

A CORRELATIONAL STUDY OF PREADMISSION AND EARLY PROGRAM
PREDICTORS OF PHYSICIAN ASSISTANT CERTIFICATION EXAM SCORES

by

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Liberty University

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Of the Requirements for the Degree
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ABSTRACT

As the physician assistant profession continues to grow, the number of physician assistant programs and the number of applicants to these programs are increasing dramatically. Programs should be diligent to choose students who are likely to be successful in the program and on passing the Physician Assistant National Certification Exam. In addition to selection processes that consider preadmission criteria, programs should also have processes in place to identify students at risk of failure to allow time to implement remediation plans. This study employed a correlational research design, attempting to demonstrate a predictive relationship between the predictor variables, undergraduate science GPA, which included anatomy, physiology, and microbiology, Graduate Record Exam scores, and physician assistant program science GPA, which included anatomy, physiology, and pharmacology, and the criterion variable, Physician Assistant National Certification Exam scores. Participants for this study included 109 graduates from the physician assistant programs at Mountain View University and Cedar Grove University (pseudonyms were used), both in West Virginia. Data was collected from the participants' undergraduate transcripts, application to the program, and a report from the National Commission on Certification of Physician Assistant that included exam scores. Descriptive statistics for the criterion and predictor variables were reported. A multiple regression was utilized to analyze the data and showed a predictive relationship between the predictor variable, graduate GPA, and exam scores, but failed to show a predictive relationship with the other predictor variables and exam scores. Further studies could be undertaken to include more participants from different physician assistant schools across the country, include noncognitive factors, or evaluate application-based curriculum as a predictor of exam success.

Keywords: physician assistant, PANCE, certification, undergraduate GPA, GRE

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List of Abbreviations

Accreditation Council for Graduate Medical Education (ACGME)

Accreditation Review Commission for Physician Assistants (ARC-PA)

American Academy of Physician Assistants (AAPA)

American Board of Surgery (ABS)

Association of American Medical Colleges (AAMC)

California Critical Thinking Skills Test (CCTST)

Central Application Service for Physician Assistants (CASPA)

Committee on Admissions (COA)

Counselor Preparation Comprehensive Exam (CPCE)

Graduate Record Exam (GRE)

Medical College Admissions Test (MCAT)

Multiple Mini Interviews (MMI)

National board of Medical Examiners (NBME)

National Commission on Certification of Physician Assistants (NCCPA)

North American Pharmacist Licensure Examination (NAPLEX)

Objective Structured Clinical Examination (OSCE)

Pharmacy College Admission Test (PCAT)

Physician Assistant (PA)

Physician Assistant Clinical Knowledge Rating and Assessment Tool (PACKRAT)

Physician Assistant Education Association (PAEA)

Physician Assistant National Certification Exam (PANCE)

United States Medical Licensing Examinations (USMLE)

CHAPTER ONE: INTRODUCTION

Overview

Successfully completing a physician assistant (PA) program is not the only prerequisite to practice medicine. Graduates of an accredited PA program must also pass the Physician Assistant National Certification Exam (PANCE). Failure to pass the PANCE results in a lack of earning potential in the field and often comes with a significant financial and emotional burden on the graduate. Not only does failure of the PANCE have implications for students, but a low pass rate on the PANCE has a negative impact on a PA program's accreditation status and admissions practices. Therefore, selecting students who have a high likelihood of completing the program and passing the PANCE is crucial for both students and PA programs.

Background

A physician assistant (PA) is a medical provider who works as part of the healthcare team in collaboration with physicians and other healthcare providers. PAs take patient histories, perform physical exams, order and interpret diagnostic tests, manage acute and chronic diseases, and can write prescriptions. All medical specialties and every setting, including clinics, hospitals, long-term care facilities, urgent care centers and emergency departments, and other treatment facilities utilize PAs as part of their multidisciplinary healthcare teams (AAPA, 2017).

Adequate healthcare for all people in the United States is a monumental goal, one that many agencies and governmental authorities have worked, and continue to work, toward. Physician assistants are an integral part of the solution, and as the need for providers has increased, so has the rate of growth of the PA profession. To help meet the needs of the aging population and increase access to care for underserved populations, employment of PAs has a projected growth of 37% from 2016-2026 (Bureau of Labor Statistics, 2018). With that growth

has come an increased number of applicants to PA programs across the country, making applicant selection a more laborious process. Selecting students who will be successful in the program is essential because failure comes with a high cost. Similar to other graduate health science programs, PA school tuition is expensive. The average tuition for private PA schools is \$83,349 for the entire program. For public schools, the average in-state tuition is \$43,550 and out-of-state tuition is \$78,214 (PAEA, 2017). In 2015, the anticipated student loan debt for 67% of PA students was between \$50,000 and \$150,000, with almost four percent of students owing more than \$175,000 (PAEA, 2016).

The priority of every PA program should be to use research evidence to evaluate and revise their admissions criteria to ensure selection of students who are most likely to be successful in the program and on passing the PANCE. There are, however, some gaps and inconsistencies in the literature pertaining to the best predictors of success. Selection criteria used by PA programs is variable, but often include type of bachelor's degree, undergraduate grade point average (GPA), undergraduate science GPA, Graduate Record Exam (GRE) scores, number of hours and types of health care experience, type of institution where prerequisites were completed, an interview score, references, and an essay completion.

The training for PAs is designed using the medical model, with prerequisites for entry into PA school similar to that of medical school. Undergraduate courses such as anatomy, physiology, microbiology, biology, and chemistry are often part of the requirements for application. PA programs often require, or at least strongly recommend, hands-on healthcare experience and shadowing of medical providers, to include PAs. Some programs set a minimum number of hours of experience and shadowing as an application requirement, while others use experience as part of the application score. The average length of PA school is 27 months, and

incorporates instruction in basic sciences, including anatomy, physiology, pathophysiology, microbiology, and pharmacology, clinical medicine, and behavioral sciences. Didactic courses are followed by a year or more of clinical experiences in areas such as family medicine, internal medicine, obstetrics and gynecology, pediatrics, emergency medicine, psychiatry, and surgery. Most PA schools currently award a master's degree upon completion, and by the year 2021, all PA programs will be required to offer a master's degree (AAPA, 2017; ARC-PA, 2018d).

The Accreditation Review Commission for Physician Assistants (ARC-PA) is the accrediting body for PA programs. There are currently 236 accredited PA programs, with 51 developing programs waiting to enter the provisional accreditation pathway (ARC-PA, 2018b, c). Because of the growth of the PA profession and an increased number of programs, applications to the Central Application Service for Physician Assistants (CASPA) have significantly increased. Ninety-five percent of accredited programs utilize CASPA for their application process. The number of unique applications submitted to CASPA increased by 22% between the 2011-2012 and the 2014-2015 application cycle. This averages to be an increase of 1,366 applications per year (Forister & Stilp, 2017). As more seats for PA programs become available, it will become increasingly challenging to fill the seats with students who will successfully complete the program and pass the PANCE. Accepting students who are not successful in the program, or on passing the PANCE, results in a high economic and emotional burden on both the student and the program (Higgins et al., 2010). Therefore, it is imperative that programs carefully consider their application process, and once students have been accepted into the program, faculty should identify students at risk for failure and develop a means for remediation as early as possible (Andreeff, 2014).

After graduating from an accredited program, graduates must pass the PANCE to be licensed to practice medicine as a PA. The purpose of the PANCE is to measure medical knowledge and cognitive skills of PA graduates to ensure they meet established standards to practice medicine. Questions to assess knowledge of professionalism will be included on the PANCE beginning in 2019 (NCCPA, 2018). Other PA competencies necessary for the PA profession include interpersonal and communication skills, patient care, practice-based learning and improvement, and systems-based practice. These competencies are not assessed on the PANCE but should have been assessed by the PA program's summative examination prior to graduation (NCCPA, 2012). The competencies of practice-based learning and improvement and systems-based practice are addressed in various ways by each program.

Not only does passing the PANCE have implications for each individual graduate, but also PANCE passage rates affect a program's accreditation status and recruitment success (Butina, Wyant, Remer, & Cardom, 2017). Programs are required to post on their website, first-time PANCE passage rates for the five most recent graduating classes, and submit an analysis of PANCE performance to the ARC-PA if the first-time pass rate for a given cohort is 85% or less. Prospective students often cite PANCE passage rates as one of their criteria when deciding on which PA schools to apply. Programs and students share the burden of success on the PANCE. Of all the challenges in PA education, identifying students at risk for failure of the PANCE and finding ways to remediate them, is one of the most formidable tasks faced by faculty (Massey, Lee, Young & Holmerud, 2013).

For successful completion of a graduate program, students must build a strong foundation of knowledge, beginning in the early days of education and continuing through undergraduate school, graduate school, and culminating when taking their national certification exam. Learning

theories applicable to graduate students are related to prior learning experiences and how adult learners learn compared to younger learners. To ensure that learners are successful, whether it be child or adult learners, teachers should consider learning theories, rather than holding to strict tradition and history, when developing curricular plans and pedagogical strategies (Hodges & Kuper, 2012). Programs must also ensure all components of the curriculum are designed to help students meet defined learning outcomes (Frank et al., 2010). Once a curriculum plan is determined, specific pedagogical strategies can be improved by relying on research evidence to guide practice.

Vygotsky, a social constructivist, described the concept of building upon prior learning, or scaffolding. This theory holds that learning is most efficient when new information is built upon what the learner already knows. Vygotsky described the zone of proximal development (ZPD), which describes how learners are more likely to be successful when new learning can relate to prior knowledge and when new concepts are put into the context of what is already understood (Taylor & Hamdy, 2013). Thus, educators should make an effort to relate topics with concepts that most students should have been presented with during their undergraduate education, specifically during prerequisite courses. Additionally, given that graduate students often come from varied backgrounds with different experiences, educators must give students the resources and learning environment necessary for success.

Malcolm Knowles's presented the term "andragogy," which differentiates adult learners from children. His adult learning theory, often criticized as not being a real theory, uses prior learning experiences as an assumption in describing how adult learners differ from children (Hagen & Park, 2016). Motivation, readiness to learn, and orientation to learning are also thought to separate adult learners from younger students (Knowles, Holton III, & Swanson,

2005; Lewis & Thompson, 2017; Taylor & Hamdy, 2013). Critics often argue that adult learners are not necessarily different than children, but rather the environment is more responsible for the noted differences in learning (Hodges & Kuper, 2012).

Research in the field of neuroscience has demonstrated that learning can change the brain and improve recall and retention. This is particularly beneficial when students are presented with new information that can be connected to prior learning experiences (Hagen & Park, 2016). Therefore, students with a strong background in science can be expected to perform better in graduate school because they are able to make connections with material learned in undergraduate coursework.

Problem Statement

PA programs have grown significantly over the past several years and applications to PA programs are higher than ever. Programs have an enormous responsibility in selecting students for their program who will fulfill their mission, as well as who are likely to be successful. Success can be defined as graduating on time and passing the PANCE, particularly on the first attempt. To practice medicine as a PA, one must first graduate from an accredited program. Upon graduation, graduates are eligible to take the PANCE, which must be passed to earn certification to practice medicine. Failing to pass the PANCE places significant financial and emotional burdens on graduates, and has accreditation and admissions consequences for PA programs.

Predicting indicators of success on the PANCE can help programs select students who will most likely be successful on their first attempt at the PANCE and identify students who are at risk and may benefit from remediation. Research has identified some predictors of success on the PANCE once a student has matriculated into a PA program. Overall GPA in the didactic

phase of a PA program and grades in PA program pharmacology and anatomy were predictive of scores on the PANCE (Brown, Imel, Nelson, Hale, and Jansen, 2013; Butina et al., 2017).

Additionally, performance on end of rotation (EOR) exams and on the Physician Assistant Clinical Knowledge Rating and Assessment Tool (PACKRAT) were positively correlated with PANCE scores (Ennulat, Garrubba, & DeLong, 2011; Hegmann, Roscoe, & Statler, 2015; Higgins et al., 2010; Massey et al., 2013; Massey et al., 2015).

Pre-admission criteria have been evaluated as predictors of PANCE scores, but with less convincing results. Conflicting research exists for the predictability of undergraduate GPA, undergraduate science GPA, and quantitative and qualitative GRE scores (Brown et al., 2013; Butina et al., 2017; Higgins et al., 2010). Only one study evaluated individual course grades for chemistry I, biochemistry, and pathophysiology as predictors of success on the PANCE (Andreef, 2014). The prerequisite course requirements vary among PA programs across the country, with some requiring biochemistry and organic chemistry courses, while others do not. All programs require at least some science courses. Determining if undergraduate science GPA can predict PANCE scores would help programs determine if setting a minimum undergraduate science GPA is advisable based upon evidence. Some programs require the GRE, while many do not. For those programs requiring it, the minimum accepted score is variable. Determining if GRE scores correlate with PANCE scores is also valuable in helping programs determine whether to require applicants take the GRE, and can guide programs in setting a minimum acceptable score.

Once matriculated in the program, faculty must identify deficiencies early through monitoring performance in all courses, particularly science courses. In fact, the accreditation standards mandate that programs “must monitor and document the progress of each student in a

manner that promptly identifies deficiencies in knowledge or skills and establishes means for remediation” (ARC-PA, 2018a, p. 22). Especially in the first semester of PA school, as students are adjusting to graduate school, implementing remediation plans and incorporating faculty mentoring has the potential to show long-term benefits for students.

Identifying pre-admission criteria that best predict success on the PANCE will help inform PA program admissions requirements and selection decisions. This will allow programs to set minimum GPA and GRE requirements that are evidence-based, not merely derived from anecdotal information or tradition. Additionally, determining program performance criteria that best predicts PANCE passage will help direct programs in their remediation plans, allowing minimum scores requiring remediation to be established based upon research. The problem is that pre-admission and early program predictors of success on the PANCE, specifically undergraduate science GPA, scores on the GRE, and GPA in science courses in the first year of a PA, are not well-supported by research.

Purpose Statement

The purpose of this correlational study is to determine if grade point average (GPA) in undergraduate science courses, Graduate Record Exam (GRE) scores, and GPA in graduate science courses during the first year of Physician Assistant (PA) school are predictive of scores on the Physician Assistant National Certification Exam (PANCE). Participants will include PA graduates from two universities in West Virginia, Mountain View University and Cedar Grove University (pseudonyms), from 2014-2018. Participants must have completed four hours of anatomy, four hours of physiology, and four hours of microbiology, and must also have taken the GRE. The independent variables are GPA in undergraduate science courses, scores on the GRE,

and GPA in graduate science courses during the first year of PA school. The dependent variable is scores on the PANCE.

Significance of the Study

To protect the public from providers who are not adequately prepared for clinical practice, the NCCPA requires passage of a high-stakes written examination, the Physician Assistant National Certification Exam (PANCE), graduates must pass prior to becoming certified to practice medicine (NCCPA, 2017). Once a PA is nationally certified, they are eligible to seek state licensure, which must be obtained in the state they intend to practice. To help meet the shortage of medical providers and to avoid financial and emotional hardships, it is important for graduating students to pass the PANCE, particularly on the first attempt, and be able to enter clinical practice.

When students are accepted into a graduate medical program and successfully progress through the program, passing the PANCE is an expectation. Programs are often judged by the accrediting body, prospective students, and other stakeholders, on their first-time PANCE pass rate. Once students have matriculated into a program, identifying deficiencies and developing a remediation plan is necessary. However, no research evidence has shown a specific pedagogical intervention that predicts passage on the PANCE (Mirly, Rodriguez, & Coombs, 2017).

Choosing students for entry into PA school who are most likely to be successful at program completion and on the PANCE is critical. Students who have a good knowledge base through undergraduate coursework should excel in graduate school. The purpose of prerequisite courses is to allow learners to develop a good foundation to build upon in future experiences (Hagen & Park, 2016). Determining if undergraduate science courses are successful in laying the foundation for graduate science courses is an important consideration in predicting success.

Performance on the GRE may be an indicator of foundational knowledge, as well as a predictor of performance on standardized exams.

Since prerequisite courses vary among programs, research on specific undergraduate courses as predictors of success can help programs determine which prerequisite requirements should be implemented or which courses are most predictive of success. Andreef (2014) found that higher grades in biochemistry and pathophysiology were more predictive of success on the PANCE, but not chemistry I. The significance of this current study will be its potential in determining pre-admission and early program predictors of success on the PANCE, specifically GPA in undergraduate science courses, scores on the GRE, and GPA in graduate science courses in the first year of a PA program. Since PAs are nationally certified, this information can help inform the admissions criteria, selection process, and remediation practices of PA programs across the country.

Research Question

The research questions for this study were:

RQ1: Is there a predictive relationship between the criterion variable, Physician Assistant National Certification Exam and the predictor variable of grade point average in undergraduate science courses?

RQ2: Is there a predictive relationship between the criterion variable, Physician Assistant National Certification Exam and scores on the Graduate Record Exam.

RQ3: Is there a predictive relationship between the criterion variable, Physician Assistant National Certification Exam and grade point average in graduate science courses in the first year of a physician assistant program for students who have graduated from a physician assistant program?

Definitions

1. *Accreditation Review Commission on Education for the Physician Assistant (ARC-PA)* – The ARC-PA is the only accrediting body for the physician assistant profession. The purpose of the ARC-PA is to protect the interests of the public by defining the standards for PA education and evaluating PA programs to ensure programs are compliant with the accreditation standards (ARC-PA, 2018a).
2. *American Academy of Physician Assistants (AAPA)* – The AAPA is the national organization for the PAs and serves to advocate for the profession, educate the public about PAs, and support the profession to provide quality and cost-effective patient care (AAPA, 2017).
3. *Central Application Service for Physician Assistants (CASPA)* – CASPA is a web-based application system that allows students to apply to multiple PA programs with a single application (PAEA, 2017)
4. *Graduate Record Exam (GRE)* – The GRE is a standardized exam used for graduate-level admissions. The exam has three question types – verbal reasoning, quantitative reasoning, and analytical writing (ETS GRE, 2018).
5. *National Commission on Certification of Physician Assistant (NCCPA)* – The NCCPA is the only certification organization for the PA profession. The purpose of the NCCPA is to ensure that PAs have met established standards of clinical knowledge and cognitive skills prior to beginning clinical practice and periodically throughout their careers (NCCPA, 2017).
6. *Physician Assistant (PA)* – A PA is a medical professional, licensed by their state and nationally certified, to practice medicine as part of a healthcare team with physicians and

other healthcare professionals. PAs have prescriptive authority in all states and U.S. territories and practice in every specialty and subspecialty, and in every healthcare setting (AAPA, 2017).

7. *Physician Assistant Clinical Knowledge Rating and Assessment Toll (PACKRAT)* – The PACKRAT is a peer-reviewed, multiple-choice examination that is created using the same content blueprint as the Physician Assistant National Certification Exam (PANCE). Its purpose is for student self-assessment and program evaluation (PAEA, 2017).
8. *Physician Assistant Education Association (PAEA)* – The PAEA is the only national organization that represents PA programs. The purpose of the PAEA is to provide educational services and information that helps to meet the needs of PA programs and faculty (PAEA, 2017).

Summary

Passing the PANCE is a requirement for graduates of a PA program to obtain certification to practice medicine. Not only does passing the PANCE have consequences for individuals, but PANCE pass rates have implications for a PA program's accreditation status and admissions process. Therefore, choosing students who have a high likelihood of successfully completing the program and passing the PANCE on the first attempt is crucial for a PA program's admissions committee. Although the ARC-PA has specific standards that programs must adhere to, admission requirements are left to each program's discretion. There is both a lack of, and conflicting research on, which pre-admission and which early program criteria are best predictors of success on the PANCE. Most programs have a minimum overall undergraduate GPA requirement, but fewer programs have a minimum undergraduate science GPA requirement. Not all programs require the GRE, and for those that do, not all have a minimum acceptable score.

To assist programs in determining if GPA in undergraduate science courses, GRE scores, and GPA in graduate science courses during the first year of PA school can help predict success on the PANCE, this study used a correlational study design to evaluate GPAs and GRE scores, correlated with PANCE scores. With growth in the PA profession and an increased number of applicants to PA programs, choosing students who will ultimately be able to help meet the shortage of medical providers is vital.

This chapter discussed the role and training of PAs, as well as the need for, and projected growth of, the PA profession. The significance of the PANCE for graduates, as well as for PA programs, was explained and sets the foundation. Determining factors that predict success on the PANCE, whether they be preadmission or post-matriculation factors, is necessary for a program's success as admission criteria and remediation requirements should be based on research and modified to help ensure the highest likelihood of graduate success. In Chapter Two, the theoretical framework will be presented, as well as research on undergraduate coursework, preadmission exams, noncognitive factors, graduate coursework, supervised clinical practice experiences, clinical year exams, and other factors that may help predict PANCE success.

CHAPTER TWO: LITERATURE REVIEW

Overview

Physician assistant programs are tasked with educating competent medical providers who have acquired sufficient medical knowledge to safely care for patients, possess good interpersonal and communication skills, demonstrate the ability to provide effective patient care, exhibit professionalism, express commitment to practice-based learning and improvement, and have attained adequate knowledge of systems-based practice (NCCPA, 2017). To demonstrate a level of medical knowledge and professional practice knowledge deemed indicative of readiness for clinical practice, graduates of an accredited PA program must pass the Physician Assistant National Certification Exam (PANCE). The other competencies should be assessed by individual programs as part of the summative examination. Therefore, PA education has two overarching goals: graduating students who are successful on the PANCE, and producing graduates who are competent and well-rounded clinicians, possessing the competencies necessary for clinical practice. This paper will focus on factors predicting sufficient medical and professional knowledge in relation to successful completion of the PANCE.

The Accreditation Review Commission on Education for the Physician Assistant (ARC-PA) has many standards that accredited programs must adhere to, including administrative, curricular, and assessment requirements. The ARC-PA has some standards that dictate specific curricular components, such as a requirement to include instruction in anatomy, physiology, pathophysiology, pharmacology and pharmacotherapeutics, and the genetic and molecular mechanisms of health and disease (ARC-PA, 2018a). There are no specific requirements, however, on course design or delivery, number of hours of instruction, or curricular sequencing.

There are many other accreditation standards that lack specificity, leaving programs the freedom to tailor the program to meet their specific needs and align with their mission, vision, and goals.

Frequent, formative assessments are an important component of the training for PAs. The ARC-PA mandates that each program frequently assess learning outcomes in both the didactic and clinical phase of the program and establish a means for identification and remediation of deficiencies (ARC-PA, 2018a). Each program must define their assessment and remediation policies and demonstrate participation in continuous program assessment of outcomes.

Additionally, the ARC-PA mandates a summative examination be administered within the final four months of a program. This assessment should assess a student's medical knowledge, interpersonal skills, patient care skills, and professionalism, and should serve to verify that a student is ready to enter clinical practice. While a written examination is an important way to assess medical knowledge, the summative examination must utilize additional assessment tools to assess the other competencies, such as skills assessments and objective structured clinical examinations (OSCE) to assess patient care skills, interpersonal skills, and professionalism (ARC-PA, 2018a). Students must be able to demonstrate proficiency in each of the competencies, rather than allowing outstanding performance in one area to compensate for poor performance in another (Frank et al., 2010).

Once a student passes the summative examination and meets all other graduation requirements, the graduate is eligible to take the PANCE. Passing the PANCE has significant implications for graduates who cannot become licensed without obtaining certification that is granted upon achieving a passing score on the PANCE. Significant debt is incurred, or money spent, on tuition and fees during PA school. In addition, time spent in class and studying is substantial, and the emotional strain of not being able to fulfill the goal of practicing medicine

can be tremendous. The implications associated with a program's first-time PANCE pass rate are also far-reaching and affect a program's ability to recruit high quality students and can lead to repercussions with accreditation status.

Admissions committees strive to choose applicants who are most likely to be successful in the program and pass the PANCE on the first attempt, but can also demonstrate critical thinking, teamwork, professionalism, and leadership skills. Since the average length of a PA program is 27 months, learning these skills without a minimal competency upon matriculation would be difficult in such a short time (AAPA, 2017). Therefore, programs most often assess noncognitive skills by use of an interview, which are conducted in various ways. Some programs use one-on-one interviews, while others utilize a panel of interviewers with a single applicant, group interviews, the multiple-mini interview, or a combination of formats (Brenneman et al., 2018).

Strong noncognitive skills are certainly important for students to demonstrate, but to be successful on high stakes assessments, candidates must possess a certain level of cognitive ability (Brenneman et al., 2018). PA programs must have a well-designed curriculum and should adhere to evidence-based educational practices, but this does not ensure all students will be successful in the program or on passing the PANCE. Programs must consider predictors of success on the PANCE to help inform admission practices and guide remediation policies. Some predictors of success have been well established, while research is lacking, or inconclusive, in some areas. This chapter presents a theoretical framework and research on predictors of success on the PANCE, specifically, preadmission predictors, program coursework predictors, formative and summative exam predictors, and supervised clinical practice experience predictors. The gaps in research will be identified, which will demonstrate the need for this research.

Theoretical Framework

Malcolm Knowles first introduced the term andragogy, a term that describes a difference in how adult students learn compared to children (Knowles et al., 2005). His adult learning theory has been criticized, however, being referred to as a list of assumptions rather than an actual theory. Critics question why the theory cannot also be applied to children, stating that the assumptions are more related to the individual's environment rather than a difference in learning (Hodges and Kuper, 2012). There is also a concern that the theory lacks a substantial research base. Despite the drawbacks, some experts believe the principles presented in the adult learning theory can be used to inform PA education practices (Hagen & Park, 2015; Taylor & Hamdy, 2013).

Whether thought of as a theory, a list of assumptions, or a technique, the principles associated with Knowles's thoughts on adult learning can suggest an adult student's motivation to learn. Initially, Knowles et al. (2005) described four principles of adult learning: concept of self-directedness, prior experiences in the learning process, learning readiness for relevant information, and a desire for the immediate application of learning. His later work expanded the list of assumptions to six, which included the addition of an adult learner's need to know why, what, and how learning is occurring, and internal motivation (Knowles et al., 2005; Hagen & Park, 2016; Taylor & Hamdy, 2013). Of these assumptions, the role of a student's prior learning experiences is to provide a foundation that will help ensure success based upon the scaffolding that occurs with related learning experiences. When student learning occurs, the information is stored in long-term memory. When related learning occurs later, students are able to retrieve concepts and build upon the previous framework (Hagen & Park, 2016).

As a social constructivist, Vygotsky postulated that learning is a process of constructing knowledge based upon what the student has already learned (Taylor & Hamdy, 2013). The zone of proximal development (ZPD) assumes that learners acquire new knowledge when the new information can be linked to previous knowledge. New information is compared with what is already known and allows the learner to reflect upon the difference between what is known and unknown and to make sense of new information. The ZPD can be extended when teachers can put new concepts into context with that of a student's prior learning experiences (Taylor & Hamdy, 2013). Using this strategy, students will have a higher likelihood of assimilating prior knowledge with new learning. Competency-based education, which PA programs have moved toward, is designed using a constructivist approach, in which learning objectives and skills throughout the program build upon prior learning activities and experiences (Frank et al., 2010).

Research by Hagen and Park (2016) connected the first four of Knowles's adult learning assumptions to the theory of neuroscience. The assumption that prior learning should be the basis for future educational experiences is relevant to the considerations of predictors of success in a PA program and on the PANCE. Scaffolding, or building upon, new knowledge improves learning and retention of material. Research in cognitive neuroscience has shown that utilizing prior experiences in the learning process is complex and requires high level cognition. When students learn something new, the brain creates a schema that can be retrieved when new, but related concepts are introduced. When information is stored in the brain as a schema, later learning becomes stored more readily and quicker (Hagen & Park, 2016). This is important in PA school as students are presented with a vast amount of content in a relatively short amount of time. The more concepts that students can retrieve, and build upon, from previous learning experiences, the more efficient the learning process will be.

The purpose of prerequisite courses is to prepare students for graduate work. Most PA programs require undergraduate courses such as anatomy and physiology. Once students matriculate into a PA program, these courses are required at the graduate level, with the undergraduate courses having built a foundation of knowledge. Courses such as chemistry and biology are also often required as prerequisites. While these courses are not part of the graduate curriculum, the undergraduate courses serve as building blocks that will be expanded upon during the curriculum in PA school. Having these prior learning experiences allow the brain to change to facilitate improved retention and recall. According to the theory of neuroscience, brain cells can be modified based upon use; they become more developed as knowledge and skills are applied. New neural connections are generated in the hippocampus of the brain, making future learning even more effective (Hagen & Park, 2016).

While some PA programs require biochemistry and organic chemistry as prerequisites, most PA programs do not include specific courses in biochemistry and organic chemistry as part of their curriculum. PA coursework, nonetheless, includes concepts that require high level cognitive skills. The learning that occurs in undergraduate science courses, whether it be anatomy, physiology, organic or inorganic chemistry, or even biology, serve as a foundation that can aid in understanding complex pathophysiological, genetic, pharmacological, and immunological principles taught in PA school. Studying the challenging content in undergraduate science courses not only builds a foundation for later learning, but modifies the brain to function at a higher level of learning (Hagen & Park, 2016).

Scaffolding is not only important when progressing from undergraduate to graduate school, but the curriculum in PA programs is designed so that concepts are built upon throughout both the didactic and clinical curriculum. First semester PA science courses are built upon during

clinical medicine modules. Clinical rotation experiences are specifically designed for students to learn to apply information learned in the didactic phase of the program to patient care and to gain a deeper understanding of disease processes. Learning in all phases of PA school should use scaffolding, and should prepare students to be competent medical providers, be prepared for life-long learning, and to pass the PANCE. As medicine is exceptionally complex and research uncovers new information daily, graduates must have a good foundation to be able to continue to learn and keep up to date with medical advances. This helps ensure patients are receiving the best care possible.

Related Literature

The PA profession began in 1965 at Duke University Medical Center, under the direction of Dr. Eugene Stead, Jr. The profession was developed because of a deficiency in the number of primary care physicians. The first PA students were Navy Corpsmen who had medical experience in the field, but no formal educational training. When these sailors returned from military service, they were unable to use their experiences in the workforce due to a lack of educational training. As a result, the PA profession was born, and PA students were most often nontraditional students with life and healthcare experiences. PA students are trained using the medical model, but with the length of PA school being shorter than medical school, PAs can enter the workforce quicker (AAPA, 2017).

Over the past 50 years, the demographics of PA students have shifted, with more students entering PA school soon after completing an undergraduate degree. In 2016, the mean age of matriculating PA students was 25.8 years (PAEA, 2017). Just 20 years prior, the 1996-1997 Annual Report on Physician Assistant Educational Programs reported the average age was 29.8 years for accepted applicants (Simon, Link, & Miko, 1997). Early in the PA profession, students

were awarded either a certificate, an associate's degree, or a bachelor's degree. Over time, the degree granted at completion of a PA program has changed. In 1980, less than twenty-one percent of PAs had four or more years of college (He, Cyran, & Salling, 2009). Currently, the majority of PA programs offer a master's degree, and by the year 2021, all PA programs will be at the graduate level (ARC-PA, 2018d).

As graduate-level education, PA programs require either a bachelor's degree or a certain number of undergraduate hours and prerequisite coursework prior to application and matriculation. To be competitive, applicants must demonstrate high academic performance in undergraduate coursework. In 2016, the average undergraduate GPA was 3.55 and the average undergraduate science GPA was 3.5. In addition to grades, many graduate programs, in all fields of study, require the GRE to ascertain preparedness for graduate school. The GRE is a written, standardized examination that assesses the areas of verbal reasoning, quantitative reasoning, and analytical writing skills (ETS GRE, 2018). The GRE is required by 51.2% of PA programs, with 7.2% of programs requiring either the Medical College Admission Test (MCAT) or the GRE. For those programs that require the GRE, the reported average verbal reasoning score was 154.8, the average quantitative reasoning score was 153.2, and the average analytical writing score was 4.0 (PAEA, 2017).

Programs want to select, and retain, the best applicants for their programs: those who will be successful in the program and on passing the PANCE on the first attempt, those who will provide exceptional patient care, and those who will fulfill the mission of the program and university. For a program to have the best applicant pool, and for students to ultimately choose to attend the PA program at their university, PA programs must possess certain characteristics that make their program desirable. Sierra, Forbes, Mirly, and Rodriguez (2018) evaluated factors

that lead to students choosing a PA program to attend. Compared to a study in 1998 that found the reputation of the institution to be the most influential factor in students choosing a PA program, their results found quality of faculty and staff, first-time PANCE pass rates, and the faculty and staff morale to be most influential.

The quality of faculty is an area that programs must diligently strive to improve. Faculty must not only teach content, but must help students develop crucial critical thinking skills, as well as develop the competencies necessary for clinical practice. Accreditation standards do not specify degree requirements or amount of clinical experience for faculty, but state that “All faculty must possess the educational and experiential qualifications to perform their assigned duties” (ARC-PA, 2018a, p. 9). PA educators often come to a career in PA education from clinical practice, with no formal educational training. The 2017 PAEA Faculty and Directors Report noted that 23.9% of faculty held a doctoral degree, with only 8.3% being a doctorate related to education (PAEA, 2017). As most PAs go through graduate school to practice medicine, and not necessarily to teach, recruiting faculty is a challenge for many programs. A lack of qualified candidates and lack of teaching experience is cited as the largest barrier to programs recruiting faculty (PAEA, 2017).

Since many PA educators come to their teaching position with little to no formal educational training, professional development activities are vitally important (Lewis & Thompson, 2017). The PAEA holds an annual educational forum which allows PA educators to attend educational sessions aimed at improving teaching and academic skills (PAEA, 2018). For programs to be able to exhibit high quality faculty and a sense of high morale, faculty development opportunities and efforts to maintain a positive environment and uplifted mood should be an important consideration and priority of the program and university. This will help

ensure faculty effectiveness in the classroom, which helps improve the chance of student success on the PANCE. High first-time PANCE passage rates is an essential characteristic that allows programs to be able to attract and secure the best students (Sierra et al., 2018).

The first certifying examination for PAs was administered in 1973 by the National Board of Medical Examiners (NBME). At that time, PAs were the only health profession, besides physicians, that required a certification exam. In 1974, the National Commission on Certification of PAs (NCCPA) was formed to oversee the certification and recertification of PAs. Those who pass the certification exam (PANCE) after graduation and the recertification exam (PANRE) after ten years, and fulfill continuing education requirements every two years, can use the designation of Physician Assistant – Certified. NCCPA is accredited by the National Commission for Certifying Agencies (NCAA) (NCCPA, 2017).

Undergraduate Coursework

Prerequisite course requirements for entry into PA school are similar across programs, but significant variability exists between some programs. While the Accreditation Review Commission on Education for the Physician Assistant (ARC-PA) mandates that all programs explicitly publish admission requirements, specific requirements for entry into PA programs are not dictated by the ARC-PA (ARC-PA, 2018a). Most programs require either a bachelor's degree or a certain number of undergraduate credit hours, and prerequisite science courses which often include, undergraduate anatomy, physiology, biology, microbiology, and inorganic chemistry I and II. Some programs require biochemistry and organic chemistry. Courses such as college algebra, statistics, and psychology are also often required as prerequisites.

Admissions decisions are at least partially based on a student's performance in undergraduate courses, with consideration often given to the overall undergraduate GPA

(uGPA), undergraduate science GPA, and prerequisite GPA. To apply to some programs, a minimum course grade in prerequisite courses or a minimum GPA is mandated. Members of admissions committees often consider grades, either using the GPA or specific course grades, to be predictive of future success in graduate coursework, as well as on certification exams. However, while some research data show GPAs to be predictive of success on certification exams, other research is conflicting. There is no preponderance of evidence suggesting that uGPA, undergraduate science GPA, or prerequisite GPA is predictive of success on the PANCE or is a better predictor than the others.

Undergraduate GPA. Undergraduate GPA (uGPA) has been found by some studies to predict success on standardized professional exams, while others have found little to no correlation between uGPA and standardized exam scores. According to Alston, Lane, and Wright (2014), who studied uGPA as a predictor of success in a pharmacy program, concluded there to be no compelling evidence that uGPA can predict success in a post-graduate program. Krupat, Pelletier, and Dienstag (2017) evaluated the outcomes of scores on the United States Medical Licensing Examinations (USMLE) Step I, scores on the USMLE Step 2 clinical knowledge (CK), scores on a comprehensive exam required for graduation that consisted of an objective structured clinical exam (OSCE), and grades on core clinical clerkships. They sought to determine if academic scores in first-year medical school courses predicted success on the defined outcomes compared with undergraduate GPA. The uGPA was found to account for variance on Step 2 CK scores, but not on any of the other evaluations.

A few studies have been conducted on uGPA and PANCE scores. Higgins et al. (2010) used data from six PA programs from 2003 to 2006. Results found uGPA to be statistically significant in predicting successful completion of a PA program and passing the PANCE on the

first attempt. Andreeff (2014), using student data from one PA program from 2006-2010, found uGPA to account for only a small amount of variance in PANCE success, making it less predictive than grades in the core science courses, specifically pathophysiology and biochemistry. However, after controlling for age and gender, uGPA was found to predict a 50.48 increase in scores on the PANCE for every unit the admission GPA was increased.

For most studies finding a correlation or predictive relationship between uGPA and PANCE scores, the majority either had a small sample size, were conducted at only one PA school, or both. For instance, one study using a sample size of 469 students from one PA program from 2003 to 2014 found uGPA to influence PANCE scores (Butina et al., 2017). Similarly, a small study of 47 participants from one PA program, showed uGPA to have a moderate positive correlation with PANCE scores (Ennulat et al., 2011). Not all studies, however, found a positive correlation between uGPA and PANCE scores. Brown et al. (2013), using data from three graduating classes from one PA program, failed to find a correlation between PANCE scores or pass/fail on the PANCE and uGPA.

Prerequisite GPA. Prerequisite courses often include both science and non-science courses, and requirements vary between programs. Prerequisite GPA has shown inconsistent results as a predictor of PANCE scores, with some studies showing a positive correlation while others finding no correlation. Higgins et al. (2010) found prerequisite GPA to be nonsignificant in predicting success. Since this study used data from six different PA schools, with varying prerequisite requirements, the variation in prerequisites by each institution may have affected the results in this study, but was not considered. Prerequisite GPA was also shown to have no effect on influencing PANCE scores in the study by Butina et al. (2017). In contrast, although a small

study, Ennulat et al. (2011) found a stronger positive correlation between prerequisite GPA and PANCE scores than was found with uGPA.

Other health professions also evaluate preadmission factors, including the prerequisite GPA, as predictors of success on various certification exams. McCall, MacLaughlin, Faike, and Ruiz (2007) conducted a study of preadmission variables as predictors of success on the North American Pharmacist Licensure Examination (NAPLEX), which all pharmacy graduates are required to take for licensure. Prerequisite GPA showed a positive correlation with performance on the NAPLEX.

Undergraduate science grades and GPA. Among PA programs, there is variation in the prerequisite requirements for science courses, particularly biochemistry, organic chemistry I and II, and pathophysiology. Few studies have examined specific undergraduate science course grades and their predictive value on certification exams. In a retrospective cohort study by Andreeff (2014), using student data from one PA program from 2006-2010, it was found that high grades in biochemistry and pathophysiology were predictors of PANCE success, while success in chemistry I was not. The correlation with PANCE scores was moderate, and statistically significant, for pathophysiology and biochemistry, but was not associated with chemistry I. When using the prerequisite courses of general chemistry I and II, microbiology, human anatomy, physiology, and general biology, Brown et al. (2013) found no correlation between PANCE scores or pass/fail on the PANCE. Science prerequisite GPA was also evaluated. There was no correlation found between PANCE scores and the science prerequisite GPA (Brown et al., 2013).

The type of institution where science courses were taken showed a moderate correlation with first-time PANCE pass/fail. Of the sample of 119 students, five students failed the PANCE

on the first attempt. Three of the five (60%) who failed, had taken most of their prerequisite courses at a 2-year college, and one (20%) had taken some courses at a 4-year college and some at a 2-year college. Said another way, three of the twelve students (25%) who took most of their science courses at a 2-year college failed the PANCE on the first attempt (Brown et al., 2013).

There are not many studies evaluating undergraduate coursework, whether it be uGPA, undergraduate science GPA, prerequisite GPA, or grades in undergraduate science course and success on the PANCE. The studies that have been conducted show conflicting results, and most have either a small sample size or a limited number of programs included in the presented study. Additionally, conflicting data is found when evaluating studies from pharmacy programs and medical schools. Because of the limited number of studies, study limitations, and conflicting results, data is not conclusive on undergraduate coursework being predictive of PANCE scores (Alston et al., 2014; Andreeff, 2014; Brown et al., 2013; Butina et al., 2017; Ennulat et al., 2011; Higgins et al., 2010; Krupat et al., 2017; McCall et al., 2017).

Admissions Tests

The GRE is often used as part of the selection criteria in PA programs, as it is in many graduate programs. Across disciplines, the GRE has extensive research showing validity of the exam to predict graduate student performance. There is not, however, a preponderance of evidence which specifically evaluates GRE scores and success in PA school or on the PANCE. In the study conducted by Higgins et al. (2010), both GRE-verbal (GRE-V) and GRE-quantitative (GRE-Q) scores were found to be predictive of successful completion of a PA program and passing PANCE scores. Butina et al. (2017) found the GRE-Q to have no effect on PANCE scores, whereas GRE-V scores were noted to be strong predictors.

In a retrospective study by Kuncel, Wee, Serafin and Hezlett (2010), the authors sought to determine if the GRE was useful in predicting performance in both master's- and doctoral-level programs. Programs were classified into the following disciplines: social sciences, humanities, life sciences, and math/physical sciences. The results showed that both the GRE-V and GRE-Q predicted overall graduate GPA and first-year graduate GPA for students in both masters and doctoral programs. Faculty ratings, such as evaluation of performance, professionalism, research achievement, and quality of thesis or dissertation, were predicted based upon GRE-V and GRE-Q scores. The results indicate that GRE scores can be used when selecting students for both graduate-level and doctoral-level programs across disciplines.

The GRE-Analytical Writing score, while reported with GRE-V and GRE-Q scores, has limited research as a predictor of success in graduate programs or on licensure exams. The research that has been done has failed to show the writing component of the GRE to be more predictive than other factors in predicting success. Graduate counselor programs often require the GRE as part of their admissions processes. Once students complete a counselor program, passing the Counselor Preparation Comprehensive Exam (CPCE) is required for counselor licensure. Hatchett, Lawrence, and Coaston (2017) found undergraduate GPA and GRE scores to be predictive of success on the CPCE exam, and while the GRE-Analytical Writing scores showed a moderation correlation with CPCE scores, the writing score did not contribute to the variance in scores more than the other variables, which included uGPA, GRE-V, and GRE-Q. The authors recognized the limitations in using uGPA and GRE scores as predictors of success, but reported those specific scores are the most valid indicators of success in counselor programs.

Pharmacy programs often use scores on the Pharmacy College Admission Test (PCAT) as part of the selection criteria for entry into a pharmacy program. Upon completion of a pharmacy

program, graduates must pass the North American Pharmacist Licensure Examination (NAPLEX). McCall et al. (2007) found the composite PCAT to be the strongest predictor of success on the NAPLEX test when considering other preadmission variables. The PCAT sub-scores of verbal, biology, reading, quantitative, and chemistry showed individual positive correlations with NAPLEX performance, but the composite score had the highest correlation.

Some pharmacy programs use the California Critical Thinking Skills Test (CCTST) as part of the interview process to assist in selection decisions. While the CCTST showed a positive correlation with NAPLEX and PCAT scores, after the regression analysis, there was no added significance beyond the composite PCAT score. This data indicates PCAT scores are likely adequate in predicting NAPLEX scores without applicants needing to complete the CCTST (McCall et al., 2007). This information can be applied to other graduate health programs, suggesting that other written assessments during the interview process may not be necessary if the intent is to predict successful completion of the program or passage of a national certification exam.

The medical college admissions test (MCAT) is a requirement for entry into medical school. Approximately seven percent of PA schools accept either the GRE or MCAT scores as an admissions requirement (PAEA, 2017). The MCAT has been studied as a predictor of success on the USMLE, but not the PANCE. There are three USLME exams that medical students must pass to graduate medical school and practice medicine: Steps 1, 2, and 3. Krupat et al. (2017) sought to determine if academic scores in first-year medical school courses predicted success on the defined outcomes compared with scores on the MCAT. The results demonstrated that MCAT scores were significant predictors of success on USMLE Step 1, USMLE Step 2 CK, and clinical clerkship grades.

Noncognitive Factors and Other Admissions Variables

Once students are determined to meet the minimum academic requirements, noncognitive factors are frequently considered as part of the selection process. For PA programs, as well as other health professions programs, interviews are the most common method of assessing noncognitive factors. Interviews can be structured or unstructured, and can consist of one-on-one interviews, group interviews, one interviewee with a panel of interviewers, or a relatively new interview format called multiple mini-interviews (MMI). Those participating in interviews can consist of PA faculty, alumni, preceptors, or faculty from other departments or schools (Brenneman et al., 2018; Higgins et al., 2010). In comparison to cognitive factors which are objective measures, interviews are more qualitative than quantitative. They tend to lack objectivity and have not been shown to be reliable measures of success (Brenneman et al., 2018). Nonetheless, many PA programs, and other professional medical programs, include an interview when deciding on applicants to accept into their program.

Using research from three large projects, Koenig et al. (2013) identified nine competencies that medical students should possess upon matriculation that are associated with behaviors likely to ensure success in medical school. These include ethical responsibility to self and others, reliability and dependability, service orientation, social skills, capacity for improvement, resilience and adaptability, cultural competence, oral communication, and teamwork. This list of competencies is endorsed by the Association of American Medical College's (AAMC) Committee on Admissions (COA), and are linked to the Accreditation Council for Graduate Medical Education (ACGME) competencies. The study investigated the most appropriate tools to assess these competencies and identified three tools that should undergo further investigation prior to widespread recommendations for implementation: situational judgment tests (SJT),

standardized evaluations of performance (SEP), and accomplishment records (Koenig et al., 2013).

According to McDaniel, Thrasher, and Hiatt (2013), the primary motivation in including noncognitive factors in the application process is to predict an applicant's likelihood of academic success in the program, success on the PANCE, and success in the healthcare field. Certain noncognitive factors are deemed influential in the decision-making process. These include interaction with faculty/staff interviewers, motivations for becoming a PA, knowledge of the profession, maturity, professional appearance and demeanor, self-awareness, compassion, and health care-related work experience with patient contact (McDaniel et al., 2013).

While the motivation for including an interview as part of the application process may be to help predict success, interviews have not conclusively demonstrated an ability to predict success in graduate school or on certification exams. In the research by Higgins et al. (2010), interview scores from the six PA programs included in the study were entered into the multiple regression. Only two of the six programs indicated significance when including the interview score to predict PANCE scores. The criteria used, and the quality being measured in each program were not reported, making generalizability impossible in the two programs that did show predictability.

Healthcare experience. Most programs either require a certain number of hours of direct patient care experiences, or favor applicants with healthcare experience. Programs accept a variety of health care exposure as qualifying experiences. This requirement is partly due to the history associated with the PA profession, which began with individuals who had prior health care experience. Studies have not shown that having healthcare experience will increase the chance of student success in the program or on the PANCE. Higgins et al. (2010) found that

years of healthcare experience was not a predictor of success on the PANCE; however, the definition of health care experience was not well defined, which may have limited the results. Brown et al. (2013) reported no correlation between hours of health care experience and success on the PANCE, pass/fail on PANCE, and GPA in the program.

Age and gender. Age has also been researched as a factor influencing success in graduate programs and on licensing exams. Mirly et al. (2017) found conflicting results between the two PA programs studied. Results from one university showed no significant relationship between age and sex and PANCE scores. In contrast, a significant correlation between age and sex and PANCE scores was found at the other university included in the study. Female students and younger students had higher scores on the PANCE. This was similar to the results shown by Ennulat et al. (2011). Although there was a small effect size, older students, especially male students, tended to have lower performance on the PANCE.

In relation to age, McCall et al. (2007) found similar results when studying pharmacy students. An inverse relationship between age and NAPLEX scores was noted. Students who successfully completed the pharmacy program and passed the NAPLEX were significantly younger than those who failed to complete pharmacy school and pass the certification exam. The authors surmised that as students get older, they are often faced with more obstacles to devoting the time required to successfully complete a graduate program. They often have other obligations that conflict with complete dedication to studying.

Not enough research has shown demographics to predict success in graduate school or on national certification exams to suggest special considerations or modifications to admission criteria. Not only is data not convincing enough to suggest changes be made, but some studies

show conflicting results. No correlation with age and gender and success in graduate school or on national certification exams was found by Andreeff (2014) and Higgins et al. (2010).

Graduate Coursework

Once a student matriculates into a PA program, graduate level coursework begins. While each program's curriculum varies, most programs have similar requirements for basic science courses. The first semester often consists of anatomy, physiology, pathophysiology, and pharmacology. How performance in these courses correlates with success in a PA program or on the PANCE would be helpful in guiding remediation policies and practices, but research in this area is limited, particularly in PA education.

Butina et al. (2017) conducted a study to determine what factors, that can be identified early in a PA program, could predict PANCE failures. The authors evaluated foundational coursework (FC), which was defined as anatomy, physiology, and pharmacology. The results found the GPA for FC to be a strong predictor of PANCE performance and showed FC to be more of a predictor of PANCE performance than admission criteria, specifically undergraduate grade point average (uGPA), undergraduate science GPA, prerequisite GPA, and both quantitative and verbal GRE scores. As stated above, the research by Butina et al. (2017) showed uGPA and vGRE to be predictors of PANCE performance, just not as strong as that of FC.

In addition to individual course grades in PA anatomy and pharmacology, Brown et al. (2013) evaluated overall PA program didactic GPA. The results showed that a student's GPA in the didactic phase of the PA program and grades in program pharmacology were strongly correlated with PANCE scores. Program anatomy showed a moderate correlation with PANCE scores. There was, however, no association between first-time PANCE pass/fail and academic

performance. These findings suggest that monitoring student performance in PA program anatomy and pharmacology, as well as overall program GPA, may help identify students at risk of scoring low on the PANCE. These findings can serve to inform remediation decisions and guide academic advising, but are limited in value since first-time PANCE pass rates were not shown to be predicted by performance in the undergraduate science courses.

Other health professions have conducted research on performance in graduate coursework and program success or success on certification exams. Alston et al. (2014) conducted a study of pharmacy students in an attempt to identify factors that could help identify students at risk of failing out of the program or failing to graduate on time. The results revealed the score on the first exam in a science course, the first semester grade in the same course, and a semester one GPA of less than 3.0 to be predictors of failure to graduate on time. This data can help identify deficiencies early so students can be remediated, but whether performance in the science courses can predict success on certification exams was not evaluated.

In a study by Krupat et al. (2017), the authors attempted to determine if performance on first-year medical school exams could add predictive value to traditional preadmission predictors of success on later high-stakes exams. After considering MCAT scores, undergraduate GPA, and gender, the number of times a student scored in the bottom-quartile on first-year exams added predictive value to the success on the USMLE Step 1 and USMLE Step 2 clinical knowledge (CK) scores, an objective structured clinical exam (OSCE), and clinical clerkship grades. This information allows identification and remediation of students who are technically passing, but frequently scoring in the bottom quartile. Remediation efforts could prevent failure on high stakes exams. Coumarbatch, Robinson, Thomas, and Bridge (2010) concluded that

grades from year two of medical school and the MCAT biological science scores were significant predictors of performance on the USMLE Step 1 exam.

Board review course. PA programs and medical schools often offer either an optional or mandatory commercially-available board review course prior to graduation. Research, however, has failed to show improved pass rates with participation in a board review course. Mirly et al. (2017) found no correlation between PANCE scores and attendance at a board review course. In-person attendance or taking the course remotely made no significant difference. In a study of physicians seeking certification through the American Board of Surgery (ABS), participation in a board review course did not show improved pass rates on the certifying examination (Jones, Biester, Lewis, & Malangoni, 2015).

Clinical Year Exams

Physician Assistant Education Association (PAEA) end of rotation exams. During the clinical year, many PA programs require students take a formative assessment on the rotation discipline just completed. Historically, faculty wrote many of these exams that were to be used exclusively for their program. In 2013, the Physician Assistant Education Association (PAEA) released, for purchase, seven end of rotation (EOR) exams, including family medicine, internal medicine, surgery, pediatrics, psychiatry, women's health, and emergency medicine. The exams are authored by a team of PA faculty members and reviewed by medical editors. To maintain exam security, questions are not released to programs. These examinations were not intended to be utilized as predictors of PANCE performance, but rather as a service to its members and as a revenue generator (Hegmann et al., 2015). More than 100 programs are using the PAEA EOR exams for formative assessments following clinical experiences (Gietzen, Roman, & Hegmann, 2018).

Since the release of the PAEA EOR exams, three studies have been conducted that show EOR exams to predict sufficient knowledge base for success on the PANCE (Gietzen et al., 2018; Hegmann et al., 2015; Massey et al., 2015). The emergency medicine, family medicine, general surgery, and internal medicine EOR exam scores had the highest correlation to PANCE scores, with psychiatry and women's health EOR exam scores having the smallest correlation (Gietzen et al., 2018). Average scores from all seven exams were shown to be reliable and were positively correlated with scores on the PANCE. A four-item score, comprised of scores from the internal medicine, family medicine, emergency medicine, and surgery exams accounted for 65.7% of the variance in PANCE scores, compared to 66.1% for the seven-item score (Gietzen, et al., 2018). These findings were similar, and an extension, to those by Hegmann et. al. (2015) and suggest that if programs choose to only use four of the exams, specifically the ones studied, PANCE scores can be predicted similarly to using all seven scores.

In a study conducted by Massey et al. (2015), a significant correlation between PANCE scores and EOR exam scores was also found. The study included 72 scores from three different PA programs, with a mean PANCE score of 426 and a mean EOR exam score of 68%. The mean EOR exam score was derived from the seven PAEA EOR exams. Forty-two graduates scored 400 or above on the PANCE and thirty scored below 400. A significant difference in average scores on the EOR exams was found between the two groups. Those scoring below 400 on the PANCE had average EOR scores of 61%, compared to 74% for those scoring 400 or higher. The mean PANCE score for those scoring less than 400 was 336, and 489 for those scoring above 400 (Massey et al., 2015).

National Board of Medical Examiners Exams. The United States Medical Licensing Examination (USMLE) consists of four separate examinations, given at different points

throughout medical school: Step 1, Step 2 Clinical Knowledge (CK), Step 2 Clinical Skills (CS), and Step 3. Many medical schools use the National Board of Medical Examiners (NBME) clinical subject examinations to assess knowledge following a clinical experience. These exams provide scores that are compared with national scores. The PAEA EOR exams are similar to the NBME subject examinations (Hegmann et al., 2015). Dong et al. (2014) evaluated NBME clinical subject examinations and their association with failure of USMLE Step 3 examinations. The results found that even one standard deviation below the national mean on a single subject examination was associated with failure on Step 3. Failure of more than one subject examination had an even higher correlation with Step 3 failure.

A study at the same medical school as the one conducted by Dong et al. (2014) was performed on students graduating in 2008-2010. Performance on the six core clerkships was considered, in correlation with scores on USMLE Steps 1 and 2 CK, as well as second- and third- year cumulative GPA. A positive correlation was found between Step 1 and 2 CK scores and scores on all subject examinations. There was also a positive correlation between the cumulative GPA at the end of the second year and USMLE Step 1 and the cumulative GPA for years two and three and Step 2 CK. When a linear regression was performed, it was found that the clerkships in primary care explained the most variance in Step 1 and 2 CK exams at 44% and 55%, respectively (Zahn et al., 2012).

PA Program Summative Exams. The National Commission on Certification of Physician Assistant (NCCPA) has developed a content list of knowledge and skills that may be included on the PANCE. The topics are organized into organ system diseases, and each question on the PANCE will fit into one of seven task areas. The authors of the PANCE use this blueprint as a guide for exam development, which undergoes periodic practice analyses to ensure that the

list covers content necessary for PA practice (Arbet, Lathrop, & Hooker, 2009). PA programs often use the blueprint when writing exams for their own programs. As part of the ARC-PA Standards, PA programs are required to administer a summative evaluation within four months of graduation (ARC-PA, 2018a). These evaluations, which are often patterned after the NCCPA's blueprint, may be able to predict students who are at risk of failing the PANCE.

In a study of six different PA programs between 2007 and 2012, two summative exams and the Physician Assistant Clinical Knowledge Rating and Assessment Tool (PACKRAT) were evaluated in relation to PANCE scores. All exams, patterned after the PANCE blueprint, showed a positive correlation with PANCE scores (Massey et al., 2013). These results suggest that programs can develop formative evaluations using the NCCPA's content blueprint, in addition to using the PACKRAT, to predict those students who are at risk of failing the PANCE. This will allow programs to identify at-risk students who may benefit from remediation, and can assist students in identifying areas of weakness for targeted study since the PACKRAT gives the breakdown of scores in each task and organ system area (Cavanagh, Lessard, & Britt, 2015). Using exam software, programs can also code their summative evaluations to allow them to provide students with their scores in specific areas.

PACKRAT. The PACKRAT is an assessment tool that many programs use to evaluate a student's strengths and weaknesses in specific content areas, given at various times in a PA program (Higgins et al., 2010). PACKRAT I is administered most often after the didactic phase to guide students in studying during the clinical year. PACKRAT II is frequently given at the conclusion of the program, prior to graduation, to help students identify weaknesses in preparation for the PANCE (Cavanagh et al., 2015; Mirly et al., 2017). The ARC-PA mandates this assessment be used only for the purpose of assisting students in identifying their strengths

and weaknesses in preparation for clinical practice and for the PANCE. One ARC-PA standard states, “Evaluation products designed primarily for individual student self-assessment, such as PACKRAT, are not to be used as an instrument that results in a passing or failing grade for students in any course(s) in the program” (ARC-PA, 2018a, p. 22).

Higgins et al. (2010) found the PACKRAT to be a significant predictor of success on the PANCE. In fact, it showed to be the best predictor of success when compared to undergraduate GPA, prerequisite GPA, graduate GPA, GRE-verbal, quantitative, and combined GRE scores, interview scores, years of health care experience, and demographics of age and gender. In the study by Ennulat et al. (2011), when used alone, multiple-choice examinations given during the didactic phase were not shown to be good predictors of students at risk for failing the PANCE. However, when combined with a program-specific summative exam and the PACKRAT, the predictability was significantly stronger.

According to Mirly et al. (2017), whose primary outcome was determining if a correlation existed between participation in a board review course and PANCE scores, found that PACKRAT II, administered at the conclusion of the program, had a strong positive correlation with PANCE scores at both programs included in the study. Cody, Adamson, Parker, and Brakhage (2004) found a strong correlation between PACKRAT scores and PANCE scores. Further statistical analysis determined for students scoring less than 55% on the PACKRAT, the likelihood of failing the PANCE increased. While this research was conducted quite some time ago, this literature review found no recent research quoting any cutoff scores as predictors.

Supervised Clinical Practice Experiences

As part of the curriculum, students in most health science programs are required to complete clinical experiences following the didactic phase of the program. While no specific

length of clinical experiences for PA programs is defined by the ARC-PA, the average length of supervised clinical practice experiences (SCPE) is 54.1 weeks (Morici, Bradford, and Leese, 2017). Few programs include clinical exposures during the didactic component; SCPEs typically occur following completion of the didactic phase. Clinical experiences are intended to help students apply, and build upon, knowledge gained during the didactic curriculum. As PA programs continue to expand, the availability of clinical sites will continue to be a challenge, making it increasingly important for programs to maximize the benefits of clinical year experiences (Jones & Houchins, 2017).

The ARC-PA requires PA programs ensure students have exposures to patients of all age groups and have the opportunity to participate in the care of patients seeking women's health, surgery, and those with behavioral and mental health conditions. Experiences in the outpatient, inpatient, operating room, and emergency department settings are required. Aside from these specific requirements, there is a large amount of variability in SCPE implementation and practices, such as length and scheduling of rotations, requirements for return to campus visits, and assessment practices. Morici et al. (2017) found three variables to be associated with above average five-year pass rates for first-time takers of the PANCE. These included rotations that were longer than 5.3 weeks, programs requiring a minimum passing score on end of rotation exams (EOR), and programs requiring a passing score on evaluations from the student's preceptor.

Just as the PA profession is expected to expand, the physical therapy (PT) profession is projected to have a 28% increase in job growth between 2016 and 2026 (Bureau of Labor Statistics, 2018). As a result, the number of PT and physical therapy assistant (PTA) programs has expanded, the number of applicants to PT and PTA programs has increased, and the number

of enrolled students has grown. As such, the need for clinical sites has become greater. In addition to the need for more clinical sites and preceptors, finding sites and preceptors willing to take students has become more challenging. Lack of clinical sites and preceptors has become a concern across health care professions programs for various reasons, among them being less time available due to increased push for productivity and changes in staffing (McCallum et al., 2014). Determining how much predictive value clinical experiences have on licensing exams is important as clinical coordinators plan clinical experiences. Research by Utley, Brown, and Robel (2016) showed that for PT students, the focus of clinical experiences did not correlate with scores on a program-specific comprehensive examination. It was found, however, that a correlation existed between academic grades and comprehensive examination scores.

Many PA programs require students to log their clinical encounters. This allows programs to track clinical exposures in an effort to ensure students are getting a variety of exposures. This information is often included as part of a program's self-assessment process. Little research has been conducted to determine the correlation between clinical encounters and PANCE performance. Min, Comstock, and Dickey (2009) found no significant correlation between the number of clinical encounters while in PA school and PANCE scores. This suggests that the number of clinical encounters should not be used as a measure of program outcomes, but rather other factors should be considered, such as the types and quality of encounters.

The Reporter-Interpreter-Manager-Educator (RIME) scoring system is used by some graduate health programs as a formative assessment for clinical year students. Preceptors give students a score based on their level of competence when demonstrating clinical skills during the rotation. The lowest possible score is that of *reporter*, while a score of *educator* is the highest. Students scoring at the level of *educator* have shown proficiency above that of their peers and

can apply evidence-based medicine in answering clinical questions. Students scoring below a benchmark of *manager* may be required to remediate to improve clinical skills (Klocko, 2016). For three consecutive PA classes at one university, it was found that more students (52%) scored in the *manager* category, and 17% scored in the *educator* category. The remaining scores were below the benchmark. Results showed that students receiving high RIME scores were more likely to have higher PANCE scores (Klocko, 2016).

Other Factors

The average length of a PA program is 27 months, with a minimum of 24 months and a maximum of 36 months (AAPA, 2017). In a study by Colletti, Salisbury, Hertelendy, and Tseng (2016), there was no relationship between total length of programs and PANCE pass rates, indicating that higher tuition debt will be increased in longer programs without evidence of benefit. However, the benefit of master's-level training has been supported by research. Bushardt, Booze, Hewett, Hildebrandt, and Thomas (2012) found that programs offering a master's degree upon completion had higher PANCE pass rates. For programs that offered a master's degree upon completion, there was a 32 times higher chance of having a pass rate on the PANCE of 90%. Currently, most PA programs award a master's degree upon completion. By 2021, this will be the requirement to gain or maintain accreditation (AAPA, 2017).

In the accreditation standards, the ARC-PA specifies that programs must have a minimum of three full-time faculty, in addition to the program director. The standards go on to mandate that programs must have enough faculty to meet the needs of enrolled students (ARC-PA, 2018a). One way in which programs can demonstrate compliance with this standard is by maintaining high PANCE pass rates. Bushardt et al. (2012), found a low student-to-faculty ratio to be associated with higher PANCE pass rates. The ratio of students to faculty was more

important to PANCE pass rates than the academic credentials of faculty. While doctorate-trained faculty are more likely to participate in research activities, the academic degree did not predict PANCE scores.

Looking at only one component of a student's application may cause educators to mistakenly classify a student's ability, especially for students with mediocre or borderline applications. All admission criteria should be evaluated when selecting students. According to early studies of health professions, when standardized tests scores are combined with GPAs, the predictive ability of either variable alone is improved (Higgins et al., 2010). However, determining the best predictor of success on certification exams is helpful when evaluating large numbers of applicants.

Summary

Acceptance into a PA program is extremely competitive given the increased number of applicants. From the 2014-2015 cycle, with 22,997 applicants, to the 2016-2017 cycle, with 26,952 applicants, there was a 10% increase in applications to the Central Application Service for Physician Assistant (CASPA) (Di Silvestro, 2017). Choosing students most likely to be successful at completing the program and passing the PANCE is crucial to help meet the needs of the nation's healthcare system, avoid financial burdens for students who are not successful, eliminate lost revenue for universities if students fail out of the program, and eliminate program accreditation issues if PANCE pass rates are low.

Research has shown it is difficult to identify early, with certainty, students who are at risk of failing the PANCE. Some studies indicated that undergraduate GPA is a significant predictor, while others showed no significant correlation or a weaker correlation than other preadmission variables. (Andreeff, 2014; Brown et al., 2013; Butina, 2017; Ennulat, 2011; Higgins et al.,

2010). GPA in prerequisite coursework has showed varied correlation with PANCE scores, while undergraduate science GPA has not been studied much and failed to show a correlation (Brown et al., 2013; Butina, 2017; Ennulat, 2011; Higgins et al., 2010). One study showed that students who had high grades in biochemistry and pathophysiology had a higher likelihood of passing the PANCE (Andreeff, 2014).

The GRE, while it has shown validity to predict performance graduate students overall, few studies have indicated its predictive value on the PANCE. One study showed predictive value for both the quantitative and verbal components, while another study showed only predictive value for the verbal scores (Butina et al., 2017; Higgins et al., 2010). The PCAT scores for pharmacy programs and MCAT scores for medical schools demonstrated predictive value for their corresponding licensure exams (McCall et al., 2007; Krupat et al., 2017). No other admissions criteria have consistently shown predictive success in professional graduate programs or success on licensing exams.

Once admitted, early identification of high-risk students is imperative, so remediation plans can be implemented to help improve the likelihood of success. Multiple-choice tests, when used alone, were not significant predictors of failure of the PANCE. However, performance in program science courses and overall program GPA can predict successful completion of the program and passing of the licensing exam (Butina et al., 2017). Once students' progress to the clinical phase, identifying those at-risk becomes a little easier. Scores on the PACKRAT have consistently shown a correlation to PANCE performance (Higgins et al., 2010). EOR exams can also be used to predict success on the PANCE (Massey et al., 2015). Summative examinations are required for students to graduate. Poor performance on the written component of this type of assessment indicates the student to be at high risk of failing the PANCE (Ennulat et al., 2011).

Efforts should be directed at improving medical knowledge.

To admit a student who is unsuccessful at completing the program or on passing the PANCE puts the student at an economic disadvantage and increases emotional disappointment. High attrition rates, as well as low board pass rates, can affect a graduate program's recruiting efforts and accreditation status. The ARC-PA mandates that PA programs publish the five most recent graduating class's first-time PANCE pass rates (ARC-PA, 2018a).

Research is fairly robust on predictors of PANCE success once a student matriculates into a program, especially assessments in later stages of the program. There is a lack of data, however, and conflicting results, on preadmission factors that predict success. Although some data exists, there needs to be more research on GRE scores and early program performance as predictors of PA student success. This study will help fill the gap by investigating whether GPA in undergraduate science courses, GRE scores, and GPA in graduate science courses can predict success on the PANCE.

This chapter reviewed the theoretical framework for this research, as well as the literature on predictors of PANCE success. Studies reviewing undergraduate coursework, preadmission exams, noncognitive factors, graduate coursework, supervised clinical practice experiences, clinical year exams, and other factors that may help predict PANCE success were presented. Chapter Three will present the study design, research question, hypotheses, participants and setting, the instrument used, procedures, and the data analysis.

CHAPTER THREE: METHODS

Overview

As the need for healthcare providers continues to grow, so does the need for physician assistants (PA). The projected growth of the profession is higher than average for other occupations, at 37% from 2016 to 2026 (Bureau of Labor Statistics, 2018). With this increased need and projected growth has come an increased number of PA programs across the country, as well as applicants to these programs (Forister & Stilp, 2017). An increased number of applicants has resulted in additional challenges for PA programs in terms of selection of applicants. Most PA programs evaluate preadmission factors in addition to grades, such as healthcare experience and evidence of altruism through volunteer activities, when making selection decisions. In using these additional criteria, and not focusing solely on GPA and GRE scores, programs must have a degree of confidence that the applicant has the intellectual ability to progress through the program and pass the Physician Assistant National Certification Exam (PANCE).

Passing the PANCE is required for graduates of a PA program to become certified to practice medicine. There is some variability in the prerequisite requirements for different PA programs across the country, but the vast majority require basic science courses such as anatomy, physiology, and microbiology. Determining if grades in undergraduate science courses and GRE scores can predict future success on the PANCE are important considerations to help evaluate and inform a program's admission criteria and selection decisions. Determining if performance in basic science courses during the first year of the PA program can predict eventual success on the PANCE can be used by PA programs to direct remediation efforts.

With the significant need for healthcare providers, choosing students who will successfully pass the PANCE and enter the workforce as a medical provider is beneficial for society.

Additionally, for programs to be competitive and attract quality applicants, programs must demonstrate a high first-time PANCE pass rate. This correlational study investigated the predictive relationship between GPA in undergraduate anatomy, physiology, and microbiology, GRE scores, and GPA in graduate anatomy, physiology, and pharmacology, with scores on the PANCE. This chapter outlines the methodology of this study, including the research design, research question, null hypotheses, participants, setting, instrumentation, procedures, and the data analysis to be used.

Research Design

This study utilized a predictive correlational research design. Correlational research is often used in educational and social science research. The research design enables scores on one variable to be predicted from the scores from another variable (Gall, Gall, & Borg, 2007). Compared to causal relationship research in which variables can be measured at any point in time, prediction research mandates that predictor variables be measured prior to criterion variables. The predictor variables in this study (GPA in undergraduate anatomy, physiology, and microbiology, scores on the GRE, and GPA in graduate anatomy, physiology, and pharmacology) were documented prior to the scores on the criterion variable (PANCE scores) (Gall et al., 2007). This study attempted to demonstrate a correlation, and thus a predictive relationship, between undergraduate anatomy, physiology, and microbiology GPA, scores on the GRE, and graduate anatomy, physiology, and pharmacology GPA and scores on the PANCE.

Research Question

The research questions for this study were:

RQ1: Is there a predictive relationship between the criterion variable, Physician Assistant National Certification Exam and the predictor variable of grade point average in undergraduate science courses?

RQ2: Is there a predictive relationship between the criterion variable, Physician Assistant National Certification Exam and scores on the Graduate Record Exam.

RQ3: Is there a predictive relationship between the criterion variable, Physician Assistant National Certification Exam and grade point average in graduate science courses in the first year of a physician assistant program for students who have graduated from a physician assistant program?

Hypothesis

The null hypotheses for this study are:

H01: There is no statistically significant predictive relationship between the criterion variable (Physician Assistant National Certification Exam scores) and GPA in specific undergraduate science courses (anatomy, physiology, and microbiology) (the predictor variable) for students who have graduated from a physician assistant program.

H02: There is no statistically significant predictive relationship between the criterion variable (Physician Assistant National Certification Exam scores) and scores on the GRE (the predictor variable) for students who have graduated from a physician assistant program.

H03: There is no statistically significant predictive relationship between the criterion variable (Physician Assistant National Certification Exam scores) and GPA in specific graduate science courses in the first year of a PA program (anatomy, physiology, and pharmacology) (the predictor variable) for students who have graduated from a physician assistant program.

Participants and Setting

The participants for the study were taken from a convenience sample of graduates from the PA programs at Mountain View University (MVU) and Cedar Grove University (CGU) (descriptors used), both in West Virginia. To be included in the study, the graduates must have completed the following courses prior to matriculation into the PA program: four hours of anatomy, four hours of physiology, and four hours of microbiology. They must also have taken the GRE. Successful completion of the PA program indicates the graduate successfully completed program anatomy, physiology, and pharmacology since completion of these courses is a requirement for progression in the program and subsequent graduation. To be included as a participant, graduates must also have taken the PANCE. Graduates not having taken undergraduate anatomy, physiology, microbiology, or the GRE were excluded from the study, as well as graduates who had not yet taken the PANCE.

MVU, a four-year public university, is located in the Eastern Panhandle of WV. This school's PA program graduated its first class of students in 2014. The program is 24 months in length, and awards a master's degree upon completion of the program. To be considered for entry into the program, applicants must have a bachelor's degree and a minimum overall GPA of 3.0 and a science GPA of 3.0. Organic chemistry and biochemistry are not required, but can replace the requirement of one year of general chemistry with a laboratory course. Selection preference is given to applicants who have patient care experiences, have a record of community service, are graduates of MVU, and are residents of West Virginia. The program accepts 18 students per year, with coursework beginning in the summer semester. The first year of the program is didactic coursework, followed by a year of clinical rotations. Basic science courses in the program's curriculum include human anatomy and physiology I and II, clinical laboratory

science, medical microbiology, pathophysiology and clinical pharmacology. The first-time PANCE pass rate for all graduates of MVU PA program is 94%. The GRE is not required for acceptance into the program.

CGU, a private, liberal arts university, is in the central part of WV. The first graduating class for CGU's PA program was in 2015. The PA program accepts 30 students per year, and awards a master's degree upon completion of all graduation requirements. CGU has two admission pathways: direct admission, which requires a bachelor's degree, and fast track, which is for CGU students who have less than 30 credit hours of study from another institution. Fast track students can be accepted into the PA program without a bachelor's degree if they earn a grade of "B" or higher in all prerequisite courses, maintain a 3.5 cumulative college GPA, complete 75 semester hours of undergraduate coursework, and obtain a cumulative GRE score of 300 or higher, and an analytical GRE writing score of at least 3.0. Once accepted into the program, students must also accrue at least 200 hours of direct patient care experience each academic year prior to matriculation into the program.

Direct admission candidates must have an overall GPA of 3.0 and obtain a cumulative GRE score of 300 or higher and an analytical GRE writing score of at least 3.0. All candidates for the CGU PA program who meet the minimum academic requirements are evaluated based upon hours and quality of healthcare experience and shadowing of medical providers, volunteer activity, an essay, and references. Applicants are also evaluated on their propensity to practice medicine in an underserved area as evidenced by a supplemental application detailing their commitment to serve the underserved patient population.

The program at CGU is 28 months in length and consists of four semesters of didactic education and three semesters of clinical rotations. Basic science courses in the program's

curriculum include applied human anatomy, physiology, mechanism of disease, and clinical pharmacology. The clinical year consists of eight, five-week rotations. The first-time PANCE pass rate for all graduates of CGU is 96%.

Participants were chosen from the graduating classes of MVU and CGU. For MVU, the first graduating class was in 2014, so participants were from the 2014-2018 graduating classes. There have been 86 graduates from MVU's PA program. Since the GRE is not a program requirement, only those who took the GRE were included. The first graduating class of CGU was in 2015, so participants were drawn from the graduating classes of 2015-2018. There have been 104 graduates from CGU's PA program. Since the GRE is required, all students who graduated were included in the study. The minimum required sample size is 66 participants. This is based on a medium effect size with a statistical power of .7 at the .05 alpha level (Warner, 2013).

Instrumentation

The instrument used in this research study was the Physician Assistant National Certification Exam (PANCE). The purpose of the PANCE is to measure medical knowledge and cognitive skills of PA graduates to ensure they meet established standards to practice medicine. The exam consists of 300 questions that are developed based upon a blueprint of organ systems and diseases and disorders, as well as specific task areas in which PAs should be competent (NCCPA, 2017).

The first certifying examination for PAs was administered in 1973 by the National Board of Medical Examiners (NBME). At that time, PAs were the only health profession, besides physicians, that required a certification exam. In 1974, the National Commission on Certification of PAs (NCCPA) was formed to oversee the certification and recertification of PAs.

Those who pass the certification exam (PANCE) after graduation and the recertification exam (PANRE) after ten years, and fulfill continuing education requirements every two years, can use the designation of Physician Assistant – Certified. The NCCPA is accredited by the National Commission for Certifying Agencies (NCAA). The overarching goal of the PANCE is to protect the public from medical providers who are unable to demonstrate competency in medical knowledge and skills (NCCPA, 2017).

The NCCPA developed the content blueprint based on the scientific evaluation of PA practice. The blueprint is evaluated every five years and is based upon a PA practice analysis. A test committee, comprised of certified PAs and physicians who are selected based upon their item writing skills, experience, and demographic characteristics (i.e., practice specialty, geographic region, practice setting, etc.), create exam questions. Each question is written independently by members of the test committee, and then reviewed by content experts and medical editors. Selected questions are pre-tested for validity on live exams prior to being included within exam scores. Passing scores were set by a team of professionals who have doctoral training. These professionals use statistical models to ensure reliability and validity of the exam (NCCPA, 2017). The NCCPA does not publish results of validity and reliability evaluations and no studies were discovered that have evaluated these measures.

The 300-question exam assesses knowledge related to each organ system in the following task areas: history taking and performing physical examinations, using laboratory and diagnostic studies, formulating most likely diagnosis, health maintenance, clinical intervention, pharmaceutical therapeutics, and applying basic science concepts. Professional practice has been added to the blueprint. See Table 1 for the percentage of questions on exam content (NCCPA, 2017).

The PANCE is a multiple-choice examination. Exam takers initially receive one point for a correct answer and zero points for an incorrect answer. The exam taker's proficiency measure is later calculated using a maximum likelihood estimation procedure, based on the Rasch model, to equate scores, correcting for slight differences in difficulty across different exam versions. The proficiency measure is then converted to a scaled score to allow results to be compared over time. The scale is based on the performance of a reference group whose scores were scaled so that the average proficiency measure was assigned a scaled score of 500 and the standard deviation was established at 100. The minimum reported score is 200 and the maximum reported score is 800. A passing score is 350 and above.

The PANCE is administered at a designated, secure testing center and includes five blocks of 60 questions. Exam takers have 60 minutes to complete each block, and 45 minutes allotted for breaks between blocks. The first-time test taker pass rate from 2012-2016 was an average of 95%. In 2016, 8,082 graduates took the PANCE. The percent of those passing on the first attempt was 96% (NCCPA, 2017).

Procedures

The first step in conducting this research study was to obtain the necessary permissions. Approval was obtained from Liberty University's IRB, as well as from the administration and Institutional Review Boards (IRBs) at Mountain View University (MVU) and Cedar Grove University (CGU). Following appropriate approvals, data collection began. The program directors from MVU and CGU reviewed transcripts from all program graduates. Grades from undergraduate anatomy, physiology, and microbiology were recorded onto an Excel spreadsheet and a GPA was calculated, as well as a calculated GPA for grades in anatomy, physiology, and pharmacology during the first year of the PA program. GRE scores were also recorded on the

Excel spreadsheet for the corresponding students. The NCCPA provides each program with PANCE score reports from all its graduates. The minimum reported score is 200 and the maximum is 800. A passing score is 350 or greater. The program directors recorded the scores onto the Excel spreadsheet in the row with the graduate's science GPAs and GRE scores. Names were removed from the spreadsheet and the data was exported into SPSS for analysis. Statistical analyses were conducted as described in the next section.

Data Analysis

Once data was recorded and subsequently exported into SPSS, descriptive statistics were obtained for the criterion variable, PANCE exam scores. Mean exam scores were reported. Mean scores for the predictor variables, GPA for undergraduate anatomy, physiology, and microbiology, GRE scores, and GPA for graduate anatomy, physiology, and pharmacology were also reported. Data was screened for inconsistencies, errors, and bivariate outliers. A multiple regression was used to analyze the null hypotheses and determine if there was a statistically significant predictive relationship between the criterion variable and the predictor variables, based upon $p < .05$. The statistical analyses require the assumptions of bivariate outliers, multivariate normal distribution, and absence of multicollinearity be met (Warner, 2013). Scatter plots were run between each pair of predictor variables, and the predictor variables and the criterion variable, and was used to determine if any extreme bivariate outliers existed and if the assumptions of multivariate normal distribution were met. A linear relationship between each pair of variables indicate the assumptions of multivariate normal distribution are met. The assumption of absence of multicollinearity was evaluated using the Variance Inflation Factors (VIF). Values less than 10 indicate there is not a violation of this assumption. The overall regression was used to determine how well scores on the PANCE could be predicted when all

three predictor variables were included. If the overall regression was statistically significant, the multiple regression was to be used to determine whether to accept or reject the null hypotheses based on a 95% confidence level and determine which predictor variable, specific undergraduate science GPA, GRE scores, or specific graduate science GPA, best predicts PANCE scores.

CHAPTER FOUR: FINDINGS

Overview

To practice medicine as a PA, graduates of an accredited PA program must pass the Physician Assistant National Certification Exam (PANCE). PA programs strive to have 100% pass rates on the PANCE. To assist programs in evaluating their selection criteria and remediation policies, this study was conducted to determine if there was a correlation between undergraduate science GPA, GRE scores, and graduate science GPA in the first year of a PA program, and scores on the PANCE. This chapter presents the findings of the study and relates the results to the three research questions and null hypotheses.

Research Questions

RQ1: Is there a predictive relationship between the criterion variable, Physician Assistant National Certification Exam and the predictor variable of grade point average in undergraduate science courses?

RQ2: Is there a predictive relationship between the criterion variable, Physician Assistant National Certification Exam and scores on the Graduate Record Exam.

RQ3: Is there a predictive relationship between the criterion variable, Physician Assistant National Certification Exam and grade point average in graduate science courses in the first year of a physician assistant program for students who have graduated from a physician assistant program?

Null Hypotheses

H01: There is no statistically significant predictive relationship between the criterion variable (Physician Assistant National Certification Exam scores) and GPA in specific

undergraduate science courses (anatomy, physiology, and microbiology) (the predictor variable) for students who have graduated from a physician assistant program.

H02: There is no statistically significant predictive relationship between the criterion variable (Physician Assistant National Certification Exam scores) and scores on the GRE (the predictor variable) for students who have graduated from a physician assistant program.

H03: There is no statistically significant predictive relationship between the criterion variable (Physician Assistant National Certification Exam scores) and GPA in specific graduate science courses in the first year of a PA program (anatomy, physiology, and pharmacology) (the predictor variable) for students who have graduated from a physician assistant program.

Descriptive Statistics

Data obtained from the criterion variable, PANCE exam scores, showed a mean PANCE score ($M = 491.65$, $SD = 80.06$). The mean GPA for the undergraduate science courses, anatomy, physiology, and microbiology, ($M = 3.49$, $SD = 0.45$), for GRE ($M = 300.90$, $SD = 7.50$), and for the graduate science courses, anatomy, physiology, and pharmacology ($M = 3.61$, $SD = 0.39$). The descriptive data can be found in Table 1. The total sample size was 121. However, there were some missing undergraduate and graduate PA grades, from errors in admissions files and program transcripts, respectively. Incomplete data was removed from the statistical analysis, leaving a sample size of 109. According to Warner (2013), the minimum sample size for multiple R is $N > 50 + 8k$ and for individual predictors it is $N > 104 + k$, where k is number of predictors. Having three predictors, the minimum required sample size is 74 and

107, respectively. Thus, the sample size should demonstrate adequate statistical power with a medium effect size.

Table 1

Descriptive Data for the Criterion Variable and the Predictor Variables

	Mean	Std. Deviation	N
PANCE scores	491.65	80.06	109
uGPA (anatomy, physiology, microbiology)	3.49	0.45	109
GRE scores	300.90	7.50	109
gGPA (anatomy, physiology, pharmacology)	3.61	0.39	109

Assumptions

The data was screened for inconsistencies, data entry error, and outliers. None were found. A multiple regression was used to analyze the null hypotheses and determine if a statistically significant predictive relationship existed between the criterion variable and the predictor variables. The analyses required the assumptions of bivariate outliers, multivariate normal distribution, and absence of multicollinearity be met. Scatter plots were run between each pair of predictor variables, and the predictor variables and the criterion variable. The scatter plots did not indicate any extreme bivariate outliers and the assumptions of normal distribution were met. Refer to Figures 1-6 for the scatter plots. The assumption of absence of multicollinearity was evaluated using the Variance Inflation Factors (VIF). There was no violation of this assumption since all values were less than five. Refer to Table 2 for the collinearity statistics.

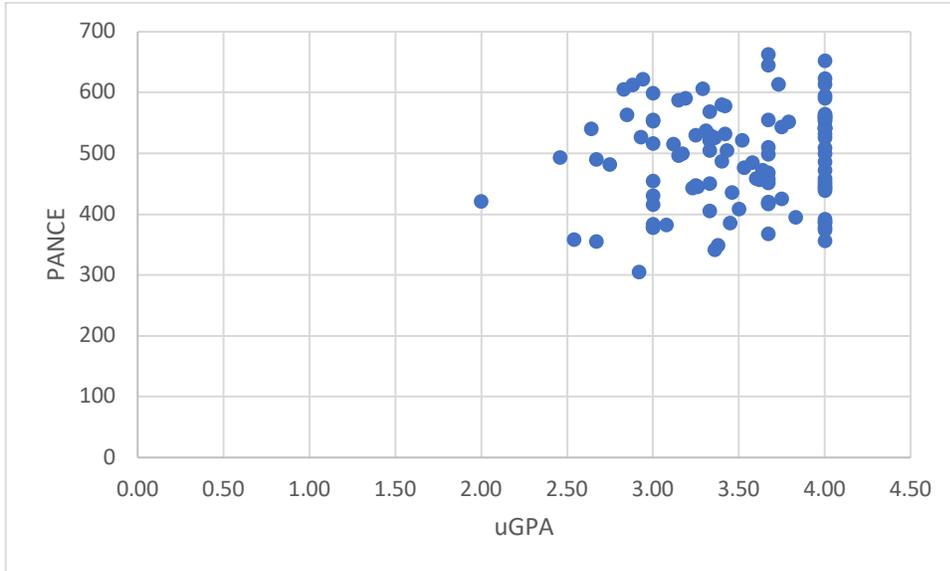


Figure 1. Scatter Plot between undergraduate GPA in anatomy, physiology, and microbiology and PANCE scores.

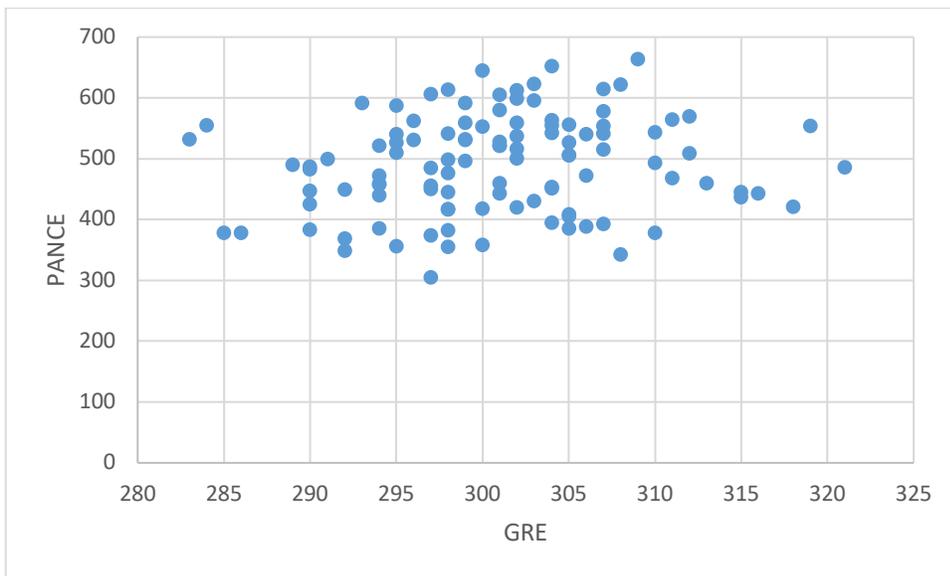


Figure 2. Scatter Plot between scores on the GRE and scores on the PANCE.

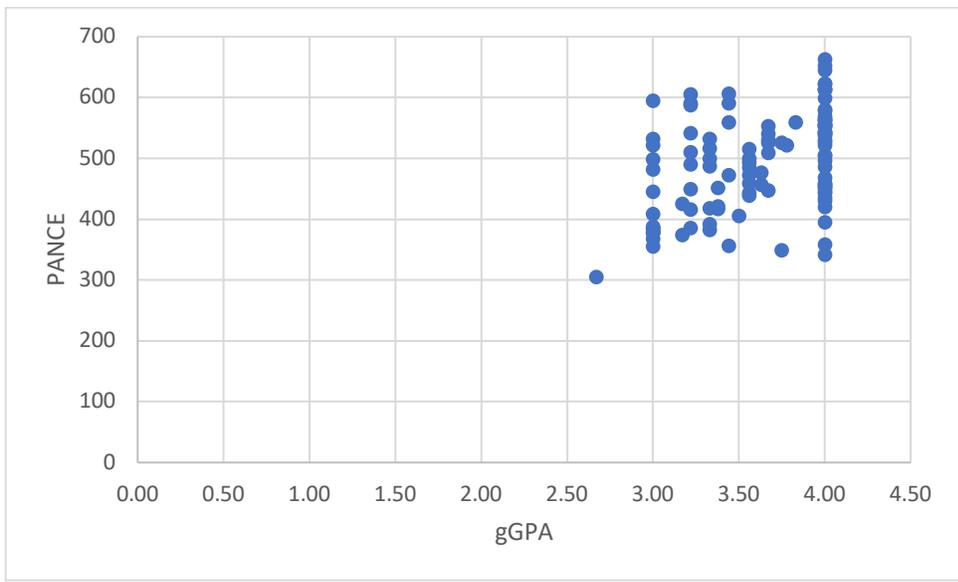


Figure 3. Scatter Plot between graduate GPA in first year anatomy, physiology, and pharmacology and scores on the PANCE.

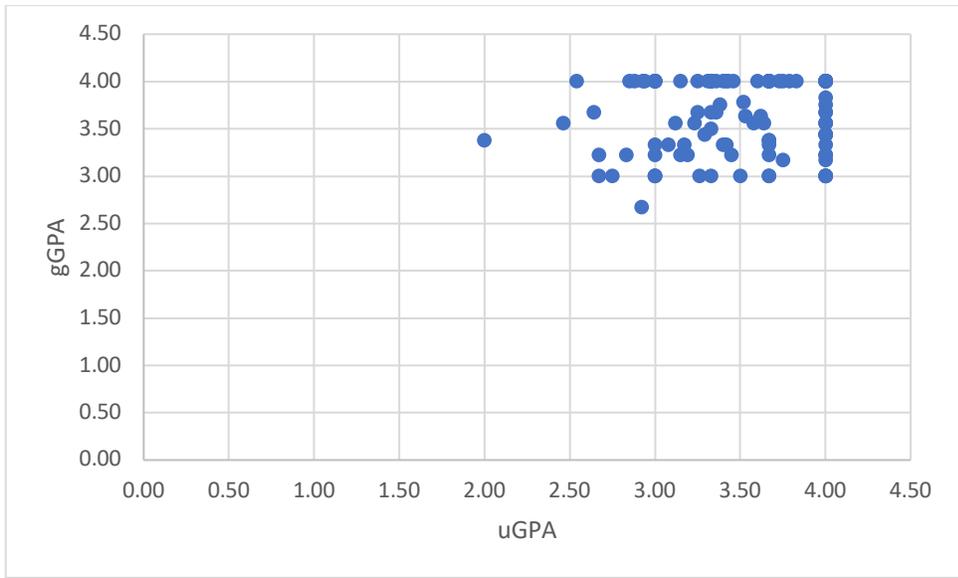


Figure 4. Scatter Plot between undergraduate GPA in anatomy, physiology, and microbiology and graduate GPA in first year anatomy, physiology, and pharmacology.

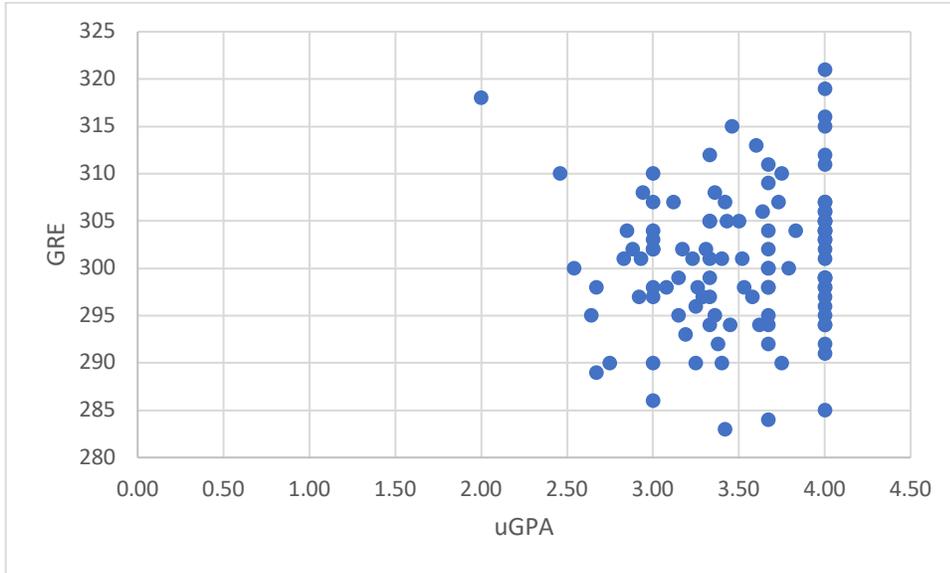


Figure 5. Scatter Plot between undergraduate GPA in anatomy, physiology, and microbiology and score on the GRE.

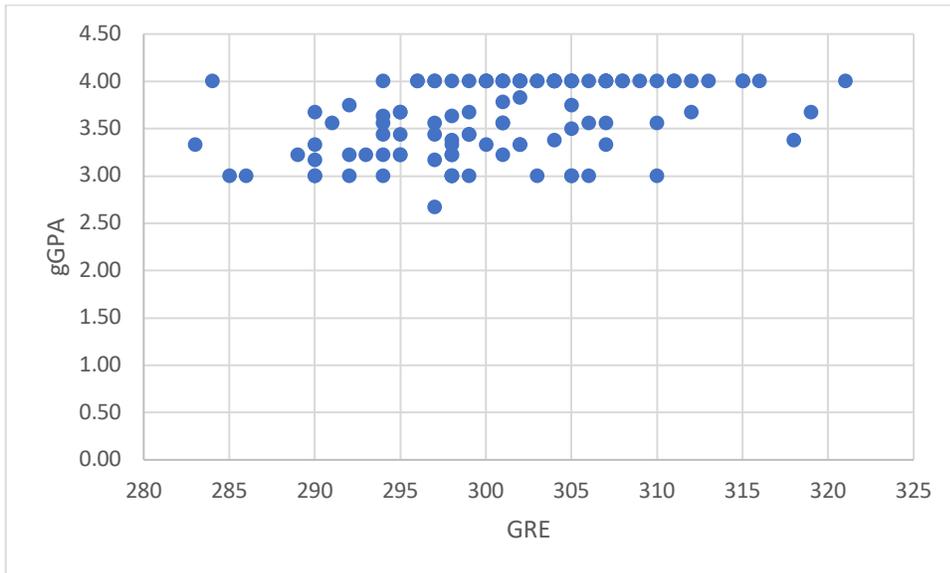


Figure 6. Scatter Plot between GRE scores and graduate GPA in first year anatomy, physiology, and microbiology

Table 2

Collinearity Statistics

Model	Collinearity Tolerance	Statistics VIF
1 (Constant)		
uGPA	.987	1.013
GRE	.823	1.215
gGPA	.821	1.219

Results for Null Hypotheses

For the overall multiple regression to predict PANCE scores from undergraduate GPA in anatomy, physiology, and microbiology, GRE scores, and graduate GPA in first year anatomy, physiology, and pharmacology, $r = .43$ and $R^2 = .19$. That is, when all three variables were used as predictors, only 19% of the variance in PANCE scores could be predicted. Refer to Table 3 for the model summary. The overall regression was statistically significant, $F(3, 105) = 8.066, p < .000$. Table 4 shows the regression data.

Table 3

Model Summary

Model	r	R^2	Adjusted R^2	Std. Error of the Estimate	Observations
1	0.432	0.187	0.164	73.20	109

Table 4

*Results of Multiple Regression**ANOVA*

Model		Sum of Squares	<i>df</i>	Mean Square	<i>F</i>	Sig.
1	Regression	129645.939	3	43215.3129	8.066	.000
	Residual	562550.813	105	5357.62679		
	Total	692196.752	108			

The first null hypothesis sought to determine if GPA in undergraduate anatomy, physiology, and microbiology could predict scores on the PANCE in students who graduated from a PA program. It was not statistically significant with a $p = .486$. The second null hypothesis evaluated if GRE scores could predict scores on the PANCE in students who graduated from a PA program. The results were not statistically significant with a $p = .645$. The third null hypothesis examined if GPA in first year graduate anatomy, physiology, and pharmacology could predict scores on the PANCE in students who graduated from a PA program. The results were statistically significant with a $p = <0.05$. Thus, the null was not rejected at a 95% confidence level for the first two null hypotheses, but was rejected for the third null hypothesis. Refer to Table 5 for data coefficients.

Table 5

Coefficients

Model		<i>t</i>	Sig.	95% Confidence Interval for <i>B</i>	
				Lower Bound	Upper Bound
1	(Constant)	.927	.356	-306.533	845.207
	uGPA	.700	.486	-20.111	42.056
	GRE	-.462	.645	-2.530	1.574
	gGPA	4.522	.000	50.909	130.431

CHAPTER FIVE: CONCLUSIONS

Overview

In this chapter, the purpose of the study will be reviewed, and the results summarized. The study's findings will be correlated with findings from previous research to help fill gaps in research. How this research can be used to inform physician assistant (PA) admission's practices will be discussed. Limitations to this study will be reviewed, and recommendations for future research will be presented.

Discussion

PA programs seek to accept applicants who are most likely to not only be successful in the graduate program but are also able to pass the PANCE, most importantly on the first attempt. Considering the increasing number of applicants to PA programs and the importance of programs maintaining a high first time PANCE pass rate, the findings in this study can be used to inform PA program admissions and remediation practices. The purpose of the study was to determine if GPA in undergraduate science courses (uGPA), specifically anatomy, physiology, and pharmacology, GRE scores, and GPA in graduate science courses (gGPA), specifically anatomy, physiology, and pharmacology during the first year of physician assistant (PA) school were predictive of scores on the PANCE.

The first null hypothesis sought to determine if GPA in undergraduate anatomy, physiology, and microbiology could predict scores on the PANCE in students who graduated from a PA program. The results of this study indicated no predictive relationship between the undergraduate science GPA and PANCE scores. One of the assumptions of Knowles's adult learning theory is that students build upon prior learning experiences (Hagen & Park, 2016). Given this theory, high performance in courses with content related to what will be learned in a

PA program would predict success on the PANCE. This study, however, revealed the independent variable, GPA in undergraduate anatomy, physiology, and microbiology, did not contribute significantly to the regression analysis. There have been few studies evaluating specific undergraduate science courses as predictors of success on the PANCE. Andreef (2014) found that high grades in biochemistry and pathophysiology were predictors of success on the PANCE, with a moderate positive correlation, more predictive than undergraduate GPA. Chemistry I was not correlated with PANCE performance. In a study by Brown et al. (2013), there was no correlation between PANCE scores and performance in general chemistry I and II, microbiology, human anatomy, physiology, and general biology. Science prerequisite GPA was also found to have no correlation.

Prerequisite courses, which include required science courses, have showed variable results as predictive of PANCE success. In studies by Higgins et al. (2010) and Butina et al. (2017), prerequisite courses were not correlated with PANCE scores. However, in a study by Ennulat et al. (2011), a positive correlation between prerequisite GPA and PANCE scores was found. Additionally, McCall et al. (2007) found that prerequisite GPA was positively correlated with performance on the North American Pharmacist Licensure Examination (NAPLEX).

As students begin to learn new concepts, a process of scaffolding occurs in which learning builds upon an already established foundation. Students should be able assimilate new knowledge with previously learned concepts (Hagen & Park, 2016). As a graduate-level exam, the GRE requires retrieval of complex processes that require students to utilize a wide knowledge base. High performance on this exam could indicate the student has a solid foundation and will continue to build upon their framework during graduate school. The second null hypothesis in this study sought to determine if scores on the GRE could predict scores on the

PANCE in students who graduated from a PA program. In relation to performance on the PANCE, GRE scores have not been studied extensively as a predictor of success, and in the studies that have been conducted, the results are somewhat conflicting. Higgins et al. (2010) found GRE scores, both verbal and quantitative components, to be predictive of successful completion of a PA program and passing PANCE scores, whereas Butina et al. (2017) found quantitative scores to have no effect on PANCE scores. Kuncel et al. (2010) concluded that GRE scores were predictive of success in master's-level and doctoral-level programs, and could be used in the selection process.

The third null hypothesis sought to determine if GPA in graduate anatomy, physiology, and pharmacology in the first year of a PA program could predict scores on the PANCE in students who graduated from a PA program. When students have built a strong foundation of knowledge through undergraduate coursework, the information is stored in their brain and can be recalled more readily, and new information stored more efficiently (Hagen & Park, 2016). Because graduate medical programs have prerequisites that will be built upon in the curriculum, the zone of proximal development (ZPD) is extended to allow new concepts to be put into context with previous learning (Taylor & Hamdy, 2013). One of Malcolm Knowles's principles of adult learning postulated that adult learners need to know why, what, and how learning is occurring (Hagen & Park, 2016; Knowles et al., 2005; Taylor & Hamdy, 2013). In PA school, much of the curriculum is application-based. Students should thrive in an environment in which learning is connected to real-world scenarios. In this study, GPA in graduate PA anatomy, physiology, and pharmacology in the first year of the program revealed an ability to predict PANCE scores. Butina et al. (2017) found GPAs in PA program foundational coursework (FC), specifically anatomy, physiology, and pharmacology, to be a strong predictor of PANCE

performance, more predictive than admission criteria. Brown et al. (2013) found that GPA in the didactic phase of a PA program and grades in program pharmacology were strongly correlated with PANCE scores. Grades in program anatomy showed a moderate correlation. However, the first-time PANCE pass rates were not shown to be predicted by overall didactic GPA or performance in anatomy and pharmacology.

Implications

The findings in this study indicated the admissions criteria evaluated cannot predict a student's success on the PANCE. Programs should not rely solely on one criterion when making selection decisions. Rather, each program should tailor admissions criteria to the program's mission and goals, consider the available research on each criterion, and evaluate each applicant's performance on multiple preadmission factors the program deems important. Since PANCE scores were shown to be predicted from GPA in program anatomy, physiology, and pharmacology, remediation may be necessary for students to be successful in the program, as well as on the PANCE. Each program should undergo continuous program self-evaluation, as required by the Accreditation Review Commission on Education for the Physician Assistant (ARC-PA), to determine what admissions criteria and remediation practices works best for their individual program, with consideration given to performance in program anatomy, physiology, and pharmacology.

Limitations

This study used data from two PA programs in WV. Mountain View University (MVU) does not require the GRE for admission into the program. Since GRE scores was an inclusion criterion, there were not as many participants from MVU ($n=15$). Generalizing results to other PA programs was already limited since the study included only participants from WV PA

programs. Having most participants from Cedar Grove University (CGU) ($n=94$) increased this limitation. Additionally, since the data was deidentified, the demographics were not known, making generalization to the general population not possible.

The ARC-PA does not dictate prerequisite requirements or program curriculum, giving programs freedom to design their program based on their mission and goals. This study evaluated first year coursework, specifically anatomy, physiology, and pharmacology. MVU has two semesters of combined anatomy and physiology and two semesters of clinical pharmacology. GCU teaches individual courses in anatomy, physiology, and pharmacology during the first semester of the program. This variability in coursework limits the study results.

GPA in undergraduate anatomy, physiology, and microbiology was an independent variable in this study. Given that students took a variety of prerequisite courses, at different institutions with different credit hours and variability in course descriptions, it is not possible to have equality in preparation for the PA program. Given the theory that success in PA school is determined by a strong undergraduate foundation, variability in undergraduate coursework is a limitation to this study.

The majority of participants ($n=94$) were from CGU. The minimum passing grade for each course in their PA program is “B”. The minimum passing grade for each course at MVU is “C”. Since all participants progressed through the program and graduated, the GPA range was quite narrow. This narrow range of data points was a limitation to the study results.

In this study, only a narrow spectrum of cognitive factors was considered. Admissions decisions often consist of noncognitive factors as well, such as an interview score, healthcare experience type and hours, number of hours of provider shadowing, and volunteer experiences

and hours. Considering a small component of cognitive factors and exclusion of noncognitive factors limits the study.

Recommendations for Future Research

Future research could include:

1. Evaluation of cognitive factors, but with a larger number of participants from programs across the United States, including addition of demographics as a factor. This would allow results to be more generalizable. The study could adjust for the variability of undergraduate and graduate coursework and evaluate performance in individual courses rather than GPA in a narrow set of courses.
2. Evaluation of noncognitive factors as predictors of success on the PANCE could add to the research already existing. Determining if there is a correlation between cognitive and noncognitive factors could be beneficial in informing admissions decisions.
3. Considering Malcolm Knowle's assumption that adult learners are motivated to learn when knowing the why, what, and how of learning and a desire for the immediate application of learning, evaluation of application-based curriculum as a predictor of success on the PANCE could inform PA curriculum design and pedagogy (Hagen & Park, 2016; Taylor & Hamdy, 2013).

PA programs have an enormous responsibility to prepare graduates to pass the PANCE and to be competent medical providers. Programs are accountable to their institution to attract and retain students, to applicants to have an admissions process that is fair and reasonable, to admitted students to prepare them for the PANCE and for medical practice, and to the public to graduate competent providers. Using admissions criteria based upon tradition and anecdotal reports is not acceptable. Programs must use research evidence, considering their individual

program's mission and goals, when making admissions and remediation policies. This study suggests programs should evaluate students' performance in program anatomy, physiology and pharmacology courses to guide remediation practices. In relation to admissions criteria, more research needs to be conducted to help establish best practices.

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APPENDICES

Appendix A

National Commission on Certification of Physician Assistants Exam (NCCPA) Content Blueprint

Organ System	% of Exam Content
Cardiovascular	13
Dermatologic	5
Eyes, Ears, Nose and Throat	7
Endocrine	7
Gastrointestinal/Nutritional	9
Genitourinary	5
Hematologic	5
Infectious Diseases	6
Musculoskeletal	8
Neurologic System	7
Psychiatry/Behavioral	6
Pulmonary	10
Reproductive	7
Renal	5

Task Area	% of Exam Content
History Taking & Performing Physical Exams	17
Using Laboratory & Diagnostic Studies	12
Formulating Most Likely Diagnosis	18
Health Maintenance	10
Clinical Intervention	14
Pharmaceutical Therapeutics	14
Applying Basic Science Concepts	10
Professional Practice	5

Appendix B

LIBERTY UNIVERSITY.

INSTITUTIONAL REVIEW BOARD

November 16, 2018

Jennifer Pack

IRB Exemption 3561.111618: A Correlational Study of Preadmission and Early Program Predictors of Physician Assistant Certification Exam Scores

Dear Jennifer Pack,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

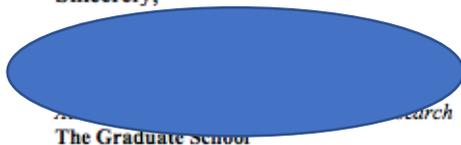
Your study falls under exemption category 46.101(b)(4), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:101(b):

(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please note that this exemption only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,



The Graduate School

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Appendix C



Sponsored Research at the University of Charleston

Instructions: This form is to be used when another institution is requesting that University of Charleston faculty, staff and/or students participate in its study. The University of Charleston will submit the approved protocol from the requesting institution, along with this form, to the Institutional Review Board (IRB) Chair for UC approval. If you have questions, please direct them to the chair of the University of Charleston's IRB.

Submit completed forms to: 1) irb@ucwv.edu and 2) signed paper copy to IRB Mailbox 9, UC-Charleston. If you have concerns, please contact Dr. Rebecca Linger, Chair, UC-IRB, at (304) 357-4998 or in person at PHAR-304G.

Primary Contact: Jennifer Pack
(must be a UC faculty or administrator)

Proposal #: 18-0047
(Leave blank. You will receive this number when the project is approved)

University of Charleston Information

Sponsor's Name: Jennifer Pack

Department: Physician Assistant

Requesting Institution Information

Primary Research Institution: Liberty University

Primary Researchers: Jennifer Pack

Faculty Advisor: Meredith Park, Ed.D.

Title of Research: A Correlational Study of Preadmission and Early Program Predictors of Physician Assistant Certification Exam Scores

Signature of UC Sponsor

Date

11/15/18

DO NOT WRITE BELOW – FOR IRB USE ONLY

I approve of the project as written

Signature of UC-IRB Reviewing Member

Date

Nov. 27, 2018

Appendix D

Approval from Mountain View University

Short answer - if you are giving her deidentified data, it is not considered human subjects research and does not need IRB. If she needs verification from our IRB that it is not human subjects research (some places require that), she can fill out the submission form and I would send her an official document from the IRB that it does not require our review. She should also verify with her institutions IRB if they require review or a submission from her as her home institution is the primary IRB.

Long answer - If the dataset has been stripped of all identifying information and there is no way that it could be linked back to the subjects from whom it was originally collected (through a key to a coding system or by any other means), its subsequent use by the lead researcher or another investigator would not constitute human subjects research, since it is no longer identifiable. Identifiable means the identity of the subject is known or may be readily ascertained by the investigator or associated with the information. In general, information is considered to be identifiable when it can be linked to specific individuals by the investigator(s) either directly or indirectly through coding systems, or when characteristics of the information obtained are such that by their nature a reasonably knowledgeable person could ascertain the identities of individuals. Therefore, even though a dataset may have been stripped of direct identifiers (names, addresses, student ID numbers, etc.), it may still be possible to identify an individual through a combination of other characteristics (e.g., age, gender, ethnicity, and place of employment).

Appendix E



Completion Date 25-Sep-2017
Expiration Date 24-Sep-2020
Record ID 24593913

This is to certify that:

Jennifer Pack

Has completed the following CITI Program course:

Social & Behavioral Research - Basic/Refresher (Curriculum Group)
Social & Behavioral Researchers (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Liberty University



Verify at www.citiprogram.org/verify/?wc561b4ab-51ff-46fe-bdff-e95b82848517-24593913