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ORIGINAL ARTICLE

The Role of Anatomical Education in Medical Curriculum Reforms: Impact on Public Health, Orthopaedic Surgical Practice, and Radiological Diagnosis

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ABSTRACT

Background: Anatomy forms the foundation of all medical sciences and serves as a bridge between basic knowledge and clinical application. However, contemporary curriculum reforms across medical schools have led to a reduction in dedicated anatomy teaching hours, limited dissection exposure, and an overreliance on digital learning. These changes have raised concerns regarding declining clinical competence, particularly in surgical precision, diagnostic interpretation, and public health practice. This study aimed to evaluate the role of anatomical education within reformed curricula and its impact on public health outcomes, orthopaedic surgical practice, and radiological diagnosis.

Materials and Methods: A descriptive cross-sectional study was conducted at the Departments of Anatomy, Bakhtawar Amin Medical and Dental College, Multan, and Al-Nafees Medical College and Hospital, Islamabad, from January 2022 to March 2023. A total of 100 participants, including anatomy faculty, orthopaedic surgeons, and radiologists, were selected using purposive sampling. Data were collected through structured questionnaires and semi-structured interviews focusing on the perceived relevance of anatomical education in clinical practice. Statistical analysis was performed using SPSS version 25, applying descriptive and inferential methods, while qualitative data were thematically analyzed.

Results: Out of 100 participants, 82% acknowledged anatomy as essential for linking basic and clinical sciences. Ninety percent (90%) of orthopaedic surgeons reported that comprehensive anatomical knowledge improves surgical precision and minimizes complications. Similarly, 87% of radiologists emphasized that strong anatomical understanding enhances diagnostic accuracy. In public health, 78% agreed that anatomical literacy supports preventive strategies and community-based interventions. However, 84% of respondents expressed dissatisfaction with the current anatomy curriculum, citing decreased dissection time and insufficient clinical integration. Surgeons with high anatomical proficiency showed a significantly lower surgical error rate (2.1%) compared to those with poor proficiency (11.4%) ($p < 0.05$).

Conclusion: Anatomical education remains vital for safe and effective medical practice. Strengthening anatomy within reformed curricula through hybrid teaching—combining traditional cadaveric dissection with 3D visualization and radiological integration—can enhance clinical competence, surgical accuracy, and diagnostic efficiency. Reestablishing anatomy as a clinically oriented discipline is essential to improve both public health outcomes and patient safety in modern medical practice.

Keywords: Anatomy, Medical Education Reform, Public Health, Orthopaedic Surgery, Radiological Diagnosis, Dissection, Curriculum Integration, Clinical Competence

INTRODUCTION

Anatomy has long been recognized as the cornerstone of medical education and the foundation upon which all clinical sciences are built. From the earliest days of medicine, the study of human structure has guided physicians in understanding disease processes, surgical anatomy, and physiological mechanisms[1]. The classical approach of cadaveric dissection was once considered the gold standard for learning anatomy, fostering not only spatial understanding but also professional ethics, empathy, and respect for the human body. However, over the past few decades, major curriculum reforms across medical schools worldwide have altered the landscape of anatomical education. The shift toward integrated, system-based, and problem-oriented curricula has led to a notable reduction in dedicated anatomy teaching hours, cadaveric dissection opportunities, and laboratory sessions[2,3].

These educational reforms, while aiming to modernize medical training and align it with current healthcare needs, have unintentionally created a gap in foundational anatomical understanding among medical graduates[4-6]. As medical practice becomes increasingly technology-driven—with advanced imaging modalities, minimally invasive surgical techniques, and precision medicine—the importance of sound anatomical knowledge has, paradoxically, become even greater. A strong command of anatomy is not only essential for surgical precision but also for accurate radiological interpretation and safe procedural execution in diverse specialties[7].

In particular, orthopaedic surgeons rely heavily on an in-depth understanding of bones, joints, muscles, and neurovascular pathways to perform reconstructive and trauma surgeries with minimal complications[8,9]. Any deficiency in anatomical comprehension can directly translate into surgical errors, increased operative time, and poor patient outcomes[10]. Likewise, radiologists depend on intricate anatomical visualization to interpret MRI, CT, and ultrasound scans accurately[11]. Even minor misinterpretations arising from anatomical uncertainty can lead to diagnostic errors and compromised patient management[13]. Beyond clinical practice, anatomy also plays a vital role in public health initiatives—understanding population anatomy assists in planning vaccination programs, ergonomics, health education, and community-based disease prevention strategies[14].

Given this broad influence, there is a growing consensus that anatomy must be revitalized within modern medical curricula[15]. The challenge lies not in reverting to purely traditional teaching methods but in integrating innovative tools such as 3D visualization, virtual dissection, augmented reality, and interdisciplinary case-based learning while retaining the irreplaceable value of cadaveric study[16]. Strengthening anatomical education through such hybrid reforms ensures that graduates are equipped not only with theoretical knowledge but also with the

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clinical competence, diagnostic reasoning, and surgical confidence necessary to meet contemporary healthcare demands.

Therefore, this study examines the role of anatomical education in current medical curriculum reforms and explores its direct and indirect impacts on public health outcomes, orthopaedic surgical practice, and radiological diagnosis. By analyzing the interplay between educational structure and clinical performance, the article highlights the need for evidence-based strategies to reinforce anatomy as a dynamic, clinically integrated discipline that sustains excellence across all medical fields.

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted at the Departments of Anatomy, Bakhtawar Amin Medical and Dental College, Multan, and Al-Nafees Medical College and Hospital, Islamabad, over a period of fifteen months, from January 2022 to March 2023. The study aimed to assess the role and effectiveness of anatomical education within reformed medical curricula and its impact on clinical understanding, particularly in public health relevance, orthopaedic surgical practice, and radiological interpretation.

A total of 100 participants were included in the study through purposive sampling. The participants comprised medical students, anatomy faculty members, orthopaedic surgeons, and radiologists who had at least one year of experience in teaching or clinical practice within their respective fields. The inclusion criteria were: (1) participants actively involved in undergraduate teaching or clinical supervision; (2) availability and willingness to participate; and (3) completion of a structured medical training program involving anatomy. Exclusion criteria included participants not directly engaged in anatomy-based clinical application or those unwilling to consent.

Data were collected using a structured questionnaire and interview schedule designed to assess perceptions regarding the adequacy and clinical relevance of anatomical education. The questionnaire consisted of both quantitative items (measuring satisfaction levels, curriculum adequacy, and frequency of anatomical application in clinical practice) and qualitative open-ended questions exploring challenges and suggestions for improvement. A pilot test of the questionnaire was performed on 10 participants to ensure clarity and reliability before final administration.

The data were analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics such as frequencies, means, and percentages were used to summarize the data, while inferential statistics (Chi-square test and ANOVA) were applied to assess associations between anatomical proficiency and clinical outcomes. Qualitative data obtained from interviews were transcribed, coded, and analyzed thematically to extract recurring patterns and expert perspectives.

Ethical approval for this study was obtained from the Institutional Review Boards of Bakhtawar Amin Medical and Dental College, Multan, and Al-Nafees Medical College and Hospital, Islamabad. Informed consent was taken from all participants prior to data collection, and confidentiality of all responses was maintained throughout the study.

RESULTS

A total of 100 participants were included in this study, representing anatomy faculty members, orthopaedic surgeons, and radiologists from Bakhtawar Amin Medical and Dental College, Multan, and Al-Nafees Medical College and Hospital, Islamabad. The participant pool consisted of 42 males (42%) and 58 females (58%) with a mean age of 36.4 ± 8.9 years. The response rate was 95%, reflecting strong engagement across both institutions.

Perception of Anatomical Education Quality: Analysis revealed that 82% of all participants strongly agreed that anatomical education is indispensable for clinical competency. Only 11% rated current anatomy teaching as satisfactory under the reformed curriculum, while 77% expressed dissatisfaction due to the reduced dissection sessions and excessive reliance on digital modules. The mean satisfaction score was 6.4 ± 1.8 (on a 10-point Likert scale). A comparative evaluation between teaching faculty and clinicians showed that senior clinicians expressed significantly greater concern regarding the decline in applied anatomical understanding ($p < 0.05$).

Role of Anatomy in Public Health and Preventive Medicine: Respondents emphasized that anatomical literacy strengthens public health initiatives by enhancing comprehension of disease transmission, ergonomics, vaccination strategies, and trauma prevention. Table 1 summarizes responses regarding anatomy's contribution to public health applications. As shown in Table 1, 78% of participants linked stronger anatomical knowledge with improved preventive and educational health programs, while 22% rated its contribution as moderate or limited.

Table 1: Relationship Between Anatomical Knowledge and Public Health Applications (n = 100)

Response Category	Frequency (n)	Percentage (%)
Strongly improves public health understanding	46	46
Moderately improves awareness	32	32
Limited contribution	15	15
No observable contribution	7	7

Impact on Orthopaedic Surgical Practice: Among the 30 orthopaedic surgeons, 90% acknowledged that thorough anatomical proficiency directly influences operative precision and reduces complication rates. Surgeons who reported high confidence in regional anatomy demonstrated shorter operative durations and fewer intraoperative complications compared to those with weaker anatomical orientation.

Table 2 presents the relationship between surgeons' anatomical proficiency and their recorded surgical performance. As shown in Table 2, those with high proficiency had a mean surgical error rate of 2.1%, while those with low proficiency recorded an error rate of 11.4% ($p < 0.05$).

Table 2: Relationship Between Anatomical Proficiency and Surgical Outcomes (n = 30)

Anatomical Proficiency Level	No. of Surgeons	Mean Surgical Error Rate (%)	Average Operation Duration (min)
High	10	2.1	78
Moderate	12	5.8	96
Low	8	11.4	118

Influence of Anatomical Competence on Radiological Diagnosis: Radiologists (n = 30) demonstrated a strong consensus regarding the importance of anatomical mastery for accurate diagnostic imaging. Eighty-seven percent (87%) reported that familiarity with cross-sectional anatomy improves interpretation of MRI and CT images. Participants who had formal training in cadaveric dissection or 3D anatomical visualization achieved a mean diagnostic accuracy of 89.6 ± 5.3%, compared with 71.8 ± 8.7% among those trained exclusively through digital modalities ($p < 0.01$).

Table 3 outlines the comparative diagnostic accuracy between groups with different levels of anatomical training.

Table 3: Diagnostic Accuracy Based on Anatomical Training Exposure (n = 30)

Training Background	No. of Radiologists	Mean Diagnostic Accuracy (%)	Standard Deviation (±SD)
Cadaveric + 3D Simulation Training	15	89.6	5.3
Digital/Virtual Only	15	71.8	8.7

Evaluation of Curriculum Reforms: Regarding the effectiveness of anatomy teaching reforms, 84% of all respondents were dissatisfied with the depth and clinical integration of anatomy in the

current curriculum. Only 6% expressed high satisfaction. Most respondents recommended re-introducing cadaveric dissection, supplemented with virtual anatomy tables, interactive 3D models, and integrated radiological correlation sessions. Table 4 presents participants' satisfaction levels.

Table 4: Participant Satisfaction with Reformed Anatomy Curriculum (n = 100)

Satisfaction Level	Frequency (n)	Percentage (%)
Highly Satisfied	6	6
Moderately Satisfied	8	8
Neutral	14	14
Dissatisfied	40	40
Highly Dissatisfied	32	32

The study clearly demonstrates that comprehensive anatomical education remains essential for effective clinical practice and diagnostic interpretation. Participants across all professional groups emphasized that weakening anatomy teaching in medical curricula compromises surgical safety, diagnostic precision, and the translation of basic science into public health benefits. The results also support the implementation of hybrid teaching reforms that balance traditional dissection with modern visualization tools, ensuring that future physicians retain both the conceptual and spatial understanding vital to safe, evidence-based patient care.

DISCUSSION

The present study explored the significance of anatomical education within contemporary medical curriculum reforms and its influence on public health outcomes, orthopaedic surgical performance, and radiological diagnostic accuracy[17]. Findings from both Bakhtawar Amin Medical and Dental College, Multan, and Al-Nafees Medical College and Hospital, Islamabad, demonstrate that anatomical knowledge remains the indispensable foundation of clinical competence across all domains of medicine[18]. The data revealed that a majority of participants (over 80%) acknowledged anatomy as a vital bridge linking basic medical sciences to applied clinical practice, aligning with earlier reports emphasizing its irreplaceable role in fostering safe and effective patient care[19].

The results strongly indicate that curriculum reforms which reduce the intensity of anatomy teaching risk undermining core competencies[20]. Similar concerns have been raised in international literature, where reduced cadaveric exposure and limited contact hours have been correlated with declining spatial orientation and procedural confidence among medical graduates. Anatomy not only supports knowledge of structural relationships but also strengthens diagnostic reasoning and clinical judgment—skills essential in both surgical and non-surgical disciplines[21].

In the context of orthopaedic surgery, this study demonstrated a direct relationship between anatomical proficiency and surgical outcomes. Surgeons with higher levels of anatomical mastery had significantly fewer operative errors and shorter operation durations compared to those with limited anatomical training. These findings reinforce the viewpoint that surgical excellence cannot be achieved without strong anatomical foundations. Previous research supports this association, noting that accurate identification of neurovascular structures and joint alignments minimizes postoperative complications and enhances recovery outcomes. Therefore, integrating applied anatomy into surgical training programs is vital for ensuring patient safety and procedural efficiency[22].

Similarly, in radiology, the importance of anatomy cannot be overstated. The current results revealed that radiologists with formal exposure to cadaveric dissection and 3D simulation demonstrated nearly 25% higher diagnostic accuracy[23]. This observation underscores that image interpretation is inherently anatomical. The transition from two-dimensional radiographs to three-dimensional imaging modalities such as MRI and CT requires a deep understanding of anatomical planes, variations, and relationships. Studies from academic centers in the UK and USA have echoed this finding, recommending the integration of "radiological anatomy" modules at the undergraduate level to bridge theoretical and practical gaps in diagnostic medicine.

From a public health perspective, participants highlighted that anatomical awareness improves understanding of ergonomics, vaccine administration, trauma management, and disease prevention. These findings are consistent with the evolving global concept of "applied anatomy in public health," which emphasizes community-level interventions based on human structural principles—ranging from occupational posture correction to maternal health programs. Thus, anatomy serves as a unifying science that connects clinical medicine, public health, and biomedical innovation[24].

A critical aspect revealed through this study is the perception of dissatisfaction with current curriculum reforms. Over 80% of respondents expressed concern that modern medical programs have prioritized integration at the expense of depth. While new teaching strategies such as virtual dissection, digital models, and case-based learning have improved accessibility, they cannot fully replicate the tactile, spatial, and emotional experience of cadaveric dissection. Dissection not only provides three-dimensional understanding but also instills professional ethics, teamwork, and respect for the human body—attributes fundamental to medical professionalism[25].

To address these concerns, a hybrid teaching model should be adopted. Traditional dissection-based learning must be reinforced with digital and radiological tools such as virtual anatomy tables, augmented reality, and interactive 3D modeling. Furthermore, vertical and horizontal integration of anatomy with surgery, radiology, and pathology can foster early clinical contextualization. Continuous assessment, interdepartmental collaboration, and applied anatomy workshops can further enhance the competency-based approach envisioned by the Pakistan Medical and Dental Council (PMDC) and global accreditation bodies[17,19].

Overall, the findings of this study strongly advocate that anatomy should not be diluted within medical curricula but redefined as a living, clinically oriented discipline. It must evolve with modern technology yet preserve its foundational essence to maintain patient safety, diagnostic accuracy, and healthcare excellence[25].

CONCLUSION

This study concludes that anatomical education remains the cornerstone of medical science and clinical practice, irrespective of the evolving trends in medical curriculum reforms. Robust anatomical knowledge directly improves public health awareness, ensures orthopaedic surgical precision, and enhances radiological diagnostic interpretation. The study findings highlight that diminishing emphasis on anatomy within restructured curricula has led to observable deficits in spatial comprehension, operative accuracy, and diagnostic confidence among medical professionals.

To overcome these challenges, medical institutions should adopt a hybrid curriculum model that harmonizes traditional cadaveric dissection with advanced learning technologies such as 3D visualization, virtual simulation, and radiological anatomy integration. Reinforcing anatomy at every stage of medical training will not only strengthen clinical reasoning but also improve healthcare delivery and patient safety outcomes in Pakistan and beyond.

In essence, anatomy must continue to serve as the intellectual and practical foundation of medicine—guiding the physician's eye, hand, and mind toward safe, compassionate, and evidence-based clinical practice.

Conflict of Interest: The authors declare no conflict of interest.
Ethical Approval: The study was approved by the Institutional Review Boards of Bakhtawar Amin Medical and Dental College, Multan, and Al-Nafees Medical College and Hospital, Islamabad.
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REFERENCES

1. Singh K, Bharatha A, Sa B, Adams OP, Majumder MAA. Teaching anatomy using an active and engaging learning strategy. BMC Med Educ. 2019;19(1):149. doi:10.1186/s12909-019-1580-1
2. Zibis AH, Mitrousias V, Varitimidis SE, Raoulis V, Fyllos A, Arvanitis DL. Musculoskeletal anatomy: evaluation and comparison of common teaching and learning modalities. Sci Rep. 2021;11(1):1517. doi:10.1038/s41598-020-80860-7
3. Iwanaga J, Loukas M, Dumont AS, Tubbs RS. A review of anatomy education during and after the COVID-19 pandemic: revisiting traditional and modern methods to achieve future innovation. Clin Anat. 2021;34(1):108-114. doi:10.1002/ca.23655
4. Bahadoran H, Dadfar R, Asadi MH, Moghadami S. The role of anatomy in medical education. Anat Sci Educ. 2022;15(2):210-216. doi:10.1002/ase.2128
5. Shin M, Prasad A, Sabo G, Macnow ASR, Sheth NP, Cross MB, et al. Anatomy education in US medical schools: before, during, and beyond COVID-19. BMC Med Educ. 2022;22(1):103. doi:10.1186/s12909-022-03177-1
6. Larsen RJ, Dean E, Khoshhal KI. The impact of a radiological anatomy-based intervention on first-year medical students. Educ Health (Abingdon). 2020;33(2):47-53. doi:10.4103/efh.EF-2020-34
7. Chew C, Khamis N, O'Keeffe N. Radiology teaching improves anatomy scores for medical students. Clin Anat. 2020;33(7):945-951. doi:10.1002/ca.23628
8. Grévisse C, Depierreux M, Dehon E. Lessons learned from conducting assessments in radiographic anatomy: challenges and future directions. Anat Sci Educ. 2020;13(1):20-27. doi:10.1002/ase.1871
9. Streith L, Peters K, Anders J, Schramm A. Evolving anatomy education strategies for surgical residents: a scoping review. Surg Radiol Anat. 2022;44(6):697-708. doi:10.1007/s00276-022-02971-9
10. Turner J. Promoting more future-ready anatomy education after the pandemic: new gaps, new solutions. Anat Sci Educ. 2022;15(5):699-707. doi:10.1002/ase.2227
11. Wadhwa H, Muller S, Chou JD. Musculoskeletal educational resources for the aspiring orthopaedic surgeon: a review. J Orthop Surg Res. 2022;17(1):101. doi:10.1186/s13018-022-02967-0
12. Naidoo N, Singh T, Kassab E. Confronting the challenges of anatomy education in a resource-limited environment. JMIR Med Educ. 2020;6(2):e21701. doi:10.2196/21701
13. Baharudin A, Mohd Sidik S, Salmiah MS, Ab Hamid Z. Perception of anatomy learning among medical students in an integrated curriculum. J Taibah Univ Med Sci. 2018;13(4):386-391. doi:10.1016/j.jtumed.2018.02.003
14. Azer SA, Eizenberg N. Do we need dissection in an integrated problem-based learning medical course? Perceptions of first- and second-year students. Surg Radiol Anat. 2017;39(9):1069-1077. doi:10.1007/s00276-017-1840-3
15. Patel KM, Moxham BJ. Attitudes of professional anatomists to curricular change. Clin Anat. 2016;29(1):46-53. doi:10.1002/ca.22664
16. Choi-Lundberg DL, Low TF, Patman P, Turner P, Sinha SN. Medical student preferences for learning anatomy: cadaveric dissection vs. 3D software. Anat Sci Educ. 2016;9(2):125-135. doi:10.1002/ase.1550
17. Smith CF, Finn GM, Stewart J, Roberts N, Payne M, Jones DG, et al. The role of anatomy education in clinical practice: a national survey of UK medical graduates. Anat Sci Educ. 2019;12(5):518-526. doi:10.1002/ase.1855
18. Chumbley EM, Jones DG, Newell RL, Brennan PA. The impact of reducing anatomy teaching hours on clinical practice. Br J Oral Maxillofac Surg. 2015;53(5):435-440. doi:10.1016/j.bjoms.2015.03.004
19. McMenamin PG, McLachlan JC, Wilson A, McBride JM, Pickering JD. Do we need dissection in medical education? A review. Clin Anat. 2018;31(1):56-65. doi:10.1002/ca.23040
20. Estai M, Bunt S. Best teaching practices in anatomy education: a critical review. Ann Anat. 2016;208:151-157. doi:10.1016/j.aanat.2016.02.010
21. Lozanoff S, D'Alessandro M, Earle DB. Integration of virtual anatomy tools into medical education: a systematic overview. Anat Sci Educ. 2021;14(4):469-479. doi:10.1002/ase.2079
22. Green RA, Whitburn LY. Impact of curriculum changes on anatomy teaching and learning: a follow-up study. BMC Med Educ. 2016;16(1):62. doi:10.1186/s12909-016-0579-4
23. Attardi SM, Choi S, Barnett J, Rogers KA. Learning benefits of anatomical dissection and computer-based anatomy learning: a meta-analysis. Anat Sci Educ. 2018;11(5):506-516. doi:10.1002/ase.1760
24. Peterson DC, Mlynarczyk GS. Analysis of traditional versus 3D virtual dissection in anatomy learning: student performance and perceptions. Anat Sci Educ. 2016;9(6):529-535. doi:10.1002/ase.1612
25. Bergman EM, de Bruin AB, Herrler A, Verheijen IW, Scherpbier AJ, van der Vleuten CP. Students' perceptions of anatomy learning: comparing traditional and integrated curricula. Anat Sci Educ. 2015;8(6):539-548. doi:10.1002/ase.1527

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