The Effects of Physical Therapy Clinical Experiences on Post-Professional Orthopaedic Knowledge

by

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ABSTRACT

While it is the case that physical therapists who complete an orthopaedic residency program are more likely to pass the orthopaedic specialist examination, it is unclear if these programs provide those students with more knowledge than students who passed the exam without completing a residency program. In other words, without detailed knowledge of the specific scores on the exams, it is difficult to determine how much more knowledge is obtained in a residency program. The purpose of this dissertation was to determine if post-professional orthopaedic residency programs provide knowledge specific to musculoskeletal medicine above and beyond what can be obtained through other types of experiences or studies. Licensed physical therapists who passed the board certification examination for orthopaedic physical therapy specialists in 2018 were invited to participate in this study. Participants completed the Freedman and Bernstein tests to assess their knowledge on musculoskeletal medicine, and results were analyzed. Examination scores on the board certification examination were also analyzed. Descriptive statistics analysis, paired sample *t*-test, independent sample *t*-test, one-way ANOVA, and Pearson correlation analysis were conducted to address the objectives of this study. There were no significant differences between the groups**.** Limited sample size, self-reported data, and generalizability were limitations for this study.

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"The student is not above the teacher, but everyone who is fully trained will be like their teacher." Luke 6:40

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CHAPTER I: INTRODUCTION

Overview

In recent years, there has been a substantial increase in the number of post professional residency and fellowship programs for physical therapists (Furze, Tichenor, Fisher, Jensen, & Rapport, 2016). In 2009, there were 81 accredited fellowship and residency programs, by 2014, there were 214 (Furze et al, 2016). As of December 12th, 2018, there were 288 accredited residency programs in which 41 were orthopaedic residencies. Physical therapists can provide some form of direct access to patients in all 50 states and US territories. Therefore, the need for autonomous practitioners who can diagnose and treat appropriately and refer to the appropriate medical provider when needed is crucial. The purpose of orthopaedic physical therapy residencies are to: 1). Prepare physical therapists to sit for the orthopaedic specialists' certifications; and 2). Increase musculoskeletal clinical knowledge and skills above that of an entry-level physical therapist.

Statement of the Research Problem

There is limited evidence to suggest that physical therapists who graduate from an orthopaedic residency program have greater knowledge in the management of musculoskeletal disorders. While it is the case that PTs who complete an orthopaedic residency program are more likely to pass the orthopaedic specialty exam, it is unclear if the program provides those students with more knowledge than students who passed the exam without completing a residency program (APTBRFE, 2015). In other words, without detailed knowledge of the specific scores on the exams, it is difficult to determine how much more knowledge is obtained in a residency program than other types of experience or study. It is also unclear if participating in one of these

residency programs improved the ability of physical therapists to treat patients by improving patient outcomes.

Purpose of the Study

The purpose of this quantitative research was to determine if post-professional orthopaedic residency programs provide graduates with knowledge above and beyond what can be obtained through clinical experience. The purpose was also to determine if participating in a residency program results in better examination outcomes than those who took the clinical hours pathway. The goal of this study was to identify another way to demonstrate the difference between test takers who followed two different eligibility pathways.

Research Questions

This study will address the following research questions and hypotheses:

Research Question 1: Are there differences in scores on the ABPTS Orthopaedic Board Certification Examination compared to the Freedman and Bernstein Test?

Research Question 2: Do post professional orthopaedic residency graduates score better on a standardized test developed to assess physicians' knowledge in musculoskeletal medicine than those who took a clinical hours pathway to examination eligibility?

Research Question 3: Are there differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' highest academic degree (, master's, doctorate), and professional/entry entry-level degree (master's, doctorate), and practice setting (civilian, federal, academic)?

Research Question 4: Are there differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice?

Significance of the Study

It is evident from the literature review that the research on knowledge of musculoskeletal disorders by medical and PT students is limited. During the search of recently published literature on these subjects, only two papers were identified as being adequate to be included in this section of the review, but neither of these compared PT and medical students' knowledge. By and large, the research identified, which was completed by Murphy et al. (2014) and Diaz-Mancha et al. (2016), concurred with the notion that there were significant deficits in knowledge of musculoskeletal disorders in medical education and offered a wealth of concepts as to how overcome this problem. However, the lack of empirically tested methodologies for identifying key areas where knowledge is lacking, and without practical, qualitative and quantitative research into this problem, solutions will likely be ignored by the medical community. This current study could possibly assist in narrowing this gap by assessing the efficacy a physical therapist orthopaedic residency program in increasing knowledge in the management of musculoskeletal disorders.

Limitations and Assumptions

A limitation of this study was that participants were volunteers and the survey itself is self-reported. The survey was administered online, and thus the researcher could not control whether the respondents answered survey questions independently or whether they understood every single survey item being asked for them to answer. The researcher could not control the number of respondents from the sample population which resulted in a small sample size and reduction of power. Finally, a correlational research design was adopted for this study; therefore, the researcher exercised caution when interpreting the results of the study in terms of causal relationships among variables. A correlational research design does not lend itself in

identifying causal relationships between or among variables but rather determines descriptive relationships.

Leedy and Ormrod (2016) defined assumption as the uncontrollable or unsubstantiated elements of a study included and accepted as true. The factors often lie beyond the control of the investigator as well as the confounding variables. In the case of the present study, the researcher accounted for several assumptions. The first assumption for the study was that all the participants will understand the questionnaire included in the data collection. Second, the study assumed that the data collection methods suited the investigation and provided an appropriate means of acquiring unbiased information regarding the relationship between the variables of the study.

Definition of Terms

Musculoskeletal medicine: Musculoskeletal medicine embodies all healthcare and medical disciplines that deal with the diagnosis of acute and chronic conditions affecting the musculoskeletal system in adults and children, including the psychosocial impact of these conditions.

Musculoskeletal: Musculoskeletal relates to the musculature and skeletal systems, together.

Orthopaedic Clinical Specialists: A Board Certified Clinical Specialist in Orthopaedic Physical Therapy, is awarded to a physical therapist who has earned board certification by successfully passing a national standardized examination in orthopaedics through the American Board of Physical Therapy Specialties, which is administered by the National Board of Medical Examiners (Wright 2018). Therapists with this credential have completed at least 2,000 hours of direct patient care in orthopaedic, or have successfully completed an orthopaedic residency

program accredited by the American Board of Physical Therapy Residency and Fellowship Education, and passed a written exam. See Physical Therapist (PT) (Wright 2018).

Orthopaedics: The branch of healthcare broadly concerned with the skeletal system.

Physical therapists: Physical therapists (PTs) are highly-educated, licensed health care professionals who can help patients reduce pain and improve or restore mobility - in many cases without expensive surgery and often reducing the need for long-term use of prescription medications and their side effects (Scholl & Sellheim 2019**).**

Residency: Relating to this study, the residency experience combines opportunities for ongoing mentoring and formal and informal feedback to the physical therapist resident, including required written and live patient practical examinations, with a foundation in scientific inquiry, evidence-based practice, and course work designed to provide a theoretical basis for advanced practice (Wright, 2018). Residency education in PT requires a minimum of 1,500 hundred clinical hours, with 150 mentored hours, 100 of which must be face-to-face.

Chapter Summary

The purpose of this chapter was to provide an introduction to the study, including background literature, the problem statement, study purpose, research questions, study significance, limitations and assumptions and definition of terms. This concludes chapter one. The following chapter contains a review of literature pertaining to the problem and purpose of this research paper and continues with the work developed by researchers and theorists who have provided initial insight into the understanding of adult education physical therapy and practice.

CHAPTER II: REVIEW OF LITERATURE

Introduction:

This section contains a review of the literature. The purpose and research questions are outlined first, followed by a review of major themes pertaining to the dissertation. The following chapter contains a description of the methodology. This chapter will assess literature pertaining to a variety of themes within the body of work. Each of these sections will be divided into separate subsections that relate back to the original theme.

Purpose of the Study

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Search Criteria

In order to develop this review, a strategic search of recently published and relevant literature was undertaken using the Google Scholar search engine. Key terms and phrases were input to the search engine; these included, but were not limited to: *educational programs for physical therapists, medical education, musculoskeletal knowledge, orthopaedic residency education, orthopaedic clinical specialist, physical therapy residency, post-professional education, quantitative research designs, experimental research designs, quasi-experimental research designs, correlational non-experimental research, internal validity, external validity, statistical analysis, statistical power.*

Musculoskeletal Examination

This section will discuss literature pertaining to the musculoskeletal examination. When researching for this section, *Freedman and Bernstein Examination* and *Musculoskeletal Examination* were inputted into a Google Scholar search engine, with the parameters of the search limited to those papers published in, or since, 2016. More than 10,000 results were revealed from this search, almost all of which pertained to assessing musculoskeletal examinations skills in all types of medical practitioners.

Most researchers favor the Freedman and Bernstein examination because it provides quantifiable measures of medical providers and students' musculoskeletal knowledge (Freedman & Bernstein, 2002). The test was developed in 1998, when the title authors created the 25-point

examination in order to test graduates' competencies in understanding the intricacies of musculoskeletal medicine. The examination was validated by orthopaedic and internal medicine residency professionals throughout North America, particularly in the United States (Freedman & Bernstein, 2002).

Many hospitals also choose to use the Freedman and Bernstein examination on incoming medical and surgical residents in order to ascertain the level of competency, and the degree of educational background each resident has had in the field of musculoskeletal medicine (Tamrakar et al., 2017). For example, Stansfield et al. (2016) described the Freedman and Bernstein examination test as favoring heuristics-based thinking with items on the test asking, after brief case descriptions, what diagnosis must be considered and similarly phrased questions. However, Stansfield et al. (2016) pointed out that students who rely on heuristics may perform well on knowledge tests but could have poor clinical examination skills. The remainder of this chapter will continue to discuss themes pertaining to the Freedman and Bernstein (2002) examination, while also assessing literature pertaining to the purpose and the problem statements.

Review of Relevant Literature

This section furthers understanding of what characteristics, program planning tasks, and attitudes are vital to the educational process for adult learners, as well as assessing literature pertaining to examples of adult education activities and definitions. This section will also describe recent evolutions in musculoskeletal education and physical therapy in order to ascertain where the profession is evolving. Finally, the last section will discuss the literature pertaining to the methodologies being used in this study.

Adult Education Teaching Philosophies and Methodologies

Adult education is education for adults who are out of school or college (Youngman, 2008). Adult education is based on principles of lifelong learning and is catered to the different learning needs of adults (e.g., applied skills and professional development (Youngman, 2008). Adult education contributes the integration of knowledge and skills with theoretical concepts to enhance the professional development of adult learners (Youngman, 2008).

This purpose of this section is to discuss research related to adult general education teaching philosophies and methodologies. Based on consideration of general adult education, discussion then narrows toward education specifically within the field of physical therapy, and then gets more specific to musculoskeletal knowledge in the following section. This review of literature is informed by theories of adult education, content design, and principles of best practice in the field of physical therapy, which has shown that clinical expertise is developed by first gaining academic and theoretical understanding of core concepts in a particular subject and then applying this knowledge in simulated clinical experiences (Champlin, Hoober & Mackert, 2019; Harris, Jacobs & Reeder, 2019). Research has also greatly supported the effectiveness of promoting evidence-based practice in the field of physical therapy, as well as in the instruction of physical therapy students in adult education environments (Champlin et al., 2019; Hohn et al., 2019). Each of these factors plays key roles in determining the course scope, sequence, content, objectives, and topics that are delivered in courses pertaining to physical therapy for PT professional.

Adult education and health literacy. The concept of adult education for physical therapy students aligns with the theory of lifelong learning and is conducive to the need for ongoing professional development in the field of physical therapy. Additionally, this concept

draws on principles of adult education, such as the need for autonomy and independence in many aspects of the course direction. Formal education programs were adopted in the late 20th century to help promote literacy in the area of health, which combined adult education and English as a second language pedagogical approaches with basic health promotion efforts (Harris et al., 2019). As knowledge of the origins of health literacy and causes of low literacy have grown, researchers have been able to provide more universal tools and skills to help adults comprehend basic health concepts and improve their awareness of the causes of injuries within the context of physical therapy (Champlin et al., 2019). Health literacy is now considered to be the possession or acquisition of knowledge and skills needed to self-manage health and adopt recommendations by health promotion experts as to healthy living and disease prevention (Hohn et al., 2019). The following section contains discussion of the literature related to physical therapy standards as promoted through adult education and post-professional physical therapy.

Adult education in the promotion of physical therapy standards. Standards of physical therapy practice and care must also be considered when determining the potential effectiveness of instructional strategies and the assessment of student knowledge. These include patient centered care, critical thinking, communication, leadership, and evidence-based practice (Harris et al., 2019). These values can be reinforced through a combination of learning activities and instructional strategies, and evidence supports diversity in the method by which course content is delivered (Edwards et al., 2019). Instructional strategies that are selected in order to promote learning and development in physical therapy students must be based on educational and professional skills that are required in that particular field. In physical therapy, critical thinking skills have been identified as important for promoting professionalism and lifelong learning (Hohn et al., 2019). Therefore, increasing emphasis is placed on promoting these skills

in physical therapy students in higher education. Any individual course that is delivered within a broader framework of graduate or post-professional physical therapy must also consider the promotion of these skills in order to promote continuity between courses in the undergraduate physical therapy program, and also to facilitate smooth transitions from the educational to professional environments. The following section includes a discussion of the literature pertaining to adult education and its role in fostering evidence-based practice and specific skill development.

Evidence-based practice and promotion of specific skills. The increasing use of evidence-based approaches has been determined to be a strength in adult education and helped to ensure that the most contemporary and relevant strategies for are taught (Palombaro et al., 2018; Edwards et al., 2019). A learner-based approach in which the material is delivered to community members helped facilitate communication and fostered a sense of autonomy that is particularly important in adult education and public health (Palombaro et al., 2018). Follow-up evaluations that have shown that adult education interventions are effectiveness within the context of post-professional development (i.e., via enhancing attendee knowledge, attended perception, and attendance). Upon completion of an adult education course, research suggests that physical therapy students should be able to interpret and evaluate course content proficiently, and also be able to articulate this material and communicate concepts to peers and instructors (Edwards et al., 2019).

There are two critical thinking skills in particular that appear to be important for physical therapy student learning and development. One includes interpretation. Specifically, physical therapists must be able to interpret evidence in the field and make informed decisions about the implementation of this evidence in practice (Edwards et al., 2019). There is an increasing trend

toward evidence-based practice in physical therapy, and physical therapy programs are now increasing their foci on teaching students to critically evaluate research (Donlan & Alpert, 2018). Therefore, requiring that physical therapy students evaluate research independently has proven to be an important method in developing this critical thinking skill.

Specifically, students of physical therapy must be able to identify sources of bias in physical therapy research and evaluate the reliability and validity of any findings that are presented (Palombaro et al., 2018). One definition of evidence based practice, (EBP), "is the conscientious and judicious use of current best evidence in conjunction with clinical expertise and patient values to guide health care decisions," (Titler, 2020). The promotion of interpretation in course content for physical therapy students can also help them navigate difficult course materials and improve their chances of success in the adult education environment. This skill can be fostered through the promotion of independent research, in which students must critically evaluate peer reviewed literature and identify study design and methodology limitations, as we all as the clinical applicability of that evidence (McCaffery et al., 2019). In physical therapy courses, multiple methods can be used to foster critical thinking and interpretation in particular.

Second, physical therapy research has shown that explanation is a critical thinking skill that is essential for professional development and clinical expertise in physical therapy students (Ziebart & MacDermid, 2019). Critical thinking is the analysis of an issue with a view to form a judgment about its validity (Ziebart & MacDermid, 2019). Clinical reasoning is the same process, but as applied to clinical issues and decisions (Edwards et al., 2019). Explanation refers to the ability to not just critically evaluate evidence, but articulate findings to peers, supervisors, and the population (Edwards et al., 2019). Many students of physical therapy will serve as

important advocates for public health and liaisons to the community with regards to health information.

Combined with explanation is communication, which is needed to clearly present messages to the community about physical therapy and health issues and to demonstrate professional competence in this regard (Hohn et al., 2019). Therefore, the proposed course will emphasize both explanation and interpretation in the design of course content and delivery of instructional material. A combination of activities can be used to promote these skills, including independent and group-based research projects and critical reflections on case studies involving previous episodes that have occurred in real clinical physical therapy scenarios. The following section includes a discussion of the literature pertaining to adult education approaches and components.

Adult education approaches and components. In addition, evidence has shown that adult education instruction can generally be divided into three approaches (Palombaro et al., 2018). These include direct instruction, informal presentation, and structural discovery (Forbes, 2017. This first includes the direct presentation of course concepts by the instructor and can help introduce students to the theory or conceptual frameworks underlying course topics. Informal presentation consists of students presenting course concepts orally to other students to foster communication and articulation of key ideas relevant to the material being learned. Finally, structural discovery consists of supervised, independent learning whereby students focus on a particular aspect of the course content and then engage in an independent learning project, such as the creation of a scientific report or literature review.

In any adult education course, content is developed through three phases (Forbes, 2017). These include planning, implementation, and assessment. Planning consists of identifying

student needs and structuring class sessions and activities in a way that meets this need. Implementation consists of matching course content with the most appropriate delivery style, as discussed above. Assessment consists of evaluating student progress, proficiency, and course quality based on a combination of formative and summative tools. Evidence of each of these phases must be present in any course design in order to ensure that student learning outcomes are optimized.

Increasing role of technology. Previous evidence with regards to physical therapy programs in adult education has illustrated the increasing role technological intervention plays in modern classrooms. Specifically, research has shown that technological interview is a particularly important tool for helping to personalize learning materials (McCaffery et al., 2019). Research has also shown that technological intervention allows for the identification of behavioral tendencies on the part of learners as they engage with course material and can modify content to adapt to these tendencies (Hohn et al., 2019). Therefore, contemporary physical therapy education must also incorporate technology wherever possible as a means to supplement instructional strategies that are used to foster learning and development in professional physical therapy students and to better prepare them for professional physical therapy practice.

Additionally, research has shown that technology is an important communicative device in modern adult education and allows members of classes and groups to interact and remain in contact with one another throughout the duration of the semester (Edwards et al., 2019). In addition to computer-assisted instruction like that described above, technological intervention plays an important supplemental role in supporting regular communication provided in the classroom (Palombaro et al., 2018). Technology is also an increasingly important component of physical therapy and health care practice, and students will be required to navigate a range of

new technological developments throughout their careers, such as health information technologies (Ziebart & MacDermid, 2019). Few other fields experiences the impacts of technological development as that of health care, and physical therapists must constantly be apprised of these developments and any subsequent changes to practice that might also occur.

Furthermore, evidence suggests that educational technology is an increasingly important component of physical therapy in particular (Donlan & Alpert, 2018). Delivering optimal patient care in physical therapy clinics requires an understanding of health information technologies, and this understanding begins in students' educational development and is further honed through clinical training and experience (Hohn et al., 2019). Therefore, technological intervention will serve as an important contributor to the development of the proposed course for adult education students. Assessment is also critical to the design and implementation of adult education courses, particularly for physical therapy students who will engage in ongoing professional development throughout their careers. The following section includes a discussion of the literature pertaining to technology and online education in physical therapy.

Technology and online education in physical therapy. Research regarding online education has increased in many ways. The results from the literature review showed that faculty members and practitioners in the field of adult education generally have low acceptance levels with regards to online teaching and education (Harris et al., 2019). Because of this low acceptance, online education effectiveness may be less optimal than desired (McCaffery et al., 2019). Additionally, tenured faculty members appear to experience many barriers to online teaching education that can render online learning environments ineffective or less effective than is optimal. Despite a growing demand for online education by students, faculty members and adult education institutions appear to be poorly equipped to meet these demands. Practitioners

and tenured faculty working in online environments in the field of adult education may find faculty development approaches useful in continuing education and professional development approaches used by adult education institutions (McCaffery et al., 2019). In addition, research has helped illustrate some of the issues that most instructors new to online teaching experience as they transfer to online with no adequate training (Palombaro et al., 2018). Online teaching seems to place additional demands on teachers who already face high levels of stress and burnout (Edwards, Kupczynski & Groff, 2019).

Researchers have begun to turn their attention toward the examination of differences between online and traditional learning environments that may help smooth the transition toward the former for tenured faculty. In the field of adult education, researchers have increasingly recognized the importance of tenured faculty having an awareness that adult learners vary in different ages and different learning experiences in using technology (Hohn et al., 2019). Therefore, tenured faculty would ideally need to know how to use technology in their teaching of adults and to adjust their teaching strategies to accommodate the skill development of adult learners (Palombaro et al., 2018). Due to the challenges of online teaching, tenured faculty members need professional development, but such development requires a time investment (Donlan & Alpert, 2018). However, the ways in which to best accomplish this time investment while still managing rigid and inflexible schedules remain unknown. The following section includes a discussion of the literature pertaining to assessment in adult physical therapy education.

Assessment in physical therapy education. Assessment is an important component of student growth and development in the field of physical therapy (Ziebart & MacDermid, 2019). Selecting the appropriate assessment strategies is as critical for the promotion of clinical skills

and expertise as the material itself, and the proposed course will draw on evidence-based strategies for assessing physical therapy student's progress throughout the semester (Edwards et al., 2019). Research has shown that the evaluation of student knowledge is essential for identifying profess in education (McCaffery et al., 2019). Evaluation will serve as an important component of designing the most appropriate and needs based content for students of adult education courses in physical therapy.

Research on general education in the university environment has supported a range of different assessment strategies for identifying pre-course knowledge, development, and course effectiveness (Forbes, 2017; Palombaro et al., 2018). This research has generally found assessment to lie in one of two categories, including formative and summative (Ziebart & MacDermid, 2019). Both are important for identifying physical therapy student knowledge and progress throughout the course, as well as allowing for modifications to be made in assistive technologies like computer-aided learning in order to best respond to individual learner's styles and needs (Donlan & Alpert, 2018; Edwards et al., 2019).

The purpose of formative assessments in physical therapy are to allow the instructor to gain an understanding of where individual students and the class fit along the continuum of novice to expertise (Forbes, 2017). Summative assessments differ from formative assessments because they are designed to assess progress and comprehensive understanding of a particular concept or subject (Ziebart & MacDermid, 2019). Research in the field of physical therapy has shown that both are important aspects of educational planning and delivery and should be used to foster a more evidence-based curriculum design and course plan (McCaffery et al., 2019).

In physical therapy education, formative assessments have largely taken the shape of simulated clinical experiences that provide students with the chance to practice their academic

understanding of course content and implement skills in a controlled clinical setting (Forbes, 2017; McDevitt et al., 2019). Best practices research in the area of undergraduate or graduate physical therapy programs has shown that the utilization of formative assessments in such environments can help instructors maximize educational effectiveness and efficiency through the increased ability to individualize material (Edwards et al., 2019).

Specifically, evidence from formative assessments can be used to improve clinical simulation experiences and to eventually lead to enhanced clinical outcomes like patient safety and professional skill development (Palombaro et al., 2018). Formative assessments can also be combined with summative assessments in order to gain a more holistic understanding of student proficiency and progress. A combination of these assessments can be used to identify student learning needs and to structure the specific instructional strategies that are delivered to a particular group of undergraduate physical therapy students.

Pre-assessments that are formative in nature can greatly enhance course design in subjects like physical therapy because of their ability to identify important gaps in knowledge and understanding as well (Ziebart & MacDermid, 2019). Research specifically pertaining to physical therapy has shown that pre-assessment tools that are formative in nature and are combined with structured and supervised clinical evaluations offer a comprehensive way to guide educational planning and determination of course content (Forbes, 2017). This process allows for a general determination of student competence and then the construction of learning objectives that match student needs and professional standards with respect to physical therapy practice (Palombaro et al., 2018).

Research in general adult education and specifically with regards to physical therapy has also shown that summative assessment is critical to understanding student development and

guiding course content (Forbes, 2017; McCaffery et al., 2019). Whereas formative assessments are preemptive and constructive in nature, summative assessments are ex post facto and deductive in nature (Edwards et al., 2019). However, both are critical to gaining a comprehensive understanding of physical therapy students' educational needs and improving both course content and delivery (McDevitt et al., 2019).

The modality of assessment implemented in physical therapy varies based on whether formative or summative in nature (Donlan & Alpert, 2018). Formative assessments frequently take the form of simulations to evaluate student progress and summative assessments can be assessed through written examinations to determine student proficiency (Ziebart & MacDermid, 2019). When constructing course content based on these assessments, the outcome should match the characteristics of students in the course, as well as reflect national standards on physical therapy student proficiency.

There has been very little research evaluating assessment models specifically in physical therapy, though some evidence exists that these assessments can predict learning and content mastery in students of this discipline (Donlan & Alpert, 2018). Such assessments serve as useful tool for determining student competence and making changes to content so as to promote the foundational knowledge and skills students of physical therapy need to become effective practitioners (Palombaro et al., 2018). It should be noted that much of the existing evidence regarding physical therapy assessment has not yet been peer-reviewed. However, preliminary findings suggest that comprehensive assessment of student learning is most conducive of the skills physical therapists need to become effective scholars and clinicians (Palombaro et al., 2018; Edwards et al., 2019). This existing evidence can be used to develop and evaluate the course content that is provided to physical therapy students.

Section summary. The purpose of this section was to provide a rationale for a course designed for undergraduate physical therapy students. This rationale is based upon the review of literature presented above, which identified the effectiveness of universal and specific instructional strategies that will enhance and support learning for undergraduate physical therapy students. It was shown in this section that physical therapy education content must be centered on theories of both adult education pedagogy and also physical therapy education.

In addition, course content must reflect professional skills that will be needed to perform the physical therapy role, such as interpretation and explanation. Assessment is also critical for guiding the evaluation and content development process. Evidence suggests that assessments in adult education environments for physical therapy students can be formative or summative in nature, with both being important for maximizing chances for student success. The following section includes a discussion of musculoskeletal education and physical therapy trends that have been identified in the literature. Later, discussion includes didactic and clinical portions of PT and curriculum design, and learner continuum entry into PT and practice experiences.

Musculoskeletal Education and Physical Therapy Trends

The purpose of this section is to discuss research into musculoskeletal education and physical therapy. The section contains the following subsections: (a) medical students and physical therapy students, (b) physical therapists and musculoskeletal disorder medicine, and (c) physical therapists and musculoskeletal knowledge. The section will conclude with a discussion of the findings.

Medical students and physical therapy students. According to Connolly, Lupinnaci, and Bush (2001) the physical therapy profession, though orientated on published educational

accreditation standards, as well as normative models of professional education, has different standards for professional versus graduate students. Knowledge within the field has been shown to drastically fluctuate from student to student, with a great deal of the difference being attributed to individual student perceptions of what they believe to be required knowledge for practice (Connolly et al., 2001). However, this is not a new discussion. Researchers and educators in the physical therapy and musculoskeletal fields have long gone back and forth on the necessity of performing outcomes research and effectiveness of different interventions, with consideration about the pressure placed on how students perform immediately after graduation (Connolly et al., 2001).

The normative testing for physical therapy (PT) students' knowledge has addressed the importance of educating PT students on the basics of independent research, as this is viewed as a core principle to guide the development of individual knowledge of musculoskeletal disorders (Connolly et al., 2001). However, the actual number of PT students who work independently on knowledge growth in their field has been found to be significantly lower than documentation reports (Connolly et al., 2001). Connolly et al. (2001) argued that one of the best means of achieving independent knowledge growth in the PT field is to place medical students in positions of original research development and mentorship. The argument in favor of practical, first-hand learning and research in order to develop information into knowledge was first posed as a concept by Connolly et al. (2001) after a longitudinal study of physical therapy students' attitudes, perceptions, and feelings of competence regarding their own research and knowledge. The study revealed that many students were incapable of accurately interpreting literature on their subject matter, suggesting that many PT students fail to appreciate the importance of

consistently taking in information on musculoskeletal disorders, and transferring that information into knowledge through practice (Connolly et al., 2001).

Musculoskeletal conditions account for roughly 25 percent of patient complaints within primary care settings (Childs et al., 2005)., Childs et al., argued that physicians showed a lack of confidence in evaluations and treatments for patients with musculoskeletal conditions. Childs et al. (2005) considered this as a de-emphasis on the subject across medical school curricula, with almost half of medical educational institutions in the United States no longer requiring their students to undertake training in the field.

Childs et al. (2005) argued that this lack of education is the reason behind the poor patient assessment, and less than optimal practice patterns for patients with musculoskeletal conditions. Childs et al. (2005) cited the work of Freedman and Bernstein, who assessed knowledge in musculoskeletal medicine among 85 physicians in their first week of an internship post-graduation from medical school. The mean score of the graduates was just under 60 percent, with only 18 percent of physicians scoring about the level determined to be the minimum threshold necessary to establish competency in musculoskeletal medicine per orthopaedic program directors' discretion (Child et al., 2005). A score exceeding 73.1 was considered passing.

Considerable evidence supports the benefits of early access to physical therapy care for patients with musculoskeletal disorders. Childs et al. (2005) used a cross-sectional design in order to describe knowledge in managing musculoskeletal conditions among physical therapist students and licensed physical therapists in the uniformed services. The authors' goal was to describe physical therapists' knowledge in managing musculoskeletal conditions using the Freedman and Bernstein examination. The examination consists of 25 open-ended questions

based on commonly encountered musculoskeletal diagnoses frequently encountered in the primary care setting (Childs et al., 2005). Childs et al. (2005) administered the examination in a web-based format without asserting a time limit for completion in order to maximize participation, but a brief demographic survey preceded the survey that queried physical therapists as to their educational background and board certification status.

The Childs et al. (2005) study highlighted the beneficial nature of using the Freedman and Bernstein examination in understanding the abilities of physical therapists in musculoskeletal practices. It also found that, of the 174 physical therapist students, and 182 licensed physical therapists, results of 24 percent and 67 percent passing rate were respectively achieved (Childs et al., 2005). When comparing these results with that of the medical students in an earlier study, it suggests that physical therapists were significantly more likely to have the necessary skills required for this form of practice than physician students in a primary care setting (Childs et al., 2005). Despite this finding, additional research conducted by Grunfeld et al. (2012) found that medical students had improved their overall results of tests on knowledge of musculoskeletal medicine. Of importance, only board certified orthopaedic physicians and physical therapist, and licensed physical therapists achieved scores exceeding 73.1.

Grunfeld et al. (2012) used the National Board of Medical Examiners Musculoskeletal Subject Examination (NBME MSK), which 144 medical students and 91 students from physician assistant schools completed. It was found that medical students with an interest in orthopaedics as a career, scored significantly higher than those without an expressed orthopaedic interest, and medical students without an expressed career interest in orthopaedic s scored significantly higher than physician assistant students (Grunfeld et al., 2012). The Grunfeld et al. (2012) study did not measure a threshold for required knowledge on musculoskeletal practices but shed light on the

difference between medical students and physician assistants in terms of their knowledge on these subjects when graduating. However, the study suggested that student physician assistants were more trained in conducting physical examinations than physicians. Therefore, it is unclear as to what factors constrained medical students and physician assistant students' abilities to acquire knowledge. Rodeghero et al. (2015) argued that training is one of the key areas of physical therapist (student or practitioner??) education for musculoskeletal disorders. Fellowship and residency training may contribute to statistically greater patient outcomes, but further research is needed to ascertain the degree of this relationship.

In their study, Rodeghero et al. (2015) used a retrospective cohort design and an electronic survey in order to compare the clinical outcomes of patients with musculoskeletal conditions treated by physical therapists. Rodeghero et al. (2015) argued that there was scant evidence that evaluates the influence of post professional clinical education on actual patient outcomes, so the researchers took data from a national database of physical therapists and surveyed the information in order to determine their level of post professional education, as well as some 25,843 patients with musculoskeletal conditions treated by 363 therapists between June 2012 and June 2013 (Rodeghero et al., 2015). A retrospective cohort design was conducted using data from a survey on the database. The database was the Focus On Therapeutic Outcomes (FOTO), a national patient outcome assessment system.

In the study by Rodeghero et al. (2015), physical therapists were classified into one of three clinical groups, determined by their post-professional education: (a) residency program completion, (b) fellowship program completion, (c) no residency or fellowship training (Rodeghero et al., 2015). Overall, the fellowship training was found to potentially contribute to statistically great patient outcomes, whereas residency training did not contribute to improved

patient outcomes, status change, or efficiency (Rodeghero et al., 2015). However, Rodeghero et al. (2015) also argued that inherent limitations exist in this type of research, and future research should seek to expand on the support for fellowship training, to ascertain why residency training was so limited, and means in which to improve training. Perez (2011) also reflected on similar research means as those employed by Rodeghero et al. (2015) and Childs et al. (2005). Perez (2011) sought to determine if there was a difference in the knowledge of the management of musculoskeletal conditions in students enrolled in different professional programs a southeastern university, but, like Rodeghero et al. (2015), it was limited in terms of research findings by generalizability, low response rates, and self-selection bias.

Despite this, the findings of Perez's (2011) study also confirmed the beneficial usage of the Freedman and Bernstein examination, which differs from the FOTO as it does allow for an explicit pass score, which the students enrolled in the Perez (2011) study failed to achieve. It warrants consideration that FOTO is a national database tool for patient outcomes and is not a test. The mean passing score of Freedman and Bernstein's examination is 73.1 percent, as any score less indicates deficiency in knowledge of musculoskeletal medicine. Perez's (2011) research did not find any variance between students from different disciplines, which was in contrast to the results found by Childs et al. (2015) and Rodeghero et al. (2015). The four professional programs that were used in Perez's (2011) research were: physical therapy, adult nurse practitioner, physician assistant, and medicine.

Thus, the major difference between the research conducted by Perez (2011) and previous studies, such as Grunfeld et al. (2012) found there were differences between the scores attained by different degree program students. This suggests that there may be discrepancies within the methodologies used to gather this data, rather than the data itself. Perez's (2011) use of the

Freedman and Bernstein examination did present differences between participants, but none that could be contributed to professional program. Perez (2011) subsequently discussed how findings in his study have been repeated throughout similar past research, adding to the argument that a great deal of reliance in these research projects was placed on the methodological design. Again, Perez (2011) found that curricula was at the root of any observed differences, which may have been related to the level of confidence expressed by those who undertook the survey.

To conclude this section, there were degrees of homogeneity between research into medical students and physical therapy students, which may have led to limitations associated with the survey designs, such as in regards to scope of questioning, and varying response rates. This only further determines the problem being assessed in this study and reconfirms the purpose of the research. However, the following section will also seek to ascertain current gaps in literature by discussing physical therapists and musculoskeletal disorders.

Physical Therapists and Musculoskeletal Disorder Medicine

Moore et al. (2005) sought to compare clinical diagnosis accuracy between physical therapists, orthopaedic surgeons, and nonorthopaedic providers at a Military Community Hospital on patients with musculoskeletal injuries. In terms of the background of the research, Moore et al. (2005) discussed how U.S. military physical therapists were usually the first credentialed providers to examine and diagnose patients with musculoskeletal injuries since the Vietnam War era. Therefore, the importance of this role in autonomously managing patients with acute musculoskeletal injuries, with or without physician referral has historically enabled orthopaedic surgeons to focus their practice on the more complex trauma and surgical cases (Moore et al., 2005).

What should be noted about the work conducted by Moore et al. (2005) is that the authors noted conflicting results presented in previous studies between orthopaedic and nonorthopaedic providers in clinical diagnosis. This led to the intuitive questions underpinning this study on how physical therapists would compare in clinical diagnostic accuracy (CDA) for musculoskeletal injuries. In addition to this, the researchers sought to determine whether patient referrals to radiology for MRIs would be appropriate. Therefore, the purpose of the Moore (2005) study was to retrospectively assess CDA between physical therapists, orthopaedic surgeons, and nonorthopaedic providers (NOPs) practicing at the army hospital on patients with musculoskeletal injuries using MRI findings.

In order to reduce sources of bias, Moore et al. (2005) performed a retrospective analysis on 560 patients referred for an MRI over a period of 18 months. Within the review, each patient's radiological profile was studied in order to assess agreement between clinical diagnosis and MRI findings. Data analysis was then performed through descriptive statistics and contingency tables (Moore et al., 2005). Overall, the results found agreement between clinical diagnosis and MRI findings. The results found the CDA of 74.5 percent for physical therapists, 80.8 percent for orthopaedic surgeons, and 35.4 percent for nonorthopaedic surgeons (Moore et al., 2005). This shows that there was little difference between physical therapist and orthopaedic surgeons, but those without proper training were below the threshold.

However, as with all previous studies cited in this section, there were limitations within the work conducted by Moore et al. (2005). Namely, using an MRI examination as the criterion reference was cited as the core limitation of the research. Moore et al. (2005) also called for further testing of the difference between physical therapists and orthopaedic surgeons, as it was often noted that these two demographics will differ in expertise depending on the extent to which

they have practiced (Jensen et al., 2000). Jensen et al. (2000) asserted that studies that do find major differences between physical therapists and other specialists in the musculoskeletal specialization are likely observing two distinctly different demographics. These differences exist due to the length of time an individual has been practicing, studying, the time they spend updating their knowledge on the musculoskeletal field of research, and their own personal beliefs on the practice of diagnosing musculoskeletal injuries.

This presents the additional limitation of work conducted by Moore et al. (2005), in that all subjects in the research study were from the same location in terms of their practice, and therefore degrees of homogeneity between additional job training and context-specific practices may have had an influence over both the physical therapist and the orthopaedic surgeons' diagnosis style (Jensen et al., 2000). Furthermore, Jensen et al. (2000) noted the importance of gathering more than just statistics and numerical data from previous work undertaken, and that emphasis on understanding the everyday practice is essential to results and discussion. It is here that Jensen et al. (2000) contended that qualitative research could assist in identifying how professional skillful action is adapted to the context of practice and learning from one's practice as a legitimate source of knowledge.

As Jensen et al (2000) suggested, there could be further research that examines and compares programs that provide t knowledge for physical therapists, to what workplace settings are found to foster the most consistency within the recent graduate cohort employed to work as a physical therapist in the musculoskeletal field. Though research by such as Davis (2015) highlighted the importance of (1) a volatile economic environment; (2) changing student demographics; (3) increased competition and global forces impacting higher education; (4) technological innovations making knowledge ubiquitous; (5) governmental policies lessening

funding support for higher education; and (6) antiquated educational practices being held onto by programs and faculty. However, it may be that these challenges only present the minimal impact on discrepancies between physical therapists' training, because at the workplace physical therapists may seek to bolster best practices once the foundations of understanding have been gained through formal education.

However, shifting the belief system of a globalized practice would take more than just the professional leadership and advocacy as asserted by Bury and Stokes (2013). Bury and Stokes' (2013) research came under the context of self-referral versus direct access to physical therapists by patients. In order to change, or evolve, leaders and advocacy groups should promote the change towards direct access and self-referral. Legislative changes would also have to occur in order for physical therapists to hone their skills in a professional setting. It was suggested that future research should seek to identify if professional settings do influence level of skill in the physical therapy field of musculoskeletal injuries.

There is a lack of consistency in literature and research regarding whether or not education needs to be improved in musculoskeletal conditions for all doctors and other medical practitioners (Akesson, Dreinhofer, & Woolf, 2003). Though dated now, the research conducted by Akesson et al. (2003) is still relevant as all people, at one point in their lives, will potentially suffer from some form of musculoskeletal condition. These conditions are inherently common, and most medical students spend little time learning the intricacies of the musculoskeletal system (Akesson et al., 2003). Though the previous section noted limitations within studying differences between physical therapy students and other medical practitioners with an interest in the field of musculoskeletal medicine, Akesson et al. (2003) argued that the issue is not between different specializations, but within education as a whole.

In terms of postgraduate training, many general practitioners (GPs) and family doctors do not have adequate musculoskeletal training, and therefore lack the competency and skills to educate new graduates of medical schools and other disciplines within the musculoskeletal field, presenting yet another limitation identified within this review of relevant literature (Akesson et al., 2003). Therefore, Akesson et al. (2003) reasoned that, as a general goal, upon graduating from medical school, every new doctor and physical therapist should be able to assess a patient's locomotor symptoms by: differentiating normal from abnormal in terms of structure and function; determining relevant investigations and interpreting the results; formulating a limited differential diagnosis; recognizing the impact of the problem on the individual; and making an appropriate management plan for medical, surgical and rehabilitation services. Akesson et al. (2003) listed a number of methodologies needed to accomplish these goals, suggested that military-trained personnel in the physical therapy division are some of the best physical therapists in the world.

In their research, Moore et al. (2005) concentrated on the practical elements of administering musculoskeletal medicine and sought to understand the skillset of military-trained physical therapists and why the rates recovery from musculoskeletal injuries were far higher for military health care beneficiaries. The level of autonomous practice incurred in military hospitals revolves around a great number of broad responsibilities, and even though military physical therapists' practice in a variety of healthcare settings, they never work independently within each setting (Moore et al., 2005a). Moore et al. (2005a) found that military physical therapists and physicians rely heavily on one another for sharing and collaborating on information regarding patient care and asserted that this is why patients in military hospitals have the lowest levels of risk in patient care throughout the healthcare system. Patients seen in military healthcare

facilities are at minimal risk for gross negligent care when evaluated and managed by physical therapists, with or without referral from a physician (Moore et al., 2005a).

This ties back to the best means of educating individuals in the complexities of musculoskeletal medicine. The purpose of orthopaedic physical therapy residencies is to increase musculoskeletal knowledge above that of an entry-level physical therapist, but as the knowledge held by most physical therapists is currently dependent on curricula and educational setting, it should be noted that educators and practice setting are also inherently important in developing knowledge.

O'Donnell (2012) concurred with this statement and argued that having sufficient mentorship can help mitigate the limited number of orthopaedic physical therapy residents graduating post-undergraduate courses without sufficient knowledge in the musculoskeletal field. The study by O'Donnell (2012) aimed to investigate how physical therapy mentors instill clinical judgement and competence during residency training in order to determine effective mentoring behaviors and techniques in physical therapy residency training. The participants included in the study were faculty of physical therapy, physical therapy residents, and resident graduates (O'Donnell, 2012). A quantitative survey design was used for the methodological approach of this study, as it was deemed the best options for gaining information about effective mentoring behaviors and techniques employed by the faculty. As a result, two surveys were developed: one for the students and graduates, and one for the faculty (O'Donnell, 2012).

The results of the study revealed that most mentors felt confident in mentoring residents based on their past experience instructing students and mentoring residents in physical therapy (O'Donnell, 2012). Most mentor respondents had not taken APTA's Credentialed Clinical Instructor Program (CCIP), and fewer had taken Advanced CCIP (ACCIP) both of which are

often used when undertaking a mentorship role in a professional setting (O'Donnell, 2012). Mentor respondents who had taken both courses felt that CCIP was less helpful in mentoring residents than was ACCIP. Overall, the results indicated important resident benefits, mentor behaviors, and characteristics of mentor-mentee relationships in residency programs (O'Donnell, 2012). However, further investigation is needed in order to determine what specific elements of the mentoring helped residency faculty feel prepared to mentor residents, and what practices have the best effects on the musculoskeletal field of medicine in the residents and graduates (O'Donnell, 2012).

Overall, the field of physical therapy and musculoskeletal medicine is one that is in constant, yet currently desperate need of evolution (Clark, 2007). The American population is an ever-changing demographic, but the need for better understandings of musculoskeletal conditions and their remedies seemingly has not changed in the last decade and a half of research. The following section discusses the literature on PT and musculoskeletal knowledge.

Physical Therapists and Musculoskeletal Knowledge

Generally speaking, the literature pertaining to PT and musculoskeletal knowledge for medical students has diminished significantly over the last decade and a half (Tilson et al., 2016). Despite this, Tilson et al. (2016) argued that physical therapists strive to consistently integrate new research into their daily practice. Tilson et al. (2016) noted the importance of using modern technology to accomplish this, citing the example of the tablet computer as a source of all information, with an easy to use set of hardware and software. Tilson et al. (2016) argued that the tablet is a transformative tool that PT students should be using during their clinical rotation experience in order to consistently update themselves on literature pertaining to their practice. In a quantitative assessment of PT students' use of tablets during their rotations, Tilson et al. (2016)

found that those PT students who consistently used their tablet for information collection during their residency were more likely to transfer that information into knowledge in clinical practice.

Tilson et al. (2016) research is a recently published study pertaining to the translation of information to knowledge for PT students. However, studies published prior to the last five years, have sought to ascertain discussions on the concept of knowledge in relation to PT students. For example, a study conducted by Jette et al. (2003) investigated the use of evidence-based practice among PT students. The purpose of the research was to identify key areas where PT students lacked knowledge, the data revealed that many healthcare professionals believed that students lacked the expertise in identifying sources of relevant information in the first place (Jette et al., 2003). Individuals who are unable to source necessary information may be a core problem throughout PT education, and the teaching of musculoskeletal disorders (Jette et al., 2003).

However, Jette et al. (2003) acknowledged that 70 percent of medical students and PT students had engaged in educational sessions on specific search strategies and agreed or strongly agreed that they had knowledge of using databases like MEDLINE and CINAHL. Furthermore, 67 percent of the same cohort also stated that they were educated in critical appraisal of research literature, but only 55 percent of these individuals were confident in their abilities in research and knowledge retention (Jette et al., 2003). One of the few moderating factors influencing the degree of self-reported knowledge on musculoskeletal and other PT practices and fields was the time that the student had been practicing in a clinical setting (Jette et al., 2003).

Gaining information directly from students on their musculoskeletal knowledge is one means of understanding how and why this field receives the smallest amount of attention in medical and physical therapy education (Jette et al., 2003). Though research into these themes

has diminished significantly over the last fifteen years, as identified through the strategic search of relevant literature, those studies that have been published on investigating these themes are largely self-reported by the students, or from their educators. Williams and Wessel (2004) posited that having students write about their experiences in musculoskeletal learning may heighten their knowledge retention, as the researchers also observed that this was one area of learning that students consistently maintained lower grade point averages.

The purpose of the Williams and Wessel (2004) qualitative research study was to gather feedback from a range of physical therapy students on their learning and knowledge growth while studying chronic musculoskeletal conditions in an American medical school. Forty-eight students participated in the study and wrote weekly entries into individual journals in order to document how and what they learned over the course of an 8-week academic unit in a 24-month, post baccalaureate, problem-based learning program (Williams & Wessel, 2004). The participating students identified significant learning events in the unit, and were required to describe their impressions, observations, and reactions to how and what they learned, as well as how they would use the knowledge they gained to respond to the same, or similar, events in their future practice (Williams & Wessel, 2004).

In order to ascertain the extent to which the students placed effort into the journals, each entry from each student participant was read, independently, by two physical therapy instructors. The instructors used a qualitative methodological process of coding in order to analyze the content of the weekly entries (Williams & Wessel, 2004). The instructors worked as a combined unit in order to categorize the coded journal entries, and to identify and develop themes within the responses (Williams & Wessel, 2004). From their coding, five themes were identified within the journal entries: (1) realization that a different approach is needed to treat patients with

chronic versus acute musculoskeletal conditions, (2) adjustment to group learning, (3) adoption of new coping strategies, (4) appreciation of the influence of students' values and beliefs on patient care, and (5) awareness of the various roles within physical therapy practice. The results suggested that the students not only gained knowledge but also had positive growth in their attitudes toward elderly clients and clients with chronic musculoskeletal conditions. In addition, the themes suggested that the students continued to adjust their learning and coping skills when in practice, and that they developed their knowledge on the scope of practice of physical therapists (Williams & Wessel, 2004).

Williams and Wessel's (2004) work is significant. As a methodological process, though qualitative research can often take far more time to complete, and provides researchers with the how and why of a trend. Therefore, the methodology presented by Williams and Wessel (2004) may provide an option for future research into PT students' and medical students' knowledge of musculoskeletal conditions.

Another demographic that can be researched and investigated to gain information on the extent of knowledge on musculoskeletal disorders held by medical and PT students are their patients. Hush, Cameron, and Mackey (2011) conducted a literature review into patient satisfaction with medical doctor and PT treatment of musculoskeletal disorders. Hush et al. (2011) used the CINAHL, MEDLINE, and EBM databases in order to critically review literature. It was found that patients were highly satisfied with the musculoskeletal treatment they received from northern Europe, North America, the United Kingdom, and Ireland. However, an unexpected finding was that treatment outcomes were infrequently and inconsistently associated with patient satisfaction, suggesting that although PTs and medical doctors treating musculoskeletal disorders may not have the best knowledge to treat these disorders, thus

potentially not so proficient in treating the disorders, they are highly proficient in patient care (Hush et al., 2011). Hush et al.'s (2011) research was based on findings by such researchers as Schmale (2005).

Schmale (2005) suggested that upwards of 80 percent of a group of graduated students, from a group of the most highly recognized medical schools in the United States, were deficient in their knowledge of basic facts and concepts in musculoskeletal medicine. Schmale (2005) explored how these results compared with those from students attending a medical school with a long-standing dedicated program to musculoskeletal education, and whether additional clinical experience in musculoskeletal medicine improved understanding of the basic facts and concepts introduced in a second-year course. In undertaking this study, a modified version of a musculoskeletal exam was used to assess the competency of incoming interns at the University of Pennsylvania. The exam assessed the competency of medical students during various stages of their training at the University of Washington in the years prior to their internships (Schmale, 2005). Despite the generally improved levels of competency with each year of training in a medical school, less than 50 percent of fourth-year students showed competency in their treatment of musculoskeletal disorders (Schmale, 2005). In contrast, students who completed a musculoskeletal clinical elective scored higher and were more competent (78 percent) than students who did not take an elective. These results suggested that the curricular approach toward teaching musculoskeletal medicine in medical school was insufficient, and that competency increased when learning was reinforced during the clinical years (Schmale, 2005).

Valenza et al. (2012) noted that the curricula of all healthcare and medical professionals have an important foundation of human anatomy, starting with the musculoskeletal elements. A comparison of the anatomy knowledge retention between students from different curricula had

not been done prior to 2012, when Valenza et al. (2012) began their research. The aim of their study was to examine the knowledge competency of third-year physical therapy students and medical students in carpal bone anatomy, specifically. The students were given 5 minutes to answer a carpal bone test, which outlined requirements for the identification of carpal bones in an illustration of the bony skeleton of the carpal region (Valenza et al., 2012). The participants of the study were 54 PT students, and 80 medical students; only 39 students correctly identified all of the carpal bones, which fell in favor of the PT students (Valenza et al., 2012). There are very few studies investigating anatomical knowledge levels between disciplines, and since the publication of the Valenza et al. (2012) research, few other scholars have sought to identify the differences between different forms of medical training and musculoskeletal knowledge. Valenza et al. (2012) found that physical therapy students exhibited better retention of anatomy of the carpal bones than medical students and concluded by calling for additional research into other areas of the human anatomy and musculoskeletal conditions using similar comparison groups of participants.

Another approach was comparing two groups of PT practitioners by setting an online examination. The study of Rundle et al. (2016) focused on the benefits that a military versus civilian setting could have on PT's knowledge of the musculoskeletal system. Rundle et al. (2016) performed a cross-sectional electronic survey to compare military and civilian PTs' knowledge of musculoskeletal conditions. Military PTs have displayed specialty knowledge in musculoskeletal conditions and can practice as a direct access provider (Rundle et al., 2016). The aim of the authors was to determine to what extent, if any, the non-military PTs fall behind military PTs in their knowledge of musculoskeletal medicine, only PTs specializing in orthopaedics were included in the study. The participants took an online examination with an

average score of 68.08%. Military and sports medicine PTs achieved more than three times better than the rest of the participants. The authors speculated that military PTs' added responsibilities to practice autonomously and their educational exposure to a higher incidence of musculoskeletal cases might explain the difference in achievement rates (Rundle et al., 2016).

To conclude this section, it is clear that the research on knowledge of musculoskeletal disorders by medical and PT students is limited. During the search of recently published literature on these subjects, only two papers were identified as being adequate to be included in this section of the review, but neither of these compared PT students and medical students' knowledge. By and large, the research identified, which was completed by Murphy et al. (2014) and Diaz-Mancha et al. (2016), concurred with the notion that there were significant deficits in knowledge of musculoskeletal disorders by healthcare professionals in medical schools, and offered a wealth of concepts as to how overcome this problem. However, the lack of empirically-tested methodologies for identifying key areas where knowledge is lacking, and without practical, qualitative and quantitative research into this problem, solutions will likely be ignored by the medical community.

Requirements: Specialist Physical Therapist

Physical therapists who desire to become a board-specified specialist have to apply for the examination, demonstrate that they meet the testing criteria, and pay the necessary registration fees. Although there are ten areas to specialize in—cardiovascular and pulmonary; clinical electrophysiology; geriatrics; neurology; oncology; orthopaedics; pediatrics; sports; women's health physical therapy; and wound management—for the purposes of this dissertation attention will be focused on orthopaedics only (APTA, 2016). Interest in orthopaedics specialization seems to be high as the American Board of Physical Therapist Specialties

(ABPTS) indicated that there were 12,893 board-certified orthopaedics specialists in June 2017 (Gardner, 2017). The importance of musculoskeletal expertise for physical therapists becomes clear when considering the APTA's 2011 description of the profession:

> Physical therapists are health care professionals who maintain, restore, and improve movement, activity, and health enabling individuals of all ages to have optimal functioning and quality of life, while ensuring patient safety and applying evidence to provide efficient and effective care. (p. 2)

This emphasis on locomotion and its underlying systems is further emphasized in the White Paper published by the APTA in 2015.

Certification entails registration, determining of eligibility and self-registration to take the desired board examination which is managed by the National Board of Medical Examiners and administered by Prometric, in different sites and dates. To be eligible to sit for the board examination, one the following requirement options must be met before permission to sit for the board examination is granted—Option A or B—as explained by the APTA's 2018 Orthopaedic Specialist Certification Candidate Guide (ABPTS, 2017a) [Table 1].

Table 1

ABPTS Examination Requirement Options

Option A	Option B
"Applicants must submit evidence of 2,000 hours of direct patient care as a licensed United States physical therapist (temporary license excluded) in the specialty area within the last ten (10) years, 25% (500) of which must have occurred within the last three (3) years. Direct patient care must include activities in each of the elements of patient/client management applicable to the specialty area and included in the Description of Specialty Practice (DSP).	"Applicants must submit evidence of successful completion of an APTA-accredited post professional clinical residency completed within the last 10 years that has a curriculum plan reflective of the Description of Specialty Practice: Orthopaedic Physical Therapy (DSP). Experience from residencies in which the curriculum plan reflects only a portion of the DSP will not be considered. Applicants must submit evidence of successful completion of an APTA-

These elements are described by the Guide to Physical Therapist Practice to be: examination, evaluation, diagnosis, prognosis and intervention" (p. 1).	accredited post professional Orthopaedic clinical residency" (p. 2).

When comparing the marks achieved by first time test takers in all ten specialty areas, the residency candidates (Option B) consistently achieved better marks compared to the direct contact candidates. Table 2 below is an excerpt from the tables published by the ABPTS for the years 2014 to 2018, only the orthopaedic specialty marks are shown.

Table 2

Comparison of Orthopaedic Specialty Marks Achieved in Options A and B

Year	Option A: Direct Patient Care	Option B: Residency Graduate
2014	73%	89%
2015	71%	86%
2016	72%	84%
2017	73.77%	87.23%
2018	79.33%	89.83%

Note: Adapted from the ABPTS Board Certification Examination Passing Rates (ABPTS, 2017c).

An important aspect of being a Board-certified specialist is that the registration is only valid for ten years and that there are specific time frames for submitting proof of commitment to ongoing professional learning in the Maintenance of Special Certification (MOSC) program. In the recertification process the PTs could provide evidence by means of a portfolio of evidence or by means of the newly introduced continuing model (MOSC) program which is a combination of evidence and examination required in cycles of three years together with a final submission in year ten (ABPTS, 2017a). Although the PTs (88%) seem to favor submission of portfolios of evidence, the Board does not encourage this option as true evaluation of quality is not possible and the Board does not have the capacity to evaluate large numbers of portfolios.

Typically, the examination consists of practice-oriented questions administered via a computer-based examination. The questions are focused on assessing the PT's abilities and professional knowledge together with the five crucial managing and application of the requirements pertaining to the elements: examination, evaluation, diagnosis, prognosis and intervention. To this end, examination questions contain a short description of a possible scenario together with multiple choice questions, demonstrating the candidate's knowledge and therapeutic abilities (ABPTS, 2017a).

The ABPTS published a *Description of Residency Practice* (DRP) in 2017 for orthopaedics (ABPTS, 2017b). This publication contains guidelines towards curriculum development to limit variations in curricula presented by the different schools for PT and establish process consistency in the certification PT specialists. There are three learning specified fields in orthopaedics, namely: (a) Knowledge orthopaedic practice which are inclusive of anatomy, physiology, movement science, pathology, pain management, treatment options in terms of medical and surgical fields, orthopaedic physical therapy—theory and practice, and evidence-based practice; (b) the field of Professional competencies include aspects such as evidence of lifelong learning and professional development, upholding ethics and values in clinical decision-making, education, and critical inquiry, (c) in the field of Psychomotor skills in patient management, orthopaedic specialist PTs are expected to administer a variety tests when examining and evaluating patients to arrive at a diagnosis, which is linked to specific prognosis and intervention aimed at predefined outcomes. The curricula should include different practice settings, patient populations, and primary health conditions to ensure exposure to a wide variety of contexts. The ABPTS is not prescriptive pertaining to the exact contents and teaching

methodologies of the subject areas but have set minimum requirements to ensure uniformity (ABPTS, 2017b).

In summary, the ABPTS requirements for orthopaedic specialty certification are extensive and covers the complete range of services expected from PTs. In addition, the examination process is structured such that the PT's skills in the five crucial elements of PT practice are evaluated together with ethics and compassion. When comparing the examination results of the direct contact and residency graduates it shows clearly the superiority of the residency graduates who consistently achieved higher marks in all nine specialty areas. Candidates who qualify to sit for the examination based on their direct contact and continued professional education do not display such high marks as they might have expected which is an indication that formal further education in the form of a residency program would benefit PTs more. However, the lack of post-professional residency program limit student's ability to participate. Even though, the physical therapy profession continues to respond to a complex and ever-changing landscape in healthcare (Furze et al., 2016). Consistent with this evolution is the development and further expansion of residency and fellowship professional programs, with many programs receiving applications that far exceed the number of places in each cohort (Furze et al., 2016). However, there has been, and continues to be discrepancies within each program (Furze et al., 2016). Furze et al. (2016) even went so far as to argue that it is imperative that these programs consistently deliver high-quality education, but the means of achieving this are still largely unknown.

Conclusion

The core conclusion that can be drawn in this section is data is lacking and inconsistent about physical therapists who graduate from orthopaedic residency programs. Data that was

made available by the ABPTS indicated that residency graduates consistently achieved better pass rates compared to the direct patient contact group (ABPTS, 2017c). However, one major consistency within the data is the degree of beneficial musculoskeletal understanding presented by physical therapists and other medical professionals within the context of military hospitals. Perhaps it is the mentorship programs that improve upon the knowledge and knowledge retention, as well as knowledge-sharing networks such as those exhibited in military hospitals.

CHAPTER III: METHODS

Introduction

This chapter will provide a detailed explanation of the methodology used in this study. This includes a description of the research design and rationale, and information regarding the population of interest. This chapter will also provide a description of the data collection instruments, operationalization of constructs, a description of the data analysis plan, and discussion of threats to validity. Finally, this chapter will conclude with ethical considerations and a summary of key information.

Purpose of the Study

The purpose of this quantitative research was to determine if post-professional orthopaedic residency programs provide graduates with knowledge above and beyond what can be obtained through clinical experience. The purpose was also to determine if participating in a residency program results in better examination outcomes than those who took the clinical hours pathway. The goal of this study was to identify another way to demonstrate the difference between test takers who followed two different eligibility pathways.

Research Questions

This study will address the following research questions and hypotheses:

Research Question 1: Are there differences in scores on the ABPTS Orthopaedic Board Certification Examination compared to the Freedman and Bernstein Test?

Research Question 2: Do post professional orthopaedic residency graduates score better on a standardized test developed to assess physicians' knowledge in musculoskeletal medicine than those who took a clinical hours pathway to examination eligibility?

Research Question 3: Are there differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' highest academic degree (,

master's, doctorate), and professional/entry entry-level degree (master's, doctorate), and practice setting (civilian, federal, academic)?

Research Question 4: Are there differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice?

Design of the Study

A research design is typically a comprehensive outline of how an exploration will take place. A research design typically includes: (a) how data are to be collected, (b) what instruments will be engaged, (c) how the instruments will be utilized, (d) and the intended means for evaluating data collected (Businessdictionary, 2016). Creswell (2009) also quantified a research design to involve the connection of philosophical assumptions, strategies of examination, and explicit methods. The study utilizes quantitative data in its design. According to Creswell (2009), research methods involve the different types of data collections, examinations, and interpretations that researchers offer for their studies. For this study, which investigated the differences between the mean scores of board certified orthopaedic physical therapists who completed a post-professional orthopaedic residency program and those that did not. A quantitative method was employed. Furthermore, quantitative research methods are appropriate when the goal of a study is to test whether one variable is related to another variable, and how that relationship can be represented quantitatively through statistical analysis. By contrast, the qualitative approach is suited to gathering exploratory, descriptive data. Additionally, qualitative data deal with perceptions and opinions (Turner, 2010), and therefore a qualitative approach would not yield the appropriate data for this study.

Protection of Human Participants

Permission was granted by the Institutional Review Board to gather data for the study (See Appendix A). To uphold the ethical standards of research, the Belmont Report (OHSR, 1979) summarized key principles to protect human participants. The key ethical principles in research include (a) the role of assessment of risk-benefit criteria in the determination of the appropriateness of research involving human subjects, (b) appropriate guidelines for the selection of human subjects for participation in such research, and (c) the nature and definition of informed consent in various research settings. The proposed participants and the topic of the study were not considered vulnerable populations, and they were identified as having minimal risk.

No identifying information no identification information will be made known, the name, nature, and location were not mentioned. Because participants were not identifiable in the data, no special precautions will be required to safeguard anonymity of confidentiality of participants.

Sample Selection

The criteria for this study included participants there were licensed physical therapists who passed the American Board of Physical Therapist Specialists (ABPTS) Orthopaedic Certification Examination in 2018. A minimum of 128 participant were needed for this study, 64 Residency trained PTs (Option B) and 64 Non-Residency trained PTs (Option A). In order to determine minimum sample size for this study, G*Power was used. This quantitative study employed a paired sample *t*-test, independent sample *t*-test, one-way ANOVAs, and Pearson correlation analysis, in order to test for statistically significant differences in mean scores For the paired sample *t*-test, in order to detect a medium effect size of Cohen's d = 0.5 at a 5% level of significance with 80% power, a minimum sample size of 34 was required. For the independent

sample *t*-test, in order to detect a medium effect size of Cohen's d = 0.5 at a 5% level of significance with 80% power, a minimum sample size of 128 was required. In order to conduct one-way ANOVAs to detect a medium effect size of F = .25 at a 5% level of significance with 80% power, a minimum sample size of 180 was required. Finally, in order to conduct Pearson's correlations to detect a medium effect size of ρ = .30 at a 5% level of significance with 80% power, a minimum sample size of 84 was required.

In examining the three minimum sample sizes, a size of at least 180 was required in order to satisfy the minimum sample size of all three types of tests. Figures 1 – 4 depict this information.

***t*-tests -** Means: Difference between two dependent means (matched pairs)

Analysis:	A priori: Compute required sample size	
Input:	Tail(s)	= Two
	Effect size d	= 0.5
	α err prob	= 0.05
	Power (1-β err prob)	= .80
Output:	Noncentrality parameter δ	= 2.9154759
	Critical t	= 2.0345153
	Df	= 33
	Total sample size	= 34
	Actual power	= 0.8077775

Figure 1. G*Power output for minimum sample size for paired sample *t*-test required to detect a medium effect size of Cohen's d = 0.5 at a 5% level of significance with 80% power.

***t*-tests -** Means: Difference between two independent means (two groups)

Analysis:	A priori: Compute required sample size	
Input:	Tail(s)	= Two
	Effect size d	= 0.5
	α err prob	= 0.05
	Power (1-β err prob)	= .80
	Allocation ratio N2/N1	= 1
Output:	Noncentrality parameter δ	= 2.8284271
	Critical t	= 1.9789706
	Df	= 126
	Sample size group 1	= 64
	Sample size group 2	= 64
	Total sample size	= 128
	Actual power	= 0.8014596

Figure 2. G*Power output for minimum sample size for independent *t*-test required to detect a medium effect size of Cohen's d = 0.5 at a 5% level of significance with 80% power.

F tests - ANOVA: Fixed effects, omnibus, one-way

Analysis:	A priori: Compute required sample size	
Input:	Effect size f	= 0.25
	α err prob	= 0.05
	Power (1-β err prob)	= .80
	Number of groups	= 4
Output:	Noncentrality parameter λ	= 11.2500000
	Critical F	= 2.6559389
	Numerator df	= 3
	Denominator df	= 176
	Total sample size	= 180
	Actual power	= 0.8039869

Figure 3. G*Power output for minimum sample size for one-way ANOVA.

Exact - Correlation: Bivariate normal model
Options: exact distribution
Analysis: A priori: Compute required sample size

Input:	Tail(s)	= Two
	Correlation ρ H1	= 0.3
	α err prob	= 0.05
	Power (1-β err prob)	= .80
	Correlation ρ H0	= 0
Output:	Lower critical r	= -0.2145669
	Upper critical r	= 0.2145669
	Total sample size	= 84
	Actual power	= 0.8003390

Figure 4. G*Power output for minimum sample size for Pearson correlation analysis.

A minimum of 180 participants were recruited for this study, 90 Residency trained PTs and 90 Non-Residency PTs. Due to the limited response rate, 22 participants who met the criteria were analyzed. For analysis purposes, participants will be subdivided based on whether a residency program preceded their specialized certification:

1). Physical therapists with an orthopaedic clinical specialists' certification who have not completed a credentialed orthopaedic ABPTRFE residency program.

2). Physical therapists with an orthopaedic and clinical specialists' certification who have completed a credentialed orthopaedic ABPTRFE residency program.

Data Collection Procedures

Instrument Development

Data used in this study to measure physical therapists' knowledge in musculoskeletal medicine has been routinely used. This test was originally developed by Freedman and Bernstein (1998) and is a common assessment employed, meaning that an appropriate quantitative instrument for data collection already exists. Thus, the reliability and validity of the instrument have not been determined through empirical testing, although face validity has been determined

based on its frequent use by experts in the PT field. The survey will include the 25-question musculoskeletal written assessment which is provided below.

Question	Answer
1. What common problem must all newborns be examined for?	1. Congenital dislocation of the hip (CHD, dislocation, subluxation also accepted). 1 point
2. What is a compartment syndrome?	2. Increased pressure in a closed fascial space. 1 point
3. Acute septic arthritis of the knee may be differentiated from inflammatory arthritis by which laboratory test?	3. Analysis of fluid from aspiration (cell count, gram stain, culture). 1 point.
4. A patient dislocates his knee in a car accident. What structure(s) is/are at risk for injury and therefore must be evaluated?	4. Must mention popliteal artery. 1 point.
5. A patient punches his companion in the face and sustains a fracture of the 5th metacarpal and a 3 mm break in the skin over the fracture. What is the correct treatment and why?	5. Irrigation and debridement; risk of infection. ½ point each.
6. A patient comes to the office complaining of low back pain that wakes him up from sleep. What two diagnoses are you concerned about?	6. Tumor and infection: ½ point each.
7. How is compartment syndrome treated?	7. Fasciotomy (surgery also accepted). 1 point
8. A patient lands on his hand and is tender to palpation in the "snuff box" (the space between the thumb extensor and abductor tendons). Initial radiographs do not show a fracture. What diagnosis must be considered	8. Scaphoid fracture. (carpal bone fracture also accepted). 1 point.
9. A 25-year-old male is involved in a motor-vehicle accident. His left limb is in a position of flexion at the knee and hip with internal rotation and adduction at the hip. What is the most likely diagnosis?	9. Hip dislocation. 1 point
10. What nerve is compressed in carpal tunnel syndrome?	10. Median nerve. 1 point.
11. A patient has a disc herniation pressing of the 5th lumbar nerve root. How is motor function of the 5th lumbar nerve tested?	11. Dorisflexion of the great toe (toe extensors also accepted). 1 point

12. How is motor function of the median nerve tested in the hand?	12. Any median function (metacarpophalangeal finger flexion; thumb opposition, flexion or abduction). 1 point.
13. A 12-year-old boy severely twists his ankle. Radiographs show only soft tissue swelling. He is tender at the distal aspect of the fibula. What are 2 possible diagnoses?	13. Ligament sprain and Salter- Harris I fracture (sprain, fracture also accepted). 1 point.
14. A patient presents with new onset low back pain. Under what conditions are plain radiographs indicated? Please name 5. (Example: history of trauma).	14. Age >50, neurologic deficit; bowel bladder changes; history of cancer; pregnancy; drug use or steroid use. Systemic symptoms (night pain, fever); pediatric population. ¼ point each, full credit for 4 correct responses.
15. A patient has a displaced fracture near the fibular neck. What structure is at risk for injury?	15. Common peroneal nerve. (Peroneal nerve also accepted.) 1 point.
16. A 20-year-old injured his knee while playing football. You see him on the same day, and he has a knee effusion. An aspiration shows frank blood. What are the three most common diagnoses?	16. Ligament tear, fracture, peripheral meniscal tear. Patellar dislocation, capsular tear also accepted. ½ point each, full credit for 2 correct responses. 1 point.
17. What are the five most common sources of cancer metastatic to bone?	17. Breast, prostate, lung, kidney, thyroid. ¼ point each, full credit for 4 correct responses. 1 point.
18. Name two differences between rheumatoid arthritis and osteoarthritis.	18. Any two correct statements (i.e. inflammatory vs. degenerative, proximal interphalangeal joint vs. distal interphalangeal joint, etc). ½ point each. 1 point.
19. Which malignancy may be present in bone yet typically is not detected with a bone scan?	19. Myeloma (full credit for hematological malignancies – leukemia, lymphoma, etc.) 1 point.
20. What is the function of the normal anterior cruciate ligament of the knee?	20. To prevent anterior displacement of the tibia on the femur. 1 point.
21. What is the difference between osteoporosis and osteomalacia?	21. Osteoporosis – decreased bone density Osteomalacia – decreased bone mineralization (any true statement about epidemiology, pathophysiology – e.g. estrogen vs. Vitamin D – also accepted.) 1 point.
22. In elderly patients, displaced fractures of the femoral neck are typically treated with joint replacement, whereas fractures near the trochanter are treated with plates and screws. Why?	22. Blood supply to the femoral head (avascular necrosis, non-union also accepted). 1 point

23. What muscle(s) is/are involved in lateral epicondylitis (tennis elbow)? 24. Rupture of the biceps at the elbow results in weakness of both elbow flexion and _____? 25. What muscle(s) control(s) external rotation of the humerus with the arm at the side?	23. Wrist extensors (full credit for any wrist extensor – extensor carpi radialis brevis, extensor carpi radialis longus, extensor digitorum communis) 1 point. 24. Supination 1 point. 25. Infraspinatus or teres minor accepted (full credit for rotator cuff). 1 point.

Data Collection and Coding

Full approval to conduct the research study was granted by the Auburn University Institutional Review Board (See Appendix A). The American Board of Physical Therapy Specialists (ABPTS) mailed a postage letter to all eligible participants (n =1, 3228) which provided the Information Letter. Participants contacted the researcher via email to participate in research study. The subjects were sent a response email with link to survey (See Appendix B). The subjects were given 90 minutes to complete the Freedman and Bernstein examination via Qualtrics (See Appendix C). Participants who participated in study agreed to release access to their performance score sheet on the ABPTS Orthopaedic Specialists Examination (See Appendix D). No personal identifiers were listed so as to ensure anonymity. Further, no inducements were offered, and participants were reminded that participation was completely voluntary and research participants could discontinue their participation in the research study at any time.

Demographic information such as gender, race, and years of experience, practice professional/entry level degree, highest academic degree, and practice setting were obtained from the ABPTS. Once subjects completed the Freedman and Bernstein test, their ABPTS

examination results were matched based on email address. Once the match was made, all personal identifiers will be removed from the data set. These scores on the Freedman and Bernstein test were based on a total of 25 points. The results of the participants who took a post-professional orthopaedic residency program will be compared with those who did not take the residency. The researcher also analyzed the difference in scores results between the ABPTS examination and the Freedman and Bernstein musculoskeletal examination. This procedure will result in the following independent and dependent variables:

Independent Variables

*Orthopaedic residency program. "*Orthopaedic residency program" is a categorical dichotomous variable where a value of "1" will designate that the participant took a post-professional orthopaedic residency program and a value of "0" will indicate the participant did not take the residency.

Years of practice. "Years of practice" is a continuous variable measured at the interval level of measurement. It denoted the number of years of practice.

Entry Level/ professional degree. "Practice professional degree" is a categorical variable measured at the nominal level. It consists of levels: (b) masters, and (c) doctorate in physical therapy.

Highest Academic degrees. "Academic degree e" is a categorical variable measured at the nominal level. It consists of three levels: (a) bachelors, (b) masters, and (c) doctorate degree.

Practice setting: "Practice setting" is a categorical variable measured at the nominal level. It consists of five levels: (a) Hospital based outpatient facility or clinic and (b) Private outpatient office or (c) group practice, (d) academic, or (e) military setting.

Dependent Variable

Score on a musculoskeletal medicine examination. "Score on a musculoskeletal medicine examination" is a continuous variable. There were two musculoskeletal medicine examination used for this study which include the ABPTS orthopaedic specialists examination and Freedman and Bernstein test. The scores for ABPTS orthopaedic specialists examination include the raw and percentage (%) score. Both the % score on both of the exams are the % of number of correct answers of the respondent in the examination. The % score can range from 0% to 100%. Scores on the Freedman and Bernstein test were dependent variables as well.

Data Analysis

The primary researcher who is a physical therapist and a Board-Certified Clinical Specialist in orthopedics (OCS) initially scored the first ten completed surveys. An additional rater who is also a physical therapist and OCS with 25+ years in clinical orthopedic practice and education scored the first ten completed surveys. The interclass correlation coefficient (ICC) was assessed in SPSS to determine absolute agreement of grading between both raters. Since the average measures ICC was greater than .9 (ICC=.97), the primary researcher scored the remaining surveys and used their scores for the purpose of this research study.

Data analyses were conducted on the statistical tool of SPSS. First, descriptive statistics were used to summarize the data of the scores on a musculoskeletal medicine examination. Specifically, central tendency measures of mean and standard deviation were used to summarize the continuous measured data. Categorical data of the data of the demographics were summarized using frequency and percentage summaries.

To complete the analysis, SPSS was used to conduct different statistical analysis which include paired sample *t*-test, independent sample *t*-test, one-way ANOVA, and Pearson

correlation analysis. It has been previously established that 180 participants were needed to obtain sufficient statistical power for these tests. A paired samples *t-test* is a measure of the difference of two means within the sample. An independent sample *t-test* is a measure of the difference of two means of two different samples. An ANOVA is a measure of the variance between two means. A Pearson correlation analysis is a measure of the degree to which two variables correlate with one another. These tests allowed the researcher to compare the mean score on the standardized test that measures musculoskeletal knowledge in physical therapists and also relationships between independent variables and dependent variable. The research questions are restated for convenience below:

Research Question 1: Are there differences in scores on the ABPTS Orthopaedic Examination compared to the Freedman and Bernstein Test?

Research Question 2: Do post-professional orthopaedic residency programs result in better outcomes on a standardized test to assess physicians' knowledge in musculoskeletal medicine than those who do not take a residency?

Research Question 3: Are there differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' highest academic degree (, master's, doctorate), and professional/entry entry-level degree (master's, doctorate), and practice setting (civilian, federal, academic)?

Research Question 4; Are there differences in score on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice?

Each of the four stated analyses of paired sample *t*-test, independent sample *t*-test, one-way ANOVA, and Pearson correlation analysis were considered as parametric statistical analyses. A required assumption of any parametric statistical analysis is that the samples of each

group were drawn from a population that was normally distributed. As such, the populations and samples were assumed to have a common variance, with samples being drawn independently from one another. The assumption of normality were assessed by inspection of the histogram for the Freedman and Bernstein exam scores, as well as skewness and kurtosis statistics. Since the scores ABPTS and the Freedman and Bernstein exams were continues variables, the use of parametric statistical analysis was warranted. Distributions with kurtosis and skewness statistics between +/- 3 were considered normally distributed. Another required assumption is that all sample sizes were in order to comply with the minimum sample size as calculated with G*Power. It was also assumed that the samples were drawn randomly from the population. These assumptions are necessary to carry out the quantitative methodologies of focus in this study. The degree to which these assumptions are met is discussed in the results section. All statistical significance is measured at the 5% level.

In order to answer research question #1, a paired sample *t*-test was conducted to determine whether there are significant differences between the scores on the ABPTS orthopaedic specialists examination and Freedman and Bernstein test. Both the scores used were the % score of the number of correct answers. A paired sample *t*-test was conducted to compare the means between two related groups meaning a pairwise comparison of the difference of the scores on the orthopaedic specialists examination and Freedman and Bernstein test per respondent/sample. A *t* statistic is calculated to measure the magnitude of the statistically significant differences between the scores on the ABPTS orthopaedic specialists examination and Freedman and Bernstein test. There is significant differences between the two scores on the musculoskeletal medicine examinations if the *p*-value of the *t*-statistic were less than or equal to the level of significance value. Mean comparison is conducted if there are significant differences

observed. If there was a violation of the normality assumption, the non-parametric Wilcoxon signed-rank test will be used. The Wilcoxon signed-rank test is a rank-based nonparametric test that can be used to determine if there are differences in two sets of scores that come from the same participants.

In order to answer research question #2, an independent sample *t*-test was conducted to determine whether post-professional orthopaedic residency programs result in better outcomes on a standardized test to assess knowledge in musculoskeletal medicine than those who do not complete a residency program. An independent sample *t*-test is a statistical analysis used to compare the means between two unrelated population means in the case of two samples. A *t* statistic is calculated to measure the magnitude of the statistically significant differences in the scores on the two musculoskeletal medicine between physical therapists that completed a post-professional orthopaedic residency program and physical therapists that did complete residency program. There are significant differences in the scores on the musculoskeletal medicine examinations if the *p*-value of the *t*-statistic is less than or equal to the level of significance value. Mean comparison is conducted if there are significant differences observed. However, there are assumptions associated with this statistical analysis. These include the assumption of equality of variances between the two groups which is assessed with Levene's test of homogeneity of variances. If there is a violation of the normality assumption, the non-parametric Mann-Whitney U test will be used. The Mann-Whitney U test (also called the Wilcoxon-Mann-Whitney test) is a rank-based nonparametric test that can be used to determine if there are differences between two groups on a continuous or ordinal dependent variable.

In order to answer research question #3, one-way ANOVAs is conducted to determine whether there are significant differences in scores on a musculoskeletal medicine examination

based on the orthopaedic physical therapist professional/entry level degree, academic doctorate, and practice setting. A one-way ANOVA is a statistical analysis used to compare the means between more than two unrelated population means. An *F* statistic is calculated to measure the magnitude of the statistically significant differences in the scores on the two musculoskeletal medicine examinations of ABPTS orthopaedic specialists' examination and Freedman and Bernstein test among the different categories of the independent variables of professional/entry level degree, academic doctorate, and practice setting. There are significant differences in the scores on the musculoskeletal medicine examinations if the *p*-value of the *F* statistic is less than or equal to the level of significance value. Post-hoc analysis using Tukey's test and mean comparison are conducted if there are significant differences observed. Homogeneity of variances is tested by Levine's test of homogeneity of variances. If there are violations of normality or equality of variances, the non-parametric version of Kruskal–Wallis test will be employed which does not have the requirements of normality or homogeneity of variances.

In order to answer research question #4, Pearson correlation analysis is employed to determine whether there are differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice. Pearson correlation analysis is used to determine the significance of the relationships; and magnitude and direction of the relationships between two continuous variables. In this case, years of practice as physical therapy specialists and scores on the two musculoskeletal medicine examinations of ABPTS orthopaedic specialist's examination and Freedman and Bernstein test are analyzed. A *p*-value that is equal to or less than the level of significance is indicative of significant relationships between variables. Then, the *r* coefficient was investigated to determine the strength and directions of the correlation between variables. The degree of relationship can vary between -

1.00 and +1.00. If there is a perfect relationship between two variables, the coefficients are either -1.00 or +1.00. The weaker the relationship between the variables, the closer the coefficient to zero. The assumption of linearity are assessed through inspection of scatterplots. If the assumption of normality is not met, the non-parametric Spearman rank correlations will be used in which the normality assumption is not a requirement.

Chapter Summary

This section described the methods that were used in this study. The sampling process consisted of obtaining permission from all participants so the data collected can be used in the study. Data analysis was performed using the statistical program IBM SPSS. Prior to analysis, the data was manually cleaned of subjects who failed to complete all parts of the survey. In addition, any potential responses that were impossible due to date collection or survey errors was also be removed. Each of the interval variables was calculated from survey responses and collected into one data set for analysis.

This study used a quantitative design, resulting in an independent t test, which will investigate the differences between the mean scores of those physical therapists that completed a post-professional orthopaedic residency program and those that did not. Chapter 4 will contain the results from this analysis, and Chapter 5 which will include the discussion and conclusion related to this study.

CHAPTER IV: RESULTS

Introduction

The focus of this chapter is to present the results of the quantitative analyses that tested the research question and hypothesis of the study. The study outcomes can be found in tables and graphs with descriptive narratives. SPSS was used for the data analysis. Chapter 4 is organized by a first discussion of the data collection results. Results of assumption testing including normality is also discussed in this chapter. Then, the discussion of the results of the hypothesis testing including paired sample *t*-test, independent sample *t*-test, one-way ANOVA, and Pearson correlation analysis were presented. This chapter ends with a summary.

Purpose of the Study

The purpose of this quantitative research was to determine if post-professional orthopaedic residency programs provide graduates with knowledge above and beyond what can be obtained through clinical experience. The purpose was also to determine if participating in a residency program results in better examination outcomes than those who took the clinical hours pathway. The goal of this study was to identify another way to demonstrate the difference between test takers who followed two different eligibility pathways.

Research Questions

This study will address the following research questions and hypotheses:

Research Question 1: Are there differences in scores on the ABPTS Orthopaedic Board Certification Examination compared to the Freedman and Bernstein Test?

Research Question 2: Do post professional orthopaedic residency graduates score better on a standardized test developed to assess physicians' knowledge in musculoskeletal medicine than those who took a clinical hours pathway to examination eligibility?

Research Question 3: Are there differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' highest academic degree (, master's, doctorate), and professional/entry entry-level degree (master's, doctorate), and practice setting (civilian, federal, academic)?

Research Question 4: Are there differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice?

Data Collection

The final sample for this study consisted of 22 physical therapists who passed the ABPTS orthopaedic certification examination in 2018. Initially, the minimum targeted sample was 180 participants. The researcher was not able to achieve this final number. The data should assume normality since different parametric statistical analyses will be conducted for this study. Typically, a sample size of at least 30 is needed to assume a normal distribution (De Canditiis, 2019). Normality testing was conducted to ensure that the actual sample size is more than enough to satisfy the normal distribution assumption.

Tables 3 and 4 summarized the demographic information of the 22 samples of orthopaedic physical therapy specialists. For gender, there were slightly more female (13; 59.1%) samples than male (9; 40.9%) samples. For race, majority (17; 77.3%) of the 22 samples of orthopaedic physical therapy specialists were White (not Hispanic). For generation, majority (17; 77.3%) of the 22 samples of orthopaedic physical therapy specialists were Gen Xers (Born Between 1965-1981) For the highest education degree, majority (17; 72.7%) of the 22 samples of

orthopaedic physical therapy specialists have earned a DPT for professional/entry-level degree. For the highest academic degree, majority (21; 95.4%) of the 22 samples of orthopaedic physical therapy specialists have earned a doctorate degree. In terms of participating in the orthopaedic resident program, there were less than half or only 8 (36.4%) out of the 22 samples of orthopaedic physical therapy specialists took a post-professional orthopaedic residency program.

In terms of employment status, almost all except one of the 22 samples worked as full-time orthopaedic physical therapy specialists. Majority (16; 72.7%) of the 22 samples of orthopaedic physical therapy specialists have a primary position as staff physical therapy. For employment setting, more than half (12; 54.5%) the 22 samples of orthopaedic physical therapy specialists worked in a private outpatient office or group practice. The remaining samples (10; 45.5%) of orthopaedic physical therapy specialists worked in a hospital-based outpatient facility or clinic. The mean number of years of experience in practicing as physical therapists among the 22 samples was 5.64 years (SD = 6.40). The range of years of practice as physical therapists among the 22 samples was from 1 to 25 years. The mean number of years of experience in practicing as physical therapist specialists among the 22 samples was 5.05 years (SD = 5.90). The range of years of practice as physical therapist specialists among the 22 samples was from 1 to 25 years. Lastly, none of the samples of orthopaedic physical therapy specialists were owner partners in the clinic they are working or active in military.

Table 3

Frequency and Percentage Summaries of Demographic Information

	n	%
Gender		
Female	13	59.1
Male	9	40.9
Race		
White (Not Hispanic)	17	77.3
Hispanic/Latino	1	4.5
Missing	4	18.2
Generation		
Gen Xers (1965-1981)	5	22.7
Millennials (1982-2000)	17	77.3
State		
CA	2	
CO	1	4.5
GA	1	4.5
IL	1	4.5
IN	2	9.1
LA	1	4.5
MN	2	9.1
MO	1	4.5
NC	1	4.5
NJ	1	4.5
OH	1	4.5
RI	1	4.5
SC	1	4.5
TN	2	9.1
TX	3	13.6
UT	1	4.5
Highest Degree (Academic Degree)		
Master's	1	4.5
DPT	19	72.7
tDPT	2	9.1

Table 3 Cont.

Entry Level PT Degree (Entry-level degree)		
Master's	3	13.6
DPT	19	86.4
Assessment Type (Orthopaedic residency program)		
Exam	14	63.6
Residency	8	36.4
Owner Partner		
No	22	100.0
Primary Position		
Supervisor/Director of PT	4	18.2
Senior PT	1	4.5
Staff PT	16	72.7
Other	1	4.5
Employment Status		

Table 3 (Continued)

Full-time salaried	21	95.5
Missing	1	4.5
Employment Setting		
Hospital based outpatient facility or clinic	10	45.5
Private outpatient office or group practice	12	54.5
Active Military		
N = 22	22	100.0

Table 4

Descriptive Statistics Summaries of Years of Practice as Physical Therapists and Years of Practice as Physical Therapy Specialists

	N	Minimum	Maximum	Mean	Std. Deviation
Years PT Practice	22	1	25	5.64	6.40
Years Specialty Practice	22	1	25	5.05	5.90

Results

Descriptive Statistics of Study Variables

Table 5 summarized the descriptive statistics summaries of the different scores on musculoskeletal medicine examination. There were two musculoskeletal medicine examinations used for this study which include the ABPTS orthopaedic specialists examination and Freedman and Bernstein test. The scores for ABPTS orthopaedic specialists examination include the raw and % score. The scores for ABPTS orthopaedic specialists examination was only the % score. The mean raw score on the ABPTS orthopaedic specialists examination among the 22 samples of orthopaedic physical therapy specialists was 634.45 (*SD* = 111.21). The mean % score on the ABPTS orthopaedic specialists examination among the 22 samples of orthopaedic physical therapy specialists was 75.27% (*SD* = 6.22%). The mean % score on the Freedman and Bernstein test among the 22 samples of orthopaedic physical therapy specialists was 72.59% (*SD* = 9.39%).

Table 5

Descriptive Statistics Summaries of Scores on Musculoskeletal Medicine Examination

	N	Minimum	Maximum	Mean	Std. Deviation
ABPTS Exam Scaled Raw Score	22	505.00	925.00	635.45	111.21
ABPTS Exam Scaled % Score	22	67.20	89.20	75.27	6.22
F&B Ortho Survey Score	22	54.00	89.00	72.59	9.39

Results of Normality Testing

A required assumption of the different parametric statistical analyses used in this study which include the paired sample *t*-test (research question one), independent sample *t*-test (research question two), one-way ANOVA (research question three), and Pearson correlation analysis (research question four) is that the data of the variables, specifically the dependent variables, should exhibit normality. The dependent variables include scores on musculoskeletal

medicine examinations of orthopaedic specialist examination and Freedman and Bernstein test. Normality was tested using skewness and kurtosis statistics and also histogram investigation. The skewness and kurtosis statistics are presented in Table 6.

It should be noted that skewness statistics greater than three indicates strong non-normality and kurtosis statistics between 10 and 20 also indicate non-normality (Kline, 2016). The range of data of the skewness statistics (-0.21 and 1.31) of the two measures of the dependent variable of scores on musculoskeletal medicine examinations were not greater than three and kurtosis statistics (-0.38 and 1.64) were not in the range of 10 to 20 for non-normality. To further support the claims of normality of the data of the dependent variables, Figure 6 showed the histogram of the Freedman and Bernstein test. It can be seen that the histogram formed a bell shaped curves which is the graph pattern for normal distribution. Thus, the assumption of normality was satisfied based on the investigation of the skewness and kurtosis statistics and visual investigation of the histogram. Even though, the ABPTS scores is not normally distributed, using parametric statistics is warranted since we are assessing continuous variables for both the ABPTS and the Freedman and Bernstein tests.

Table 6

Skewness and Kurtosis Statistics of Study Variables

	N	Skewness		Kurtosis	
		Statistic	Std. Error	Statistic	Std. Error
ABPTS Exam Scaled Raw Score	22	1.31	0.49	1.64	0.95
ABPTS Exam Scaled % Score	22	0.83	0.49	0.42	0.95
F&B Ortho Survey Score	22	-0.21	0.49	-0.38	0.95

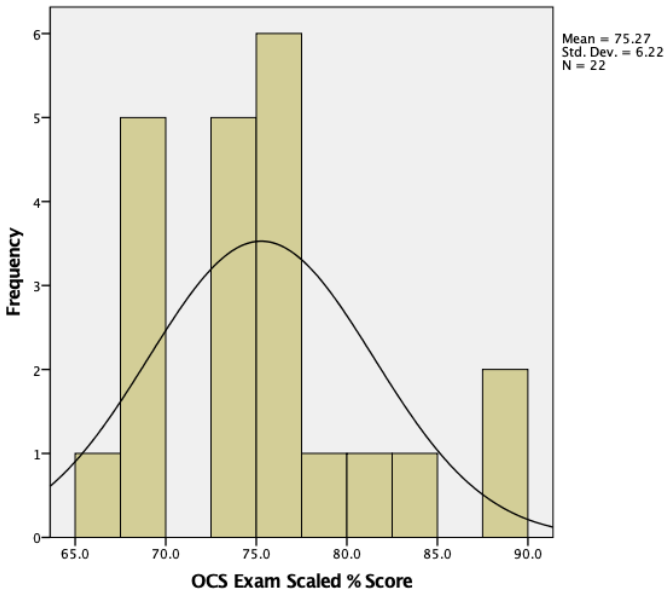

Figure 5. Histogram of data of % score on orthopaedic specialist examination.

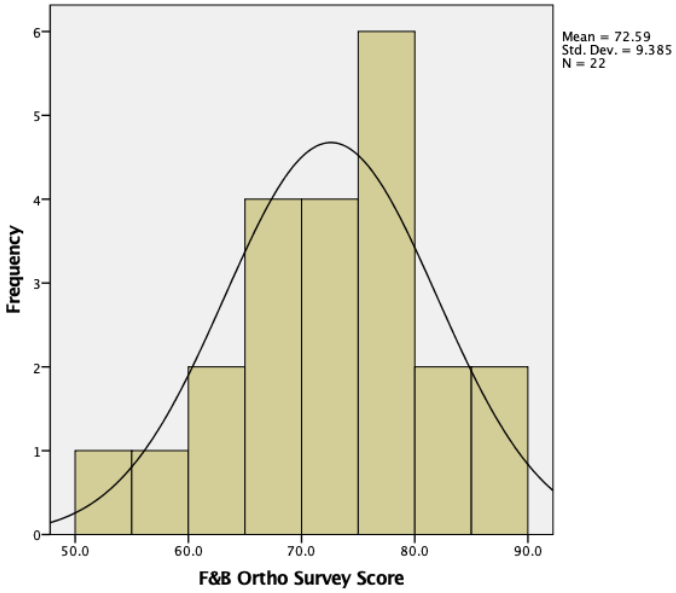

Figure 6. Histogram of data of % score on Freedman and Bernstein test.

Results of Paired Sample *t*-test for Research Question One

Paired sample *t*-test was conducted to address research question one to determine whether there are significant differences between the scores on the ABPTS orthopaedic specialists examination and Freedman and Bernstein test. Both the scores used are the % score of the

number of items correct. A paired sample *t*-test was conducted to compare the means between two related groups meaning a pairwise comparison of the difference of the scores on the orthopaedic specialists examination and Freedman and Bernstein test per respondent/sample. Results of the paired sample *t*-test are shown in Table 8. A level of significance of 0.05 was used in the paired sample *t*-test.

Results of the paired sample *t*-test showed that there were no significant differences between the scores on the ABPTS orthopaedic specialists examination and Freedman and Bernstein test ($t(21) = 1.44$, $p = 0.17$). There were no significant differences since the *p*-values of the *t*-test was greater than the level of significance of 0.05. Specifically, mean comparison in Table 7 showed that mean % score on the ABPTS orthopaedic specialists examination (M = 75.27%; SD = 6.22%) and mean % score on the Freedman and Bernstein test (M = 72.59%; SD = 9.39%) have only a mean difference of 2.68 which was insignificant. Thus, this supports the results of the t-test that there were no significant differences in scores on the orthopaedic specialist examination compared to the Freedman and Bernstein test among the samples of orthopaedic physical therapy specialists.

Table 7

Descriptive Statistics Summaries of % Scores on Orthopaedic Specialist Examination and Freedman and Bernstein Test

Variable	Mean	*N*	Std. Deviation	Std. Error Mean
ABPTS Exam Scaled % Score	75.27	22	6.22	1.33
F&B Ortho Survey Score	72.59	22	9.39	2.00

Table 8

Results of Paired Sample t-test of Significance of Paired Difference Between % Scores on Orthopaedic Specialist Examination and Freedman and Bernstein Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
ABPTS Exam Scaled % Score - F&B Ortho Survey Score	2.68	8.76	1.87	-1.20	6.57	1.44	21	0.17

Results of Independent Sample *t*-test for Research Question Two

Independent sample *t*-test was conducted to address research question two to determine whether post-professional orthopaedic residency programs result in better outcomes on a standardized test to assess physicians' knowledge in musculoskeletal medicine than those who do not take a residency. Results of the independent sample *t*-test are shown in Table 9. A level of significance of 0.05 was also used in the independent sample *t*-test.

Prior to conducting the independent sample *t*-test, a required assumption of homogeneity of variances was tested using the Levene's test of homogeneity of variances. Results of the Levene's test of homogeneity of variances showed that variances in both the % scores on the ABPTS orthopaedic specialists examination (F= 0.09, p = 0.77) and Freedman and Bernstein test (F = 0.35, p = 0.56) were homogeneous or equal across the two groupings of participation in orthopaedic residency program. Thus, there were no violations of both the normality and homogeneity or equality of variances assumption for the independent sample *t*-test.

Results of the independent sample *t*-test in Table 10 showed that there were no significant differences in both % scores on the ABPTS orthopaedic specialists examination (t(20) = -0.53, p

= 0.60) and Freedman and Bernstein test ($t(20) = -0.01$, $p = 0.99$) between participants that took a post-professional orthopaedic residency program and participants that did not take the residency. There were no significant differences since the *p*-values of the *t*-test was greater than the level of significance of 0.05. Thus, the participation in post-professional orthopaedic residency programs does not result in better outcomes on a standardized test to assess knowledge in musculoskeletal medicine than those who do not take a residency.

Table 9

Descriptive Statistics Summaries of % Scores on Orthopaedic Specialist Examination and Freedman and Bernstein Test by Participation on Orthopaedic Residency Program

Dependent Variable	Assessment Type (Orthopaedic residency program)	*N*	Mean	Std. Deviation	Std. Error Mean
ABPTS Exam Scaled % Score	Exam (No)	14	74.73	6.06	1.62
	Residency (Yes)	8	76.21	6.80	2.40
F&B Ortho Survey Score	Exam (No)	14	72.56	8.98	2.40
	Residency (Yes)	8	72.63	10.70	3.78

Table 10

Results of Independent Sample t-test of Significance of Differences of % Scores on Orthopaedic Specialist Examination and Freedman and Bernstein Test by Participation on Orthopaedic Residency Program

	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
Dependent Variable	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ABPTS Exam Scaled % Score	-0.53	20	0.60	-1.48	2.81	-7.34	4.37
F&B Ortho Survey Score	-0.01	20	0.99	-0.06	4.26	-8.95	8.83

Results of one-way ANOVA for Research Question Three

A One-way ANOVA was conducted to address research question three to determine

whether there were significant differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' practice professional/entry level degree, academic degree, and practice setting. A level of significance of 0.05 was used in the different one-way ANOVA.

Prior to conducting the one-way ANOVA a required assumption of homogeneity of variances was tested using the Levene's test of homogeneity of variances. Results of the Levene's test of homogeneity of variances showed that variances in each of the % scores on the ABPTS orthopaedic specialists examination ($F(6, 14) = 0.62$, $p = 0.72$) and Freedman and Bernstein test ($F(6, 14)= 1.48$, $p = 0.25$) were homogeneous or equal across the different groupings of the independent variables of orthopaedic physical therapy specialists' highest academic degree, entry-level degree, and practice setting. Thus, there were no violations of both the normality and homogeneity or equality of variances assumption for the one-way ANOVA.

Results of the one-way ANOVA showed that there were no significant differences in the % scores on the ABPTS orthopaedic specialists examination by differences in the orthopaedic physical therapy specialists' highest academic degree and practice setting. Also, results of the one-way ANOVA showed that there were no significant differences in the % scores on the Freedman and Bernstein test by differences in the orthopaedic physical therapy specialists' highest academic degree. There were no significant differences in the different one-way ANOVA results since the *p*-values of the *F*-test was greater than the level of significance of 0.05. Both the results of the two ANOVA showed that there were no significant differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' highest academic degree, entry-level degree, and practice setting.

Table 11

Descriptive Statistics Summaries of % Scores on Orthopaedic Specialist Examination and Freedman and Bernstein Test by Entry-level degree, and Practice Setting

Entry-level degree	Statistics	ABPTS Exam Scaled % Score	F&B Ortho Survey Score
Master's	N	3	3
	Minimum	67.20	70.00
	Maximum	83.10	80.90
	Mean	74.37	74.63
	Std. Deviation	8.06	5.63
DPT	N	19	19
	Minimum	67.70	54.00
	Maximum	89.20	89.00
	Mean	75.41	72.26
	Std. Deviation	6.14	9.92

Table 12

Descriptive Statistics Summaries of % Scores on Orthopaedic Specialist Examination and Freedman and Bernstein Test by Academic Degree

Highest Degree (Academic Degree) grouping	Statistics	ABPTS Exam Scaled % Score	F&B Ortho Survey Score
Master's	N	1	1
	Minimum	72.80	80.90
	Maximum	72.80	80.90
	Mean	72.80	80.90
	Std. Deviation	.	.
DPT	N	19	19
	Minimum	67.7	54.0
	Mean	75.41	72.26
	Std. Deviation	6.14	9.92
tDPT	N	2	2
	Minimum	67.20	70.00
	Maximum	83.10	73.00
	Mean	75.15	71.50
	Std. Deviation	11.24	2.12
		.	

Table 13

Descriptive Statistics Summaries of % Scores on Orthopaedic Specialist Examination and Freedman and Bernstein Test by Employment Practice Setting

Employment Setting grouping	Statistics	ABPTS Exam Scaled % Score	F&B Ortho Survey Score
Hospital based outpatient facility or clinic	N	10	10
	Minimum	67.70	57.00
	Maximum	89.20	89.00
	Mean	76.51	74.09
	Std. Deviation	6.61	8.85
Private outpatient office or group practice	N	12	12
	Minimum	67.20	54.00
	Maximum	88.70	89.00
	Mean	74.23	71.33
	Std. Deviation	5.96	10.01

Results of Pearson Correlation Analysis for Research Question Four

A Pearson correlation analysis was conducted to address research question four to determine whether there were differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice. This analysis determines the correlation between scores on a musculoskeletal medicine examination and orthopaedic physical therapy specialists' years of practice. A Pearson correlation analysis is conducted since both variables are continuous measured. Results of the Pearson correlation analysis for research question four are shown in Table 14. A level of significance of 0.05 was also used in the Pearson correlation analysis.

Results of the Pearson correlation analysis in Table 14 showed that both % scores on

musculoskeletal medicine examinations of orthopaedic specialist examination ($r(20) = -0.24$, $p = 0.28$) and Freedman and Bernstein test ($r(20) = 0.06$, $p = 0.81$) were not significantly correlated with the orthopaedic physical therapy specialists' years of practice. There were no significant correlations since the *p*-values of the correlation analysis were greater than the level of significance of 0.05. With these results, it was determined that there were no significant differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice. Visual inspection of the scatterplot in Figures 6 and 7 revealed no linearity or linear relationship between % scores in orthopaedic specialist examination and orthopaedic physical therapy specialists' years of practice; and between score in Freedman and Bernstein test and orthopaedic physical therapy specialists' years of practice. There were no linear relationships because there was no linear or straight-line trend exhibited in the two scatterplots.

Table 14

Results of Pearson Correlations between Scores on Musculoskeletal Medicine Examination and Orthopaedic Physical Therapy Specialists' Years of Practice

		Years Specialty Practice
APTS Exam Scaled % Score	Pearson Correlation	-0.24
	Sig. (2-tailed)	0.28
	N	22
F&B Ortho Survey Score	Pearson Correlation	0.06
	Sig. (2-tailed)	0.81
	N	22

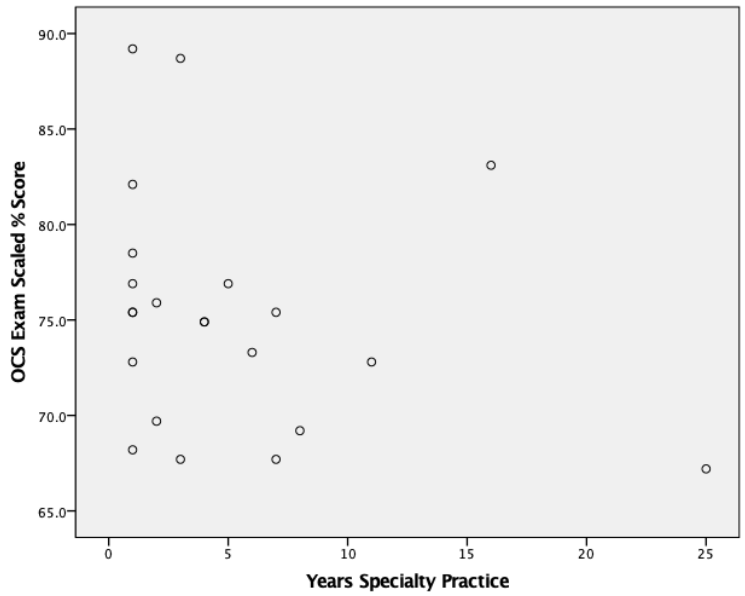

Figure 7. Scatterplot of orthopaedic physical therapy specialists' years of practice versus % score on orthopaedic specialist examination.

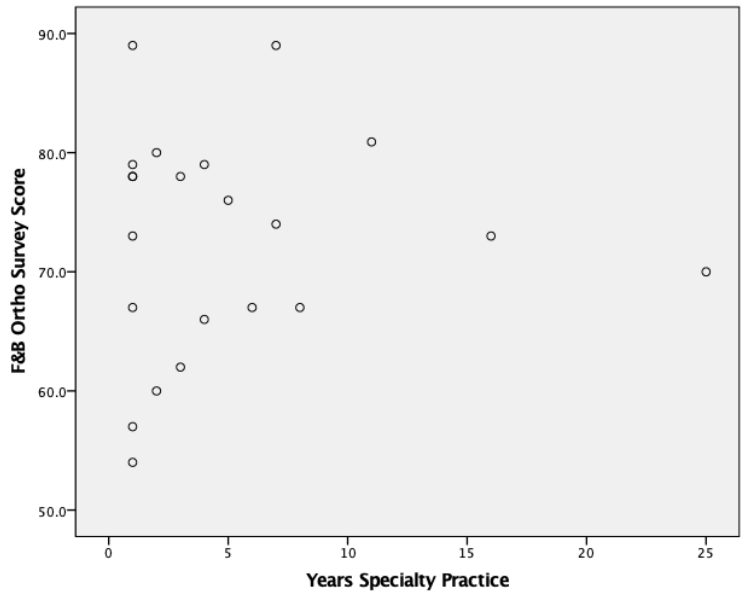

Figure 8. Scatterplot of orthopaedic physical therapy specialists' years of practice versus % score on Freedman and Bernstein test

Summary

The purpose of this quantitative study was to determine if post-professional orthopaedic residency programs provide graduates with knowledge above and beyond what can be obtained through other means. As stated, descriptive statistics analysis, descriptive statistics analysis,

paired sample *t*-test, independent sample *t*-test, one-way ANOVA, and Pearson correlation analysis were used in this study. For research question one, results of the paired sample *t*-test showed that there were no significant differences in scores on the ABPTS orthopaedic examination compared to the Freedman and Bernstein test. For research question two, results of the independent sample *t*-test showed that post-professional orthopaedic residency programs did not result in better outcomes on a standardized test to assess physicians' knowledge in musculoskeletal medicine than those who do not take a residency. For research question three, results of the one-way ANOVA showed that there were no significant differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' practice professional/entry level degree, academic degree, and practice setting. For research question four, results of the Pearson correlation analysis showed that there were no significant differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice.

The following chapter, Chapter 5 concludes this study. Implications of the results of the data analysis will be discussed in detail in Chapter 5. Suggestions on how the findings may be applied in an organizational setting and a summary of recommendations for future research are also discussed in Chapter 5.

CHAPTER V: DISCUSSION, IMPLICATIONS, AND AREAS FOR FURTHER RESEARCH

Introduction

This research was aimed at addressing the limited evidence which suggests that physical therapists who graduate from an orthopaedic residency program have greater knowledge in the management of musculoskeletal disorders (APTBRFE, 2015). This chapter provides conclusions and recommendations based on the results of the study. The purpose of the study is reviewed first, followed by interpretation of the findings. The limitations of the study are provided subsequently. Recommendations for practice and future research follow and are proceeded by the implications of the study. A summary concludes the study.

Purpose of the Study

The purpose of this quantitative research was to determine if post-professional orthopaedic residency programs provide graduates with knowledge above and beyond what can be obtained through clinical experience. The purpose was also to determine if participating in a residency program results in better examination outcomes than those who took the clinical hours pathway. The goal of this study was to identify another way to demonstrate the difference between test takers who followed two different eligibility pathways.

Research Questions

This study will address the following research questions and hypotheses:

Research Question 1: Are there differences in scores on the ABPTS Orthopaedic Board Certification Examination compared to the Freedman and Bernstein Test?

Research Question 2: Do post professional orthopaedic residency graduates score better on a standardized test developed to assess physicians' knowledge in musculoskeletal medicine than those who took a clinical hours pathway to examination eligibility?

Research Question 3: Are there differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' highest academic degree (, master's, doctorate), and professional/entry entry-level degree (master's, doctorate), and practice setting (civilian, federal, academic)?

Research Question 4: Are there differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice?

Participants

Participants were 22 licensed physical therapists who passed the American Board of Physical Therapist Specialists (ABPTS) Orthopaedic Certification Examination in 2018. The sample contained slightly more female participants (59.1%) than males (77.3%). Most participants were White (77.3%) Gen Xers (77.3%) who had acquired a DPT or tDPT (95.5.7%). Less than half (36.4%) had participated in a residency program (see Table 3). The independent variables that were studied were participation in a residency program, years of practice, practice professional degree, and academic doctorate, while the dependent variable was scores on the musculoskeletal written assessment and ABPTS Orthopaedic examination. SPSS software was used to assist with organizing and analyzing the data. An independent t-test and one-way ANOVAs were conducted.

Participants completed a 25-question musculoskeletal written assessment that was originally developed by Freedman and Bernstein (1998). The 25-question assessment used during this study is commonly-implemented in the medical field to test musculoskeletal knowledge, and previous research has established its validity and reliability. Questions included in this assessment are not divided or categorized in any particular order; topics covered by the assessment include musculoskeletal composition, conditions, diagnoses, and treatments.

The following research questions guided this study:

Research Question 1: Are there differences in scores on the ABPTS orthopaedic examination compared to the Freedman and Bernstein test?

Research Question 2: Do post-professional orthopaedic residency programs result in better outcomes on a standardized test to assess physicians' knowledge in musculoskeletal medicine than those who do not take a residency?

Research Question 3: Are there differences in scores on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' highest academic degree (, master's, doctorate), and professional/entry entry-level degree (master's, doctorate), and practice setting (civilian, federal, academic)?

Research Question 4: Are there differences in score on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice?

This chapter provides conclusions and insights into the results of the study. First, the results will be reviewed. Subsequently, the findings will be interpreted within the context of the study and framework of the study. The limitations of the study will then be discussed, followed by the implications of the study. A conclusion will be provided at the end of the chapter.

Research question one centered on determining whether there were differences in scores on the ABPTS orthopaedic examination compared to the Freedman and Bernstein test. Among the 22 participants, the mean percentage score on the ABPTS orthopaedic specialist examination was 75.27% (SD = 6.22%). By contrast, the mean percentage score on the Freedman and Bernstein test was 72.59% (SD = 9.39%). The mean score on the ABPTS examination was 2.68% higher than the mean score on the Freedman and Bernstein test. The results of a paired sample *t*-test to determine whether the difference in scores was significant indicated that the difference in mean scores was not significant ($t(21) = 1.44$, $p = 0.17$) at the .05 level of

significance. Thus, while there was a measurable difference in mean scores between the two tests, the difference in mean scores was revealed to be insignificant within the context of the study.

Research question two centered on determining whether post-professional orthopaedic residency programs resulted in better outcomes on a standardized test to assess physicians' knowledge in musculoskeletal medicine than those who do not take a residency. Of the 22 participants, eight (36.4%) of them had completed a residency. The mean percentage score on the ABPTS examination for those who completed a residency was 76.21%, while the mean score for those who did not complete a residency was 74.73%. The mean percentage score on the Freedman and Bernstein test for those who completed a residency was 72.63%, while the mean score for those who did not complete a residency was 72.56%. Like the *t*-test that was conducted with research question one, a .05 level of significance was used. Normality and variance tests revealed no violations. Upon conducting an independent *t*-test, no significant differences were revealed when comparing scores on the ABPTS orthopaedic specialists examination ($t(20) = -0.53$, $p = 0.60$) and Freedman and Bernstein test ($t(20) = -0.01$, $p = 0.99$) between participants that took a post-professional orthopaedic residency program and participants that did not take the residency.

Research question three centered on determining whether there were differences in score on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' highest academic degree (master's, doctorate), and professional/entry entry-level degree (master's, doctorate), and practice setting (civilian, federal, academic)?. A significance level of .05 was once again used to conduct a one-way ANOVA test to address the research question. Normality, variance, and homogeneity tests revealed no violations. Upon conducting

the one-way ANOVA test, no significant differences in mean scores were found on the basis of participants' professional/entry-level degree, academic doctorate or practice setting.

Lastly, research question four centered on determining whether there were differences in score on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice. A Pearson correlation test was conducted to address this research question. Again, a .05 level of significance was selected for this test. Upon conducting the Pearson test, it was determined that scores on the ABPTS examination ($r(20) = -0.24$, $p = 0.28$) and Freedman and Bernstein test ($r(20) = 0.06$, $p = 0.81$) were not significantly correlated with the number of years participants had been practicing physical therapy. Plotting the data on two scatter plots revealed no linear relationship between scores for either test and years of practicing physical therapy.

Interpretation of the Findings

This section involves the interpretation of the findings within the context of extant literature. The findings will be interpreted for each of the four central research questions. Because no theoretical framework was selected for this study, relevant theories and seminal studies will be discussed throughout.

Research Question One

Research question one was aimed at determining whether there were differences in scores on the ABPTS orthopaedic examination compared to the Freedman and Bernstein test. Upon analyzing the data, no statistically differences in scores were found on the ABPTS orthopaedic examination compared to the Freedman and Bernstein test. The standardized nature of the ABPTS, as well as multiple confirmations of the validity of the Freedman and Bernstein test, make it unlikely that any potential error could be attributed to this finding on the basis of the examinations involved.

No extant research was found which offered a comparison and analysis of ABPTS and Freedman and Bernstein scores. However, previously conducted studies indicate that scores on orthopaedic competency examinations are significantly higher for individuals that take part in APTA-accredited post professional clinical residencies than those who solely complete 2,000 hours of direct physical therapy patient care to receive their certification (ABPTS, 2017a).

The ABPTS examination and the Freedman and Bernstein test cover very similar subject knowledge. The ABPTS examination centers on the assessment of the PT's abilities and professional knowledge about five key forms of knowledge management and application: examination, evaluation, diagnosis, prognosis, and intervention. The examination questions contain a short description of a medical scenario paired with multiple-choice questions. Like the ABPTS, the Freedman and Bernstein test primarily provides short scenarios or questions about the diagnosis, treatment, and evaluation of musculoskeletal conditions (Freedman & Bernstein, 1998). However, one key difference between the two tests is response format, as the Freedman and Bernstein test is in an open-response format.

Though the difference was determined not to be statistically significant, the mean score on the ABPTS was 2.68% higher than the mean score on the Freedman and Bernstein test. Researchers such as Hubbard, Potts, and Couch (2017) and Yudkowsky, Park, and Downing (2019) have found that factors such as the format of responses on an assessment can significantly influence the results, as response format can affect how students conceptualize constructs and problem solve. Thus, the open-response format, significant differences in test length, and other format-related factors could have contributed to differences in mean scores that did not

necessarily reflect participants' musculoskeletal knowledge or abilities changing over time (Hawkins et al., 2015).

Research Question Two

Research question two was aimed at determining whether post-professional orthopaedic residency programs result in better outcomes on a standardized test to assess physicians' knowledge in musculoskeletal medicine than those who do not take a residency. Data analysis revealed no significant differences when comparing scores on the ABPTS orthopaedic specialists examination and Freedman and Bernstein test between participants that took a post-professional orthopaedic residency program and participants that did not take the residency. This finding conflicts with a significant body of literature which indicates that completing a residency or fellowship can lead to significant improvements in medical knowledge assessment results and/or clinical outcomes.

While a significant body of literature indicates the importance of residency programs for treatment outcomes and/or assessment results for medical professionals, only a small number of researchers have focused on orthopaedic and physical therapy residencies. Rodeghero et al. (2015) found that physical therapists' completion of a fellowship or residency program significantly improved the clinical outcomes of their patients who had various musculoskeletal conditions. Similarly, Cunningham and McFelea (2017) found that taking part in an orthopaedic residency program effectively improved residents' capacity for performing evaluations and examinations that were necessary for treating and diagnosing musculoskeletal conditions. While it is entirely possible that no differences in examination scores were found based on participation in a residency because participants who had completed a residency did not acquire a significant degree of new knowledge that was relevant to their profession, it is important to note that

limitations of this research may have affected this finding. Namely, the small sample size and/or the small number of participants who had completed a residency could have skewed the results.

Research Question Three

Research question three was aimed at determining whether there were differences in score on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' highest academic degree (, , master's, doctorate), and professional/entry entry-level degree (, master's, doctorate), and practice setting (civilian, federal, academic). Upon analyzing the data, no statistically significant differences in mean scores on the ABPTS or Freedman and Bernstein test were found to be associated with participants' highest academic degree, entry-level degree, or practice setting.

Some literature indicates strong associations between factors such as highest academic degree, entry-level degree, and/or practice setting in relation to practical knowledge and/or examination outcomes among medical professionals. Russek, LaShomb, Ware, Wesner, and Westcott (2016), for example, considered physical therapists' entry-level degrees and other factors with their knowledge about fibromyalgia, joint hypermobility syndrome, and rheumatoid arthritis, but found no significant connection to entry-level degree type. During another recent study, O'Keeffe et al. (2016) found that organizational and environmental factors, such as treatment setting, were perceived to be related to the quality of care and patient-doctor interactions for physical therapy patients. It should be noted that most extant literature that involves consideration of physical therapists' highest academic degree, professional/entry-level degree, and/or practice setting concerns patient outcomes or quality of care measures, rather than written assessment results. Thus, while there is some literature on these topics, the inconsistent nature of extant research results coupled with the focus on patient experiences over therapists'

knowledge makes it difficult to compare the findings for research question three with previous findings.

Research Question Four

Research question four was aimed at determining whether there were statistically significant differences in score on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice. Data analysis revealed no statistically significant correlation between scores on the ABPTS or Freedman and Bernstein test with the number of years participants had been practicing physical therapy. This finding partially conflicts with findings from the extant literature. Some researchers have indicated the significance of physical therapists' years of experience in relation to physical therapy knowledge and skills. Camden, Rivard, Pollock, and Missiuna (2015) found that the number of years physical therapists had been practicing professionally had a significant impact on their ability to implement skills and knowledge that were taught through an online Developmental Coordination Disorder (DCD) module. In particular, researchers have emphasized the significance of the "knowledge-to-practice gap" for physical therapists and other medical professionals who recently graduated (Everett-Thomas et al., 2015; Furze, Tichenor, Fisher, Jensen, & Rapport, 2016; Hickerson, Taylor, & Terhaar, 2016).

Interestingly, Manns, Norton, and Darrah (2015) found that medical professionals who had recently graduated from a physical therapy program had a higher degree of knowledge concerning evidence-based practice skills as compared to physical therapists who had been practicing professionally for six to 15 years; however, knowledge gained through clinical experience was utilized more frequently by all participants than knowledge acquired through formal medical education. In regards to the knowledge necessary to pass physical therapy

knowledge-based assessments, previous research findings may have contributed to the expectation that those who had been practicing for a shorter period would demonstrate better results on the Freedman and Bernstein test, as they were taught evidence-based practice skills more recently. However, Manns et al.'s (2015) finding that clinical experience may be more frequently employed in the clinical environment than formally-taught skills may help to explain why differences in scores based on participants' years of practice were not statistically significant.

Limitations of the Study

Limitations are factors related to the nature of the study that are outside of the researcher's control (Greener, 2018); as is the case for all research, several limitations may have affected this study. Participants were volunteers who provided self-reported data using an online survey. Thus, participants could have received outside help or otherwise provided misleading results (Nardi, 2018; Queirós, Faria, & Almeida, 2017; Ross & Zaidi, 2019). Participants were reminded that taking part in the study was completely voluntary and that the results would not affect their professional practice or status.

The final sample size of 22 respondents may also have served as a limitation (Story & Tait, 2019; Stratton, 2015). Story and Trait (2019) contended that a low number of survey responses or a rate of response under 20% can lead to a sample that is under-representative or is not an accurate representation of the study population. Further, Stratton (2015) noted that three of the five most common forms of survey bias can result from a sample that is too small. Though survey reminders were administered to participants, the desired sample size of at least 128 participants was not achieved. Thus, the findings of the study may not be generalizable for all of the studied variables, or for all licensed physical therapists who passed the ABPTS examination.

In particular, the small number of participants who completed a residency, (n=8), decreased the validity of conclusions concerning whether participating in a residency is associated with higher examination scores. Lastly, due to the nature of the quantitative data and the statistical methods used during analysis, the researcher could not prove causation and could only draw conclusions concerning whether differences in scores between the ABPTS Orthopaedic certification examination and the Freedman and Bernstein musculoskeletal examination were statistically significant.

The researcher was initially informed by the ABPTS that email addresses for all therapists who passed the ABPTS Orthopaedic examination in 2018 would be available for researcher purposes. In this scenario, the researcher would have emailed all potential participants a copy of the Information Letter and link to the survey. Follow-up email reminders would have been sent every two weeks. Unfortunately, a memorandum was subsequently implemented denying researchers access to confidential information for research purposes. This is included access to email addresses of board certified physical therapists. Therefore, the ABPTS agreed to mail the Information Letter via postage mail. The potential subjects were required to email the researcher in order to participate in the study. The researcher believes minimum participation was due to new restrictions and lack of initial access to email addresses, which subsequently resulted in the researcher's reliance on subjects to actively pursue engagement in the study.

Recommendations

Several recommendations for future research may be offered based on the findings of this study. First and foremost, the small sample size that was acquired for this study contributes to the

recommendation that the study is repeated with a significantly larger sample that reflects a more even distribution of the factors and demographics at the core of this research. Doing so may lead to conclusions and insights related to the research questions that can be compared more effectively with findings in extant literature. To increase the sample size, the researcher recommends including therapists who passed the ABPTS examination in preceding years. Since the *Description of Specialty Practice* is analyzed and revalidated every ten years to reflect changes in specialty practice, the content tested on the ABPTS examination is similar throughout this decennial timeframe. The researcher could have included participants from similar specialty practices. For example, licensed physical therapists who are board-certified in sports physical therapy (SCS), require MSK knowledge and skills equivalent to Orthopaedic specialists.

Another recommendation for future research would be to conduct a similar study while focusing on fewer independent variables. While the focus of the study was primarily on the implications of residency programs in relation to physical therapy assessment results, many demographic and education-related factors were considered. Focusing on a smaller number of demographic and education-related factors in a future study may lead to more definitive conclusions about the relationship between participation in an orthopaedic residency and results on the Freedman and Bernstein and/or ABPTS examination results.

The researcher also recommends that another study be conducted in the future that compares responses to questions on the Freedman and Bernstein test and ABPTS examination based on individual questions that reflect comparable knowledge or skills. In other words, items aimed at assessing a particular knowledge base, such as musculoskeletal composition or conditions, could be compared between the two assessments to see if participants scored better on questions reflecting the same type of knowledge on one assessment over the other. Doing so

could help to elucidate why there was a difference of 2.68% in mean scores between the two assessment types, though that difference was found to be statistically insignificant within the context of the study. Due to the limitations and scope of the study, it is recommended that the instruments at the center of the study are research further in a similar research context; however, the review of literature revealed no existing instruments which would have been more suitable for the purposes of this research.

Implications

Findings from this research did not reveal any statistically significant associations or impacts related to the variables that were considered. However, implications from this study may still have significance and importance related to social change, research methods, existing theories, and clinical practice. Theoretical implications were not assessed for this research, as this research was rooted in the constructs and physical therapy assessment methods that were considered rather than one or more previously-developed theories.

Broadly speaking, studies such as this one may contribute to improved clinical outcomes and/or graduation rates from physical therapy education programs. Having a better understanding of the factors associated with physical therapy assessment results could lead to improved understandings of how assessment results relate to physical therapists' actual knowledge and professional skills related to physical therapy. In medical education settings, particularly those concerned with physical therapy education, findings from this research could lead to increased consideration of response format and type when educators are choosing which assessment(s) to implement. Ensuring that physical therapy assessment results are not skewed and reflect therapists' knowledge accurately is key to ensuring favorable therapist training outcomes and patient outcomes. Further, ensuring that response format does not significantly influence

physical therapy assessment results could be useful for reducing therapist turnover, improving job satisfaction, and other key outcomes, as medical professionals are more likely to stay employed and enjoy their profession when prerequisite education and assessments accurately assess and reflect the skills and knowledge necessary to be successful in the clinical setting (Blouin & Tekian, 2018; Bowe & Armstrong, 2017).

Conclusion

In conclusion, the purpose of this quantitative research was to determine if post-professional orthopaedic residency programs provide graduates with knowledge above and beyond what can be obtained through other means, and to determine if participating in one of these programs resulted in better outcomes than those who do not take a residency. Examination and demographic data were gathered from 22 licensed physical therapists who passed the American Board of Physical Therapist Specialists (ABPTS) Orthopaedic Certification Examination in 2018. The data were analyzed using descriptive statistics, paired sample t-test, independent sample t-test, one-way ANOVA, and Pearson correlation analysis.

The following research questions were addressed during this study:

Research Question 1*:* Are there differences in scores on the ABPTS orthopaedic examination compared to the Freedman and Bernstein test?

Research Question 2*:* Do post-professional orthopaedic residency programs result in better outcomes on a standardized test to assess physicians' knowledge in musculoskeletal medicine than those who do not take a residency?

Research Question 3*:* Are there differences in scores on a musculoskeletal medicine examination based on the orthopedic physical therapy specialists' highest academic degree (,

master's, doctorate), and professional/entry level degree (master's, doctorate), and practice setting (civilian, federal, academic)?

Research Question 4*:* Are there differences in score on a musculoskeletal medicine examination based on the orthopaedic physical therapy specialists' years of practice?

Regarding the first research question, it was determined that there were no statistically significant differences in scores on the ABPTS orthopaedic examination compared to the Freedman and Bernstein test among participants. In response to the second research question, no significant differences were revealed when comparing scores on the ABPTS orthopaedic specialists examination and Freedman and Bernstein test between participants that took a post-professional orthopaedic residency program and participants that did not take the residency. Concerning the third research question, no significant differences in mean scores on the ABPTS exam or Freedman and Bernstein test were found based on participants' professional/entry-level degree, academic doctorate, or practice setting. In response to the fourth research question, the researcher determined that participants' scores on the ABPTS examination and Freedman and Bernstein test were not significantly correlated with the number of years participants had been practicing physical therapy.

While no statistically significant relationships were found during this study, several implications and findings are useful for future research and professional practice. Namely, differences between the ABPTS examination and Freedman and Bernstein test results, though statistically insignificant, highlighted how factors related to assessment format, rather than the content of the assessments, may lead to differences in scores on assessments that measure the same constructs, skills, and knowledge. Conducting similar research in the future with a significantly larger sample size and/or a more narrowed focus on which variables are considered

may lead to more conclusive insights about whether post-professional orthopaedic residency programs provide graduates with knowledge above and beyond what can be obtained through clinical practice , and/or if participating in one of these programs results in better outcomes than those who do not take a residency.

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APPENDIX A

Information Letter

EDUCATIONAL FOUNDATIONS, LEADERSHIP AND TECHNOLOGY

INFORMATION LETTER
for a Research Study entitled
The Effects of Physical Therapy Clinical Experiences on Post-Professional Orthopaedic Knowledge

You are invited to participate in a research study to examine post-professional orthopaedic knowledge and whether there is a difference based on direct patient or residency program experience. The study is being conducted by Jeremy Houser, DPT, OCS, doctoral candidate at Auburn University, under the direction of Dr. Maria Witte in the Auburn University Department of Education. You are invited to participate because you are a licensed physical therapist who recently passed the American Board of Physical Therapist Specialists (ABPTS) Orthopaedic Certification Examination and are 18 years or older.

What will be involved if you participate? Your participation is completely voluntary. If you decide to participate in this research study, you will be asked to (a) click on the survey link at the bottom of the page, (b) answer the assessment questions, and (c) submit your replies. The average total time commitment is 30 minutes.

Are there any risks or discomforts? The risks associated with participating in this study are that you might get tired answering the questions. To minimize these risks, we set a 90 minute time limit in answering the questions.

Are there any benefits to yourself or others? If you participate in this study, you can expect to reestablish your knowledge of musculoskeletal medicine. I cannot promise you that you will receive any or all of the benefits described.

Will you receive compensation for participating? There will be no compensation for your participation.

Are there any costs? If you decide to participate, you will need to access the Internet for the duration of your assessment.

If you change your mind about participating, you can withdraw at any time by closing your browser window. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. Once you've submitted anonymous data, it cannot be withdrawn since it will be unidentifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or ABPTS.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by allocating a code number to your assessment answers. Information collected through your participation may be used to fulfill an educational requirement and/or published in a professional journal.

By agreeing to participate in this study, you give the researcher access to your redacted 2018 Specialist Certification Examination in Orthopaedic Physical Therapy Performance Report and demographic information (professional degree, highest academic degree, years of practice, and practice setting) from the ABPTS records.

If you would like to participate or have questions regarding this study, please contact Jeremy Houser at housejd@tigermail.auburn.edu or (334)799-8112.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

The Auburn University Institutional Review Board has approved this document for use from 9/04/18 to 9/04/19. Protocol # 18-356 EX 1809

4036 Haley Center, Auburn, AL 36849-5221; Telephone: 334-844-4460; Fax: 334-844-3072

www.auburn.edu

APPENDIX B

EMAIL TO SUBJECTS

Dear Physical Therapists,

Congratulation on passing the Orthopaedic Certification Examination in 2018! I appreciate your willingness to participate in my research study.

If you have any familiarity with the two studies listed below, please let me know prior to completing the assessment/survey:

Freedman KB, Bernstein J: The adequacy of medical school education in musculoskeletal medicine. J Bone Joint Surg Am 1998, 80:1421-1427.

Matzkin E, Smith ME, Freccero CD, Richardson AB: Adequacy of education in musculoskeletal medicine. J Bone Joint Surg Am 2005, 87-A:310-314.

The first page of survey is the Information Letter you received in the mail. Please review the Information Letter, then scroll down to bottom of page and select I agree to voluntarily participate in the study.

If you are having difficulty with a question, please answer to the best of your ability and move on.

Please make sure that your answers are from your own knowledge to ensure we gather relevant research data. Do not use sources such as Internet searches, textbooks, notes, colleagues, etc. to help you answer the questions.

Please click on the link below to begin:

https://auburn.qualtrics.com/jfe/form/SV_5nl3fAkOx5TeDad

Thank you so much!

Jeremy D. Houser, DPT, OCS
Board-Certified Orthopaedic Physical Therapist
PhD Student in Adult Education Auburn University
Cell: (334) 799-8112
Email: housejed@auburn.edu

APPENDIX C

COMPLETE QUALITRICS SURVEY

Informed Consent Form

EDUCATIONAL FOUNDATIONS, LEADERSHIP AND TECHNOLOGY

INFORMATION LETTER

for a Research Study entitled

The Effects of Physical Therapy Clinical Experiences on Post-Professional Orthopaedic Knowledge

You are invited to participate in a research study *to examine post-professional orthopaedic knowledge and whether there is a difference based on direct patient care or residency program experience. The study is being conducted by Jeremy Houser, DPT, OCS, doctoral candidate at Auburn University, under the direction of Dr. Maria Witte in the Auburn University Department of Education. You are invited to participate because you are a licensed physical therapist who recently passed the American Board of Physical Therapist Specialists (ABPTS) Orthopaedic Certification Examination and are 18 years or older.*

What will be involved if you participate? *Your participation is completely voluntary. If you decide to participate in this research study, you will be asked to (a) contact Jeremy Houser at housejd@tigermail.auburn.edu., (b) answer the assessment questions, and (c) submit your replies. The average total time commitment is 30 minutes.*

Are there any risks or discomforts? *The risks associated with participating in this study*

1/10

are that you might get tired answering the questions. To minimize these risks, we set a 90 minute time limit in answering the questions.

Are there any benefits to yourself or others? *If you participate in this study, while not guaranteed, you can expect to reestablish your knowledge of musculoskeletal medicine.* ***You will also receive the results of the completed assessment.***

Will you receive compensation for participating? *There will be no compensation for your participation.*

Are there any costs? *If you decide to participate, you will need to access the Internet for the duration of your assessment.*

If you change your mind about participating*, you can withdraw at any time by closing your browser window. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. Once you've submitted anonymous data, it cannot be withdrawn since it will be unidentifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or ABPTS.*

Any data obtained in connection with this study will remain anonymous. *We will protect your privacy and the data you provide by allocating a code number to your assessment answers. Information collected through your participation may be used to fulfill an educational requirement and/or published in a professional journal.*

By agreeing to participate in this study*, you give the researcher access to your redacted 2018 Specialist Certification Examination in Orthopaedic Physical Therapy Performance Report and demographic information (professional degree, highest academic degree, years of practice, and practice setting) from the ABPTS records.*

If you would like to participate or have questions regarding this study, please contact Jeremy Houser at housejd@tigermail.auburn.edu or (334) 799-8112.

If you have questions about your rights as a research participant, *you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone*

2/10

(334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

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- ○ I agree to voluntarily participate in the study.
- ○ I do not agree to participate in the study.

Block 3

Please provide your email address.

Block 3

You have a maximum of 90 minutes to complete the assessment.

Please make sure that your answers are from your own knowledge to ensure we gather relevant research data. Please do not use sources such as Internet searches, textbooks, notes, etc. to help you answer the questions. Thank you.

Freedman and Bernstein (1998) Musculoskeletal Assessment

These page timer metrics will not be displayed to the recipient.

First Click: *0 seconds*

Last Click: *0 seconds*

Page Submit: *0 seconds*

Click Count: *0 clicks*

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3/10

APPENDIX C

COMPLETE QUALITRICS SURVEY CONTINUED

What common problem must all newborns be examined for?

What is a compartment syndrome?

Acute septic arthritis of the knee may be differentiated from inflammatory arthritis by which laboratory test?

A patient dislocates his knee in a car accident. What structure(s) is/are at risk for injury and therefore must be evaluated?

A patient punches his companion in the face and sustains a fracture of the 5th metacarpal and a 3 mm break in the skin over the fracture. What is the correct treatment and why?

4/10

APPENDIX C

COMPLETE QUALITRICS SURVEY CONTINUED

A patient comes to the office complaining of low back pain that wakes him up from sleep. What two diagnoses are you concerned about?

How is compartment syndrome treated?

A patient lands on his hand and is tender to palpation in the "snuff box" (the space between the thumb extensor and abductor tendons). Initial radiographs do not show a fracture. What diagnosis must be considered?

A 25-year-old male is involved in a motor-vehicle accident. His left limb is in a position of flexion at the knee and hip with internal rotation and adduction at the hip. What is the most likely diagnosis?

5/10

APPENDIX C

COMPLETE QUALITRICS SURVEY CONTINUED

What nerve is compressed in carpal tunnel syndrome?

A patient has a disc herniation pressing of the 5th lumbar nerve root. How is motor function of the 5th lumbar nerve tested?

How is motor function of the median nerve tested in the hand?

A 12-year-old boy severely twists his ankle. Radiographs show only soft tissue swelling. He is tender at the distal aspect of the fibula. What are 2 possible diagnoses?

6/10

APPENDIX C

COMPLETE QUALITRICS SURVEY CONTINUED

A patient presents with new onset low back pain. Under what conditions are plain radiographs indicated? Please name 5. (Example: history of trauma).

A patient has a displaced fracture near the fibular neck. What structure is at risk for injury?

A 20-year-old injured his knee while playing football. You see him on the same day, and he has a knee effusion. An aspiration shows frank blood. What are the three most common diagnoses?

What are the five most common sources of cancer metastatic to bone?

7/10

APPENDIX C

COMPLETE QUALITRICS SURVEY CONTINUED

Name two differences between rheumatoid arthritis and osteoarthritis.

Which malignancy may be present in bone yet typically is not detected with a bone scan?

What is the function of the normal anterior cruciate ligament of the knee?

What is the difference between osteoporosis and osteomalacia?

8/10

APPENDIX C

COMPLETE QUALITRICS SURVEY CONTINUED

In elderly patients, displaced fractures of the femoral neck are typically treated with joint replacement, whereas fractures near the trochanter are treated with plates and screws. Why?

What muscle(s) is/are involved in lateral epicondylitis (tennis elbow)?

Rupture of the biceps at the elbow results in weakness of both elbow flexion and _____?

What muscle(s) control(s) external rotation of the humerus with the arm at the side?

Block 4

Please provide your email to confirm completion of this assessment.

9/10

APPENDEX D

Sample ABPTS Performance Score Sheet

American Board of Physical Therapy Specialties

2018 SPECIALIST CERTIFICATION EXAMINATION IN ORTHOPAEDIC PHYSICAL THERAPY – FORM 1

Performance Report

Name: [redacted]
ID #:

This report shows your performance on this examination. Information to assist you in interpreting your scores is provided in the accompanying Performance Interpretation Guidelines document.

Pass/Fail Decision*	**PASS**
Minimum Passing Scale Score	**500**
Your Scale Score	**580**
Your Percent Correct Score	**72.3**

	Percent Correct Score		
	Your Score	**Total Group Mean**	**Total Group SD**
Content Area			
Human Anatomy & Physiology	81	76	14
Movement Science	67	64	13
Pathology/Pathophysiology/Pain Science	67	69	11
Medical/Surgical Interventions	79	75	12
Orthopaedic Physical Therapy & Practice	--	--	--
Critical Inquiry for Evidence-based Practice; Other Professional Roles/Responsibilities/Values	--	--	--
Examination/Evaluation/Diagnosis	66	70	10
Prognosis/Intervention/Outcomes	76	69	9
Body Region			
Head/Maxillofacial/Craniomandibular	--	--	--
Cervical Spine	76	75	10
Thoracic Spine/Ribs	--	--	--
Lumbar Spine	75	69	11
Pelvic Girdle/Sacroiliac/Coccyx/Abdomen	--	--	--
Shoulder/Shoulder Girdle	81	73	12
Arm/Elbow/Wrist/Hand	75	67	12
Hip	47	75	13
Thigh/Knee	80	71	12
Leg/Ankle/Foot	50	62	12

** A Pass/Fail Decision of "PASS" (score of 500 or higher) indicates that you have passed the exam and are considered to be Board certified by the American Board of Physical Therapy Specialties effective immediately.*