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The Relevance of Clinical Applied Embryology Knowledge in the Preclinical Undergraduate Medical Students: A Scoping Review Protocol

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ABSTRACT

Embryology is an integral part of the anatomy core curriculum in the preclinical phase of medical education. It provides fundamental principles governing human anatomical structures and topography while establishing the rationale for anatomical variations and congenital abnormalities. In recent years, significant advancements in embryology research and technology have been on the rise, which have affected the way this course is taught in medical institutions. However, embryology has remained minimally prioritised compared to other anatomy branches. Therefore, this review aims to explore how much embryological knowledge is relevant in clinical practice and elucidate how it is instrumental to preclinical students in understanding clinical concepts during their preclinical years. This paper presents a scoping review protocol designed to comprehensively analyse the importance of embryological knowledge within the undergraduate medical curriculum, particularly its relevance in clinical practice over the past three decades. This scoping review will be conducted using the framework proposed by the Joanna Briggs Institute. The resources search process will involve three electronic databases using the three-phase search strategy. The resources of this review, which incorporate studies from both primary and secondary research, as well as the grey literature, will be searched from 1993 to 2023 . Two independent reviewers will be involved in the screening process, study selection and data charting based on the predefined inclusion and exclusion criteria. This scoping review aims to document the components of the embryology syllabus and evaluate the effectiveness of embryology while providing information on how undergraduate students apply their embryology knowledge in clinical settings.

Keywords: *Artificial intelligence, ChatGPT, Medical education*

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INTRODUCTION

Embryology is a branch of anatomical knowledge that delves into human developmental processes from conception to birth. It provides fundamental knowledge that enhances our understanding of other aspects of medical knowledge (1). During the preclinical years of the medical curriculum, embryological knowledge is customarily integrated with gross anatomy knowledge of the corresponding system alongside other basic science subjects. This integration allows for a comprehensive understanding of each subject matter. Furthermore, the early introduction of embryology knowledge into the medical curriculum is crucial for enhancing students' understanding of human anatomy, potential anatomical variations and various developmental anomalies leading to congenital malformations (2).

It has been argued that the clinical application of embryological knowledge is comparatively limited compared to other branches of anatomical knowledge (3). Nevertheless, embryological knowledge holds significant importance within certain medical specialities, particularly obstetrics, paediatrics and surgery. Dealing with and managing the consequences of congenital disorders requires expertise across multidisciplinary units, such as genetics, medicine and radiology. In addition to its clinical relevance, the field of embryology has evolved to encompass molecular development in genetics and tissue engineering, the discovery of stem cells within the revolutionary field of regenerative medicine and the emergence of assisted reproductive technologies (ART) involving the manipulation of embryos, as well as embryological imaging technologies (4).

Embryology knowledge has substantially contributed to medical research, subsequently impacting the embryological syllabus in medical schools. However, learning embryology is often perceived by medical students as challenging since it demands strong visuospatial and mental imagery abilities when dealing with embryological structures (5). Furthermore, not only inconsistencies have been encountered when the learning outcomes of the embryological syllabus for the preclinical medical

curriculum were determined, but also a lack of standardized reference documents reporting on essential embryological competency has been found so far (6). Therefore, it is critically important to analyse the available literature on the clinical relevance of embryology knowledge to achieve effective and safe clinical practices.

Unlike gross anatomy and histology classes, embryology classes lack practical sessions and hands-on learning materials. The scarcity of access to actual embryology specimens and the inability to visualise embryological structures are often presented in the abstract form of three-dimensional (3D) units, which may place a greater cognitive burden on students and potentially dampen their interest and motivation to learn embryology (7). Consequently, preclinical undergraduate medical students often struggle not only to acquire a comprehensive understanding of embryology but also to effectively apply this knowledge in their clinical practice (8). Likewise, anatomy teachers face challenges in determining the most effective approaches for teaching embryology to medical students. In addition to traditional teaching methods such as lectures, tutorials and discussions, technology-enhanced pedagogical innovations, including augmented reality (AR) and virtual reality (VR), as supplementary educational tools for teaching embryology to medical students, are becoming more popular. These advancements have demonstrated their potential to enhance the effectiveness of the learning process, especially in embryology (9). Furthermore, embryological input is actively being integrated into student-centred learning approaches, namely problem-based learning (PBL) and team-based learning (TBL) (10,11). Despite these multimodal teaching approaches, it is imperative to establish a structured syllabus that reflects the relevance of embryology knowledge to be applied within clinical settings.

Due to limited consensus on the relevance of embryology knowledge among medical and anatomy educators, the embryology syllabus often receives less emphasis in the medical curriculum compared to gross anatomy, neuroanatomy, surface anatomy and histology. Therefore, this review aims to explore the relevance of embryology knowledge for clinical practice and how this knowledge can assist preclinical undergraduate medical students in understanding its clinical application.

Additionally, the usability of the embryology knowledge acquired by preclinical undergraduate medical students in the form of knowledge application, integration and translation into their clinical practice will be explored.

OBJECTIVES AND RESEARCH QUESTIONS

This scoping review aims to investigate the role of embryology knowledge in preclinical undergraduate medical education and its relevance for clinical practice. The review will attempt to answer a research question:

a. What are the elements of embryology knowledge relevant to clinical practice in preclinical undergraduate medical students?

METHODS AND ANALYSIS

This protocol has already been registered on Figshare (10.6084/m9.figshare.24203493) and officially published in this scholarly journal. The current protocol was developed in accordance with the best practice guidelines provided by the Scoping Review Methodology Group of the Joanna Briggs Institute (JBI) (12). The review process was carried out from April 1, 2023, to May 31, 2023, and will be documented according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (13). Any modifications to the methodological procedure will be thoroughly reviewed and explained in the final report.

REVIEW TEAM

The committee of reviewers consists of six anatomists (FAI, SNH, MASA, FN, MSI, SAS) from the Department of Anatomy at Universiti Sains Malaysia. One of the reviewers, SNH, is an expert in anatomy education and holds a doctorate degree in Medical Education. Additionally, each reviewer has a minimum of five years of experience teaching embryology to undergraduate medical students during their preclinical years.

INCLUSION CRITERIA

Types of Participants

This scoping review will incorporate records and resources that elucidate the relevance of embryology knowledge in clinical applications for preclinical undergraduate medical students. The term "undergraduate preclinical medical students" refers to those who had studied embryology either as an individual subject or as part of their preclinical medical syllabus, specifically within the context of anatomy subjects, in their first or second year of medical school. Resources that discuss embryological knowledge from the perspectives of dental, health sciences and veterinary undergraduate students, postgraduate students or anatomy lecturers will be excluded from this review.

Concept

The scoping review will encompass records that describe all relevant elements pertaining to clinical application of embryology knowledge in the preclinical undergraduate medical curriculum. The concept of relevance applied in this review emphasises the significance of integrating the clinical application of embryology knowledge in the early stage of the preclinical curriculum to uphold safe medical practice. The introduction of embryology knowledge establishes a cornerstone for

understanding clinical practice and enriches students' comprehension by bridging theoretical knowledge with clinical correlation. This includes understanding the principles underlying the pathogenesis of congenital malformation, structural variation and genetic diseases and acquiring the ability to interpret and manage neonatal disorders. In this review, the relevance of embryology knowledge will be examined from two perspectives: the embryology knowledge implemented by medical schools and the practical applicability of embryology knowledge as perceived by medical students. The term "embryology knowledge" involves the scope, topics, pedagogical techniques, assessment methods, learning outcomes and the constructive alignment of embryology content within the preclinical undergraduate medical curricula. The usability of embryology knowledge, on the other hand, pertains to how preclinical undergraduate medical students perceive the importance of embryology concepts in terms of knowledge application, integration and translation into clinical practice.

The embryology scope, topics and learning outcomes cover both general and systemic embryology concepts, which may be taught either independently or as part of other anatomy discipline syllabi (8). Pedagogical techniques refer to the combination of teaching methods and learning activities employed in embryology classes, including but not limited to instructional design and instructional delivery (14). Assessment methods refer to the formative and summative evaluation of cognitive, psychomotor and affective learning outcomes related to embryology content (15). Constructive alignment is assessed based on documented evidence that demonstrates alignment between learning outcomes, teaching methods and assessment practices in embryology subjects within undergraduate medical curricula (16). All forms of measurement on students' perceptions of the usability of embryology knowledge, including surveys, focus group discussions, in-depth interviews and reflective writing, will be included in the review.

Context

The context of this review is the clinical application and practice of embryology knowledge acquired during the preclinical medical curriculum. The application of embryology knowledge is evident in the ways medical students utilise their knowledge to comprehend clinical data and formulate clinical diagnoses. The understanding of clinical data is indicated by student's capability to integrate embryology knowledge with the pathogenesis of diseases (17). On the other hand, making a diagnosis reflects students' ability to correlate their embryology knowledge with clinical data while formulating clinical provisional and differential diagnoses, whether in problem-based or clinical-based learning (18). Resources documenting the application of embryology knowledge beyond the preclinical medical curriculum will be excluded.

SOURCES

This scoping review will cover both primary and secondary research. Primary research comprises both quantitative and qualitative approaches utilising a wide range of study methods not limited to surveys, experiments, observations, secondary data analysis, in-depth interviews and focus group discussions. Meanwhile, secondary research consists of literature reviews, systematic reviews, meta-analyses, thematic analyses, review articles and commentaries. Given the expected scarcity of literature on the clinical relevance of embryology knowledge, all types of published grey literature will also be incorporated into the data analysis. This review will cover articles in the English language that were published over a 30-year period, from January 1993 to December 2023. Unpublished literature, websites, podcasts and blog posts will not be considered for inclusion in this review in order to maintain the reliability of the resource data.

SEARCH STRATEGY

A three-phase search strategy outlined in the JBI Scoping Review guideline will be utilized for the search process. The first phase will involve identifying suitable keywords and search terms with Boolean combinations through an initial limited search of resources. This search will be conducted in two databases: Wiley Online Library and Scopus. The search terms proposed in this initial search are as follows:

(embryology relevance OR embryology importance OR embryology application OR embryology role) AND (embryology knowledge OR embryology syllabus OR embryology scope OR embryology topic OR embryology content OR embryology learning OR embryology learning outcome OR embryology curriculum OR embryology module OR clinical embryology) AND (undergraduates students OR medical students OR preclinical students) AND (clinical practice OR clinical attachment OR clinical application OR clinical scenario OR clinical rotation OR clinical environment OR clinical competency)

The second phase will involve testing these search terms across three databases that will be used for the actual search: Scopus, Wiley Online Library and PubMed. The Scopus database was selected to capture articles published beyond anatomy and medical education journals. Meanwhile, Wiley Online Library and PubMed databases were selected because many medical education and anatomy journals have been indexed in these databases. The third phase of this review will include searching the reference lists of all included records and searching for grey literature using the Google search engine.

SELECTION OF SOURCES

After completing the three-phase search strategy, all identified resources will be exported to Microsoft Excel format and screened for duplicates. The selection of these resources will adhere to predefined

inclusion and exclusion criteria. Pilot testing will be conducted before the actual selection process to assure accuracy and consistency and minimise the risk of bias and error. Approximately 20 to 30 titles and abstracts will be selected for inclusion criteria screening in the pilot study. All team members will independently review these titles and abstracts to determine inclusion criteria. Any discrepancies in the interpretation of the identified resources among the research team members will be resolved through discussions. The actual screening will commence when the team achieves more than 75% agreement on eligibility criteria and the screening process. Whenever this level of agreement is not reached, the eligibility criteria will be modified by the current researchers so that the clarity and consistency of the search process are enhanced. Following the pilot study, two researchers will independently screen the titles and abstracts of the records for inclusion criteria. Whenever any disputes happen between any two independent researchers during the selection process, a third reviewer will come aboard and involve in the discussions to reach a consensus. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) flow diagram will be used to report the search process profile, ensuring transparency in the selection process. Any reasons for exclusion will also be documented in the final report.

EXTRACTION OF DATA

The data to be extracted from the included resources will encompass the following elements:

a. Article title
b. Authors
c. Year of publication
d. Geographical distribution
e. Types of resources (primary research, secondary research and grey literature)
f. Study approach

g. Study design
h. Research methods and tools
i. Elements of the embryology knowledge (scope, topics, learning outcomes, pedagogical techniques, assessment methods or constructive alignment)
j. Clinical application of embryology knowledge involving understanding clinical input and making diagnoses

This data will be entered into a Microsoft Excel form, utilising the template provided in Tables 1 and 2. The data extraction process will be carried out by two independent reviewers. Reviewers will be required to follow a set of guidelines generated based on the instructions provided in Tables 1 and 2 to ensure consistency in the process of data extraction. Before the actual data extraction begins, a pilot study will be conducted on a small subset of studies to ensure efficiency, accuracy and reliability while minimising the risk of errors during the process. In the event of any discrepancies arising during the extraction procedure, a discussion involving a third reviewer will be initiated. The extraction procedure, including any emerging issues and decisions made throughout the process, will be meticulously documented and reported.

PRESENTATION OF RESULT

A PRISM-ScR flow diagram will be used to illustrate the review process flow. All the extracted data will be presented in a table consisting of the frequency and percentage of the identified profiles. A map displaying the geographical distributions of the included studies will be provided. A table mapping of key concepts will be provided to illustrate the link between the relevancy of embryology knowledge and different domains of clinical application or practice. A narrative description of the

relevancy of embryology knowledge for understanding clinical concepts and practice will be provided.

ETHICS DECLARATIONS

Ethics and Dissemination

Essentially, this review constitutes secondary research involving a comprehensive analysis of the existing literature on the topic of the relevance of embryological knowledge; therefore, it does not require an ethical approval. The present review aims to highlight key points regarding the relevance of embryology knowledge within the context of the undergraduate medical curriculum. The findings of this review will be disseminated through various channels, including peer-reviewed journals and conference proceedings, with a particular emphasis on reaching anatomists and clinical educators worldwide.

Conflict of Interest

The authors declare no competing interests.

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REFERENCES

1. Varga, I. (2017). Embryology teaching: An often-neglected part of the medical curriculum. Enseñanza de la embriología: Una parte del curriculum médico habitualmente relegada. *Revista Argentina de Anatomía Clínica*, 9(2), 47–51. https://doi.org/10.31051/1852.8023.v9.n2.16899

2. Tijani, A. A., Alese, M. O., Adetunji, A. E., & Oluwadiya, K. S. (2022). Clinical observership as an aid to learning and understanding of human embryology. *Anatomy Journal of Africa,* 11(1), 2129–2136. https://doi.org/10.4314/aja.v11i1.13

3. Holland, J. C., Smith, C., O'Shea, M., Stewart, J., Ockleford, C., & Finn, G. M. (2019). The anatomical society core embryology syllabus for undergraduate medicine. *Journal of Anatomy,* 235(4), 847–860. PMID: 31218692; PMCID: PMC6742929.https://doi:10.1111/joa.13023

4. Maani, A., Forma, A., Baj, J., & Maciejewski, R. (2022). Medical embryology and its importance in the 21st century curriculum: A mini review. *Italian Journal of Anatomy and Embryology*, 125(1), 95–102. https://doi.org/10.36253/ijae-12966

5. Tait, K., Poyade, M., & Clancy, J. A. (2020). eLearning and embryology: Designing an application to improve 3D comprehension of embryological structures. *Advances in*

Experimental Medicine and Biology, 1262, 19–38. https://doi.org/10.1007/978-3-030-43961-3_2

6. Kazzazi, F., & Bartlett, J. (2017). Condensing embryology teaching for medical students: Can it be taught in 2 hours? *Advances in Medical Education and Practice,* 8, 797–806. https://doi:10.2147/amep.S151880

7. Abdel Meguid, E. M., Holland, J. C., Keenan, I. D., & Mishall, P. (2022). Exploring visualisation for embryology education: A twenty-first-century perspective. *Advances in Experimental Medicine and Biology,* 1356, 173–93. https://doi.org/10.1007/978-3-030-87779-8

8. Carneiro, B. D., Pozza, D. H., & Tavares, I. (2023). Perceptions of medical students towards the role of histology and embryology during curricular review. *BMC Medical Education Journal,* 23(1), 1–11. https://doi:10.1186/s12909-023-04019-4

9. Connor, C. O., Jordan, K., Vagg, T., Murphy, C. E., Barry, D. S., & Toulouse, A. (2023). Animated teaching improves student learning of human gastrulation and neurulation. *Annals of Anatomy - Anatomischer Anzeiger*, 247, 152057. https://doi:10.1016/j.aanat.2023.152057

10. Carroll, M., Tomova, A. M., & Hunter, H. R. (2023). Exploring the use of problem-based learning in clinical embryology training. *Journal of Biological Education*, Feb, 1-9. https://doi.org/10.1080/00219266.2023.2182816

11. Mohammed, H. M. (2021). Team-Based Learning (TBL) implementation in general embryology at the Faculty of Medicine – Jazan University, KSA. *Bahrain Medical Bulletin*, 43(4), 689–94.

12. Peters, M. D. J., Godfrey, C., McInerney, P., Khalil, H., Larsen, P., & Marnie, C. (2022). Best practice guidance and reporting items for the development of scoping review protocols. *JBI Evidence Synthesis,* 20(4), 953–68. https://doi:10.11124/jbies-21-00242

13. Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., & Levac, D. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, 169(7), 467–73. https://doi:10.7326/M18-085

14. Maria Josephine A. M. S. (2021). Improved pedagogical practices strengthens the performance of student teachers by a blended learning approach. *Social Sciences & Humanities Open Journal*, 4(1), 100199. https://doi.org/10.1016/j.ssaho.2021.100199

15. Hadie, S. N. H., Woon, C. K., Lin, T. S., Abd Ghafar, N., Noor, N. F. M., & Rushaidhi, M. (2022). Imagineering anatomy assessment amidst covid-19: turning obstacles into achievements. *Malaysian Journal of Medical Sciences,* 18(5), 153–61. https://doi:10.47836/mjmhs18.s14.17

16. Gilic, F. Dalgarno, N., & Simpson, M. T. W. (2022). Applying constructive alignment and cognitive load in teaching: Case study involving a foundational family medicine medical school course. *Canadian Family Physician*, 68(4), 308-10. 1. PMID: 35418398; PMCID: PMC9007130. https://doi:10.46747/cfp.6804308

17. Sume, B. W. (2022). Medical students' attitude and perception towards embryology course at Debre Markos University, Ethiopia. *Advances in Medical Education and Practice*, 13, 789-96. PMID: 35959136; PMCID: PMC9357559.https://doi:10.2147/amep.S377999

18. Bansal, A., Singh, D., Thompson, J., Kumra, A., & Jackson, B. (2020). Developing medical students' broad clinical diagnostic reasoning through gp-facilitated teaching in hospital placements. *Advances in Medical Education and Practice*, 11, 379–88. PMID: 32547289; PMCID: PMC7259453.https://doi:10.2147/amep.S243538

Table 1: Characteristics of Study Profile

Article Number/Code	Title (authors)	Year of Publication	Geographical distribution	Types of resources			Study approach (For primary and secondary research)		Study design (For primary and secondary research)	Research method/tool (For primary and secondary research)	Type of grey literature
				Primary research	Secondary research	Grey literature	Quantitative	Qualitative			

Table 2: Results Related to Embryology Knowledge Relevance

Article Number/Code	Title	Elements of Embryology Knowledge Stated/Described in the Article *(Scope, Topics, Learning Outcomes, Pedagogical Technique, Assessment Method or Constructive Alignment)*	Usability Of Embryology Knowledge Stated/Described in the Article *(Knowledge Integration, Application and Translation into Clinical Practice)*	Clinical Application of Embryology Knowledge by Undergraduate Students Stated/Described in This Article *(Understanding Clinical Input and Making Diagnosis*