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Promoting more future-ready anatomy education after the Covid-19 pandemic

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Published in:
Anatomical Sciences Education

DOI:
[10.1002/ase.2227](https://doi.org/10.1002/ase.2227)

Publication date:
2022

Licence:
Other

Document Version
Peer reviewed version

[Link to publication in Discovery Research Portal](#)

Citation for published version (APA):

Gasmalla, H. E. E., Mossa, A. H., Taha, M. H., Wadi, M. M., Shehzad, K., Abdalla, M. E., & Hadie, S. N. H. (2022). Promoting more future-ready anatomy education after the Covid-19 pandemic: A scoping review. *Anatomical Sciences Education*, 15(6), 1120-1137. <https://doi.org/10.1002/ase.2227>

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ASE-22-0035

Relevant Review

Scoping Review of Teaching and Assessment Practice in Anatomy Education During Covid-19 Pandemic

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Running title: Anatomy Education During Covid-19 Pandemic

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Grant: This work was supported by the Universiti Sains Malaysia Research University Grant.

Grant number: 1001/PPSP/8016121.

ABSTRACT

The coronavirus disease 2019 (Covid-19) pandemic has resulted in an abrupt transition from face-to-face to online anatomy teaching, learning, and assessment. Although online education has ensured the continuity of education provision in anatomy during the pandemic, its implementation is challenging, and its effectiveness has been questionable. Hence, elaborations of pertinent literature related to the online and remote anatomy education during the pandemic is crucial. To understand the Covid-19 disruption to anatomy education This scoping review was conducted to explore the changes, disruptions, and gaps of teaching and students' assessment in anatomical education during the Covid-19 pandemic, in the field of medical and health profession education by utilizing the enhanced Arksey and O'Malley six-stage protocol. Five online databases and were searched for articles that described the changes, disruption, and gaps in anatomy education. Screening process of the titles, abstracts and full text articles were performed by three independent researchers; while the data extraction, charting and synthesis were conducted by another four researchers independently. The review generated six themes reflecting the changes and disruptions (i.e., immediate strategic plans and actions, changes in anatomy teaching and learning, online assessment practice, students' and educators' receptivity and adaptation, effects of online learning and assessment, and future directions) and four gaps in anatomy education (i.e., anatomy curriculum is not future ready, learning obstacles, administrative and teaching challenges, and ethical issues in online education) during the Covid-19 pandemic. The results were reported in tabular and narrative forms. Finally, we reported the review following the PRISMA extension for scoping reviews (PRISMA-ScR guidelines). Understanding the evolution and gaps of anatomy education during the Covid-19 pandemic helps anatomists to be agile in designing a future-ready and adaptable curriculum.

Keywords: Covid-19, pandemic, gross anatomy education, online teaching, online learning, online assessment, remote learning

INTRODUCTION

Anatomy is an important medical subject with high clinical relevancy (Moxham and Plaisant, 2007). By studying anatomy, medical and allied health sciences students develop a basic knowledge foundation for their safe clinical practice (Turney, 2007). Having adequate anatomy knowledge is an inevitable criterion for medical doctors, as they need to utilize their anatomy knowledge and related skills in conducting physical examinations, performing procedures and providing diagnosis, (Dangerfield et al., 2000). The coronavirus disease 2019 (Covid-19) pandemic has caused significant changes in anatomy education, whereby face-to-face anatomy teaching has been replaced with online learning (Tg Muda et al., 2021). Although online learning is not a new phenomenon in anatomy education (Patil et al., 2003; Lim et al., 2009), the abrupt transition from in-person to online learning has altered the anatomy learning environment (Yusoff et al., 2020; Tg Muda et al., 2021).

During the Covid-19 restriction, anatomy teaching was delivered either synchronously or asynchronously via various digital and online platforms, namely webcast teleconferencing application, web-based application and learning management system (Tg Muda et al., 2021). Although the use of these digital platforms in anatomy has been established even before the Covid-19 pandemic (Estai and Bunt, 2020), students and lecturers' receptivity toward online anatomy learning varies considerably based on their prior exposure to the digital tools and online environment (Cheng et al., 2021). Prior to the Covid-19, anatomy subject was normally taught through in-person lecture and laboratory session—particularly cadaveric dissection. Many lecturers faced difficulties when creating online instructional materials, as they had to learn and adapt using various digital tools within a short period of time. The Covid-19 pandemic has imposed a significant impact on practical anatomy classes, because of which students have limited opportunities to conduct hands-on learning activities (McWatt, 2021). The anatomy laboratory session including cadaveric dissection, which is invaluable for psychomotor and affective learning, was greatly compromised due to strict standard operating procedures for a face-to-face session, and declining numbers of donated bodies for medical education (Saverino, 2020). Consequently, digital cadaver was used as a learning tool during anatomy laboratory as it is more accessible and inclusive during the pandemic (Baptiste, 2021).

Likewise, anatomy assessment during the Covid-19 pandemic was conducted through online platform, whereby cadaveric-based assessment materials were replaced by anatomical and

radiographic images. During the early phase of Covid-19 pandemic, some medical schools suspended the summative assessment and converted it into continuous assessment (Cheng et al., 2021). The rapid transition to online assessment had triggered threats to assessment validity, particularly in assessing the psychomotor skills and affective learning. With limited access to cadaveric specimens, there were significant barriers in assessing skills competency in an online Objective Structured Practical Examination (Green et al., 2014). Besides, poor internet network connection, use of unsuitable devices, and problems during online invigilation are amongst the drawbacks of online assessment in anatomy (Longhurst et al., 2020).

Hence, it is argued that the online teaching and learning is not without obstacles (Yusoff et al., 2020; Tg Muda et al., 2021). Although anatomy educators have adapted well to the use of digital anatomy resources during their classes, there is a scarcity of evidence reflecting the effectiveness of these teaching methods (Cheng, 2021). Many anatomy educators and instructors have echoed their concern about the drawbacks of being reliant on remote online teaching, as this modality hinders the acquisition of important learning competencies (Pearson, 2020; Evans and Pawlina, 2021; Tg Muda et al., 2021). The greatest challenge is to ensure the achievement of skills and affective learning outcomes, which can be achieved through face-to-face teaching (Naidoo et al., 2020). Indeed, students have been voicing out their concern about uncertainties of their future, as as they perceived their cognitive competency, psychomotor skills, and interprofessional and interprofessional skills were prematurely developed due to the Covid-19 disruption (Franchi, 2020)

In general, anatomy theoretical and practical classes aim to achieve cognitive and psychomotor skills as a preparatory measure for students to embark into the clinical phase of their study (Hadie, 2018). Over the past two decades, there has been an emerging trend in designing anatomy education in that it can cater to the attainment of professional behaviors (Escobar-Poni and Poni, 2006; Swartz, 2006, Böckers et al., 2010; Pearson and Hoagland, 2010). The teaching of medical professionalism in anatomy is essentially introduced during cadaveric dissection (Escobar-Poni and Poni, 2006), gross anatomy laboratory practice (Swartz, 2006), reciprocal peer teaching (Krych et al., 2005), reflective practice (Lachman and Pawlina, 2006), group activities (Huggett et al., 2016), clinical simulations (Torres et al., 2014), and interprofessional education (Hamilton et al., 2008). For instance, Greene and Scott (2021) incorporated the use of deaf patients during anatomy classes as an effective means to develop cultural competence

among students. However, these competencies were achieved through teaching and learning activities that required the presence of students in the class. During these face-to-face sessions, students could conduct hands-on learning activities; interact with their peers, tutors, and patients; manage their learning resources within the stipulated period; and appreciate the ambient of being in the structured physical learning environment. Since face-to-face learning activities are limited during this Covid-19, the current situation has imposed substantial learning barriers for students to achieve these competencies in anatomy (Franchi, 2020).

As remote teaching continues, anatomy educators need to be innovative in their teaching approaches to ensure that these modalities can evolve beyond a mere need of ensuring the continuity of educational provision during the Covid-19 pandemic (Evans and Pawlina, 2021). Rather, a more structured approach based on strong educational principles is required. Hence, elaborations on necessary literature that can guide anatomy educators in assessing the strengths, weaknesses, opportunities, and threats of current online anatomy teaching during a pandemic are crucial. This information will help anatomy educators design effective anatomy instructions for the pandemic-teaching era. Hence, a scoping review was conducted to explore the changes, disruptions, and gaps of teaching and students' assessment in anatomical education during the Covid-19 pandemic, in the field of medical and health profession education.

MATERIALS AND METHODS

A scoping review was performed according to the six-stage protocol developed by Arksey and O'Malley (2005) and customized by Westphaln et al. (2021) as follows: (1) identification of the research question, (2) identification of relevant studies, (3) selection of specific studies, (4) data charting, (5) summarizing, synthesizing and reporting the results, and (6) consultation. The conduct of the review was performed based on several enhanced criteria for each stage of the Arkey and O'Malley framework, which were proposed by Levac et al. (2010) and Westphaln et al. (2021). The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist was used to ensure that all elements of scoping reviews were covered (Tricco et al., 2018).

Identification of initial research question

The research question was determined based on specific populations, concept and context. The populations that were included in the reviews were the medical and allied health sciences students, professionals, programs and institutions, who were involved in anatomy teaching, learning and assessment during the Covid-19 pandemic. The concept of the review concentrates on evaluating the patterns and trends of teaching and assessment methods, in the context of anatomy courses and programs during the pandemic. Based on these criteria, two research questions were generated through several rounds of discussion among the authors. The research questions include:

(1) What are the reported changes or disruption in anatomy education during Covid-19 in the field of medical and health profession education?, and

(2) What are the gaps in anatomy education that emerged during the Covid-19 pandemic?

Identification of relevant studies

The identification of relevant studies was performed through a collaborative approach, whereby researchers from three different specialty—anatomy (HEEG, AHM, KS), anatomy education (SNH) and medical and interprofessional health education (MHT, MMW, MEA)—were involved in the process.

An electronic search was performed using the databases Scopus (Elsevier B.V., Amsterdam, Netherlands), Web of Science (Clarivate Analytics, Philadelphia, PA), CINAHL (EBSCO Industries Inc., Birmingham, AL), ERIC (Institute of Education Sciences, Washington, DC), and PubMed (US National Library of Medicine, National Institutes of Health, Bethesda, MD) for articles published from April 1, 2020, to December 20, 2021. To ensure inclusion of relevant studies that could have been missed through indexing, we also performed manual hand searching and contacted experts in the field. We used the following search strategies:

(“Anatomy education OR anatomical education”) AND (“covid-19 OR COVID19 OR COVID-19 OR SARS-CoV-2 OR SARS-CoV2 OR severe acute respiratory syndrome coronavirus 2 OR severe acute respiratory syndrome coronavirus 2 OR 2019-nCoV OR 2019nCoV OR coronavirus OR coronavirus OR pandemic”)which were generated from the “MeSH Terms” related to anatomy, education, teaching, learning, and assessment during Covid-19.

Among the variables of interest for this review included: (1) students’ and faculty members’ perception of online teaching and assessment, (2) coping strategies utilized by the

students, faculty members and institutions during online learning, (3) Change in the anatomy curriculum, (4) students' and faculty members' opinions on the lack of hands-on learning and assessment activities, and (5) Challenges faced by the students, faculty members and institutions in anatomy teaching and assessment during the Covid-19.

Study selection

The screening process was performed in three stages: title screening, abstract screening, and full-text screening. The title screening was performed by the last author (SNH) by using several inclusion criteria for the title, namely: (1) The title was written in English language, (2) The title highlights the context of anatomy education during the Covid-19 pandemic, and (3) The title reflects either anatomy teaching, learning, assessment, or gaps in anatomy education. There were identified through database searching and the duplicate titles were removed. The remaining titles were scrutinized by two independent researchers (KS and AHM) to confirm the rigor of the search.

Then the abstracts were retrieved and reviewed by three independent researchers (HEG, MHT, and MW) based on the inclusion criteria for the abstract, namely: (1) The abstract is written in English language; (2) The abstract highlights the context of anatomy education during the Covid-19 pandemic, and (3) The abstract reveals outcomes or variable of interest related to anatomy teaching, learning, assessment and gap in anatomy education. After resolving any disagreement through discussion, 176 abstracts that fulfilled the inclusion criteria were selected for the next stage of screening.

The complete articles abstracts were retrieved and reviewed by three researchers (SNH, KS, and AHM) based on several eligibility criteria for full articles. The criteria include: (1) the article was published in the English language, (2) Types of included articles are original articles, reviews, commentaries, personal views, letter to the editor, guidelines, and practical tips, and (3) The article highlights the context of anatomy education during the Covid-19 pandemic, and (4) The article elaborates outcomes or variable of interest related to anatomy teaching, learning, assessment and gap in anatomy education. Each article was screened independently by two of the three authors to decide whether to include or exclude it, and the decisions were made through the consensus of the two authors. When disagreement arose, the third author was consulted to resolve it.

Data charting

We developed a data extraction form that included the following information: (1) author(s), (2) year of publication, (3) location, (4) study design, (5) intervention performed, (6) reported results, (7) outcomes, (8) description of main themes, and (9) conclusion and recommendation.

The data charting process were piloted by two researchers (HEEG and MEA) using the data extraction form. The process was conducted using the Google Form software (Google LLC, California), which allowed the data to be automatically captured by the Microsoft Excel Spreadsheet software (Microsoft Corporation, Washington).

The data charting was conducted by three researchers (SNH, KH, and AHM), whereby data from each article were extracted by two of these three researchers and counter-evaluated by another researcher for accuracy or missing information. Selected data with contradictory information were re-evaluated by the entire team, and the discrepancy was resolved through a discussion to reach a consensus.

Summarizing, synthesizing, and reporting the results

Based on the recommendation by Westphaln et al., (2021), a mixed approach analysis that involved descriptive statistics and thematic analysis was performed on the extracted data. The descriptive statistics about the types of articles, study design, and geographical distribution were collated. A thematic analysis was performed to identify the patterns and trends of teaching and assessment of anatomy, as well as gaps in anatomical education during the Covid-19 pandemic. The thematic analysis was conducted by using a-three level coding approach—open, axial and selective codes— which was adapted from the grounded theory coding method (Saldana, 2009; Williams and Moser, 2019). This method was selected since the coding process of the grounded theory method discovers patterns that may not be explicit from the raw data (Glaser, 2002). This inductive analysis reduces the raw data into several meaningful and relevant categories that are related to the research question (Creswell, 2012)

To ensure the trustworthiness of the thematic analysis, the analysis was independently conducted by three researchers: first author (HEEG), the second author (AHM), and the last author (SNH).

The extracted data from each selected study were converted into electronic formats using ATLAS.ti software, version 22 (Scientific Software Development, GmbH, Berlin, Germany).

The raw data were broken down into several chunks of data that were compared and grouped into several open codes (OC)—categories that reflect general phenomena. The second-level coding involved explorations of the OCs for any connection, overlap and duplicates. Consequently, the OCs that had similar features and connections were grouped under one common axial code (AC). During the third level coding, the content and interrelations between the ACs were explored and the ACs were then categorized into several common codes, known as the select code (SC). Throughout the coding process, the researchers journalized memos of patterns and categories, which were subsequently used for comparison and triangulation. To increase the credibility of the data, the generated codes that were generated by each researcher were discussed among the research team members in several online meetings to achieve the final consensus (Boeije, 2002; Saldana, 2009).

Stage 6: Consultation

Several anatomists and medical educationists were consulted during the article selection process. Based on the experts' suggestion, two articles were handpicked to be included in the pools of articles. The thematic analysis data was also triangulated among experts in anatomy and medical education, whereby the list of open, axial and selective codings were reviewed, renamed and recategorized accordingly.

RESULTS

Selection of the sources of evidence

A total of 416 titles were identified through database searching, and following the removal of duplicates, 330 records remained. Screening by title and abstract excluded 155 resources. Consequently, the full-text screening process of the remaining 175 full-text articles excluded 98 resources. The justifications for exclusion by full-text screening included the following: the study was not conducted specifically in response to Covid-19 ($n = 45$), the study predated Covid-19 ($n = 10$), anatomy was not the sole focus of the study but rather a part of it ($n = 20$), and the scope of the study was not related to research question ($n = 23$). The remaining 77 articles were subsequently analyzed according to the research questions. Out of these 77 articles, 7 articles were published as an early view during the review period, and published in a volume and issue in 2022. The results of the data selection process are illustrated in Figure 1.

“Insert Figure 1 here”

Characteristics of the included studies

From the final selected 77 articles, several bibliographic data were analyzed: types of articles, study design, and geographical distribution of the selected studies. Most of the articles were original research (n= 39), followed by personal views, (n= 25), reviews (n= 11) and guidelines (n= 2). Most of the original research was cross-sectional studies that involved a quantitative-observational approach. In terms of geographical distribution, the selected studies originated from the following six continents of the world: Europe (i.e., United Kingdom, Italy, Germany, Turkey, Portugal, Greece, Croatia, Ireland, Malta, France, and Denmark) (35.1%), Asia (i.e., India, China, Turkey, Kingdom of Saudi Arabia, United Arab Emirates, Oman, Jordan, Japan, Singapore, Hongkong, Malaysia, Indonesia, Thailand, Nepal) (32.5%), North America (i.e., the United States of America, Canada, and Barbados) (24.7%), Africa (i.e., Nigeria and Rwanda) (3.9%). Oceania (i.e., Australia and New Zealand), (2.6%), and South America (i.e., Brazil) (1.3%). The frequency and percentage of the type of articles, and study design are summarized in Table 1, and the geographical distributions of the selected final articles are illustrated in Figure 2.

“Insert Table 1 here”

“Insert Figure 2 here”

Results of individual sources of evidence

In view of the large number of articles, the key findings of each included article were summarized in Supplementary Table 1. In addition, the findings were grouped into several themes and are presented in Table 2 and Table 3. Table 2 summarized the changes and disruptions of anatomy education during the Covid-19 pandemic; while Table 3 outlines the gaps in anatomy education that emerged during the pandemic.

“Insert Table 2 here”

“Insert Table 3 here”

Synthesis of results: Changes and disruptions of anatomy education

The included articles focused on six themes related to the patterns and trends of anatomy teaching and assessment amidst Covid-19: (1) immediate strategic plans and actions, (2) evolution and innovation in anatomy teaching and learning, (3) online assessment practice, (4) students' and educators' receptivity and adaptation, (5) effects of online learning and assessment, and (6) future directions.

Theme 1: Immediate strategic plans and actions

The Covid-19 pandemic has resulted in an abrupt transition of anatomy education from face-to-face to online learning. When the Covid-19 lockdown was enforced worldwide, immediate contingency plans and strategic actions were implemented by the universities to ensure the continuity of educational provision. Given the fact the anatomy courses were mostly delivered face-to-face prior to the Covid-19, there was an urgency for anatomy lecturers and students to be adaptable to the online education; hence, teaching and assessment guidelines were immediately developed by the higher institutions after the enforcement of Covid-19 lockdown (Tg Muda et al., 2021). To support the implementation of online education in anatomy, online software and video teleconferencing application were procured by the institutions and the learning management system (LMS) platform were upgraded (Tg Muda et al., 2021). The lecturers were given training on online learning and encouraged to adopt multimodal approaches into their teaching activities (Tg Muda et al., 2021). Besides that, continuous feedback that identified constraints and challenges in online teaching and learning were undertaken by the university authorities, and program coordinators (Longhurst et al, 2020). Apart from ensuring the quality and effectiveness of anatomy resources, this action is a pertinent measure in facilitating the higher authorities making decision of in teaching, learning and assessment policy (Longhurst et al, 2020). In addition, the conduct of online anatomy courses was continuously re-evaluated to ensure the achievement of course learning outcomes, as there was increasing concerns regarding psychomotor skills and affective learning competency attainment due to limited access to in-person cadaveric dissection (Baptiste, 2021). In terms of cadaveric dissection training, guarded approach and diligent screening for body donation process and standard operating procedure for anatomical embalming were developed by institutions to prevent the risk of Covid-19 infection from an infected donor (Patra et al., 2021b; Rajasekhar and Kumar, 2021)

Theme 2: Evolution and innovation in anatomy teaching and learning

To mitigate the spread of Covid-19 infection, anatomy classes including cadaveric dissection, were mainly conducted through an online platform. Anatomical concepts were delivered either synchronously via web-based teleconferencing application and virtual reality technology, or asynchronously using prerecorded videos and narrated PowerPoint (Iwanaga et al., 2021a). To reduce the risk of receiving bodies infected with SARS-CoV-2, the practical sessions were conducted either fully online—using various online resources—or through a combined approach of online and in-person practical session (Cheng et al., 2021). Given the fact that online anatomy practical lacks active learning and peer interaction, systematic guidelines on conducting online anatomy practical, or modules of specific online anatomy courses were introduced to promote facilitation of learning in social and cognitive context (Flynn et al., 2021). For instance, Pather et al., (2020) outlined six teaching elements in the management of anatomy education during the Covid-19 pandemic, namely synchronous teaching, community care, clear communications, clarified expectations, constructive alignment, community of practice, ability to compromise, and adapt and continuity planning. In addition, several strategies on virtual appreciation ceremony for silent mentors or body donors was introduced to promote the development of professional behaviors (Singal et al., 2021).

Besides, utilization of multimodal physical tools (e.g., anatomy models, 3D printed models, and cadaveric specimens) and digital resources (i.e., digital software, Massive Open Online Course (MOOC), anatomical images, digital histology slides, YouTube and online videos, virtual and augmented reality simulations, digitized live streamed cadaveric dissection, virtual laboratory workspace, virtual worksheet, and mobile applications) were emphasized to address the inequality of online learning accessibility (Singh et al., 2020; Srinivasan, 2020; Byrnes et al., 2021; Bernigau et al., 2021; Böckers et al., 2021; Chan et al., 2021; Chiuta et al., 2022; Griep et al., 2021; Harmon et al., 2021; Iqbal et al., 2022; Iwanaga et al., 2021c; John et al., 2021; McWatt, 2021; Nakai et al., 2022; Owolabi and Bekele, 2021; Saverino and Zarcone, 2021; Stunden et al., 2021; Tucker and Anderson, 2021). Besides that, the blended learning approach including virtual flipped classroom model that involves synchronous and asynchronous strategies, were implemented to empower active and self-directed learning among the students (Harmon et al., 2022; Iqbal et al., 2022; McWatt, 2021; Yoo et al., 2021). Students were enforced to be involved in content design and delivery, which could subsequently enhance their

engagement and performance in an online learning environment (Border et al., 2021). Likewise, the adoption of instructional design models, namely the Gagne-9-event and the Analyse, Design, Develop, Implement, and Evaluate (ADDIE) models during the development of learning materials were encouraged to ensure a systematic and engaging learning session (Naidoo et al., 2020; Naidoo et al., 2021). With the adoption of innovative strategies, online education would enhance learning efficiency in anatomy (Banovac et al., 2021).

Theme 3: Online assessment practice

In general, the duration for online anatomy assessment has been shortened and anatomy content is assessed through various questions that can evaluate different levels of cognitive skills (Harmon et al., 2021; Sadeesh et al., 2021). Despite higher student test performance compared to those who attended dissection-based examination (Harrell et al., 2021), the validity of online summative assessment in assessing the expected competencies of the students remains questionable (Franchi, 2020). Certain types of online question formats (i.e., open-book examination) and the use of online exam software require training for the lecturers to design the questions, and for the students to familiarize with the assessment format (Sadeesh et al., 2021). Furthermore, a longer online examination duration is required to anticipate internet connection problems and allocate time for students to type their answers (McWatt, 2021). Nevertheless, online written questions including multiple choice questions are flexible assessment method for cognitive learning outcomes (Sotgiu et al., 2021; McWatt, 2021). Despite the good quality of exhibits in the form of photographs and diagrams displayed through an online platform, face-to-face practical examination is favored more by students (Harmon et al., 2021; Sadeesh et al., 2021; Saini et al., 2021). Since laboratory and practical assessment is less feasible during this pandemic period, formative and programmatic assessments are emphasized as a suitable alternative for assessing psychomotor competency and integration of anatomy knowledge (Alsharif et al., 2020; Border et al., 2021; Harrell et al., 2021). Furthermore, it is unable to conduct assessment in a virtual reality workspace that allows active learning during laboratory and practical session (Nakai et al., 2022)

Theme 4: Students' and educators' receptivity and adaptation

In general, students' and anatomists' receptivity to online education varies (Cheng et al., 2021; Totlis et al., 2021; Papa et al., 2022). Many students are unsure about replacing face-to-face classes with online courses due to various reasons (Totlis et al., 2021; Ortadeveci, et al., 2021). Some students perceived being detached from a real classroom when learning in gross anatomy online courses (Babacan and Dogru Yuvarlakbas, 2022) due to declining engagement (Banovac et al., 2021; Thom et al., 2021), lack of interaction and hands-on activities, as in cadaveric dissection and laboratory practical sessions (Cuschieri and Calleja Agius, 2020; Albalushi et al., 2021; Duloherly et al., 2021). Indeed, some students and lecturers preferred face-to face anatomy courses due to technical-related issues, namely unstable internet network and restricted access of online resources (Şenol et al., 2021; Sotgiu et al., 2021). Furthermore, students who are financially compromised and senior faculty members who were unfamiliar with online learning are disadvantaged as the access and utility to online devices could have been restricted (Khasawneh, 2021; Bauler et al., 2022). These situations stimulate their anxiety, reduce their self-confidence, and compromise the achievement of learning outcomes, their professional development and future career attainment (Cuschieri and Calleja Agius, 2020; McWatt, 2021). The dependency on online teaching and learning during the pandemic has imposed an immense workload on academic staff, as they have to adapt to the new technology while preparing learning materials (Bauler et al., 2022). Some of the anatomy lecturers believe that their online teaching materials are not optimally designed and insufficient for the acquisition of practical skills and professional behaviours (Cheng et al., 2021; Totlis et al., 2021). It was argued that preclinical anatomy teachers had relatively poor preparation for online learning compared to clinical lecturers (Yan et al., 2021).

Conversely, some students and lecturers faced no difficulties during online learning as it was perceived as a flexible way of learning that promotes their motivation, and monitor students' performance (Co et al., 2021; Mahdy and Sayed, 2021; Babacan and Dogru Yuvarlakbas, 2022). For instance, flipped classrooms, live real-time dissection, and virtual laboratory worksheets are valued positively by students because the materials are readily accessible at their convenience (McWatt, 2021). The use of communication chat voice in the teleconferencing application, is appreciated as an effective tool for communication during online classes (McWatt, 2021). Besides, there was an increased used of self-directed online tools, namely online quizzes, and pre-recorded lecture that were perceived to be beneficial in enhancing students understanding

(Banovac et al., 2021). Online learning was perceived to be suitable for the delivery of content knowledge (Cuschieri and Calleja Agius, 2020; Şenol et al., 2021), and had improved students' and lecturers' digital skills⁴⁰. Besides that, there was no significant difference of students' attendance to online anatomy classes during pandemic, compared to physical classes indicating that students are adapting well with online learning (Natsis et al., 2021; Vidya et al., 2021). It was argued that a successful online or remote learning does not only depend on good internet connection, but requires the ability of utilizing social media platform to ensure and good organization skills (Banovac et al., 2021)

Theme 5: Effects of online learning and assessment

There are heterogeneous reports on the effects of online anatomy education during the pandemic. The use of guided self-directed learning online applications, such as BlueLink and Complete Anatomy, and an audience response system in e-tutorials promote active learning during practical classes, improved students' laboratory performance (Kurtulmus-Yilmaz and Önöral, 2021), and enhanced students learning experience (Choudhary, 2021). Likewise, the use of 3D imaging software and virtual reality simulation have allowed students to manipulate anatomical structures, which has consequently increased students' cognitive performance and spatial visualization (Bartoletti-Stella et al., 2021). These online instructional materials have resulted in comparable learning performance to face-to-face anatomy classes (Saverino and Zarcone, 2021; Stunden et al., 2021; Thom et al., 2021). The availability of 3D scanning applications has allowed anatomists to design online anatomy content that can effectively promote the understanding of anatomical knowledge (Iwanaga et al., 2021c). Moreover, students value the use of YouTube videos and PDF materials, as these tools facilitate their understanding of anatomical content (Vidya et al., 2021). Besides that, online education allows students to adopt a broader range of pedagogical methods that cater for various learning styles and stimulates their motivation and self-directed learning (Co et al., 2021; Choudhary, 2021; Patra et al., 2021a). The use of online platform in anatomy education also facilitates administrative tasks such as teaching evaluation, feedback measurements and attendance monitoring (Choudhary, 2021)

Conversely, online learning in anatomy has taken a toll on students and educators wellbeing. Given the need to rapidly changed from in-person to remote learning, online education has imposed anxiety and stress on the students and lecturers due to increase workload. Furthermore,

the decline in cadaveric dissection and laboratory practice opportunity was perceived to have had impaired the students professional and skill growth (Chytas et al., 2021; Patra et al., 2021a)

Theme 6: Future directions.

The Covid-19 pandemic has changed the anatomy education landscape, which opens up opportunities for improvement. The role of anatomists is no longer limited to providing anatomical knowledge and guidance to students; rather, they have to be vigilant and adaptable to change, diligent in making a decision, provide a good benchmark for adequate medical education, rapidly adapt to the online educational environment, and be flexible and creative in obtaining solutions for teaching based on the findings of empirical evidence (Evans et al., 2020; Evans and Pawlina, 2021; Smith and Pawlina, 2021). The Covid-19 pandemic has unlocked the barrier to technology-enhanced teaching among anatomists, whereby future curriculum design is expected to adopt hybrid model, that integrates online and practical off-line anatomy instructions (Baptiste, 2021; Böckers et al., 2021; Cortese and Frascio, 2021; Onigbinde et al., 2021). Due to limitations in body donation and cadaveric dissection (Iwanaga et al., 2021c), there is intention to replace traditional anatomy dissection laboratory to anatomy studio and utilize digitized content as an adjunct tool for physical dissection, which allow transdisciplinary collaboration and utilization of interactive digital content (Brassett et al., 2020; De Carvalho Filho et al., 2021). Indeed, the Covid-19 pandemic has become a catalyst for redesigning anatomy education by involving partnerships from various specialties—instructional designers, web designers, information technologists, and computer engineers—in devising engaging and stimulating digitized content (De Carvalho Filho et al., 2021). Considering that cadaveric dissection is vital for the development of surgical skill, the in-person cadaveric dissection should be reserved for postgraduate clinical training in situation where there is limited opportunity for cadaveric dissection (Chytas et al., 2021). In addition, future anatomy curriculum should incorporate social learning elements through the enhancement of inter-faculty and inter-departmental academic collaborations (Singh et al., 2020), development of strong support system from technical and laboratory staff (Singh et al., 2020) and provision of inclusive anatomy education (Pacheco et al., 2020). Nevertheless, the changes require a prior need assessment to identify the gaps, re-evaluate the values of anatomy education and to conduct continuous reform to ensure an agile and

adaptable curriculum (Brassett et al., 2020; Cuschieri and Calleja Agius, 2020; Evans et al., 2020; Baptiste, 2021; Evans and Pawlina, 2021; Iwanaga et al., 2021b; Bauler et al., 2022)

Synthesis of results: Gaps in anatomy education

Four gaps in anatomy education that emerged during the Covid-19 pandemic were identified from this review: (1) Anatomy curriculum prior to pandemic was not future ready, (2) learning obstacles identified during pandemic; (3) administrative and teaching challenges, and (4) ethical issues in online anatomy education.

Gap 1: Anatomy curriculum prior to pandemic was not future ready

Given the challenges faced by the faculty members and university authorities in conducting online learning during the early phase of pandemic, it is evident that the anatomy curriculum prior to pandemic was not agile or future ready. When the Covid-19 lockdown was first enforced globally, all higher institutions were closed, and face-to-face activities were rapidly suspended. With lack of administrative, educational and infection control guidelines prior to Covid-19 lockdown (Alsharif et al., 2020), the university authorities and educators struggled to develop a standard operating procedure for online teaching, learning and assessment as to ensure the continuity and quality of education provision. Besides, anatomy instructions prior to Covid-19 was mainly delivered in classroom setting, via face-to-face approach (Tg Muda et al., 2021). Despite the increase trend in the use of digital and virtual reality in anatomy education, this technology-enhanced tools were not fully utilized before the Covid-19 (Singal et al., 2020), and the formal anatomy courses lack of online or hybrid teaching and learning approaches (Alsharif et al., 2020)

Gap 2: Learning obstacles identified during pandemic

There is an increasing concern among students and anatomy educators about the substandard education quality during the Covid-19 pandemic due to the declining teacher–student interaction (Franchi, 2020; Choudhary, 2021; McWatt, 2021). The Covid-19 pandemic has disrupted the accessibility to cadavers and other anatomy learning resources (Pearson, 2020; Khasawneh, 2021). The Covid-19 lockdown has restricted the cadaveric dissection and anatomy laboratory teaching practice (Ooi and Ooi, 2020; Pather et al., 2020), and lecturers had to be creative in

creating an online anatomy practical session that could cater for the expected learning competency. Although anatomists are satisfied with their ability to teach online (Yan et al., 2021), the effectiveness of online anatomy practical is questionable as there was lack of kinaesthetic learning experience (Franchi, 2020; Pather et al., 2020; Choudhary, 2021), and thus students may not be able to appreciate anatomy knowledge relevance for clinical practice (Franchi, 2020). Indeed, the challenges of remote learning, namely unequal access to online learning resources (Franchi, 2020; Patra et al., 2021a), learning distraction and poor time management (Khasawneh, 2021), longer screen time (Choudhary, 2021), had imposed financial, social and psychological burdens, especially anxiety, of among students (Khasawneh, 2021; Patra et al., 2021a; Srivastava et al., 2021).

Gap 3: Administrative and teaching challenges

The Covid-19 pandemic has forced the lecturers to work beyond their comfort zone, whereby they had to modify their routine teaching practice, which might not be aligned with their personal educational philosophies (Pather et al., 2020). Anatomy educators in some countries were mobilized to cater for online teaching and learning (Pather et al., 2020). Technical staffs and anatomy demonstrators experienced change in their role and job scope, as they had to assist in the digital content creation (Pather et al., 2020, Tg Muda et al., 2021). As pandemic progress, many institutions faced financial difficulties as a result to unanticipated continuous expenses while providing online education to their students (Pather et al., 2020, Tg Muda et al., 2021). Hence, continuous monitoring and re-evaluation of the online learning and assessment in anatomy is crucial in ensuring its cost effectiveness.

Gap 4: Ethical issues in online anatomy education.

The use on internet and social media in anatomy learning has widened the opportunity for students to receive digital content in the form of cadaveric body images (Lemos et al., 2021). The use of these images of donated cadavers may be incongruent with the donors' expectation, as these images can be misused by students especially when they are shared in social medial. Besides, the lecturers were also concerned about using free copyrighted materials for their classes as these materials can also be disseminated freely after class. There were also other

ethical obligations during the pandemic, such as students' welfare, the security online assessment and invigilation, and the increasing academic workload among anatomy lecturers (Jones, 2020)

DISCUSSION

A total of 77 included articles were published in 22 months, from April 1, 2020, to the end of 2021, which is an average of 3.5 articles each month from different parts of the world describing the response of anatomy educators to the rapid transition during the Covid-19 pandemic. About fifty percent of the included manuscripts were original research. The remaining articles were letters to the editor, commentaries, personal views, reviews, guidelines, and practical tips. Six themes related to the contingency measures, evolution, practice, stakeholders' receptivity, effects and future direction of anatomy teaching, learning, and assessment during the Covid-19 pandemic were identified from this review. This review also unearthed four gaps in anatomy education that emerged due to the uncertainties in teaching, learning, and assessment practice during the Covid-19 pandemic. These findings contribute to the historiographical debates concerning the best method to teach and assess anatomy competencies among medical and allied health sciences students.

The Covid-19 pandemic has triggered a shift from classical face-to-face teaching in lecture rooms and dissection laboratories to several other modalities. The most affected teaching and learning element during the Covid-19 pandemic is the classical cadaveric dissection course, which is regarded as the gold standard in anatomy teaching by many anatomy educators (Bay and Ling, 2007; Ghosh, 2017a; Selcuk et al., 2019). The Covid-19 disruption brought to light the anatomy educational system frailty, whereby most of the anatomy courses were noted not to be future-proof. Despite the strategic planning and drastic actions taken by the university authorities and anatomy educators in providing the online learning environment, the implementation of remote anatomy learning during pandemic was indeed a challenging task (Patra et al., 2022). The emergence of new guidelines in teaching, learning and assessment had facilitated the process of online learning; however, it is uncertain whether this new curriculum design is effective in the attainment of anatomy related competencies particularly the development of psychomotor skills and affective learning (Yusoff et al., 2020). These guidelines might be suitable in the emergency

situation—as the educators had limited options to conduct their courses—but may not be effective during the pandemic aftermath or future pandemic waves. Hence, it is imperative to conduct a proper foresight evaluation based on the past, current and emerging trends in anatomy education including the cadaveric dissection training in effort to design an agile future proof curriculum (Behar and Hlatshwayo, 2021; MacPherson and Lisk, 2022).

Despite the availability of technology-enhanced tools and digitized anatomical instructions during the pre-pandemic era, the utility of online pedagogy and assessment in anatomy education was not optimized, as in-person cadaveric dissection and laboratory training were given much emphasis in the curriculum. This review identified four important scenarios in anatomy pedagogy throughout the Covid-19 pandemic: (1) disruption of cadaveric dissection training and anatomy laboratory practice; (2) utilization of multimodal teaching approaches and tools; (3) adoption of blended learning approaches to integrate online and face-to-face learning, and (4) empowerment of pedagogical innovation in anatomy courses. Even though the value of classical cadaver-based laboratory teaching is an area of ongoing debate, anatomy educators and students have been raising their concern over the lack of hands-on practical session due to the decline in the classical cadaver-based laboratory training (MacPherson and Lisk, 2022). Indeed, the perception of the public is another factor that had prevented anatomy educators from moving away from cadaver-based teaching, as the public relies heavily on the authentic teaching experience perceived in cadaver-based teaching (McMenamin et al., 2018). Although the unprecedented Covid-19 pandemic has provided an opportunity for anatomists to find alternative teaching methods that are comparable to cadaveric dissection, it is imperative to create a meaningful online learning experiences that can develop the skills and competencies, which are most needed in the present practice, and for the future needs (Prabhath et al., 2022). In fact, the United Nations Educational, Scientific and Cultural Organization (UNESCO) has outlined the four pillars of education that is required for the 21st century learning, comprises of learning to know (cognitive competency; e.g comprehension and analysis of knowledge), learning to do (psychomotor competency; e.g. able to act and apply knowledge), learning to live together (interpersonal skills; e.g., communication and cultural and sensitivity) and learning to be (intrapersonal skills; e.g., critical thinking, self-esteem, and emotional intelligence) (Delors et al., 1996). These four pillars of learning deserve equal consideration when designing a learning content (Sobe, 2021). Hence, it is argued that a fully online anatomy course is not capable in

ensuring the attainment allocated learning outcomes (Papa et al., 2022). The adoption of blended learning and implementation of innovative pedagogic ideas during the pandemic are efficient ways to combine traditional face-to-face teaching methods with authentic online methodologies (Abu Bakar et al., 2021; Xiao and Adnan, 2022). However, the effectiveness of these approaches and their implications on post-pandemic anatomy curriculum should be explored further to ensure their sustainability in the curriculum.

Additionally, this review identified modified anatomy assessment practice during the Covid-19 pandemic. Although the efforts were successful in ensuring the continuity of assessment method, there are several threats of validity to these assessment practice, identified by the authors. First, the attainment of learning outcomes is at stake as not all learning outcomes could be captured by the online anatomy assessment (Abd Elgalil et al., 2022). At this point, it is also unclear to what extent students develop their competency through a multimodal approach and how comparable their performance is with those who have learned anatomy through hands-on practical sessions. Besides, ensuring the integrity and security of online anatomy assessment is crucial as this effort requires optimization of information communication and technology (ICT) facility, namely internet network stability and online examination software, which are quite costly (Vivian et al., 2022). In addition, online examination requires familiarization of the online examination software, and the invigilation process is labour intensive (Adam et al., 2022). Despite using multiapproach of online anatomy assessment, the validity of summative assessment is limited to evaluating the cognitive competency (Vivian et al., 2022). Ideally, the assessment of psychomotor skills should be conducted in-person; therefore, it is suggested that assessment of psychomotor competency during pandemic should be conducted in small group, which may be not feasible in some institutions. Hence, it is argued that the utility of summative anatomy assessment during Covid-19 pandemic declines as anatomy educator struggles to ensure the validity, reliability, practicality, feasibility, cost effectiveness and educational impacts of the online anatomy assessment (Van Der Vleuten, 1996). Hence, leveraging the formative assessment and adhering to the best assessment practice in medical education (i.e., utility of assessment and constructive alignment) are utmost important in ensuring high quality anatomy assessment during the pandemic (Mishall et al., 2022). It should be noted that these assessment practices need to be continuously revisited and re-evaluated to suit the current and future needs of anatomy education.

Besides that, this review revealed varied students and lecturers' receptibility to online learning and assessment during the Covid-19 pandemic. There are various factors that could have influenced their perception and response to Covid-19 disruption in anatomy education, namely socioeconomic background, familiarity to online education and tools, prior experience of online learning and assessment, availability of technical support, psychological well-being, and educational belief and principle (Bast, 2021; Tg Muda et al., 2021). Consistent with findings of a previous study, these factors, especially being familiar to online learning influenced students' and educators' attitudes, perceptions, experiences, and receptivity of the new learning environment (Ma and Luo, 2022). To create a future-proof anatomy curriculum, online learning is indispensable as it need to be integrated with physical classes and aligned with the emerging fourth industrial revolution and education 4.0 (Ellahi et al., 2019). Moreover, the hybrid approach has been reported to promote cognitive and psychomotor competency in anatomy education through self-directed active learning and critical thinking among students (Kelleserain, 2018). Hence, to ensure successful implementation of the hybrid teaching model, equal emphasis should be given to cadaveric-based laboratory teaching as these modality provides authentic experience to identify and describe anatomical variations, clinical and surgical skills, anatomical and spatial relationships, and the structures of tissue textures (McMenamin et al., 2018). In conjunction with cadaveric dissection courses, many institutions have conducted commemorating ceremonies to the deceased, who donate their bodies for medical education purposes (Winkelmann and Guldner, 2004; Chiou et al., 2017; Ghosh, 2017b; Pabst et al., 2017). This practice inculcates the development of professional behaviors in the medical and allied health sciences that eventually mold them into becoming compassionate practitioners (Chiou et al., 2017). Therefore, it is crucial to ensure the development of digital competency and the use of technology alongside classical cadaveric-based training in enriching the future anatomy learning environment (Lachman and Pawlina, 2022).

Besides that, this review unearthed the implications of online anatomy education to learning performance, teaching, curriculum, administration, and psychological wellbeing of the students and faculty members. The effectiveness of these online teaching and learning methods in anatomy is prematurely concluded, as there is no proper well-designed study that has evaluated the impact of these teaching methods on students' learning during the Covid-19 pandemic. When mapped with the four levels of Kirkpatrick evidence of educational evaluation (Yardley and

Dornan, 2012), the included studies are limited at Level-1 (i.e., the studies explored participants' view on the lecturers' teaching behavior, instructional design, and instructional materials) and Level-2 (i.e., the studies explored students' modification of attitude, knowledge, and skills of the students). There is a scarcity of studies that have evaluated Level-3 and Level-4 of Kirkpatrick evidence of educational evaluation, which indicates that the impact of online teaching and learning on anatomy has been inadequately explored. Furthermore, the Covid-19 pandemic is a new situation that could have limited the conduction of research by anatomy researchers. Well-designed research conducted within an adequate period is indispensable to ensure a valid and reliable conclusion on the efficacy of online anatomy teaching and learning in the attainment of competencies and outcomes.

Indeed, the Covid-19 pandemic has diversified the thinking paradigm of anatomists on how they should design the future anatomy education curriculum during the aftermath of the Covid-19 pandemic. The Covid-19 disruption has held up a reflection that anatomy education is yet to become future-ready and requires involvement by various stakeholders in empowering the hybrid learning approach that is agile and adaptable to uncertainties of the future (Xiau and Adnan, 2022). There is a necessity for continuous need assessment and re-evaluation of the anatomy curriculum as this effort provide basis for curriculum change and revamp (Mishall et al., 2022). The Covid-19 has reinforced the conviction of mutual collaboration in provision of virtual, equitable and inclusive education. The constraints imposed by Covid-19 demand equal attention and collective action from all the stakeholders of anatomy education (Wickramasinghe et al., 2022). In conjunction with strategic planning and foresight evaluation, a well-designed anatomy curriculum with underpinning educational theoretical framework is required to address the gaps in the current curriculum (Mishall et al., 2022).

Strength of the study

The key strength of this study is that it represents a comprehensive examination of the literature related to anatomy education practice during the Covid-19 pandemic. Given the scarcity of original articles with well-designed studies in the anatomy education literature, we included other types of articles in this scoping review to gather experts' and stakeholders' opinions and experience on the conduct of anatomy teaching, learning, and assessment during the Covid-19 pandemic. Furthermore, this review captured articles from various geographical distributions,

including studies from developed, developing, and underdeveloped countries. Therefore, the scoping review provides a more reliable picture of the evolution of anatomy education amidst Covid-19 and of how anatomy communities from different socioeconomic backgrounds adapted to the changes. In addition, we adhered to the six stages of the extended scoping review protocol outlined by Levac et al. (2010) and Westphaln et al. (2021), whereby we conducted a comprehensive search using four databases: Scopus, Web of Science, CINAHL, ERIC, and PubMed. This step-by-step systematic approach was performed according to the PRISMA-ScR checklist, to ensure the validity and reliability of the scoping review findings.

Limitations of the study

Nevertheless, this study is limited by the lack of information on experimental data that is conducted in either simulated or authentic environments. The impact of anatomy education practice on Level-3 (i.e., the educational intervention resulted in students' learning behavioral change) and Level-4 (i.e., the educational intervention resulted in the change of the organizational practice and provided benefits to the stakeholders) of Kirkpatrick's best evidence in medical education intervention is not explicit from the literature. Rather, the changes in the learning behaviors and organizational practice reported in the literature are attributed to the unprecedented events occurring in response to the Covid-19 pandemic and were not contributed by the effectiveness of the online anatomy teaching and learning approaches. Moreover, the literature in this field is rapidly evolving. Hence, it is challenging to sample newly published articles to be included in the review.

CONCLUSIONS

The Covid-19 pandemic is the catalyst for changes in the anatomy education curriculum. Anatomists and students responded well to the change by utilizing multimodal tools during remote teaching and assessment. However, some of them faced challenges during the implementation of online teaching and assessment; thus, their receptivity to online anatomy education varies. Furthermore, the efficacy of online teaching in ensuring the attainment of psychomotor skills and professional behavior outcomes is unclear due to the lack of empirical evidence generated from well-designed studies. Nevertheless, this pandemic has unlocked the barrier to technology-enhanced teaching among anatomists, who consequently became more

aware of the importance of a suitable instructional design. This review provides a holistic view of the current anatomy education scenario during the Covid-19 pandemic. Understanding the evolution of anatomy education during this pandemic helps anatomists to be agile in designing a future-ready and adaptable curriculum.

ACKNOWLEDGMENTS

This work was supported by the Universiti Sains Malaysia (RUI grant numbers: 1001/PPSP/8016121).

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FIGURE LEGENDS

Figure 1: The flow of the scoping review process according to the Preferred Reporting Items for Systematic reviews extension for scoping reviews (PRISMA-ScR) protocol.

Figure 2: The frequency and percentage geographical distribution of included articles according to the six continents of the world: Europe (35.1%), Asia (32.5%), North America (24.7%), Africa (3.9%). Oceania (i.e., Australia and New Zealand), (2.6%), and South America (i.e., Brazil) (1.3%).