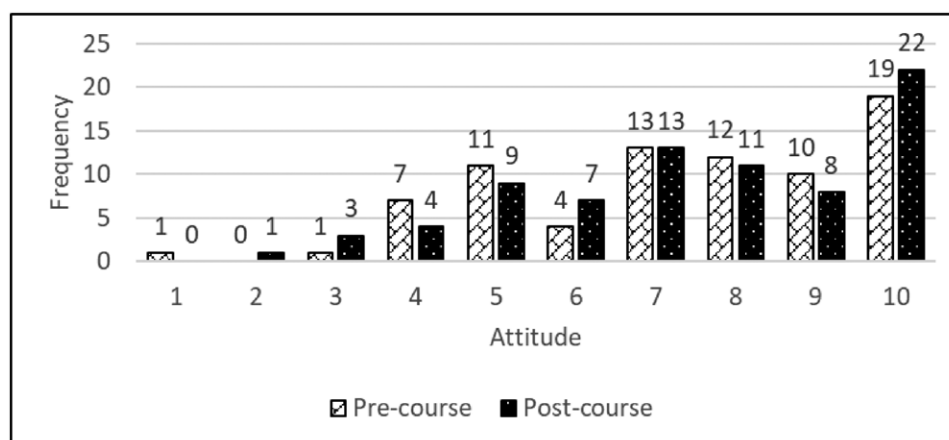|	
1	Although anatomy is interesting, the subject needs a selective understanding of first aid.
2	Anatomical terminology is the vocabulary of first aid.
3	Anatomy is a useful tool for the satisfactory application of first-aid procedures.
4	Anatomy is a "necessary evil" in first aid.
5	Anatomy is of some use in first aid, but its importance may be exaggerated.
6	Anatomy is only of benefit in certain medical specialties, but not first aid.
7	Every first aider must have a good knowledge of anatomy.
8	It is impossible to conceive of a good application of first aid without major anatomy knowledge.
9	It is not possible to make a reasonable assessment of injury without knowledge of anatomy.
10	First aid could not exist without anatomy.
11	Most first aid procedures do not require a great knowledge of anatomy.
12	Of all the basic sciences, anatomy is the most relevant in first aid.
13	Only a limited anatomical knowledge is required for the satisfactory application of first aid.
14	The principles of first aid are not founded on anatomical knowledge.
15	Without a knowledge of anatomy, a person applying first aid is of limited effectiveness.
16	You have taken anatomy topics relevant to first aid in your previous anatomy courses.
17	You are confident that your knowledge of anatomy is enough to help you understand first aid better.

Figure 1. Frequency distribution of attitude rating (1–10) in pre- and post-course surveys for the 2020–2021 students.

Package for the Social Sciences (SPSS) version 26 software (IBM Corporation, Armonk). Data were tested for normality. All data were found to be not normally distributed, except the anatomy quiz and first aid scores of the 2022–2023 cohort which were found to be normally distributed. Appropriate tests were employed. To evaluate the relationship between students' pre-course anatomy knowledge and their performance in the first-aid course, Pearson/Spearman correlation coefficient was applied. Additionally, the percentage and range of attitude scores were calculated. The Wilcoxon signed-rank test was utilized to compare attitude scores prior to and following the course, while the Kruskal–Wallis test was employed to assess differences among the 3 groups. Also, delivery modality (online vs in-person) was not adjusted for due to the observational design and small sample size. A significance level of $P < .05$ was established for determining statistical relevance.

3. Results

During the 2020–2021 academic year, a total of 78 students participated in the study. The pre-course survey revealed that 19 students (24%) assigned the highest attitude rating of 10. Notably, no students selected a rating of 2, while one student (0.65%) indicated a rating of 1, and another student (0.65%) chose a rating of 3.

In the post-course survey, 22 students (28%) again selected the highest rating of 10, with no participants choosing a rating of 1, and only 1 student (1.3%) selecting a rating of 2.

Figure 1 illustrates the distribution of student responses across the attitude ratings from 1 to 10. The analysis shows that the frequencies for ratings 1, 4, 5, 8, and 9 decreased, whereas the frequencies for ratings 2, 3, 6, and 10 increased. The frequency for rating 7 remained unchanged. For the 2020–2021 cohort, the median pre-course attitude score was 8, which was also the median for the post-course score. The Wilcoxon signed-rank test showed that the differences between these scores were not statistically significant ($Z = -0.167$, $P = .868$, approximate 95% confidence interval [CI] = –0.5 to 0.5).

Of the 78 participants, 65 completed the anatomy quiz at the outset of the course, with an average score of 13.73 (standard deviation [SD] = 3.69). By the end of the first-aid course, these students achieved an average total score of 80.84 (SD = 8.31). For the 2020–2021 cohort, a Spearman correlation analysis demonstrated a significant positive correlation between the scores of the anatomy quiz and the first-aid course scores (rho = 0.490, $P < .001$).

During the 2021–2022 academic year, 39 students participated in the study. The pre-course survey indicated that a rating of 10 was the most frequently selected, chosen by 11

students (28%); notably, no participants selected ratings of 1 or 2. In the post-course survey, ratings of 10 and 7 were the most commonly selected by 7 students (18%), and again, no participants selected a rating of 2. Figure 2 illustrates the distribution of these rating choices in both the pre- and post-course surveys.

It was observed that the frequencies of ratings 6, 9, and 10 exhibited a decline, while the frequencies for ratings 1, 3, 4, and 8 increased. Ratings 2, 5, and 7 remained unchanged. For the 2021–2022 cohort, the median pre-course attitude score was 8; whereas, the median for the post-course score was 7. The Wilcoxon signed-rank test showed that the differences between these scores were not statistically significant ($Z = -1.464$, $P = .143$, approximate 95% CI = –1.5 to 0).

A total of 39 students participated in the course, with 37 successfully completing the anatomy quiz at the outset. These students achieved a mean score of 15.4 (SD = 3.18) on the quiz. In conjunction, they attained a mean total score of 83.15 (SD = 9.98) in the first aid course. For the 2021–2022 cohort, a Spearman correlation analysis demonstrated a significant positive correlation between the scores of the anatomy quiz and the first-aid course scores (rho = 0.026, $P = .880$).

For the 2022–2023 academic year, a cohort of 81 students engaged in pre- and post-course attitude surveys. In the pre-course survey, the rating of 10 was the most commonly selected option, chosen by 23 students (28%), a trend that persisted in the post-course survey, where 27 students (33%) selected the same rating. Conversely, a rating of 2 was the least frequently chosen in the pre-course survey, with no respondents selecting it. In the post-course survey, ratings of 2 and 3 were also the least selected, each chosen by 3 students (3.7%). Figure 3 presents the frequency distribution of these attitude ratings across both surveys. Notably, the frequencies of ratings 1 through 5 and 10 exhibited an increase, while those of ratings 6 through 9 displayed a decrease. For the 2022–2023 cohort, the median pre-course and post-course attitude scores were both 8. The Wilcoxon signed-rank test showed that the differences between these scores were not statistically significant ($Z = -1.051$, $P = .293$, approximate 95% CI = –1.0 to 0.5).

Additionally, from the same group of 81 students, 68 completed the anatomy quiz at the start of the course, achieving a mean score of 14.37 (SD = 3.29). These students also recorded a mean total score of 91.53 (SD = 3.65) in the first aid course. A Pearson correlation test indicated a significant correlation between the anatomy quiz scores and the first-aid course scores ($r = 0.253$, $P = .038$).

Table 3 presents the frequency and percentage of participants who selected the highest attitude ratings (8–10) and the lowest attitude ratings (1–3) across the 3 student samples analyzed. The
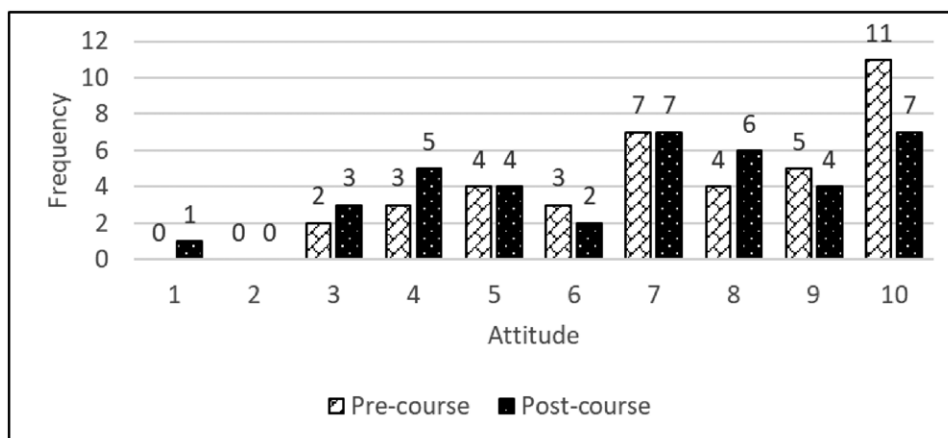
Figure 2. Frequency distribution of attitude rating (1–10) in pre- and post-course surveys for the 2021–2022 students.
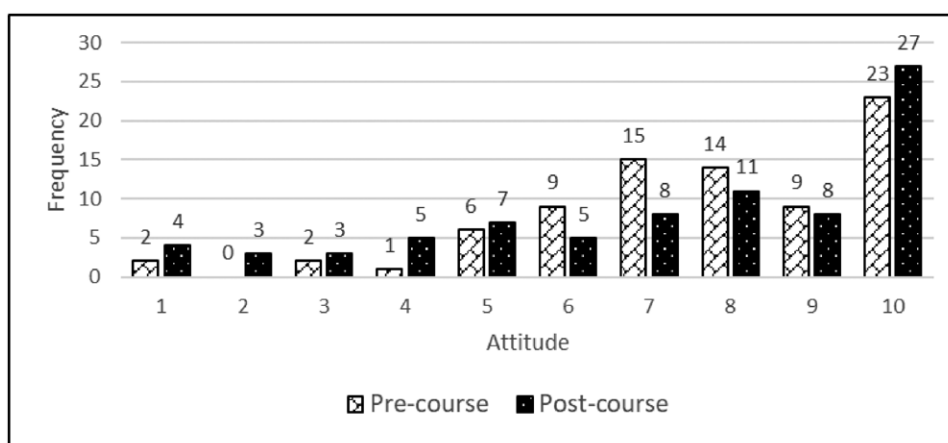

Figure 3. Frequency distribution of attitude rating (1–10) in pre- and post-course surveys for the 2022–2023 students.

Table 3

Frequency and percentage of the highest and lowest attitude ratings.

	Survey			
	Pre-course		**Post-course**	
Year	**Ratings 1–3**	**Ratings 8–10**	**Ratings 1–3**	**Ratings 8–10**
2020–2021	2 (2.6%)	41 (52.6%)	4 (5.1%)	41 (52.6)
2021–2022	2 (5.1%)	20 (51.2%)	4 (10.3%)	17 (43.6%)
2022–2023	4 (4.9%)	46 (56.8%)	10 (12.3%)	46 (56.8%)

attitudes of these participants were evaluated using the Kruskal–Wallis test for comparison. The findings revealed no significant differences in the pre-course survey results ($H[2] = 0.825$, $P = .662$) or in the post-course survey results ($H[2] = 2.322$, $P = .313$).

4. Discussion

A comprehensive understanding of human anatomy is crucial for the effective application of various first-aid procedures. This includes accurately identifying pulse locations, administering injections with precision, and properly realigning dislocated joints.

This study assessed students' attitudes regarding the significance of anatomical knowledge in contextualizing first-aid scenarios over 3 academic years. The first 2 years (2020–2021 and 2021–2022) involved remote teaching due to the COVID-19 pandemic. In contrast, the 3rd year (2022–2023) saw the resumption of on-campus learning, allowing students to engage in practical sessions focused on human anatomy within laboratory settings. The first-aid course was conducted in an auditorium, utilizing mannequins for demonstration of specific procedures.

Prior to enrolling in the first-aid course, students completed a general anatomy course, which provided a concise overview of essential anatomical concepts pertaining to various bodily systems. Building on this foundational knowledge, students were presented with a series of first-aid questions that emphasized anatomical points relevant to emergency care (refer to Table 1). Analysis revealed a significant correlation between the

scores from this assessment and the overall scores for the first-aid course in both the 2020–2021 and 2022–2023 academic years. This suggests that a solid understanding of anatomy is advantageous for learning first-aid techniques. However, in the 2021–2022 academic year, no significant correlation was identified. This may be attributed to the challenges posed by online instruction and assessments, as well as the smaller sample size of only 37 students who completed the anatomy quiz. The lack of correlation in the 2021–2022 cohort may also reflect unmeasured differences in student engagement or motivation. However, due to the small sample size, we were unable to perform meaningful subgroup or regression analyses to further explore this result.

The results of a pre-course attitude survey indicated that participants across all 3 academic years generally held a positive perception of the role of anatomical knowledge in delivering effective first aid. More than 50% of students rated their attitude toward this knowledge highly (scores ranging from 8 to 10) on the assessment scale, while approximately 5% or fewer provided low ratings across all years (see Table 3). This strong appreciation for anatomical knowledge in the context of first aid may reflect the effectiveness of the anatomy instruction received. These findings highlight the importance of a solid foundation in anatomical knowledge for clinical scenarios requiring first aid, supporting previous research that underscores the benefits of early and contextually relevant anatomy education in enhancing students' preparedness for various clinical practices.[13–15]

During the first-aid post-course survey for the 2021–2022 academic year, it was observed that the percentage of respondents who rated their experience in the highest range (8–10) diminished compared to the results of the pre-course survey. In contrast, the percentage of responses indicating the lowest satisfaction (1–3) doubled across all 3 years in the post-course survey. Furthermore, a comparison of pre- and post-course survey outcomes revealed that the differences were statistically insignificant for all 3 years. Although post-course attitude scores showed a downward trend in some cohorts, these differences were not statistically significant. Therefore, no causal conclusions can be drawn about the course's impact on students' perceptions. The observed changes should be interpreted cautiously and warrant further investigation through more robust study designs.

While these differences did not reach statistical significance, they may indicate a potential shift in students' attitudes towards anatomy following the completion of the first-aid course. This change in perception likely arose from several pedagogical challenges faced during the course delivery at Hashemite University School of Medicine. Notably, the large cohort sizes, ranging from 700 to 1000 students per batch, significantly hindered the implementation of practical hands-on training, resulting in limited opportunities for applying anatomical knowledge in relevant contexts.

The onset of the COVID-19 pandemic further exacerbated these limitations, requiring a shift to online instruction that eliminated face-to-face engagement. Even in the post-pandemic period, instructional demonstrations were primarily instructor-led and did not provide students with opportunities for practical practice. This transition from online to in-person learning is a key confounding variable. The lack of hands-on practical sessions for the online cohorts may have influenced not only their practical skill acquisition but also their perception of anatomy's relevance, as tactile application often solidifies theoretical knowledge. This difference in modality could partially explain the variation in correlation strength between anatomy and first-aid scores across the years, as the in-person cohort may have benefited from demonstrations that better linked anatomical landmarks to procedures.

These factors likely contributed to the students' perceptions regarding the significance of anatomical knowledge in first-aid scenarios, as reflected in our 2nd survey results. This situation underscores the necessity for innovative pedagogical strategies that can effectively address the challenges posed by large class sizes and limited resources in medical education, particularly in courses designed to integrate theoretical knowledge with practical skills.[16]

The challenges identified may reflect a more extensive concern within medical education: a significant loss of knowledge in the basic sciences. This issue appears to stem, in part, from inadequate teaching time and a perceived lack of relevance in the curriculum.[17,18] Addressing these challenges requires a comprehensive approach. This may involve reducing the volume of content, focusing on clinically relevant topics, and enhancing the integration of basic and clinical education. Potential strategies include implementing additional simulation and practical sessions, as well as embracing problem-based learning methodologies. These initiatives aim to foster a deeper understanding and application of knowledge in clinical settings.[19,20]

The limitations of this study include the self-reported nature of the data, which may introduce potential bias, along with the small size of the convenience sample, which might not be fully representative. Additionally, we did not account for potential confounding variables such as grade point average, prior clinical experience, or demographic characteristics, which could have influenced performance and perceptions. Furthermore, the single-institution design may limit the generalizability of the findings. It is also important to recognize that data collection during the COVID-19 pandemic might not reflect typical educational environments. The shift from online to in-person learning over the course of the study introduces variability that could have affected both students' perceptions and performance. This factor was not controlled for in the analysis, which may impact the comparability across cohorts. Future studies should incorporate these variables to allow adjusted multivariate analysis.

Looking ahead, future research should prioritize the development and evaluation of innovative educational strategies that effectively connect theoretical anatomical concepts with their practical applications in clinical settings, particularly in first-aid situations. Investigating the effectiveness of diverse teaching methods, such as simulation-based learning, interactive 3D models, and problem-based learning, could provide valuable insights. Moreover, examining the impact of early clinical exposure on students' retention and application of anatomical knowledge in emergency contexts could greatly inform curriculum development and enhance the relevance of basic science education in medical training.

5. Conclusion

This study emphasizes the significant role anatomical knowledge plays in enhancing the understanding and application of first-aid procedures among medical students. A consistent, though variable, correlation was identified between anatomy proficiency and first-aid performance across various academic years, underscoring the importance of a solid grounding in anatomy within emergency medical contexts.

While students initially recognized the relevance of anatomy to first-aid practices, there was a notable decline in perceived significance following the course. This shift may be associated with instructional challenges such as large class sizes, limited opportunities for hands-on training, and the transition to remote learning during the COVID-19 pandemic.

These findings indicate a pressing need to more effectively integrate anatomy with first-aid training through innovative, interactive, and clinically relevant teaching strategies. Enhancing the curriculum to bridge theoretical knowledge with practical skills through methods such as simulation, early clinical

exposure, and problem-based learning could reinforce students' understanding and sustain their appreciation for the relevance of anatomy in clinical practice. Ongoing research should explore these pedagogical advancements across diverse educational settings to optimize learning outcomes and support the long-term retention of essential clinical knowledge.

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