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A Survey of Human Gross Anatomy Laboratories in DPT Programs across the United States

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Abstract

Purpose: The purposes of this study were to 1) describe the current teaching methodology used in Doctor of Physical Therapy (DPT) human gross anatomy (HGA) labs, 2) examine the demographics and perceptions of HGA instructors and compare responses based on years of experience, 3) determine the utilization and instructor perceptions related to cadaver dissection and other methods of instruction, and 4) determine which safety/security protocols are used in HGA laboratories. Method: All DPT programs (N=250) in the United States (US) accredited by the Commission on Accreditation of Physical Therapy Education (CAPTE) were eligible to participate. The anonymous, 89-item online survey was completed by either an HGA instructor or DPT program director in March of 2020. Seventy-four individuals responded for a response rate of 29.6%. Results: Respondents represented programs from 65.2% private and 34.8% public institutions. Fifty percent of respondents dedicated 31-60% of their HGA course to face-to-face lab time, with 68% reporting an instructor to student ratio in lab of 1:15 or smaller. Seventy percent of instructors were US licensed PTs, and 78% of those PTs held an academic doctorate. The average years of anatomy teaching experience was 11.3. Ninety-six percent of programs utilized cadavers. Most programs (86%) had students perform hands-on cadaver dissection. Overall, 90% of instructors incorporated learning activities into lab beyond dissection. Ninety-four percent of instructors reported enjoyment teaching HGA, and a majority felt they had adequate teaching support and academic preparation. Sixty percent of respondents felt that cadavers were the only way to teach lab, while 90% felt that cadavers were the best way to teach lab. Regarding safety, 38% of instructors had concerns regarding chemical exposure in lab, and 11% believed their health was at risk. Comparative analyses found significant differences in instructor perceptions based on years of anatomy teaching experience (+/- 10 years). Less experienced faculty were more likely to believe that a non-cadaver approach to teaching HGA can be as effective as using cadavers given the right technology, while more experienced faculty were more likely to believe that teaching HGA with cadavers was the best way to teach lab. Conclusions: DPT program directors and instructors may find this study valuable to compare their HGA course(s) to other programs in the US. Although there is a clear preference for including cadavers in HGA laboratories, it is evident that most instructors are incorporating other learning approaches in their HGA laboratories.

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ABSTRACT

Purpose: The purposes of this study were to 1) describe the current teaching methodology used in Doctor of Physical Therapy (DPT) human gross anatomy (HGA) labs, 2) examine the demographics and perceptions of HGA instructors and compare responses based on years of experience, 3) determine the utilization and instructor perceptions related to cadaver dissection and other methods of instruction, and 4) determine which safety/security protocols are used in HGA laboratories. **Method:** All DPT programs (N=250) in the United States (US) accredited by the Commission on Accreditation of Physical Therapy Education (CAPTE) were eligible to participate. The anonymous, 89-item online survey was completed by either an HGA instructor or DPT program director in March of 2020. Seventy-four individuals responded for a response rate of 29.6%. **Results:** Respondents represented programs from 65.2% private and 34.8% public institutions. Fifty percent of respondents dedicated 31-60% of their HGA course to face-to-face lab time, with 68% reporting an instructor to student ratio in lab of 1:15 or smaller. Seventy percent of instructors were US licensed PTs, and 78% of those PTs held an academic doctorate. The average years of anatomy teaching experience was 11.3. Ninety-six percent of programs utilized cadavers. Most programs (86%) had students perform hands-on cadaver dissection. Overall, 90% of instructors incorporated learning activities into lab beyond dissection. Ninety-four percent of instructors reported enjoyment teaching HGA, and a majority felt they had adequate teaching support and academic preparation. Sixty percent of respondents felt that cadavers were the only way to teach lab, while 90% felt that cadavers were the best way to teach lab. Regarding safety, 38% of instructors had concerns regarding chemical exposure in lab, and 11% believed their health was at risk. Comparative analyses found significant differences in instructor perceptions based on years of anatomy teaching experience (+/- 10 years). Less experienced faculty were more likely to believe that a non-cadaver approach to teaching HGA can be as effective as using cadavers given the right technology, while more experienced faculty were more likely to believe that teaching HGA with cadavers was the best way to teach lab. **Conclusions:** DPT program directors and instructors may find this study valuable to compare their HGA course(s) to other programs in the US. Although there is a clear preference for including cadavers in HGA laboratories, it is evident that most instructors are incorporating other learning approaches in their HGA laboratories.

Keywords: education, anatomy, healthcare, teaching methods, physical therapy

INTRODUCTION

Human gross anatomy (HGA) is one of the foundational cornerstones of physical therapy (PT) student education. Despite the importance of this course in Doctor of Physical Therapy (DPT) curricula, there have only been two survey-based studies on this topic. In 1994, Mattingly and Barnes published survey results from 103 Physical Therapy programs in the US (71% response rate), but focused on the teaching of anatomy overall and not the laboratory specficially.[1] In 2012, Gabard, Lowe, and Chang published a study which included 60 PT programs (response rate of incomplete surveys, 42%; complete responses, 38%).[2] The focus of the Gabard et al study was not only to describe current practices in HGA courses (mostly focused on cadaver dissection), but future teaching methods as well as factors that influenced educational practices. Also, Gabard et al found little concern among anatomy educators related to the health and safety of the HGA laboratory environment.[2] However, these survey studies are dated and have not focused on the laboratory section of HGA courses in DPT programs.

In addition to the survey studies, two articles describe predictions related to future HGA instruction. In 2010, Sugand, Abrahams, and Khurana from the United Kingdom, predicted that anatomy education was starting to rely more on models, imaging, simulation, and the internet and shifting away from cadaver dissection.[3] Similarly, Gabard et al predicted a decline in cadaver utilization by 2020 due to a number of factors such as cost, time, and instructor availability. Furthermore, Gabard et al predicted an increase in instructional time devoted to imaging, computerized teaching aids, living surface anatomy, and prosections.[2]

Since the Gabard study in 2012, the number of DPT programs across the US has continued to increase.[2] The current number of CAPTE accredited DPT programs at the time of this study's launch was 250. In addition, there have been a number of major developments in the past eight years in the types of teaching modalities available to anatomy instructors such as virtual dissection tables, 3-dimensional anatomy computer programs and mobile applications. In Estai and Bunt's article in 2016, they stated "Cadaver-based instruction continues to be a primary focus of instruction in human gross anatomy however due to limitations on curricular time, trained anatomy faculty, and resources for gross anatomy courses in integrated or/and system-based curricula, have led many medical and allied health schools to abandon costly and time-consuming dissection-based instruction in favor of alternative methods of instruction including prosection, medical imaging, living anatomy, and multimedia resources."[4] This suggested pedagogical shift away from traditional cadaver-based laboratories has only been reported in a few articles, and there is no current research to validate these findings in physical therapy education.[5-8]

This idea of pedagogical shift is not new when reflecting on anatomy education from a historical perspective. Moxham and Plaisant give an excellent overview of the history of HGA education.[9] According to this article, the "traditionalists" are often considered to be the educators that teach primarily via dissection. However, cadaver dissection as a common method of instruction, is a relatively recent development, and not widely available until legislation (such as the Uniform Anatomical Gift Act of 1968) permitted body donation when requested by the deceased superseded those of next of kin in court.[10] However, Moxham and Plaisant suggest that as anatomy education shifts to more "modern" problem-based and computer -based learning, it is not truly modern, but actually more similar to earlier forms of anatomy education that was mostly book work as compared to experiential learning.[9]

Even though the literature is limited in describing anatomy courses overall, there have been several studies that have described or compared specific types of teaching methods in HGA courses. Many of these studies examined which teaching methods were the most effective for student learning.[11-28] Some of HGA teaching methods that were found in the literature include, but are not limited to, conventional vs. problem-based learning, flipped classrooms, examination structures, peer teaching vs. faculty teaching, virtual reality instruction, and multimodal teaching methods. This study explored which of these teaching methods were being incorporated into HGA instruction in DPT programs, but not the effectiveness of the various methods.

The purposes of this study were to 1) describe the current teaching methodology used in Doctor of Physical Therapy (DPT) human gross anatomy (HGA) labs across the United States, 2) examine the demographics and perceptions of HGA instructors and compare responses based on years of experience, 3) determine the utilization and instructor perceptions related to cadaver dissection and other methods of instruction, and 4) determine which safety/security protocols are used in HGA laboratories.

METHODS

This study was approved by the Institutional Review Board at Texas Woman's University. The data was collected via an anonymous, 89-item survey which was developed after an extensive literature review related to anatomy instruction. In addition, the researchers consulted with a group of three HGA instructors (all licensed PTs with over 5 years of experience teaching anatomy) to gather information relevant for the survey construction. Finally, the survey questions were reviewed by three members of the Texas Woman's University (TWU) physical therapy faculty, the executive director of the Center for Faculty Excellence at TWU, and two additional persons to assure survey clarity and completeness. Questions included demographics items related to

the DPT program and the respondent, overall HGA course format, teaching methods, use of cadavers, laboratory safety, laboratory security, and a final section which asked respondents to share their opinions on procedures used in HGA laboratories across the US. Question types consisted of multiple choice, multiple selection, and Likert-type survey items with opportunity for an open-ended response following most of the items (Table 1).

Table 1. Survey Content Areas and Number of Items

Question Group	Item Example	Number of Survey Items
DPT program description	Public or Private Institution?	3
Overall description of HGA course	How much time is spent in face to face lectures?	22
Description of HGA laboratory	How many hours is one typical in-person anatomy lab session?	6
Instructor	What is your current academic position?	9
Utilization of Cadavers in Lab	Does your human gross anatomy course utilize cadavers?	12
Safety and Security	Who performs the air sampling tests?	8
Instructor Perceptions	I am academically prepared to teach human gross anatomy. (strongly agree to strongly disagree)	29

All Commission on Accreditation of Physical Therapy Education (CAPTE) accredited DPT programs in the U.S. were eligible for recruitment in this study. The 250 eligible programs were identified through the American Physical Therapy Association's (APTA) online directory of accredited DPT programs in the US.[29] An online link to a PsychData survey was distributed via email using the publicly available email addresses listed on the CAPTE website. Completion and submission of the survey was described in the introductory email as giving consent to participate. On the initial invitation email, four emails experienced delivery failure and four returned an "out-of-office" message. In the case of delivery failure, a different email address was found using the university's website and the survey link was resent.

The recruitment email requested the survey be completed by the program director or a human gross anatomy instructor. The initial email was sent out on 4/21/2020 with a reminder email sent out two weeks later, and survey closure after four weeks. Due to the global COVID pandemic, respondents were asked to respond with information related to their "typical" course, and not their current practice. Seventy-four individuals responded to the survey for a response rate of 29.6%. However, two participants were removed for incomplete data. A total of 69 participants completed the question related to years of experience, these participants were included in the analysis which compared views based on experience.

Anonymous data from 74 participants were downloaded from PsychData to Excel 2016 and further analyzed with SPSS 25.0. Two individuals did not complete the survey (answered five or fewer questions) and were removed from the analysis yielding 72 participants. Descriptive statistics were calculated for all survey items. For comparisons based on years of experience, the respondents were divided into two categories: 10 years or fewer years of teaching experience and 11 or more years of teaching experience. For the opinion responses, strongly agree was coded as a "1" and strongly disagree was coded as a "5." For these comparisons, Mann-Whitney U tests were conducted at an alpha level of .05. Of the 72 participants, three did not complete the years of experience question and therefore were not included in those comparative analyses.

RESULTS

Program Demographics

Descriptive statistics on the responding programs can be found in Table 2.

Table 2. Demographics for the Responding Programs

Survey Item	Response Options	Percentage of Responses
How would you best describe your DPT program?	Face to face Hybrid other	91.7 4.2 4.2
How would you best describe your university?	public university with undergraduate and graduate students private university with undergraduate and graduate students public health sciences center with graduate students only private health sciences center with graduate students only	33.3 58.3 1.5 6.9

Select the geographic region for your program (map provided on survey)	West Pacific Mountain Midwest West North Central Midwest - East North Central South - West South Central South - East South Central South - South Atlantic Northwest - Middle Atlantic Northeast - New England	6.9 6.9 9.7 6.9 9.7 12.5 22.2 16.7 8.3

HGA Course Descriptive Results

For course format questions, the respondents were asked to select the percentage of time (0%, 1-10%, 11-20%, 90-100%) dedicated to each of the following activities: face-to-face lectures, online lectures, face-to-face laboratories, online laboratories, face-to-face discussion, online discussion, exam, quiz, or practical assessments, or other learning activity. As expected, most respondents indicated their HGA course was a combination of face to face and online lectures, face-to-face laboratories, and discussion. The average number of students in one HGA course was 57.1 students (range: 23-220) with most programs reporting a 1:10 (27.8% of respondents) or 1:15 (40.3%) instructor to student ratio. Additional results for this section can be found in Table 3.

Table 3. HGA Course Descriptive Results

Survey Item	Response
Length of HGA Course	One short semester, 26.4% One full semester, 35.1% More than one semester, 22.2% Other, 15.3%
Average number of DPT students taught per program per 12 month academic year.	75 (standard deviation: 33.6)
Typical number of instructors teaching HGA to any one cohort of students.	one instructor (19.4%) two instructors (31.9%) three instructors (18.1%) Other (30.6%)
HGA course by discipline of students (note: all responding programs included physical therapy students)	64% Physical Therapy only 15.3% Occupational Therapy included 13.9% Physician Assistant included
Most commonly listed textbooks	Clinically Oriented Anatomy and Essentials of Clinical Anatomy by Moore et al Gilroy's Atlas of Anatomy Grant's Atlas Gray's Anatomy Netter's Anatomy.
Course Format Breakdown: Most common response (% of respondents that selected this category)	Face to face lectures: 31-40% (20.8%) Face to face lab: 41-50% (21.7%) Online lectures: 0% (55.7%) Online labs: 0% (most frequent response at 83.3%) Face to face discussion: 1-10% (31.6%) Online discussion: 0% (70.7%) Exam, quiz, or practical: 1-10% (52.2%) Other learning activities: 1-10% (47.3%)
Number of major exams during HGA course	0 exams, 5.6% 1 exam, 2.8% 2 exams, 9.7% 3 exams, 18.1% 4 exams, 41.7% 5 exams, 11.1% 6 exams, 1.1%

	Other, 9.9%
Number of practical exams during HGA course	0 exams, 1.4% 1 exam, 0% 2 exams, 23.6% 3 exams, 20.8% 4 exams, 34.7% 5 exams, 6.9% 6 exams, 6.9% Other, 5.7%
Length of GHA laboratory sessions	2 hours, 45.9% 3 hours, 25.1% Other, 29%
Average grade distribution	Grade of A, 37% Grade of B, 50% Grade of C, 11%
% of HGA courses taught at same physical location as the campus (defined as the location where most of the DPT curriculum is taught).	78%
Number of lab groups assigned to one lab, % of respondents	1 lab, 100% of student cohort in each lab, 56.9% 2 labs, approximately 50% of student cohort in each lab, 31.9% 3 labs, approximately 33% of student cohort in each lab, 5.6% 4 labs, approximately 25% of student cohort in each lab, 1.4% Other, 4.2%

HGA Instructors

The demographic data for the HGA instructors can be found in Table 4. The average number of years teaching HGA in a DPT program was 11.3 years (+/- 8.1) with a range from 0 to 33 years.

Table 4. Respondent Demographics

Survey Item	Response Options	Percentage of Responses
Gender	Male Female	51.4 48.6
Please indicate your current academic position?	adjunct assistant professor associate professor professor other administrator	1.4 30.6 36.1 18.1 8.2 5.6
What is your highest earned degree?	masters clinical doctorate academic doctorate other	1.4 15.3 77.8 5.5
Indicate your entry-level PT degree	bachelors masters DPT other not a PT	40.3 15.3 19.4 1.4 23.6
Licensed as a Physical Therapist	Yes, in the US Yes, outside the US No Other	70.4 1.4 26.4 1.8
Degree in Anatomy	Yes No	28.2 71.8

While teaching HGA are you required to teach any other large group courses besides anatomy during the same semester or quarter?	Yes	32.4
	No	59.2
	Other	8.5

Utilization of Cadavers

Ninety-six percent of the respondents' indicated cadavers were utilized in their HGA course laboratory. There was a range in the number of cadavers utilized per student cohort from 2 to 32, with an average of 9.9 (+/- 6.3). To the question, "How many DPT students are assigned to one cadaver?" the responses ranged from 2 to 12 with the most frequent responses as follows: 4 (26.4%), 12 (25%), 6 (19.4%) and 5 (18.1%). Eighty-three percent of respondents indicated that students were responsible for the hands-on cadaver dissection. Most instructors reported requiring students to rotate among cadaver tanks at each lab (30.4%). Also, most instructors do not assign tank leaders (75.7%), but most do assign students to tank groups (73.6%). If tank groups are assigned, most instructors never change tank group membership during the course (63.4%). Most programs are utilizing dry tanks without a downdraft table (45.6%), the rest are as follows: dry tank with downdraft tables (25.0%), wet tanks (14.7%), combination of tanks (5.9%) or other (8.3%).

Teaching Methods

An overview of the various types of teaching and learning activities are shown in Figure 1.

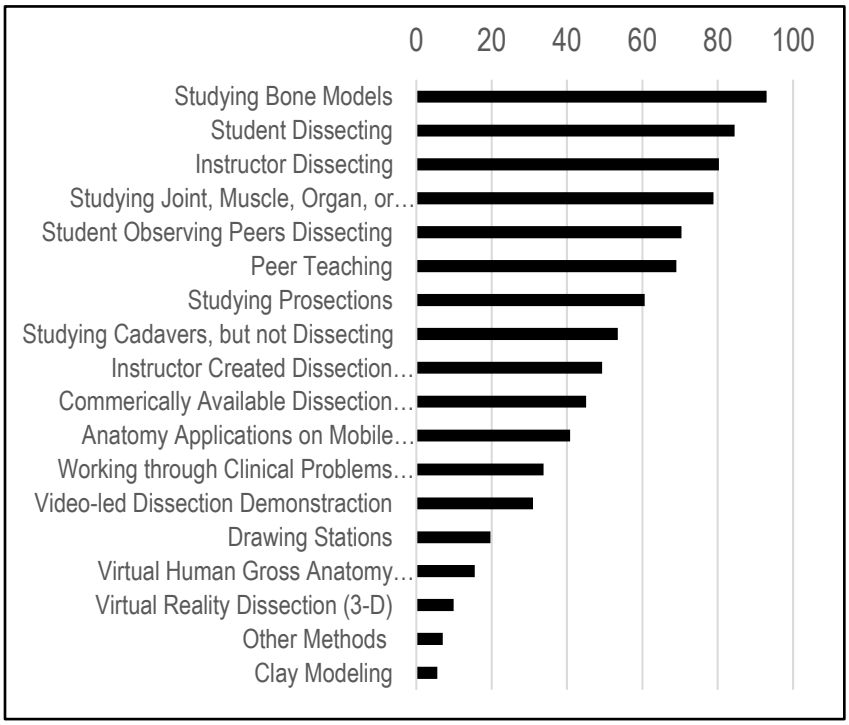

Figure 1. Percentage of Respondents Utilizing Various Teaching Methods in HGA Laboratories

HGA Laboratory Safety

Detailed information on safety from the responding programs can be found in Table 5. The respondents indicated that HGA labs have their air quality sampled and tested by an environmental safety department within the university (65.7%), by an outside contractor (12.9%), not sure who was responsible for the air sampling testing (14.3%), and other (7.1%), Thirty-four percent of the respondents knew the air quality was sampled via an air sampling badge, 25.4% reported a handheld device, 19.7% said other, and 20.9% indicated N/A.

Table 5. Respondents Results Related to HGA Laboratory Safety

Survey Item	Response Options	Percentage of Responses
Scrubs are required	Yes	42.3
	No	57.7
Long sleeves are required	Yes	31.0
	No	69.0
Masks are required	Yes	9.9
	No	90.1
Facemasks are required	Yes	7.0
	No	93.0
Disposable gloves are required	Yes	94.4
	No	5.6
Lab coats are required	Yes	25.4
	No	74.6
Closed toes shoes are required	Yes	97.2
	No	2.8
Goggles are required	Yes	42.3
	No	57.7
Sharps containers are used	Yes	94.4
	No	5.6
Air quality is routinely checked	Yes	80.3
	No	19.7
Air is filtered from under the tank	Yes	18.3
	No	81.7
Air is filtered into overhead vents	Yes	26.8
	No	73.2
Students undergo sharps training	Yes	80.3
	No	19.7
Eyewash station is available in lab	Yes	95.8
	No	4.2

HGA Laboratory Security

The responding DPT programs indicated their lab was secured via lock and key (23.9%), badge (62%), or passcode (29.6%). There was video surveillance in 39.4% of labs, 28.2% had a security guard(s) in the building and/or a security alarm system (9.9%). Most programs (75.7%) limited lab access to currently enrolled students, and 18.6% of programs allowed both currently enrolled and previously enrolled students into the lab. Forty-three percent of programs allowed access to the lab 24 hours of day, 45.7% only allowed access during set hours, and 6.9% only allowed access during lab hours.

Respondent Perceptions Towards HGA

The final section of the survey asked the respondents to share their view to a variety of statements related to teaching HGA. Table 6 includes the statements and the percentage of respondents who strongly agreed or agreed with the statement. For comparison, the respondents were sub-divided by 10 or fewer and 11 or more years of HGA teaching experience. Table 7 includes the results from the comparative analyses. Nine of the statement responses were significantly different based on the respondents' years of HGA teaching experience.

Table 6. Responses to Opinion Statements (N=69)

Category	Survey Item	Percentage of Respondents who Strongly Agreed or Agreed with the statement
Teaching and Career	I enjoy teaching HGA.	94.4
	I am academically prepared to teach HGA.	91.4
	I have adequate teaching support when teaching HGA.	86.0
	I plan on teaching HGA for the rest of my academic career.	83.1
	I tend to teach HGA the same way year after year.	47.8
	I would like to have access to high-tech (computer-based) dissection software for teaching	44.2
Cadaver Utilization	I incorporate other learning activities into lab beyond dissection in order to improve students' learning during lab time.	90.1
	I believe teaching HGA with cadavers is the best way to teach lab.	90.0
	I believe HGA with cadavers is the only way to teach lab.	60.0
	I would like to utilize more human cadavers in lab, but I don't have adequate lab space.	32.4
	If I had access to more cadavers in my lab, it would benefit my students.	29.3
	I believe HGA can be effectively taught without the use of human cadavers.	19.7
	I would like to utilize more human cadavers, but I don't have the funds to purchase additional ones.	15.9
	I would like to try other teaching/learning activities other than cadaver dissection, but I am not allowed to change the course.	8.8
	I would like to utilize more human cadavers in lab, but I don't have an adequate supply source.	8.6
	I believe a non-cadaver approach to teaching HGA can be as effective as using cadavers given the right technology.	8.6
Safety	I believe administration would purchase needed equipment for my HGA lab if my health was at risk.	83.1
	I feel adequately prepared to handle the hazards present in a HGA lab with cadavers. Ex/ chemical exposure.	83.1
	I know which chemicals are used to preserve the cadavers during the semester.	80.0
	I know which specific chemicals are used in to embalm the cadavers that are used in my lab.	68.6
	If the air quality is checked in the lab, I understand the results.	61.5
	If the air quality is checked in your lab, I receive a copy of the results.	53.6
	I have concerns about exposure to chemicals when teaching HGA.	38.1
	I incorporate other learning activities in lab (other than dissection) in order to minimize the students' risks to chemicals.	32.9
	I believe my health is at risk when I am in the lab.	11.3
	I believe the health of my students is at risk while in the lab.	8.6

Table 7. Comparison of Respondent Views based on Years of Teaching HGA Experience

Category	Survey Item	Respondents with 10 or fewer years of experience Mean Rank (N=43)	Respondents with 11 or more years of experience Mean Rank (N=26)	P-value
		The lower the mean rank, the more the group agreed with the statement.		
Teaching and Career	I enjoy teaching HGA.	38.33	29.50	**.005**
	I have adequate teaching support when teaching HGA.	40.03	26.67	**.002**
	I am academically prepared to teach HGA.	39.01	26.74	**.001**
	I plan on teaching HGA for the rest of my academic career.	38.47	29.27	**.039**
	I tend to teach HGA the same way year after year.	38.37	28.25	**.031**
	I would like to have access to high-tech (computer-based) dissection software for teaching	34.10	35.15	.824
Cadaver Utilization	I believe HGA with cadavers is the only way to teach lab.	40.52	24.77	**.001**
	I believe teaching HGA with cadavers is the best way to teach lab.	38.19	28.16	**.012**
	I believe HGA can be effectively taught without the use of human cadavers.	29.97	43.33	**.006**
	If I had access to more cadavers in my lab, it would benefit my students.	36.80	32.02	.326
	I would like to utilize more human cadavers, but I don't have the funds to purchase additional ones.	33.56	34.69	.812
	I would like to utilize more human cadavers in lab, but I don't have adequate lab space.	35.20	34.67	.914
	I would like to utilize more human cadavers in lab, but I don't have an adequate supply source.	33.90	35.46	.743
	I incorporate other learning activities into lab beyond dissection in order to improve students' learning during lab time.	35.67	33.88	.689
	I would like to try other teaching/learning activities other than cadaver dissection, but I am not allowed to change the course.	32.90	34.42	.737
	I believe a non-cadaver approach to teaching HGA can be as effective as using cadavers given the right technology.	30.61	40.79	**.031**
Safety	I believe administration would purchase needed equipment for my HGA lab if my health was at risk.	36.02	33.31	.553
	I have concerns about exposure to chemicals when teaching HGA.	36.44	32.62	.433
	I feel adequately prepared to handle the hazards present in a HGA lab with cadavers. Ex/ chemical exposure	37.97	30.10	.086
	I believe the health of my students is at risk while in the lab.	35.65	32.52	.503
	I believe my health is at risk when I am in the lab.	36.62	32.33	.370
	I know which specific chemicals are used in to embalm the cadavers that are used in my lab.	35.99	32.10	.644

Category	Survey Item	Respondents with 10 or fewer years of experience Mean Rank (N=43)	Respondents with 11 or more years of experience Mean Rank (N=26)	P-value
		The lower the mean rank, the more the group agreed with the statement.		
	If the air quality is checked in your lab, I receive a copy of the results.	35.00	32.32	.576
	If the air quality is checked in the lab, I understand the results.	36.11	31.90	.376
	I know which chemicals are used to preserve the cadavers during the semester.	35.99	32.10	.398
	I incorporate other learning activities in lab (other than dissection) in order to minimize the students' risks to chemicals.	35.90	32.23	.446

DISCUSSION

Review of Key Findings and Commentary

This study provided an overview of HGA laboratory instructors, course formats, instructional methods and health and safety measures currently being utilized in DPT programs across the US. When respondents were compared based on the number of years of HGA teaching experience, significant differences were found in the areas of cadaver use and teaching/career path. Regarding teaching and career path, it is concerning that with the current shortage of physical therapy faculty in the US, the HGA instructors with less experience felt significantly less supported and less likely to stay in HGA instruction as compared to those instructors with more experience. When looking at cadaver utilization, instructors with more experience were more likely to believe that cadavers were the only way to teach a HGA laboratory, while instructors with less experience were more likely to believe that a non-cadaver approach to teaching can be as effective as using cadavers given the right technology. Furthermore, less experienced instructors were more likely to believe that HGA could be taught effectively without cadavers. Whether this finding is due to a true superiority in use of cadavers or a generational bias with the younger faculty presumably being more comfortable to the use of technology for teaching and learning and the more experienced faculty having a bias toward traditional teaching methods is unclear. Also, it should be noted that Gabard's[2] proposed decrease in cadaver utilization was not supported in this study, with 96% of the respondents indicating cadavers were utilized in their HGA course laboratory.

The survey also revealed the wide-range of supplementary teaching tools currently in use in HGA laboratory courses. Despite the technological tools available to instructors and students, the incorporation of tools such as virtual dissection tables and virtual reality was not often utilized. However, previous literature, such as Houser et al, found that a multi-modal (three-arm) approach to learning had the most benefit to medical students' learning. In addition, the Houser article found that these three areas had the largest percentage of student responses in the "beneficial to very beneficial to learning" categories: cadaver dissection (89.8%), multimedia dissector (91.0%), and ultrasonography (90.4%).[8] When the new multi-modal approach (which included the integration of multimedia resources, ultrasound imaging, and modern teaching modalities with cadaver dissection) was compared to the traditional cadaver dissection method, scores showed marked improvement suggesting that student preparation for board examinations was improved after implementation of the new curriculum.[8] However other studies, such as Wilson et al, suggest while a majority of students and educators favor or value cadaver learning over other forms of laboratory modalities, student performance, measured through short-term knowledge-based examinations, are equivalent regardless of being exposed to either dissection or other laboratory instructional strategies.[7] Previously, Estai et al reported that although digital virtual simulation (DVS) is an excellent supplement to traditional pedagogic methods, the resolution was not completely satisfactory and small structures could not be observed in detail.[4] Afsharpour et al suggested that although some HGA courses have found plastination and prosections to be effective in HGA laboratories, plastinations and prosections are costly and there is still the added risk of exposure to chemical fixatives.[18]

This study investigated the safety and security protocols used in HGA laboratories. This survey found no differences in the perceptions of health concerns in the HGA lab based on years of teaching experience. But overall, a majority of respondents did not believe their health, or the health of their students were at risk. This may be a concern when paired with the results that only

68.6% knew which chemicals were used to embalm the cadavers, less than 62% received and/or understood air quality results, and only 80% knew the chemicals used to maintain preservation of the cadavers during the semester. The hazards of formaldehyde have been well documented and Bhat et al urged anatomy instructors to assure their labs had adequate ventilation, use personal protective equipment, and be aware and monitor for adverse effects.[30] Bhat reported formaldehyde laboratory levels between 2.9 and 6.3 parts per million (PPM), with a permissible exposure limit of .75 PPM over 8 hours or 2 PPM for 15 minutes. In Bhat's study, students reported eye and nose mucosal irritation, and instructors with more prolonged exposure reported more severe respiratory symptoms and migraines. Ohmichi et al discovered that the personal exposure of toxic chemicals in HGA labs for students and faculty was between 2 and 3 times higher than the room averages.[31] In 2011, Cope et al reported in their multi-site study, physical therapy students were exposed to formaldehyde levels higher than standards set by the American Conference of Governmental Industrial Hygienists and Occupational Safety and Health Administration (OSHA).[32] In addition, a majority of respondents in this study stated that the cadaver tank air was not filtered from under the tank (82%) or via overhead vents (73%). These results are similar the study by Gabard et al in 2012. He predicted that cadaver use would decline by 2020 in both medical and physical therapy schools due to the "expense of operating a laboratory that meets OSHA standards, the rising cost of cadavers, the shortage of qualified anatomy instructors, and the negative health effects of formaldehyde exposure." Interestingly, he also found that only 17% of anatomy instructors had health concerns and 8% had safety concerns, which is similar to this study.[2] These findings suggest that despite known concerns about laboratory exposure to chemicals, many current instructors may not have the adequate skills or training necessary to assess their laboratory environment safety. Whether these findings are due to the majority of DPT instructors being PTs and presumably having limited understanding of the OSHA standards and environmental health regulations as well as the long-term risks of chemical exposure from inappropriate lab ventilation and protective measure is unclear. A comparison of these findings with HGA instructors in medical schools may be interesting.

Finally, this study investigated HGA laboratory security protocols due to the limited information on this topic, beyond facility standards set by state anatomical boards.[33,34] Most of the study respondents indicated their HGA lab was accessed via badge at 62%, with video surveillance in 39.4% of labs. Furthermore, most programs (75.7%) limited HGA lab access to only currently enrolled students. These initial findings will allow DPT programs to compare their individual security protocols with the programs included in this study.

Study Strengths and Limitations

This study is a current overview of HGA laboratory instruction in DPT programs across the US. This study also provides valuable reference data for physical therapists teaching anatomy and highlights the need to establish some best practices for PTs teaching HGA in terms of laboratory safety and overall health and well-being of both students and faculty.

This study, as with many survey-based studies, had a lower than desired response rate and therefore did not receive input from a majority of physical therapist education programs in the US, which certainly limits the interpretation of the results. This survey was sent out in Spring of 2020, therefore the responses may have been limited due to the COVID pandemic. In addition, the anonymous survey method does not allow for the respondent to benefit from in-person assistance if needed, or clarification of items. The survey used for this study was lengthy, so the authors did not address the reasons why instructors selected certain pedagogical methods over other teaching methods, And the survey was developed by the authors and was not tested for reliability and/or validity prior to its use. Also, there was limited geographic representation in the West Pacific (6.9%), West Mountain (6.9%), and Midwest East Northern Central (6.9%).

Future Research

Future studies should further explore why anatomy instructors in DPT programs select certain pedagogic methods over others, what objective benefits and limitations are associated with various teaching modalities utilized in HGA laboratory instruction, and how instructor readiness and/or barriers to integrating teaching technology plays into those decisions. DPT programs could also investigate various anatomy pedagogy or specific teaching methods and its relationship to student academic performance and satisfaction which is similar to studies conducted in medical programs. Lastly, the American Association for Anatomy recently posted an article "Gross Anatomy during the Pandemic" on its website.[35] This resource describes not only the impact of COVID on anatomy education (for example, need for educators to seek new methods of teaching), but also describes the value of in-person dissection as an integral part of educating future healthcare professionals. Along this same line, surveying how DPT HGA instructors have changed their teaching methods and perceptions related to virtual HGA instruction during and post-COVID would be of interest.

CONCLUSION

This study reported on current teaching methodology as well as safety and security protocols used in Doctor of Physical Therapy (DPT) human gross anatomy (HGA) labs and compared perceptions of HGA instructors based on years of experience. DPT program directors and anatomy instructors may find it valuable to compare their HGA course to other DPT programs in the US. And even though some institutions are electing to teach future medical professionals via a non-cadaveric approach,[9,12,13] this study found that DPT anatomy education in the US is still heavily dependent on cadaver dissection. And although there is a clear preference and value placed on incorporating cadavers in HGA laboratories in DPT programs, there is evidence that instructors with less experience feel more willing to consider adopting various multi-modal teaching approaches in their HGA laboratories.

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