

# TESTING AND STRATEGIES OF THE ANATOMAGE TABLE USE IN TEACHING PHYSICAL ANTHROPOLOGY

**Dzintra Kazoka**

Rīga Stradiņš University, Institute of Anatomy and Anthropology, Latvia

**Mara Pilmane**

Rīga Stradiņš University, Institute of Anatomy and Anthropology, Latvia

**Abstract.** *At the Department of Morphology, integrating the Anatomage Table (AT) into medical education is a supplementary resource to teach virtual Human Anatomy to medical students and their future professional and clinical careers. This study aimed to examine and test an AT in teaching a virtual Physical Anthropology course and assess the tutors' beliefs and perceptions regarding using technology for teaching. Two tutors participated in the study from autumn 2022 until autumn 2023. Data were collected by tutors who followed specific methods to identify and measure anthropometrical points for evaluation. Tutors paid attention to the available virtual human body images for data collection, research, teaching and learning. Several anthropometrical measurements were performed and collected based on standard methods and positions in the table views. AT was mandatory to verify precise indicators' location and confirm digital instruments for their detection over several human bodies. As part of this study, suggestions for the utilization of the AT to gather essential anthropometrical information have been prepared. Future studies can aim to generate unique methods and supplemental procedures for getting anthropometrical data in contact with AT and using this technology in teaching Physical Anthropology.*

**Keywords:** *Anatomage Table, anthropometry, Physical Anthropology, teaching, tutors.*

## Introduction

Today, tutors are under pressure to start and deliver high-quality Human Anatomy and Physical Anthropology study courses teaching, including new educational technologies (Scheffel & Wirth, 2022) and resources for undergraduates and postgraduates in medical education. Some adapt existing methods and sources, while others create new possibilities and courses (Guimarães & Ferreira, 2020). Tutors should build the fundamental competencies needed for students' practical experience in further medical and/or clinical studies by providing students with unique teaching and learning opportunities in practical classes of the Physical Anthropology course. The Anatomage Table has a significant role in the academic purposes of the human body (Brown et al., 2015). Related to this, three-dimensional (3D) pictures are designed to meet the need of teaching, details obtaining, gathering and surveying (Bartoletti-Stella et al., 2021).

Digital anthropology should become necessary in developing and creating methods and standards for data collection from virtual bodies (Heymsfield & Stevens, 2017).

Since the additional and helpful performance of the Anatomage Table during the course Human Anatomy from 2015 until 2023, the number of tutors and students using this platform in the Department of Morphology has been rapidly growing. As a result, the tutors decided to use the Anatomage Table in other study course or Physical Anthropology. Our academic staff previously believed that the competent teaching and learning of the external composition of the human body could be maximized with the assistance of this technology. In the literature, there is a minimal amount of studies related directly to using the Anatomage Table in teaching virtual Physical Anthropology course and anthropometry (Gaya-Sancho et al., 2023). This study aimed to examine and test an Anatomage Table in teaching the virtual study course Physical Anthropology and to assess the beliefs and perceptions of the tutors regarding using the technology for its teaching.

## **Materials and Methods**

### *Case study*

In 2015, Rīga Stradiņš University's Department of Morphology integrated the Anatomage Table (version 6.0.3.) as an additional tool for learning and teaching Human Anatomy. The Anatomage Table, developed by Anatomage Inc. in San Jose, CA, USA, features four digitalized whole human bodies, including an Asian woman and man, and a Caucasian woman and man. These bodies were reconstructed from frozen cadavers via the U.S. and Korean National Library of Medicine's Visible Human Projects. Each body was separated into narrow slices ranging from 0.60 to 1.00 mm, then reproduced at maximum determination and virtually regenerated. This allowed the examination of different internal structures from multiple angles, providing an effective learning tool for students and teachers (Allen, Kirkpatrick, & Agosto, 2019). The first experience of testing the usage of the Anatomage Table in teaching the study course Physical Anthropology was researched as a case study. Therefore, this investigation included two questions:

- 1) How did the tutors manage using the Anatomage Table for digital detection of a few external human body measurements?
- 2) What are the Anatomage Table technology advantages, disadvantages and satisfaction detected by the tutors to begin teaching the study course Physical Anthropology?

### *Sample, setting, reliability and data gathering*

This study's sample consisted of two tutors of the Department of Morphology who were involved in using the Anatomage Table to teach the study courses Human Anatomy and Physical Anthropology from autumn 2022 until

autumn 2023. A specific protocol was devised to enable quick and efficient data collection on anthropometric points, distances, measurements and evaluations. Its design aimed to gather the necessary information, which was required to answer all the search issues and had assisted in receiving this study's findings.

#### *Detection of anthropometrical points and distances*

The procedure was performed over two days: the first period lasted about two hours, and the second round took place the following day. Primarily, every virtual human body was sliced until the skeletal system. Measurements took place without contact with the natural objects, and it was challenging to identify selected anatomical landmarks on flat scans and sensitive touch screens. According to this, all human virtual bodies were adopted to specific poses. By positioning the human body in a constant, fixed and regular metric position on the Anatomage Table's touch screen, the investigator could detect the locations of the anthropometric indicators and distances. This enabled the precise positioning of digital instruments over each virtual figure, making studying and analyzing the details easier. Anthropometric measurements were taken using the digital distance measurement tool from the Anatomage Table Application Toolbar. Each virtual body was measured using the standard methods proposed by Norton (2018). In the bony frame, three simply noticeable, definitive two-sided indicators were chosen:

- 1) acromiale (an anatomical landmark at the superior and external border of the acromion process);
- 2) iliospinale anterius (refers to the most prominent point that protrudes downwards and forwards on the iliac crest);
- 3) iliocristale (the most lateral point on the superior outer edge of the iliac crest).

The locations of certain points were identified in two different planes – frontal (coronal) and sagittal. Then, three landmarks (acromial, iliospinale and iliocristale) were fixed on both sides of the body, and their positions were also determined in previously announced planes. The distances between bilateral indicators (bi-acromial, bi-iliospinal, and bi-iliocristal widths) were measured and recorded using a distance measurement tool. One investigator repeated measurements several times to reduce human errors. The accuracy of these details was verified by one of both tutors, who was also an experienced anthropometrist.

#### *Data analysis and validity*

Two different approaches were used to investigate the data collected through the protocol. Firstly, the study was based on experimental access to a specific case the authors examined. Secondly, the protocol used in the survey mainly contained open-ended questions, and the ranking was qualitative (Abuhamda, Ismail, & Bsharat, 2021). To evaluate the overall feedback given by the tutors during this

study, their responses were recoded and subjected to qualitative analysis using thematic content analysis (Elo & Kyngäs, 2008). To maintain the quality and validity of this study, the tutors’ responses were preserved in their original form and not altered in any way.

## Results

The using an Anatomage Table in the Department of Morphology differs because of the various characteristics and demands of the courses. This study’s findings were fractioned into four categories placed on the type of questions. The protocols’ questions allowed the tutors’ experience to be analyzed. Thus, it was attractive for the tutors who participated in the educational process to find their first experience using the Anatomage Table to detect a few external human body measurements digitally. An analysis of the fixed answers in protocols revealed that the tutors underlined various points. The main of them were included using the Anatomage Table to detect anthropometrical points, advantages, disadvantages and satisfaction of employing the Anatomage Table in teaching the course Physical Anthropology. The main detected categories and subcategories are presented in Table 1.

*Table 1 Tutors’ main points of using Anatomage Table in teaching Physical Anthropology (made by authors)*

Category	Subcategory
The using of the Anatomage Table in the detection of anthropometrical points	Anatomical landmarks and anthropometrical points difficult identification on flat scans and sensitive touchscreen
	Fixation, customizing of virtual bodies in constant positions
	Specific poses for possible measurements
	Long-time detection and repeating of precious anthropometrical points’ distances
Advantages of using Anatomage Table in teaching Physical Anthropology	The access to different virtual human bodies
	Enhanced, realistic, high-quality visualization on the screen
	Storage of the 3D images in different formats
	Information about different diseases and variations
	Direct examination and investigation in real-time and place
	Safe, more hygienic and friendly environment for the users
	No need to use a special set of anthropometrical instruments
	Better and more precise labeled or magnified structures
	Repeating steps till ideal user skills
	Moving, examination in various anatomical planes and layers
	Users digital and technical skills development and improving
Easy to customize, design the navigation and structures in the Anatomage Table menu	

Disadvantages of using Anatomage Table in teaching Physical Anthropology	Lack of instructions/guidelines on detecting and measuring human bodies on touch screens
	Anthropometrical points' migration and landmarks deformities
	Time-consuming and monotonous activities
	No opportunity to feel the texture of the different tissues
	Not understandable standard examination methods of the human body without special instruments
	Different technical issues
Satisfaction of using Anatomage Table in teaching Physical Anthropology	Link to the not-well-handled problems
	Traditional teaching support by virtual technology
	A late decision to use the Anatomage Table in teaching
	Not debated and explained advantages and disadvantages
	Human anthropology specialists and technologists necessary support

### *The using of the Anatomage Table in the detection of anthropometrical points*

Conversely, both tutors affirmed that identifying selected anatomical landmarks and anthropometrical elements on flat scans and sensitive touchscreen was rugged. Several comments reflected these tutors' difficulties and discomfort about using the Anatomage Table to detect anthropometrical points.

From the tutors' experience, they mentioned that virtual bodies were more flexible to fix and customize them in constant positions. Comparative measurements were taken only after adapting human virtual bodies to specific poses in the sagittal and frontal planes.

Some tutors' comments related to the prolonged and repetitive time to detect precious distances between anthropometrical points.

### *Advantages of using Anatomage Table in teaching Physical Anthropology*

One of the finding points is how study courses are undertaken in higher education, relates to the indications and directions that new technology can bring compared to traditional things. In the Department of Morphology study, it seemed essential to detect which benefits the tutors established for the following users, including students, and about the Anatomage Table in teaching the course Physical Anthropology in comparison with classical possibilities and methods of this course.

About this idea, tutors suggested that the Anatomage Table contains the opportunity to use different virtual human constitutions together with enhanced, realistic, high-quality visualization of them on the screen. Moreover, the tutors found that the 3D figures can be stored in different formats. Besides, these 3D images provide information about topics that real humans may be unwilling to discuss during anthropometrical investigation, including their diseases and variations.

Most of the tutors' statements were about using the system. The tutors have raised a second benefit regarding the protocol. The Anatomage Table allows

direct examination of virtual human bodies and investigation activities in real-time and place. The environment is safer, more hygienic and friendly to the users.

Another positive feedback from tutors was that there is no need to use a unique set of anthropometrical instruments. Labeling or magnifying details can enhance their visibility and enable more accurate detection than traditional anthropometry. They felt this new system allows them to repeat steps until the users ideally obtain the skills. Additionally, virtual human bodies can be moved and examined in various anatomical planes, quickly reaching different layers.

Generally, the tutors who had mentioned design characteristics discussed the benefits of developing the users' digital skills and improving their technical skills. Finally, both lecturers emphasized how easy it is to adopt and represent course directing and details using the Anatomage Table menu. All of these points must be considered because it is vital to acknowledge the active role of users of the Anatomage Table in teaching the Physical Anthropology course.

#### *Disadvantages of using Anatomage Table in teaching Physical Anthropology*

Despite the advantages of the Anatomage Table for the study tutors, users identified several disadvantages, particularly when compared to traditional anthropometry. Our tutors pointed out that the main idea was related to the need for more instructions or guidelines on detecting and measuring human bodies on touch screens.

One of the most concerning points is the migration of anthropometrical points from one to the other and the deformities of the landmarks. It is more challenging to incorporate this into the course materials. Regarding this point of view, both tutors mentioned that the general disadvantage was that it was time-consuming, and the users may feel monotonous.

There was no opportunity to feel the texture of the different tissues of human bodies. The tutors also stated that detecting the anthropometrical points and distances without special instruments could not offer a complete understanding of standard examination methods of the human body in teaching the Physical Anthropology study course.

Different technical issues can also make the content and design of this study course more complicated and challenging.

#### *Satisfaction of using Anatomage Table in teaching Physical Anthropology*

Tutors are satisfied with the testing of the Anatomage Table, related to the detection of the anthropometrical points and their measurements. On the other hand, the tutors considered the virtual platform linked to the problems that are not well handled in the transfer of Physical Anthropology study course from the traditional need to be better digital. Consequently, the Physical Anthropology course has to be remodeled from conventional to new with a combination of digital possibilities.

Additionally, the tutors commented that this virtual technology supports their traditional teaching of the Physical Anthropology study course. They mentioned that adopting this platform in teaching and learning other study courses also could be an excellent reinforcement.

Finally, the third point that bothered these tutors is that the decision to use the Anatomage Table in teaching Physical Anthropology was developed only eight years after the Anatomage Table implementation in the Human Anatomy study course in the Department of Morphology. Regarding this, tutors responded with the advantages and disadvantages of this technology that have never been adequately debated and explained before. This point highlighted the need for good support from the human anthropology specialists and technologists throughout the complete use of the Anatomy Table in the teaching process of the Physical Anthropology study course because it could be beneficial to understand more about this technology for its full implementation.

### **Discussion**

Several authors (Alasmari, 2021; Periya & Moro, 2019) state that the Anatomage Table is a powerful innovation and machine. This equipment can intensify and support medical education and sciences in specific scenarios, types and directions. In a Human Anatomy study course, it is helpful to teach, learn, demonstrate, compare and illustrate virtual dissections, to review clinical cases and simulate several procedures, functions and possibilities, depending on the available versions, settings, users' experience, skills and necessity (Smith, Ruholl, & Gopalan, 2019). This technology provides digital, 3D full-size images of human bodies created from scanned views of human cadavers (fresh and frozen). It offers the best possible visualization of the human body and its composition (Raja, Chandra, Azam, Das, & Agarwal, 2022). The Anatomage Table enables immediate management of 3D volumetric pictures fabricated from computer tomography (CT) scans and radiographs, including topographical information together with surface rendering (Chaudhry et al., 2023; Patra, Asghar, Chaudhary, & Ravi, 2022).

At the same time, other aims exist, including obtaining experience with the Anatomage Table equipment and the tools and images it offers, as well as testing hypotheses (Said Ahmed, 2023). Nowadays, digital possibilities should also be implemented in forensic and physical anthropology, also known as biological anthropology (Williams, 2017). It is a discipline that dictates high practical skills and content. By investigating and understanding the various changes and factors over time, we can better realize humanity's past, present and future growth. Teaching students about physical anthropology is crucial in developing a deep appreciation for the human variety and giving them a higher position to be interested in further anthropological studies (Ubelaker, 2018). In this discipline,

visualization is one of the most essential tools for teaching and learning anthropometrical measurements and osteometric structures (Mocini et al., 2023). However, a fast and fascinating modification is happening that proceeds anthropology to the present age with the initiation of computational anthropology. This transition is more severe and accelerated, and this area has yet to adopt recently developed ideas and theories stimulated by the technological uprising (Bubb, 2004). By offering new hands-on experiences with modern technologies, resources and equipment, students should be able to study how to use physical anthropology's basic techniques and digital options in the natural human body and practice, such as determining gender, ethnicity and age differences.

Demonstration and studying with the virtual dissection equipment in the Department of Morphology require special attention as they are new experiences. Each case of manipulation with the Anatomage Table is different because every faculty, tutor and student has other aims, aspects and needs in practical classes. Using technologies in higher education requires a lengthy planning process involving numerous, varied people and materials (Anjankar, Chavan, Wankhede, & Hajare, 2023). Success in developing technology may be difficult, including establishing the flow of details and knowledge between the large number of experts and professional categories with their divergent aspects and comprehension bases in a need to produce current methods in the pedagogy (Sayidova & Mirzayeva, 2020). The Anatomage Table use and implementation process includes separate steps to turn on the procedures followed.

Physical Anthropology relates to a convenient study course with difficulty rooted in research experience, and the discipline has a significant theoretical aspect. Competent teaching of the theoretical background of this study course should generate professionals who are inside of their field of mastery and who are aware of their restrictions. The traditional teaching methods of introductory medical study courses can be modernized and transformed into innovative digital training strategies for students in medical education (Santos, Barreira, & Saad, 2022; Yang, 2023). The research conducted by Almizani et al. (2022) underlined that teaching medical students requires continuous effort, and numerous measures should be taken to uphold and enhance a positive outlook toward fundamental knowledge. Physical Anthropology teaching should focus more than just anatomy and "standard" techniques (Jerković et al., 2022). It also requires instilling logical analysis, the ambition for skills collection and the means to investigate approved preparation (Fyfe, Fyfe, Dye, & Radley-Crabb, 2018). Owolabi et al. (2022) state a need to promote educational innovations, including the Anatomage Table.

Access to real human skeletons is essential for the constructive guidance of the Physical Anthropology study course. Facilitating and improving tutors' teaching and students' learning experiences through interactive digital tools such as the Anatomage Table is possible (Kavvadia, Katsoula, Angelis, & Filippou,



2023; Mani, Armstead, Boyd, Ghulmi, & Nunez, 2023; Kopcak et al., 2021). Anthropometry includes a set of complete measuring methods to demonstrate the proportions of the human figure and shape that comprise the measurements of the framework, its parts and skull (Kuriyan, 2018). Precision is vitally crucial as it requires a lot of practice (Ozsoy, Demirel, Yildirim, Tosun, & Sarikcioglu, 2009). Data collection is essential to the success of each scientific study. To explain the body's physical characteristics, unique assessment or their fusions must be considered, accompanied by baseline values by stage of life and gender. Measurements should be done by trained personnel and unique standard protocols (Preedy, 2012).

As the significant criterion between qualitative statistics, direct observation has been described in gathering methodologies (Morgan, Pullon, Macdonald, McKinley, & Gray, 2017). This study was focused mainly on the first experience of using this technology from the tutors' perspective in teaching the Physical Anthropology study course. Tutors have professional and educational levels in human morphology, including anatomy, physical anthropology and anthropometry. It is important for tutors to have technical knowledge to effectively communicate and work with students who require appropriate testing of devices. The Anatomage Table provides an opportunity for teachers to inspire and encourage students in innovative directions. Our tutors should also be able to provide links that may be useful for students.

Although technical equipment can be a fabulous attachment to practical classes, this item can also be a cause of dissatisfaction for tutors and students. Besides, the validity of the accessible software, devices and digital mechanisms must be checked to provide their preciseness, as basic measurements have demonstrated. Regular validation of the digital machines could promote the production of recent human identification techniques with repeated practice. Unless the tutors are controllable in technology and/or can endorse the computer's mechanical system in connection with practical classes, technology experts will be required to fix difficulties.

In teaching Physical Anthropology, practical classes should be used at every stage of the study process. Regular training gives the tutors and students experience evaluating the body composition and anthropometrical points and interpreting the observations. Their expressions, differences and fluctuations of a human figure from the regular physical composition and proportions may be determined. In the natural practice of Physical Anthropology study course, anthropometric equipment, grading tape and special alternative facilities are attached to precisely measure the fundamental details of the human body (Sevillano Oriola, Armentano Oller, & Martínez-Abadías, 2022). Before the physical structures detection, it is crucial to complete the correct location of anthropometric marks on the human form. Before a tutor can teach students to master the techniques of detecting human anthropometrical points and body types

with their proportions, they must gain profound information and perception of human osteological material or bony architecture (Rathia, Rathore, John, & Ukey, 2023).

In the classical Physical Anthropology study course, teaching human osteological points allows students to become familiar with touching and detection, recognize them from each other and distinguish between their morphological characteristics, composition, shapes and sizes. It should be noted that differences exist between natural (fixed) and digital points (Heymsfield et al., 2018). Fixed anthropometric points and their positions should be visible and always on the same body part. Virtual anthropometric points can change position based on the bodily pose, and these marks cannot always be localized in the same place. Their determination is related to the competencies of the assessor.

The present examination has numerous strong points. As far as we know, this investigation is the earliest survey in our homeland to obtain the use of the Anatomage Table in detecting anthropometrical points and to begin using this technology in teaching the Physical Anthropology study course. However, there are some limitations, too. The main reasons for them are that current case study research is related to the new study design in a specific place and time, comprises a small number of tutors, and our limited ability to identify a complete anthropometrical investigation of the four virtual human bodies in the Anatomage Table. Nevertheless, this study helps us to understand general principles and directions about the Anatomage Table use process in teaching the Physical Anthropology study course.

Tutors can stimulate an appreciation for innovations in the Physical Anthropology study course and inspire their further academic performances. This area is worth watching closely for upcoming challenges and modernizations.

## **Conclusions**

Teaching Physical Anthropology benefits tutors' academic development and deepens an appreciation and an understanding of the virtual possibilities in the composition of the human body. The Anatomage Table was mandatory to verify precise indicators' location and confirm digital instruments for their detection over several human bodies. The findings showed several advantages and disadvantages compared to the traditional anthropometry field. Through this study, suggestions for the utilization of the Anatomage Table to gather essential anthropometrical information have been prepared. Despite that, future studies can aim to generate unique methods and supplemental procedures for getting anthropometrical data in contact with the Anatomage Table and using this technology in teaching Physical Anthropology study course.

## Acknowledgements

We thank the tutors for participating in this study and for sharing their valuable time and experiences. The study was made possible by their contributions in filling out the protocols.

## References

- Abuhamda, E. A., Ismail, I. A., & Bsharat, T. R. (2021). Understanding quantitative and qualitative research methods: A theoretical perspective for young researchers. *International Journal of Research*, 8(2), 71-87.
- Alasmari, W. A. (2021). Medical Students' Feedback of Applying the Virtual Dissection Table (Anatomage) in Learning Anatomy: A Cross-sectional Descriptive Study. *Advances in medical education and practice*, 12, 1303-1307. DOI: <https://doi.org/10.2147/AMEP.S324520>
- Allen, M. A., Kirkpatrick, N., & Agosto, E. R. (2019). Anatomage Table 6. *Journal of Electronic Resources in Medical Libraries*, 16(2), 59-66. DOI: <https://doi.org/10.1080/15424065.2019.1638866>
- Almizani, M. S., Alotaibi, M. A., Bin Askar, M. F., Albaqami, N. M., Alobaishi, R. S., Arafa, M. A., & Jumaa, M. I. (2022). Clinicians' and Students' Perceptions and Attitudes Regarding the Anatomical Knowledge of Medical Students. *Advances in medical education and practice*, 13, 1251-1259. DOI: <https://doi.org/10.2147/AMEP.S370447>
- Anjankar, V., Chavan, G. N., Wankhede, K. P., & Hajare, S. (2023). The scope of virtual dissection modalities in today's technological era over the conventional anatomical teaching. *Journal of Datta Meghe Institute of Medical Sciences University*, 18(3), 559-562. DOI: [https://doi.org/10.4103/jdmimsu.jdmimsu\\_280\\_23](https://doi.org/10.4103/jdmimsu.jdmimsu_280_23)
- Bartoletti-Stella, A., Gatta, V., Mariani, G. A., Gobbi, P., Falconi, M., Manzoli, L., Faenza, I., & Salucci, S. (2021). Three-Dimensional Virtual Anatomy as a New Approach for Medical Student's Learning. *International journal of environmental research and public health*, 18(24), 13247. DOI: <https://doi.org/10.3390/ijerph182413247>
- Brown, J., Stonelake, S., Anderson, W., Abdulla, M., Toms, C., Farfus, A., & Wilton, J. (2015). Medical student perception of anatomage – A 3D interactive anatomy dissection table. *International Journal of Surgery*, 23, S17-S18. <https://doi.org/10.1016/j.ijsu.2015.07.053>
- Bubb, H. (2004). Challenges in the application of anthropometric measurements. *Theoretical Issues in Ergonomics Science*, 5(2), 154-168. DOI: <https://doi.org/10.1080/14639220210129378>
- Chaudhry, H., Rana, S., Bhatti, M. I., Al-Ansari, N., Al Theyab, A., Almutairi, T., Kazani, B., Almasri, M., Sadiq, Z., Hussein, R., Kim, D., Chung, D., Khalil, O., Alroobi, H., Aly, A., & Raof, A. (2023). Utility of the Anatomage Virtual Dissection Table in Creating Clinical Anatomy and Radiology Learning Modules. *Advances in medical education and practice*, 14, 973-981. DOI: <https://doi.org/10.2147/AMEP.S417831>
- Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, 62(1), 107-115. DOI: <https://doi.org/10.1111/j.1365-2648.2007.04569.x>
- Fyfe, S., Fyfe, G., Dye, D., & Radley-Crabb, H. (2018). The Anatomage table: Differences in student ratings between initial implementation and established use. *Focus on Health Professional Education: A Multi-Professional Journal*, 19(2), 41. DOI: <https://doi.org/10.11157/fohpe.v19i2.215>

- Gaya-Sancho, B., Sanjuan-Sánchez, D., Ráfales-Perucha, A., Zaurín-Paniagua, L., Sáez-Gutiérrez, B., & Galarreta-Aperte, S. (2023). Comparison of measurements made on dry bone and digital measurements in Anatomage for the sacral bone in a Spanish population. *Scientific Reports*, *13*(1), 20578. DOI: <https://doi.org/10.1038/s41598-023-48013-8>
- Guimarães, B., & Ferreira, M. A. (2020). Is Medical Education Changing? Five Challenges for the Near Future. *Acta medica portuguesa*, *33*(6), 365-366. DOI: <https://doi.org/10.20344/amp.13063>
- Heymsfield, S. B., Bourgeois, B., Ng, B. K., Sommer, M. J., Li, X., & Shepherd, J. A. (2018). Digital anthropometry: A critical review. *European Journal of Clinical Nutrition*, *72*(5), 680-687. DOI: <https://doi.org/10.1038/s41430-018-0145-7>
- Heymsfield, S. B., & Stevens, J. (2017). Anthropometry: Continued refinements and new developments of an ancient method. *The American Journal of Clinical Nutrition*, *105*(1), 1-2. DOI: <https://doi.org/10.3945/ajcn.116.148346>
- Jerković, I., Bašić, Ž., Bareša, T., Krešić, E., Hadžić, A. A., Dolić, K., Čavar Borić, M., Budimir Mršić, D., Čavka, M., Šlaus, M., Primorac, D., Anđelinović, Š., & Kružić, I. (2022). The repeatability of standard cranial measurements on dry bones and MSCT images. *Journal of Forensic Sciences*, *67*(5), 1938-1947. DOI: <https://doi.org/10.1111/1556-4029.15100>
- Kavvadia, E.-M., Katsoula, I., Angelis, S., & Filippou, D. (2023). The anatomage table: A promising alternative in anatomy education. *Cureus*, *15*(8), e43047. DOI: <https://doi.org/10.7759/cureus.43047>
- Kopcak, M., Wika, K., Portway, B., Lentz, L., Brockel, A., Bollech, E., & Sand, G. (2021). The many technical contributions of the anatomage table: Seeing anatomy differently. *2021 Design of Medical Devices Conference*, V001T12A002. DOI: <https://doi.org/10.1115/DMD2021-1022>
- Kuriyan, R. (2018). Body composition techniques. *Indian Journal of Medical Research*, *148*(5), 648. DOI: [https://doi.org/10.4103/ijmr.IJMR\\_1777\\_18](https://doi.org/10.4103/ijmr.IJMR_1777_18)
- Mani, K., Armstead, A. B., Boyd, A., Ghulmi, L., & Nunez, F. (2023). Exploring the experience of entry-level OTD students on the use of anatomage® table to learn anatomy: A survey. *The American Journal of Occupational Therapy*, *77*(Supplement\_2), 7711505073p1-7711505073p1. DOI: <https://doi.org/10.5014/ajot.2023.77S2-PO73>
- Mocini, E., Cammarota, C., Frigerio, F., Muzzioli, L., Piciocchi, C., Lacalaprince, D., Buccolini, F., Donini, L. M., & Pinto, A. (2023). Digital anthropometry: A systematic review on precision, reliability and accuracy of most popular existing technologies. *Nutrients*, *15*(2), 302. DOI: <https://doi.org/10.3390/nu15020302>
- Morgan, S. J., Pullon, S. R. H., Macdonald, L. M., McKinlay, E. M., & Gray, B. V. (2017). Case study observational research: A framework for conducting case study research where observation data are the focus. *Qualitative Health Research*, *27*(7), 1060-1068. DOI: <https://doi.org/10.1177/1049732316649160>
- Norton, K. I. (2018). Standards for anthropometry assessment. In K. Norton & R. Eston (Eds.), *Kinanthropometry and Exercise Physiology* (68-137). Oxford: Routledge.
- Owolabi, J. O., Ojiambo, R., Seifu, D., Nishimwe, A., Masimbi, O., Okorie, E., & Ineza, D. (2022). A study of anatomy teachers' perception and acceptance of the anatomage table technology and digital teaching materials in the training of medical and allied health students. *Cureus*, *14*(12), e32163. DOI: <https://doi.org/10.7759/cureus.32163>
- Ozsoy, U., Demirel, B. M., Yildirim, F. B., Tosun, O., & Sarikcioglu, L. (2009). Method selection in craniofacial measurements: Advantages and disadvantages of 3D digitization method. *Journal of Cranio-Maxillofacial Surgery*, *37*(5), 285-290. DOI: <https://doi.org/10.1016/j.jcms.2008.12.005>

- Patra, A., Asghar, A., Chaudhary, P., & Ravi, K. S. (2022). Integration of innovative educational technologies in anatomy teaching: new normal in anatomy education. *Surgical and radiologic anatomy*, 44(1), 25-32. DOI: <https://doi.org/10.1007/s00276-021-02868-6>
- Periya, S. N., & Moro, C. (2019). Applied learning of anatomy and physiology: Virtual dissection tables within medical and health sciences education. *The Bangkok Medical Journal*, 15(1), 121-127. DOI: <https://doi.org/10.31524/bkkmedj.2019.02.021>
- Preedy, V. R. (2012). *Handbook of anthropometry: Physical measures of human form in health and disease*. New York: Springer.
- Raja, B. S., Chandra, A., Azam, M. Q., Das, S., & Agarwal, A. (2022). Anatomage - the virtual dissection tool and its uses: A narrative review. *Journal of postgraduate medicine*, 68(3), 156-161. DOI: [https://doi.org/10.4103/jpgm.jpgm\\_1210\\_21](https://doi.org/10.4103/jpgm.jpgm_1210_21)
- Rathia, D. S., Rathore, M., John, M., & Ukey, R. K. (2023). The efficacy of utilizing the anatomage table as a supplementary educational resource in osteology instruction for first-year medical students. *Cureus*, 15(10), e46503. DOI: <https://doi.org/10.7759/cureus.46503>
- Said Ahmed, M. A. A. (2023). Use of the anatomage virtual table in medical education and as a diagnostic tool: An integrative review. *Cureus*, 15(3), e35981. DOI: <https://doi.org/10.7759/cureus.35981>
- Santos, V. A., Barreira, M. P., & Saad, K. R. (2022). Technological resources for teaching and learning about human anatomy in the medical course: Systematic review of literature. *Anatomical sciences education*, 15(2), 403-419. DOI: <https://doi.org/10.1002/ase.2142>
- Sayidova, S. N., & Mirzayeva, M. R. (2020). Types of pedagogical technologies and their role in the development methods in pedagogy. *Theoretical & Applied Science*, 84(04), 976-980. DOI: <https://doi.org/10.15863/TAS.2020.04.84.179>
- Scheffel, M., & Wirth, J. (2022). Educational Technologies [Educational technologies]. *Unterrichtswissenschaft*, 50(4), 517-523. DOI: <https://doi.org/10.1007/s42010-022-00160-z>
- Sevillano Oriola, L., Armentano Oller, N., & Martínez-Abadías, N. (2022). Virtual anthropology: Forensic applications to cranial skeletal remains from the Spanish Civil War. *Forensic Science International*, 341, 111504. DOI: <https://doi.org/10.1016/j.forsciint.2022.111504>
- Smith, K. E., Ruholl, H. O., & Gopalan, C. (2019). Utilization of anatomage table technology enhances knowledge, comprehension, and application of human anatomy and physiology in multiple settings. *The FASEB Journal*, 33(S1). DOI: [https://doi.org/10.1096/fasebj.2019.33.1\\_supplement.598.19](https://doi.org/10.1096/fasebj.2019.33.1_supplement.598.19)
- Ubelaker, D. H. (2018). Recent advances in forensic anthropology. *Forensic Sciences Research*, 3(4), 275-277. DOI: <https://doi.org/10.1080/20961790.2018.1466384>
- Williams, A. (2017). Forensic anthropology teaching practice. In A. Williams, J. P. Cassella, & P. D. Maskell (Eds.), *Forensic Science Education and Training* (19-38). Hoboken: Wiley-Blackwell.
- Yang, J. (2023). Technology-Enhanced Preclinical Medical Education (Anatomy, Histology and Occasionally, Biochemistry): A Practical Guide. *Advances in experimental medicine and biology*, 1431, 65-93. DOI: [https://doi.org/10.1007/978-3-031-36727-4\\_4](https://doi.org/10.1007/978-3-031-36727-4_4)