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# The Predictive Validity of Pre-Admission Measures on Podiatric Medical School Performance

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The Predictive Validity of Pre-Admission Measures on  
Podiatric Medical School Performance

by

Kevin M. Smith

Presented to the Faculty of  
the Graduate College at the University of Nebraska  
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The Predictive Validity of Pre-Admission Measures on  
Podiatric Medical School Performance

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University of Nebraska, 2014

Advisor: James Griesen

This study explored the influence of pre-admission measures on podiatric medical school performance. The purpose of the study was to predict which students are most likely to succeed in podiatric medical school when admitted, and potentially decrease the cost of attrition experienced by the student and institution. A review of the literature on medical school admissions was completed and used to develop this research.

Podiatric medical students from a Midwestern institution who enrolled between the years 2000 and 2015 were included as the sample for the study (n = 804). Pre-admission measures that were available for the subjects included Medical College Admission Test scores, Undergraduate Grade Point Average, Science Grade Point Average, ethnicity, age, gender and institutional selectivity of undergraduate institution attended. These measures served as independent variables. The first year podiatric medical school GPA was used as the dependent variable. A multivariate linear regression was used to assess the relationship between performance during the first year of podiatric medical school and the independent variables.

The study also described the use of a composite index for selectivity that was constructed by averaging the Barron's Admissions Selector Rating and Peterson's Four-

Year College rating. To the author's knowledge, a composite index for selectivity has never been described in medical school admission research.

The regression analysis revealed that for the sample of podiatric medical students in this study that UGPA, MCAT biological science, SGPA, composite index for selectivity, gender and age together had a significant effect on the dependent variable ( $F = 30.54, P < .001$ ). These independent variables accounted for 29.7% of the variance in first year GPA.

The study demonstrated that some pre-admission variables such as UGPA, SGPA, MCAT biological science, age, gender and composite index for selectivity were statistically significant in predicting first year podiatric medical school performance and should be considered when screening podiatric medical school applicants in an effort to decrease attrition and future research should include a uniform dependent variable such as national board scores.

## DEDICATION

This is dedicated to my entire family: my wife, Jill; my son, Tyler; and my daughters, Haley and Hannah. I owe this entire process to Jill, for without her none of this would have ever been possible. She has had to be the primary caregiver for our family while I attended graduate school. There were always literature reviews to conduct, papers to write, discussion threads to participate in, advisors and committees to meet with and she has always stepped up and allowed me to pursue my dream of obtaining a second doctoral degree. She is an amazing woman that deserves all of the credit for my accomplishments and her contribution can never fully be paid back or forgotten.

My children have also sacrificed a great deal while I attended graduate school. I have always tried to be there for them and attend as many of the most important events that I could. Although I am sure they appreciated those times, I have missed out on numerous trips to the park, movies and games and that is a burden that I will have to carry with me for the rest of my life. I just want them understand the importance and power of education.

## ACKNOWLEDGEMENTS

This project would not have been possible without the support given to me by so many people along the way. I am blessed to have a circle of family, friends, colleagues, and academic advisors that are understanding at times, critical at times and have always had my best interest at heart.

My wife, Jill, has always supported me and offered encouragement throughout this entire journey from medical school to graduate school. She has always edited my drafts and provided honest feedback on my work. My children, Tyler, Hannah and Haley, have endured numerous absences at events directly related to my coursework.

I am thankful to be surrounded by colleagues that always provide me encouragement through very busy days and months. They have weathered the relentless discussions and complaining related to my research and writing. Without their support none of this would have been possible.

I have been fortunate to have a great group of mentors with me during this process. First, Dr. Tom Westbrook was aware of my goals and pushed me to improve my thought process and writing skills throughout graduate school. Second, Dr. Tim Yoho is the living example of a higher education administrator and someone I look up to and try to emulate. Lastly, Dr. James Griesen has always been there to answer my questions and guide me through this process. I would also like to thank all of my committee members, Dr. Miles Bryant, Dr. Larry Dlugosh, and Dr. David Crouse for their support.

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## Chapter 1

### Introduction

#### Background

It is difficult to predict which podiatric medical school<sup>1</sup> applicants will be successful in medical school. Most medical schools rely on pre-admission measures or variables contained within the applicant's file such as the undergraduate cumulative grade point average (UGPA)<sup>2</sup>, undergraduate cumulative science grade point average (SGPA)<sup>3</sup>, Medical College Admission Test (MCAT) score<sup>4</sup>, as well as institutional selectivity<sup>5</sup>. Each of these factors aids in the selection of students by decreasing the size of applicant pools, determining which students are granted an interview. Although extensive research on this subject has been done in allopathic and osteopathic medicine, few studies have been conducted in podiatric medicine. It is also presumptuous to conclude that the predictive value of pre-admission measures would be the same for podiatric medical school applicants since there are not as many qualified applicants.

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<sup>1</sup> Podiatric Medical School: Medical school that grants a Doctor of Podiatric Medicine degree (DPM). A Doctor of Podiatric Medicine specializes in the diagnosis and treatment of disorders in the foot and ankle.

<sup>2</sup> Undergraduate Cumulative Grade Point Average (UGPA): The average cumulative grade earned by a student that is figured by dividing the grade points earned by the number of graded credits attempted.

<sup>3</sup> Undergraduate Cumulative Science Grade Point Average (SGPA): The average cumulative grade earned by a student in science courses that is figured by dividing the grade points earned by the number of credits attempted.

<sup>4</sup> Medical College Admission Test (MCAT): Standardized admission examination designed to assess knowledge of basic concepts in biology, chemistry, and physics. The examination also includes an essay component.

<sup>5</sup> Institutional Selectivity: Classification of undergraduate institutions based on admission selectivity. Classification criteria typically include freshman entrance examination scores, high school class rank percentile, and application-to-acceptance ratio. A highly selective institution typically has a freshman profile of high entrance examination scores and accepts a small percentage of applicants.

Podiatric medical school applicants have lower UGPA's and MCAT scores when compared to allopathic and osteopathic medical applicants (see Table 1).

Table 1

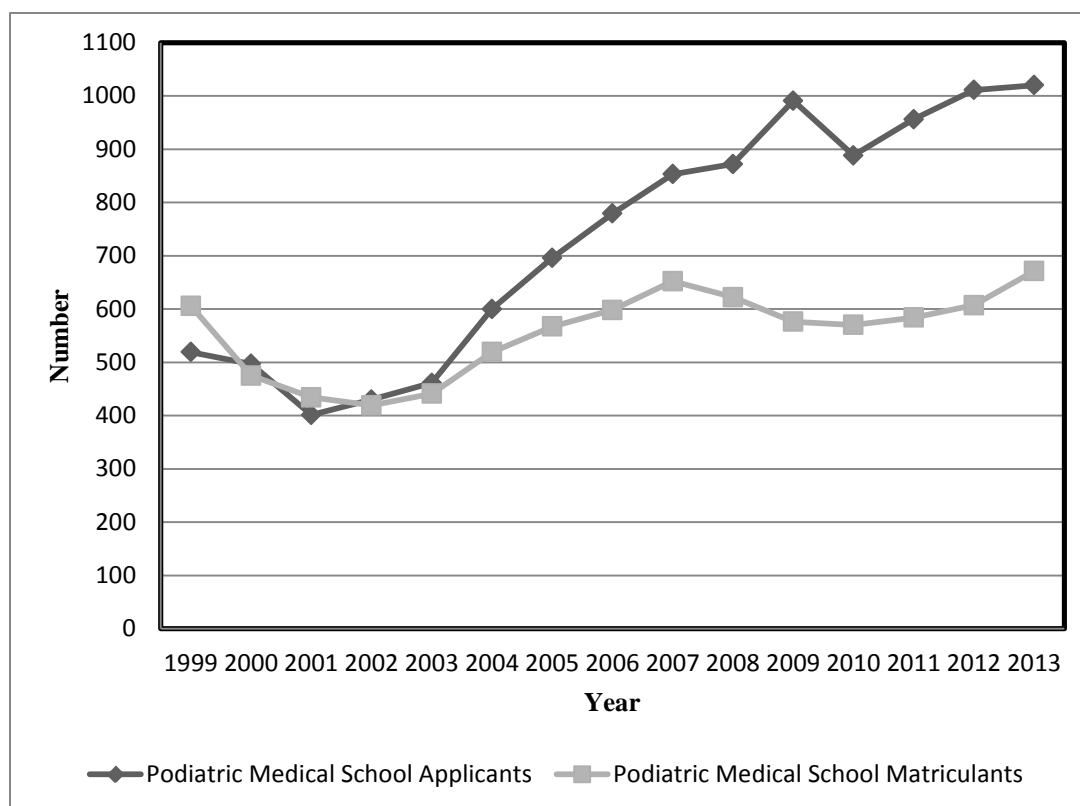
*Allopathic, Osteopathic and Podiatric Medical Student Pre-admission Measures for 2013*

	<u>Allopathic Medicine</u>		<u>Osteopathic Medicine</u>		<u>Podiatric Medicine</u>	
	Applicants	Matriculants	Applicants	Matriculants	Applicants	Matriculants
MCAT						
VR	9.1	10.0	8.4	8.7	6.6	6.8
PS	9.5	10.6	8.4	8.7	6.8	7.0
BS	9.8	10.8	9.0	9.4	7.1	7.4
GPA						
Science	3.44	3.63	3.27	3.38	3.00	3.20
NS	3.66	3.76	3.54	3.60	3.50	3.50
Overall	3.54	3.69	3.42	3.50	3.20	3.30

*Note.* VR = verbal reasoning; PS = physical science; BS = biological science; NS = non-science.  
(Source: American Association of Colleges of Osteopathic Medicine, 2013; American Association of Colleges of Podiatric Medicine, 2013; Association of American Medical Colleges, 2013)

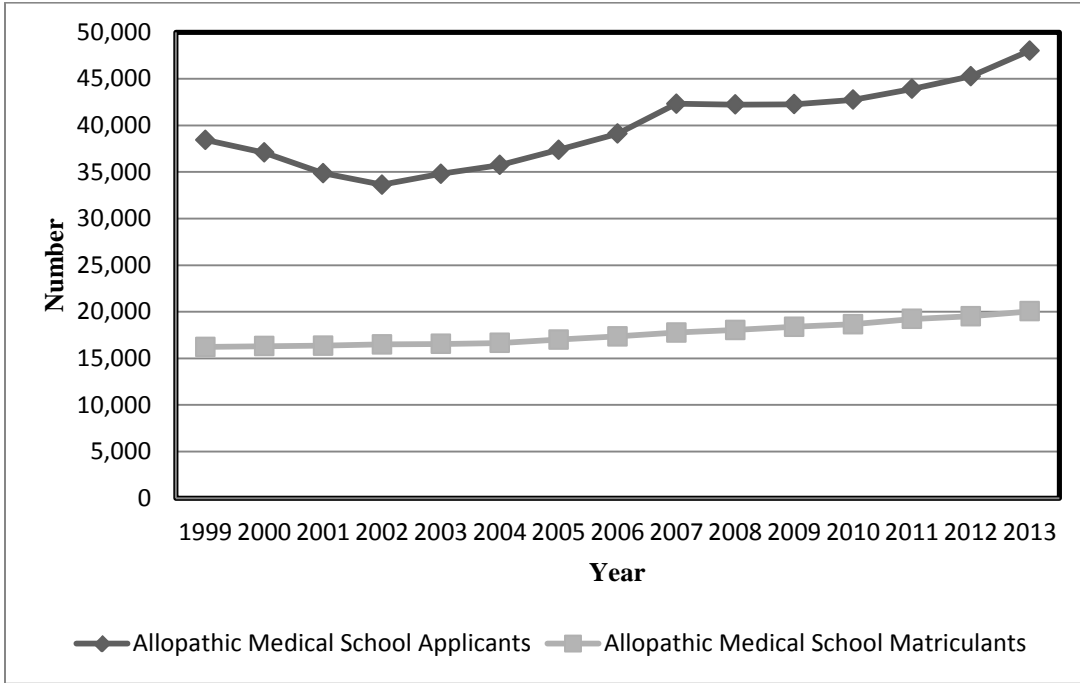
It is noteworthy that in podiatric medicine the matriculant GPA and MCAT scores are essentially identical to the applicant scores. This indicates that the academic quality of the applicant pool is not that much different from those admitted to the first-year in podiatric medical school and reflects the fact that the applicant pool in podiatric medicine is only slightly larger than the number of first-year seats available.

The applicant pool in podiatric medicine has been increasing in recent years, but still lags significantly below allopathic and osteopathic medicine (see Figures 1, 2, and 3).



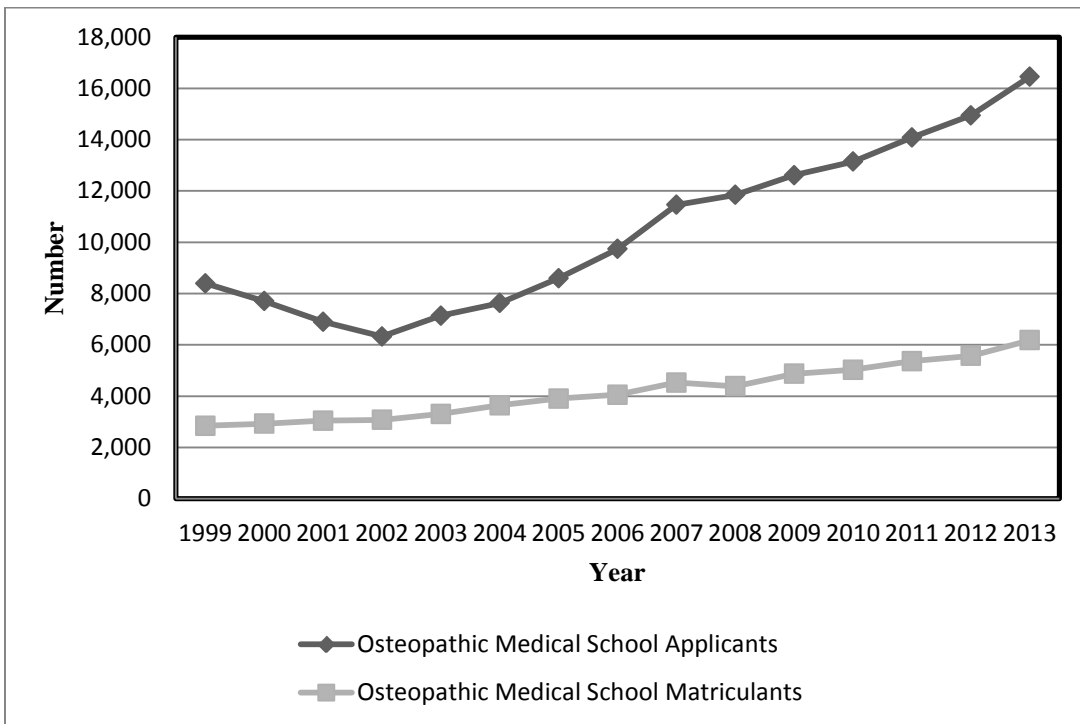
There were more matriculants than applicants in 1999 and 2001 because the New York College of Podiatric Medicine and Surgery was not part of the podiatric central application service until 2005 (Source: American Association of Colleges of Podiatric Medicine, 2005, 2013)

*Figure 1.* Podiatric medical school applicants and matriculants.



(Source: Association of American Medical Colleges, 2005, 2103)

Figure 2. Allopathic medical school applicants and matriculants.



(Source: American Association of Colleges of Osteopathic Medicine, 2005, 2013)

Figure 3. Osteopathic medical school applicants and matriculants.

Over the last ten years the average applicant-to-matriculant ratios in allopathic, osteopathic and podiatric medicine have been 2.29, 2.53 and 1.45, respectively (American Association of Colleges of Podiatric Medicine, 2013; American Association of Colleges of Osteopathic Medicine, 2013; Association of American Medical Colleges, 2013).

Since applicant pools in allopathic and osteopathic medicine are larger, these institutions utilize pre-admission measures to screen out unqualified applicants and interview a smaller number of applicants for admission to medical school. The podiatric medicine applicant pool is slightly larger than the number of seats available for matriculants and schools do not have the luxury of screening out unqualified applicants prior to interviews. In previous years, the podiatric medical profession admitted almost every applicant from the national pool and this lack of admission selectivity could increase the risk of attrition. The students that matriculate at the study institution have traditionally been stronger candidates based on pre-admission measures (see Table 2). As other institutions strive to improve their programs, knowing which variables are the most reliable in predicting which students are most likely to succeed when admitted can minimize the financial impact incurred by the student and institution due to attrition.

The cost of attrition is difficult to determine and there have been no studies published that assess the impact of student attrition on the medical students or the institutions. Dunleavy, Kroopnick, Dowd, Searcy, and Zhao (2013) stated that a medical student's progress through medical school has individual, institutional and societal implications. They also demonstrated that pre-admission variables such as the MCAT predicted unimpeded student progress toward graduation. Internal data from the study

Table 2

*Podiatric Medical Student Pre-admission Measures for 2013*

	<u>All DPM Institutions</u>		<u>Study Institution</u>	
	Applicants	Matriculants	Applicants	Matriculants
MCAT				
VR	6.6	6.8	7.4	8.1
PS	6.8	7.0	7.4	7.4
BS	7.1	7.4	7.8	8.2
GPA				
Science	3.00	3.20	3.04	3.30
Overall	3.20	3.30	3.21	3.45

*Note.* VR = verbal reasoning; PS = physical science; BS = biological science; NS = non-science. (Source: American Association of Colleges of Podiatric Medicine, 2013; K. Gross, College of Podiatric Medicine and Surgery at Des Moines University, personal communication, May 1, 2013)

institution provides some indication of the impact of attrition on the institution. The tuition cost incurred by podiatric medical students at the study institution averaged \$24,610 from fiscal year 2004 to 2013. The lost revenue from student attrition has totaled \$4,551,076 over the last ten fiscal years when you calculate the cost of tuition over four years (see Table 3). Dunleavy et al. (2013) also discuss the opportunity cost incurred by the institution. This is demonstrated by the lost opportunity to fill slots with other students instead of those that were dismissed for academic reasons.

The financial impact of attrition incurred by the student is not just the expense for tuition. The cost of attendance also includes books, health insurance, transportation, loan fees and living expenses such as rent, food, and utilities. The average cost of attendance



Table 3

*Student Tuition Cost and Lost Revenue Summary*

	2004	2005	2006	2007	2008	
Total Revenue from tuition	2,471,439	2,831,090	3,095,291	3,710,512	4,482,984	
Tuition per student/year	20,625	21,125	21,760	23,300	23,885	
Lost revenue from student withdrawals/dismissal	380,542	594,556	451,684	312,476	483,415	
	2009	2010	2011	2012	2013	Total
Total Revenue from tuition	5,028,975	5,437,784	5,665,422	5,377,055	5,381,963	43,482,515
Tuition per student/year	24,960	25,960	27,320	28,160	29,006	
Lost revenue from student withdrawals/dismissal	309,068	380,003	484,971	616,155	538,206	4,551,076

Note. Dollar values listed are for specific years and are not adjusted for inflation.

(Source: M. Pieffer, Accounting Department at Des Moines University, personal communication, June 11, 2014)

at the study institution in 2013 was \$55,174. Institutional data demonstrates that the average debt load for podiatric medical students after four years of education has risen to \$174,934 or \$43,733.50 per year in 2013 (see Table 4). Dunleavy et al. (2013) support these debt figures by stating that the median cost of attendance in 2012 at U.S. medical schools was \$53,685 for public institutions and \$72,344 at private institutions. The average debt load at allopathic institutions was also \$170,000 for the same time period.

Table 4

## Student Indebtedness

Class Year	Number of Graduates	Number of Students with Loans	Percent of Students with Loans	Average Loan Debt of Borrowers	Number of Students with No Loans
1998	54	50	92.5	\$128,139	4
1999	46	45	97.8	\$137,144	1
2000	43	43	100.0	\$138,420	0
2001	42	42	100.0	\$144,031	0
2002	45	43	95.5	\$135,450	2
2003	29	28	96.5	\$136,660	1
2004	23	20	86.9	\$135,417	3
2005	38	37	97.3	\$147,292	1
2006	31	29	93.5	\$147,732	2
2007	27	27	100.0	\$139,807	0
2008	41	39	95.1	\$161,461	2
2009	47	46	97.9	\$162,125	1
2010	53	49	92.4	\$169,034	4
2011	61	56	91.8	\$159,316	4
2012	55	51	92.7	\$171,901	4
2013	44	42	95.5	\$174,934	4

Note. Dollar values listed are for specific years and are not adjusted for inflation.

(Source: Internal data from Office of Financial Aid at Des Moines University, personal communication, May 20, 2014)

Students who withdraw or fail out of podiatric medical school most likely do so during the first year and since tuition is paid on a semester basis, the approximate financial impact of attrition for a students is \$14,503 if they withdraw during the first

semester and \$29,006 if they withdraw during the second semester. These figures only capture podiatric medical school tuition and do not include other cost of attendance items such as books, health insurance, transportation, loan fees and living expenses. The figures also do not capture lost wages that could have been earned by the unsuccessful student if they had not matriculated.

The loan default rate for the study institution reported by the Department of Education has averaged 0.13% over the last three years. The Department of Education reports the institutional default rate and this is not broken down to reflect the specific college default rate. The default rate is calculated by dividing the number of borrowers who defaulted over a two year period by the total number of borrowers during the same two year time period. The default rate can be misleading because of the manner in which it is calculated. Each borrower is given a 6-month grace period and the time period used for the calculation is actually 18 months with the addition of the grace period. A student technically only has to make their loan payments for 18 months before they are excluded from the institutions loan default report (U.S. Department of Education, 2005a, p. 3). The stakes for the institution and the student are quite high and identifying the students that are most likely to succeed in podiatric medical school is critical.

The use of pre-admission measures is a common practice in the medical school admissions process. Koenig, Parrish, Terregino, Williams, Dunleavy and Volsch (2013) suggest that a significant part of admission screening occurs prior to the medical school interview. In fact the average applicant to allopathic medical school submitted 14 applications and only received two interviews (Association of American Medical Colleges, 2012). A mixed-methods study by Mitchell (1987) reported that admissions

officers rated pre-admission measures as highly important in processing applications. The pre-admission criteria indicate past performance, serve as a measure of an applicant's academic ability and are thought to be a predictor of future performance. Monroe, Quinn, Samuelson, Dunleavy and Dowd (2013) surveyed 120 admission officers at allopathic medical institutions and found that 68% of the schools utilize the MCAT and 77% use UGPA to predict performance in the basic sciences. However, there is debate amongst admissions officials regarding the ability of pre-admission variables to predict medical school performance.

Some authors have chosen to correlate pre-admission variables to pre-clinical performance as defined by first year medical school GPA and licensing examinations. Mitchell (1987) stated that the MCAT scores and UGPA can substantially predict student performance in the basic science or pre-clinical years of medical school. Shen and Comrey (1997) have also demonstrated that pre-admission variables are able to predict success on licensing examinations. Dunleavy et al. (2013) stated that certain pre-admission variables such as UGPA and MCAT predicted unimpeded progress toward graduation.

Others have used clinical performance to define success and presented contrary evidence regarding the validity of pre-admission variables. In their quantitative study, Silver and Hodgson (1997) stated that mean clinical performance as measured by clerkship grades was not related to any pre-admission variables.

Authors on both sides of the debate agree that institutional selectivity or measure of undergraduate academic rigor is an important factor when evaluating certain pre-admission variables such as UGPA (Clapp & Reid, 1976; Silver & Hodgson, 1997).

In a quantitative study, Jones and Adams (1983) stated that MCAT scores are able to confirm a student's level of academic achievement, regardless of undergraduate institution.

Additional characteristics such as age, race and gender are also contained in applicant files and utilized in admissions research, but not to deny admission due to legality. Ramsbottom-Lucier, Johnson, and Elam (1995) reported in a quantitative study that younger matriculants had significantly higher UGPA and SGPA than their older peers, but no performance difference was found on the MCAT. Reiter, Lockyer, Ziola, Courneya, and Eva (2013) found that UGPA and MCAT were negatively correlated with age. Several authors have asserted that men perform better on the MCAT than women (Ramsbottom-Lucier et al., 1995; Weinberg & Rooney, 1973). Research has demonstrated that minority student performance on the MCAT is lower than majority students (Association of American Medical Colleges, 2007; Shea & Fullilove, 1985).

Non-psychometric factors such as applicant interview and letters of recommendation are used to determine a student's acceptance, but the psychometric measures provide admissions officers the opportunity to make direct comparisons amongst podiatric medical school applicants. The non-psychometric criteria previously studied demonstrate that the validity is low when compared to psychometric measures (Benbassat & Baumal, 2007; Shaw, Martz, Lancaster, & Sade, 1995). Eva and Reiter (2004) suggested that applicants which rate high on non-psychometric measures also tend to rate high on psychometric measures as well. This chapter describes the rationale for using pre-admission measures in the medical school selection process and reviews the

relevant literature related to pre-admission measures and student characteristics such as age, race and gender.

### **Statement of the Problem**

Due to the cost of attrition for the student and the institution, podiatric medical school administrators need to predict which students are most likely to succeed in podiatric medical school when admitted. Although similar research has been conducted in allopathic medicine, there has not been a multi-year study conducted in podiatric medicine, and applying previous research from a different profession such as allopathic medicine can be problematic. Podiatric medicine applicant pools are slightly larger than the seats available and in some instances were almost equal. The size of the podiatric medical school applicant pool does not allow podiatric medical institutions to be as selective as allopathic medical institutions. The podiatric medical school applicant pools also have lower pre-admission measures and applying results from stronger allopathic applicants to podiatric medical school applicants may result in rejecting too many applicants that could otherwise be successful and prevent administrators from filling incoming classes. Podiatric medical school administrators often have to fill all of their available first-year seats for budgetary reasons and identifying potential applicants from the podiatric medical school applicant pool that will persist in podiatric medical school is extremely important.

### **Research Question**

How can admissions officers better predict which applicants will be successful during their first-year of podiatric medical school by examining pre-admission measures,

thus reducing the cost of attrition incurred by the student and minimizing lost revenue for the college?

### **Hypotheses**

This study used a multivariate linear regression with ten independent variables to predict first year GPA in a podiatric medical school. The independent or predictor variables were selected based on their importance in predicting student success in medical schools in prior investigations. The following are the research hypotheses:

- H<sub>1</sub>: Controlling for all other predictor variables in the model, the combined Baron's and Peterson's institutional selectivity index is a significant predictor of first year GPA in a podiatric medical school.
- H<sub>2</sub>: Controlling for all other predictor variables in the model, MCAT section scores are a significant predictor of first year GPA in a podiatric medical school.
- H<sub>3</sub>: Controlling for all other predictor variables in the model, UGPA is a significant predictor of first year GPA in a podiatric medical school.
- H<sub>4</sub>: Controlling for all other predictor variables in the model, SGPA is a significant predictor of first year GPA in a podiatric medical school.
- H<sub>5</sub>: Controlling for all other predictor variables in the model, ethnicity is a significant predictor of first year GPA in a podiatric medical school.
- H<sub>6</sub>: Controlling for all other predictor variables in the model, age is a significant predictor of first year GPA in a podiatric medical school.
- H<sub>7</sub>: Controlling for all other predictor variables in the model, gender is a significant predictor of first year GPA in a podiatric medical school.

H<sub>8</sub>: By optimally weighting selected pre-admission variables podiatric medical schools can maximize their ability to predict which applicants will succeed in podiatric medical school.

For each research hypothesis the null hypothesis statement will be derived for the purpose of statistical testing.

### **Methodology**

The study utilized the following independent variables that represented MCAT, UGPA, SGPA, gender, age, ethnicity, and institutional selectivity that included the Barron's Admissions Selector Rating and Peterson's Four-Year Colleges guide. The dependent variable represented the first year podiatric medical school GPA. The study consisted of performing a univariate analysis of the independent variables and first year podiatric medical school GPA which was represented in the study as a percentage value to assess if the variables were normally distributed, as is required for use in a multiple regression modeling. The only independent variables that were not included in the univariate analysis were gender and ethnicity because they were binary variables. A bivariate correlation technique was used to model the relationships between first year podiatric medical school GPA and the independent variables. The study then utilized a multivariate linear regression technique to model the relationships between first year podiatric medical school GPA and the independent variables. This technique was ideal for the purposes of this research because it allowed the investigator to assess the relationship between one research variable that can be logically designated as a dependent variable and other variables that can be designated as independent variables.



## Definition of Terms

Terms used in this study are operationally defined in the following manner:

*Undergraduate Cumulative Grade Point Average (UGPA)*—The average cumulative grade earned by a student that is figured by dividing the grade points earned by the number of graded credits attempted.

*Undergraduate Cumulative Science Grade Point Average (SGPA)*—The average cumulative grade earned by a student in science courses that is figured by dividing the grade points earned by the number of graded credits attempted.

*Medical College Admission Test (MCAT)*—Standardized admission examination designed to assess knowledge of basic concepts in biology, chemistry, and physics. The examination also includes an essay component.

*Institutional Selectivity*—Classification of undergraduate institutions based on admission selectivity. Classifications often include freshman median entrance examination score, class rank and number of applicants accepted to the institution. A highly selective institution typically has a freshman profile of high entrance examination scores and accepts a small percentage of applicants.

*Allopathic Medical School*—Medical school that grants a Medical Doctor degree.

*Osteopathic Medical School*—Medical school that grants a Doctor of Osteopathy degree.

*Scholastic Aptitude Test (SAT)*—A standardized multiple-choice college entrance examination consisting of math and verbal components.

*American College Testing (ACT)*—A standardized multiple-choice college entrance examination that consists of English, mathematics, reading and science components. There is also an optional writing test.

*Podiatric Medical School*—Medical school that grants a Doctor of Podiatric Medicine degree (DPM).

*Chiropodist* – Doctor that specializes in the treatment of disorders of the foot. Typically involves treatment of condition relating to corns, calluses and nail disorders.

*Podiatrist* – Doctor that specializes in the medical and surgical treatment of all disorders of the foot and ankle.

### **Delimitations and Limitations**

This study was delimited to data collected from one podiatric medical school in the Midwest and although the findings may be used by other podiatric medical schools, the results are not generalizable to other podiatric medical schools or medical professions. A potential limitation of the study was the phenomenon of restriction of range for some variables such as MCAT scores, UGPA, and SGPA. When the full ranges of variables are not permitted to enter the analysis because applicants with lower grade point averages and MCAT scores are not admitted to Podiatric Medical School, the correlations may have been artificially lowered. Another limitation of the study was the institutional selectivity index and the point at which institutions were categorized. These data were coded using the most recent institutional selectivity indices and since this data set spans 15 years the institutional selectivity rating of institutions may have changed over time.

## **Chapter 2**

### **Literature Review**

Podiatric medical schools have fewer applicants to the profession than allopathic and osteopathic medicine and this creates a situation where it is critical to identify the matriculants that are most likely to succeed because the cost of attrition can greatly impact the student and the institution.

On the surface, it is easy to conclude that a body of research from similar professions would produce similar results. However, this may not be the case since the student populations are quite different in size and ability. It is also important to understand the history of the profession in order to set the stage for the basis of this research. Podiatric medicine is a younger profession when compared to allopathic and osteopathic medicine and it is important to provide a brief historical review of the profession. Levy (2006, p. 1) also illuminates this distinction by stating that compared to the long history of the profession of medicine, podiatric medicine is in a formal sense a relatively new discipline.

#### **History of Podiatric Medicine and Podiatric Medical Education**

Podiatric medicine, as it is known today, was previously called chiropody in the 18th century and podiatry in the early 20th century. In 1785, D. Low was the first person to use the term chiropodist (Lerner, 1974; Levy, 2006, p. 2). Early chiropodists had no medical training and were in essence analogous to barbers. Chiropody in the 18th century was primarily a European profession. In 1830, chiropodist came to the United States and started to open practices, largely located in storefronts (Levy, 2006, p. 2).

The first school in the profession was established in New York; called the New York College of Chiropody (Gibley, 1987). By the end of the 1920's, three additional chiropody colleges had opened in Illinois, Ohio and California respectively. The first two colleges were opened by allopathic physicians (Levy, 2006, p. 3). In 1918, Felix Von Defele coined the term podiatry and this resulted in all of the colleges changing their names to Colleges of Podiatry or Podiatric Medicine (Lerner, 1974). In 2009, nine colleges of podiatric medicine existed in the United States.

Prior to 1918, a student could enroll in a College of Chiropody without a high school diploma and the chiropody curriculum at that time was one year in length. In 1923, a high school diploma and two years of full-time study in a podiatry school was required to practice podiatry. In 1949, all podiatric colleges went to a four year curriculum, but still only required one year of college for admission. It wasn't until 1978 that all podiatric colleges required a minimum of three years of college and the same prerequisite courses as allopathic and osteopathic medicine prior to admission (Levy, 2006, p. 5). Although podiatric medical schools now have the same requirements as allopathic and osteopathic schools, the profession was already quite established before this change occurred. The discrepancy in admission requirements partially explains the lack of integration into traditional allopathic and osteopathic medical education and practice. The beginning of the podiatric medical education profession as it is known today essentially began with the change in admission requirements in 1978.

The disparity in admission requirements also explains the lack of acceptance of podiatric medicine in traditional medical circles. Another aspect relating to the lack of acceptance is the type of degree that was conferred by podiatric medical schools. In 1916,

colleges were granting Doctor of Surgical Chiropody (D.S.C.) degrees to students that had not even graduated high school (Gibley, 1974; Levy, 2006, p. 3). The current Doctor of Podiatric Medicine (D.P.M.) was not granted by all schools until 1971 (Gibley, 1974). This is still seven years prior to mandating the same admission requirements as allopathic and osteopathic medicine. This lack of acceptance was illustrated by Stanabak of the National Association of Chiropodists in 1914 when he warned chiropodists not to use the title Doctor on professional cards, since to do so would antagonize physicians (Levy, 2006, p. 3).

Early in the 20th century, the medical profession recognized that a problem existed with the education and training of physicians and prompted the educational system to be studied (Gibley, 1987). Flexner (1910) ultimately provided recommendation that led to major changes in medical education. The current basic science/clinical science curriculum model used by allopathic and osteopathic medical schools today can be traced back to the Flexner Report. Gibley (1987) stated that the podiatric profession also recognized its deficiencies within podiatric medical education and commissioned the Selden Report, the podiatry equivalent of the Flexner Report, in 1961. The Selden Report was designed to stimulate improvements in podiatric medical education through numerous recommendations.

The most significant recommendation from Selden was to establish and implement more rigorous admission standards which eventually occurred 17 years after the report in 1978. One facet of this recommendation that did happen quickly was the creation of the College of Podiatry Admission Test (CPAT) that was ultimately replaced by the Medical College Admission Test (MCAT) in 1978 (Gibley, 1987).

In 1973, the American Podiatry Association recommended that any new podiatric medical school be established in academic health centers. Gibley (1987) stated that the rationale for university affiliation of podiatric medical schools has had numerous supporters from outside the profession and within the profession. Pellegrino (1973) stated the following:

Podiatry can realize its full potential only if it becomes a full and active member of the health care team, and this can happen only if podiatrists are educated in the academic health centers, enjoying the privileges and the pains of a dynamic relationship with the other health professions, all of whom have an ethical responsibility to redefine their roles in the light of public needs. (p. 12)

This sentiment is also echoed by Levy (1977):

The appropriate place for podiatric medical education at all levels is the academic health science center. In addition to improving the quality of education in the profession, such an environment will better prepare podiatrists to accept their role in an increasingly more complex and interdisciplinary health care system. Resources for educational, clinical, and research activities previously unavailable to podiatric medical colleges are potentially available in academic health science centers. Of great importance is the opportunity for students and faculty from podiatric medicine and other professions to interact and clarify their roles as well as begin the communication process necessary to resolve interdisciplinary conflicts. (p. 20)

As a strong advocate of podiatric medical schools affiliating with academic health science centers, Levy opened a podiatric medical school within the State University of New York at Stony Brook in 1974, but the school closed a year later due to a severe fiscal crisis in the state of New York (Gibley, 1987). Levy then opened a new podiatric medical school that was affiliated with an osteopathic medical school in Des Moines, Iowa in 1982. Since the American Podiatry Association recommendation in 1973, only four of the nine podiatric medical schools are associated with academic health science centers. Des Moines University is the only podiatric medical school that is fully

integrated with an allopathic/osteopathic medical school requiring its students to take the same classes and examinations as osteopathic medical students.

In 2007, the American Podiatric Medical Association (APMA) developed the Vision 2015 plan which calls for Doctors of Podiatric Medicine to be universally recognized as physicians within our education, training and experience by the year 2015 (Taubman, 2009). The only portion of the plan regarding education calls for podiatric medicine to develop comparable competencies to allopathic and osteopathic medicine. The plan is inherently flawed because it views matriculation as the starting point of the podiatric medical education process. The plan does not recognize the fact that the podiatric medical profession has applicant pools slightly larger than the available seats for matriculants or that the academic quality of the applicant pool as measured by GPA and MCAT scores is much weaker than its allopathic and osteopathic counterparts.

### **Undergraduate Cumulative and Science Grade Point Average**

The UGPA and SGPA are used extensively by medical schools as a measure of a student's previous academic performance and possible predictor of future performance (Smith & Geletta, 2010). In addition to selecting students who are likely to succeed in medical school, these variables are also used to reduce applicant pools to a more manageable size (Jackson & Dawson-Saunders, 1987). The UGPA and SGPA seem to have the ability to predict performance during the pre-clinical phase of medical school, but have less value in predicting performance on medical licensing examinations and clinical practice (Smith & Geletta, 2010).

Investigators such as Daubney, Wagner and Rogers (1981), Hall and Bailey (1992), and Nowacek, Pullen, Short, and Blumner (1987) have found that UGPA were

relatively strong predictors of academic success in medical school. Hall and Stocks (1995) pointed out that the SGPA correlates significantly with pre-clinical performance. Friedman and Bakewell (1980) suggested that the SGPA is the most important predictor variable. Several studies have demonstrated that when a student's UGPA is low, he or she may experience academic difficulty (Jackson & Dawson-Saunders, 1987). Hendren (1988) found that the likelihood of academic difficulty increased when a student's UGPA was lower than 3.0. Huff and Fang (1999) demonstrated in a quantitative study that students were more likely to encounter academic difficulty with a SGPA below 3.25.

Although numerous studies suggested that the UGPA and SGPA have the ability to predict medical school performance, McGaghie (1990) adamantly disagreed with this notion. In his literature review, he stated that the presumed link between aptitude for medical education as measured by the MCAT and UGPA is weak. He supported his contention by reporting that the study correlations of other researchers drop when students move from the lecture hall to the clinic. He continued by reporting that others have also been unable to demonstrate that measures of aptitude relate to professional conduct. McGaghie's assumptions are correct; however previous studies have set out to identify which students would be successful in medical school, not which students would be competent physicians. Most authors agree that the UGPA is a better indicator of pre-clinical (lecture hall) performance than clinical performance (Hall & Bailey, 1992; Markert, 1985; Silver & Hodgson, 1997). Huff and Fang (1999) also pointed out that the majority of student dismissals and withdrawals occur during the first year of medical school.



The use of UGPA alone as a variable to predict medical school performance is considered by some to be inaccurate because of the differences in academic rigor between undergraduate institutions and the possibility that the UGPA reflects disparate grading procedures (Silver & Hodgson, 1997). Clapp and Reid (1976) found that an adjusted UGPA that takes into account an undergraduate school's institutional selectivity was more useful than the raw UGPA. Sarnacki (1982) also advised that predicting future medical school performance is tenuous when the UGPA is not adjusted for institutional selectivity through a quantitative study.

Didier, Kreiter, Buri and Solow (2006) state that grading standards vary widely across undergraduate institutions and if the UGPA is considered without reference to the institution attended then it will disadvantage applicants from institutions with rigorous grading standards. Salvatori (2001) suggests that if grades are not comparable across institutions or programs then their reliability is threatened.

An additional factor that is relevant to UGPA and academic rigor is grade inflation. Felton and Koper (2005) suggest that grade inflation has diminished the utility of the UGPA and recommended a simple adjustment that compensates for grade inflation. They posit that a nominal or actual GPA be reported on transcripts, but a real GPA that is calculated using the GPA of all the students in the class should also be included. This would allow admissions committees to directly compare a student to his or her peers in the same class.

Other institutions have also tried similar methods of GPA adjustment to account for grade inflation. Dartmouth reports a student's grade in an individual class, the median grade for all student's in the same class and the total enrollment for the class on

transcripts (Felton & Koper, 2005). Indiana University utilizes the class GPA, which is the average of the GPA's of all the students in the class. They also calculate an index which is the number of students in the course receiving the same grade or higher grade divided by the total number of grades given in the course in addition to the student's grade for comparison (McConahay & Cote, 1998). Duke University attempted to formalize a GPA index that took into account the performance of other students in a particular class, but this concept was rejected by the faculty (Johnson, 1997). If the GPA potentially contains institutional bias, then using an unadjusted GPA for ranking medical school applicants may be an unfair practice (Didier et al., 2006).

The presence of grade inflation is thought to be an issue between institutions, but also can exist within institutions. In a study by Beck (1999) at the University of Wisconsin, the GPA in the department of curriculum and instruction was 3.90 and in mathematics was 2.64. The disparate grading between departments could influence the undergraduate major chosen by students because of the impact it may have on medical school admission. Johnson (1997) states that grades represent the currency of education and grade inflation or a lack of precision in the grading process can have a profoundly negative influence on higher education and medical school admission.

Some authors have suggested that relying on the UGPA may be unfair because it may include student grades from a semester or year in which he or she underperformed and it is not a true measure of their academic ability. Trail, Reiter, Bridge, Stefanowska, Schmuck, and Norman (2008) posit that institutions should weight recent experience more heavily on the basis of academic abilities and discount the worst year or choose only the best year or best two years as a better measure of capability. They continue by

stating that it is fairer to under-weight weak academic years under the assumption that academic under performance is due to presumptive stress filled events.

Trail et al. (2008) studied different grade weighting schemas and their correlation with academic success in medical school. They examined traditional UGPA with equal weighting throughout the entire four years of undergraduate study, progressive weighting with the emphasis on more recent academic experience, and with emphasis on the best two years of undergraduate study. They found extremely high correlations of 0.973 to 0.990 and concluded that regardless of the algorithm employed, students would be rank-ordered similarly. In essence, good students remain so across academic years, as do poor students. To date there have been no studies that specifically evaluate a positive or negative grade trend in allopathic or osteopathic medicine.

Jones and Thomae-Forgues (1984) cautioned that the UGPA is not standardized, but is based on repeated assessments of a student's performance over a period of time. They affirmed that a shortcoming of using the MCAT as a variable is that it is based on a single performance in an artificial setting and suggested that the UGPA and MCAT should complement one another. In fact, numerous quantitative studies showed that the predictive value of admission variables increased when the UGPA and the MCAT are utilized together (Koenig, Sireci & Wiley, 1998; Shen & Comrey, 1997; Wiley & Koenig, 1996).

Markert (1985) found that the pre-admission variables of UGPA and MCAT were not that successful in predicting clinical performance in medical school. Silver and Hodgson (1997) also confirmed this finding by stating that the predictive value of the UGPA and MCAT appears to decrease as students progress to the clinical years. The

UGPA was also found to be a weak predictor of performance on the first part of the allopathic licensing examination (Julian, 2005; Nowacek et al., 1987).

Even though some researchers posit that the UGPA has some issues related to reliability due to the academic rigor of institutions and possible grade inflation, others believe that these issues solidify the need for admissions committees to rely on a standardized examination such as the MCAT. The MCAT examination is taken by every prospective medical student and serves as a benchmark that can be used to evaluate applicants irrespective of UGPA and undergraduate institution attended.

### **Medical College Admission Test**

The MCAT is a multiple choice standardized examination intended to assess the ability to acquire knowledge in medical school as well as higher-order processes such as clinical reasoning and the application of knowledge into clinical practice or aptitude for medicine (Collin, Violato, & Hecker, 2008). The examination was revised in 1991 to include four sections designed to assess knowledge of basic concepts in biological sciences, physical sciences, verbal reasoning, and writing sample (Gilbert, Basco, Blue, & O'Sullivan, 2002; Mitchell, Haynes, & Koenig, 1994). The biological science, physical science, and verbal reasoning sections are scored on a numerical scale from 0 to 15 and reported as individual section score, but some medical schools utilize the total score of the three subsections.

The writing sample consists of two 30-minute essay questions designed to assess analytical thinking and writing skills (Collin et al., 2008; Gilbert et al., 2002). Each essay is evaluated by two readers and graded on a six point scale. The final score is determined by summing the score of each rater for a total possible of 4 to 24 points. The 21 point

numeric scale is then converted to an 11 point alphabetic scale having a low score of J and a high score of T (Gilbert et al., 2002; Hojat et al., 2000). Gilbert et al. (2002) studied the inter-rater reliability of the writing sample and found that it ranged between .68 and .78.

The MCAT scores may also have the ability to confirm a student's level of undergraduate achievement by providing an opportunity to be assessed with standard content on a standard scale irrespective of undergraduate institution origin, which is not possible due to the variability in grading at different institutions (Jones & Adams, 1983). In a quantitative study, Nowacek et al. (1987) stated that the MCAT provides a standard measure of performance on which all applicants can be compared regardless of their specific backgrounds and education.

The relationship between the MCAT and its ability to predict those most likely to succeed in medical school is well documented in the literature (Smith & Geletta, 2010). Huff and Fang (1999) found that students with lower MCAT scores are more likely to encounter academic difficulty in medical school. Their study revealed that 26% of students with a mean MCAT score below seven did not have academic difficulty. Multiple studies have examined the predictive validity of the MCAT combined with the UGPA to determine to what extent these variables aid in predicting performance.

Wiley and Koenig (1996) found that MCAT scores had higher correlations with medical school grades than UGPA, and the combination of variables revealed even more significant correlations. The correlation was .67 for the MCAT and .58 for UGPA, but when the two predictors were combined the correlation improved to .76. Other authors have presented similar findings and state that although the MCAT alone is a good

predictor of medical school performance, its predictive value increases when combined with UGPA (Donnon, Paolucci & Violato, 2007; Koenig et al., 1998; Shen & Comrey, 1997; Vancouver, Reinhart, Solomon & Haf, 1990; Veloski, Callahan, Xu, Hojat, & Nash, 2000). Conversely, several quantitative studies have demonstrated that the MCAT was more valuable as a predictor of performance on licensing examinations than UGPA (Jones & Thomae-Forgues, 1984; Shen & Comrey, 1997; Veloski et al., 2000).

Donnon et al. (2007) conducted a meta-analysis of published studies from 1991 to 2005 to determine the predictive validity of the MCAT. They found that the overall predictive validity of the MCAT on performance in medical school was small to medium. Although they concluded that the MCAT was a useful assessment tool having evidence of predictive validity, they cautioned that it should not be the only criterion used for medical school selection. Markert (1985) contended that the predictability of the MCAT is artificially lowered due to the fact that the full range of scores of all MCAT test takers is not being considered in the data. The medical school screening process eliminates applicants with low UGPAs and MCAT scores and this restriction of range lessens the predictability of these pre-admission variables.

Much of the discussion regarding the MCAT and its ability to predict medical school performance centers around the biological and physical science subsections. Gilbert et al. (2002) examined the value of the MCAT writing sample and found that the addition of the writing sample to a model that included the science subsection scores and the UGPA did not improve the prediction of medical school performance.

Some authors have shown that performance differences do exist among MCAT examinees grouped by race and sex (Flowers, 1996). Koenig et al. (1998) stated that

performance differences alone are not indicators of bias as long as they reflect actual differences in skill levels. They continued by stating that bias is present when performance differences exist and are accompanied by differences in predictive accuracy. However, if the same population of student groups is consistently performing lower on the examination then the question of bias still needs to be considered despite the predictive accuracy of the instrument. Several studies have examined race and gender bias for the MCAT and found the test to have predictive validity. Koenig et al. (1998) studied six specific groups of candidates based on race (African American, Asians, Caucasians, and Hispanics/Latinos) and sex and found no evidence of bias for either women or the minority groups. Johnson, Lloyd, Jones, and Anderson (1986) examined the validity of MCAT scores for predicting performance at Howard University College of Medicine, a historically black medical school and reported validity coefficients similar to other studies performed at predominantly white medical schools. Koenig et al. (1998) also pointed out that efforts are made to avoid item bias when developing the MCAT. Items are written by contributors from diverse backgrounds and items undergo review for racial, regional and sex bias prior to appearing on the test. Items are also examined for statistical evidence of bias during a pilot test and the actual test.

Since the MCAT is reported to provide a standard measure of a student's basic science aptitude and it is used to judge applicants from different institutions that may differ in academic rigor. Regardless of the institution a student graduates from, they must take the same entrance examination and are judged accordingly. Anaya (2001) reported that the influence of between institution characteristics was greater than that of within institution characteristics with regard to MCAT performance. This suggests that the

institution attended does matter when students are considering applying to medical school and the concept of institutional selectivity must be examined.

### **Institutional Selectivity**

The use of institutional selectivity or academic caliber of an applicant's undergraduate institution as a variable in the admissions process allows for constant interpretation of grades across colleges and universities (Mitchell, 1987). Currently, four formal measures of selectivity or categorization have been studied and utilized for the medical school admission process. These measures include the Astin index, Peterson's Four Year Colleges Guide, Barron's Profiles of American Colleges Admissions Selector Rating of undergraduate schools, and the Carnegie Foundation for the Advancement of Teaching Classification (Blue, Gilbert, Elam & Basco, 2000; Kleshinski, Khuder, Shapiro & Gold, 2009). Some medical schools utilize an internal formula to adjust the weighted science grade point average. This weighted average is calculated by taking the product of the science grade point average and institutional selectivity and then dividing by 1,000. This process may result in applicants receiving up to 0.55 additional points included in their science grade point average if they attended a highly selective institution (Basco, Gilbert, & Blue, 2002).

Julian (2005) stated that a selectivity index reflects the characteristic of an institution, so all individuals who graduated from a particular institution receive the same value for their selectivity index. Medical schools use undergraduate selectivity to compensate for psychometric inadequacies of college grade-point averages, such as grade inflation. They believe that the UGPA is more meaningful when the stringent admission standards or selectivity is considered.



The Astin index is the average combined Scholastic Aptitude Test (SAT) score for all entering freshman at a particular institution and serves as an alternative for academic quality of that institution. The index classifies institutions into four groups: low selectivity: institutions with average SAT score of 892 or less; medium selectivity: institutions with average SAT score of 893 to 1036; high selectivity: institution with average SAT score of 1037 to 1181; very high selectivity: institutions with average SAT score of 1182 or more (Jones & Adams, 1983).

The Barron's Profiles of American Colleges Admissions Selector Rating examines an undergraduate school's competitiveness based on admission standards and separates schools into six categories. The rating is based on the median entrance examination scores on the SAT or American College Testing (ACT), high school GPA, class rank required for admission, and the proportion of applicants offered acceptance. The categories are most competitive, highly competitive, very competitive, competitive, less competitive, and noncompetitive (Barron's Profiles of American Colleges, 2012).

The Peterson's Four-Year Colleges Guide is similar to the Barron's index and has also been used in medical school admissions research (Kleshinski et al., 2009). The guide includes levels or classifications of entrance difficulty as reported by each school based on the percentage of applicants accepted, percentage of freshman in the top 10% of their high school class and average SAT or ACT scores. The classifications are most difficult, very difficult, moderately difficult, minimally difficult, and noncompetitive (Peterson's Four-Year Colleges, 2013).

The Carnegie Classification includes most degree-granting colleges and universities in the United States that are accredited by agencies recognized by the U.S.

Department of Education. The classification utilizes 18 categories based on the type of degree-granting programs at the institutions and the amount of annual federal support received at each institution. This classification is not specifically a measure of institutional selectivity, but a categorization of the degree spectrum offered, ranging from doctoral degrees through associate of arts degrees (Blue et al., 2000).

Although the Carnegie Classification is not a measure of institutional selectivity, it has been utilized in admissions research as a variable to highlight the differences between institutions. Anaya (2001) posits that colleges and universities are distinguished by a variety of characteristics such as type of governance (public and private), mission and selectivity. The mission of the institution generally prescribes the highest degree offered and whether or not research is conducted. Anaya continues by stating that public and private universities typically have the greatest resources, greater variety of academic programs, more doctoral faculty members, and produce greater amounts of research. Toutkoushian and Smart (2001) studied how institutional characteristics affect student gains using a collapsed Carnegie Classification. They found that the Carnegie Classification of an institution tended to have an important influence on student gains in learning and knowledge with the highest gains occurring in research and doctoral institutions.

Researchers have reported mixed results on whether institutional selectivity is useful for predicting medical school performance. Evans, Jones, Wortman, and Jackson (1975) reported that institutional selectivity was the single best predictor of success for minority students. Roman, Sorenson, Davis, and Erickson (1979) reported similar findings in a quantitative study stating that competitiveness of the undergraduate college

was one of the strongest predictors of academic performance, also among minority students. In a quantitative study by Jones and Adams (1983), they stated that there are systematic differences in the MCAT performance of applicants with identical UGPA's, but from colleges that differ in selectivity these differences tended to be fairly constant at each point in the GPA scale. Hall and Bailey's (1992) quantitative research supported the role of selectivity on pre-admission variables by stating that the mean GPA for students from colleges of high selectivity is significantly lower than those for the students in the intermediate and low-selectivity groups. However, the mean MCAT scores were similar. Huff and Fang (1999) reported that students from institutions with a lower selectivity rating were at an increased risk for academic difficulty. Mitchell (1990) stated that adding selectivity information to other pre-admission variables such as the MCAT and UGPA increased the predictive value for determining medical school performance. Kleshinski et al. (2009) found that students from the most selective undergraduate institutions score higher on licensing examinations than those students from minimally selective institutions.

Smith and Geletta (2010) utilized the Baron's Selector Rating and found that institutional selectivity was statistically significant in predicting first year podiatric medical school grade point average and this metric should be considered when screening podiatric medical school applicants.

Contrary evidence regarding selectivity has also been presented in the literature. Wiley and Koenig (1996) did not find an increase in the predictive value when selectivity was added to the UGPA and MCAT. Blue et al. (2000) reported that selectivity did not add to the ability to predict performance if the MCAT scores and UGPA were available

through a quantitative study. This claim further supported the validity of the MCAT as a predictor for medical school performance. Kleshinski et al. (2009) suggest that their results may be attributed to using a different selectivity index. They continue by stating that the Peterson's Four-Year Colleges Guide is potentially more sensitive than other selectivity indices. Although their use of the Peterson's Four-Year Colleges Guide resulted in institutional selectivity being a predictor of success on licensing examinations, it was the weakest predictor overall when compared to student characteristics such as race, age and gender. These student characteristics have also been studied and thought to provide predictive value with regard to medical school success.

### **Gender**

The medical profession has traditionally been fairly homogenous with regard to gender. Since the 1970s, the composition of medical graduates changed from almost all men to an equal distribution between the sexes (Bright, Duefield, & Stone, 1998; Weinberg & Rooney, 1973). In 2013, women made up 45.7% of the total applicant pool and 47.2% of the matriculants (Association of American Medical Colleges, 2013). Despite the growing number of women entering medical school, some authors suggested that their retention and graduation rates were generally lower than those of males (Johnson & Sedlacek, 1975). However, recent published accounts reveal that the medical school attrition rate is 8% and 9% for women and men respectively (Association of American Medical Colleges, 2007). Although the attrition rate is lower for women, differences still exist between men and women in pre-admission measures.

Several authors have demonstrated the gender differences on the MCAT. Ramsbottom-Lucier et al. (1995) demonstrated that men had higher total MCAT scores

than women. In a survey of a national database, Weinberg and Rooney (1973) reported similar results stating that women scored lower than their male counterparts on the MCAT, regardless of undergraduate major. Case, Becker, and Swanson (1993) also stated that men perform better on the MCAT, but only on the science and quantitative portions of the exam through a quantitative study. This idea is supported by Weinberg and Rooney (1973), who stated that although women had a lower total MCAT score, they often scored higher on the verbal reasoning section of the MCAT. However, women currently score lower on every section of the MCAT. The greatest difference between women and their counterparts exists in the science portions of the MCAT (Association of American Medical Colleges, 2013).

Differences exist between men and women in other pre-admission measures such as UGPA and SGPA. Case et al. (1993) suggested that men and women had similar SGPA's, but women had higher non-science GPA's. However, this finding does not explain why women perform lower on the science portions of the MCAT. Ramsbottom-Lucier et al. (1995) stated that women had lower UGPA's than men and this difference was significant. This finding is contrary to the results presented by Case et al. (1993). The differences between genders continue to exist in medical school as well.

The academic performance of men and women in medical school revealed that although women's performance in the early didactic years was slightly lower than that of men, overall academic performance was equal by the senior year (Weinberg & Rooney, 1973). They continued by stating that women scored an average of 1.93 points lower than men in basic science courses offered in the first two years of medical school. This

difference in basic science scores is also reported by other authors (Case et al., 1993; Ramsbottom-Lucier et al., 1995).

Performance differences on licensing examinations also existed between men and women, especially on the basic science portion of the examinations. Multiple studies revealed that men performed better than women on part one of the licensing boards (Case et al., 1993; Ramsbottom-Lucier et al., 1995; Weinberg & Rooney, 1973). The gap between men and women was broader at earlier points in medical school, but narrowed later in medical education. The same studies demonstrated that women performed just as well on part two, or the clinical portion of the licensing board. In fact, women outperformed men in certain areas of this examination. One proposed explanation for this occurrence is that women tended to perform better in areas related to specialties that attract large numbers of women such as pediatrics, psychiatry and obstetrics and gynecology (Case et al., 1993). Another proposed explanation by the same authors was that women had a weaker background in science at the time of matriculation, but caught up as a result of medical school training.

Although most of the medical education research approaches gender as an isolated variable, Haist, Wilson, Elam, Blue, and Fosson (2000) examined the influence of a gender by age interaction. A correlation analysis revealed that a significant gender by age interaction was present. Women performed better than men in clinically based examinations; however younger women were more likely to have academic difficulty. Failure to consider the gender by age interaction may explain the results of some studies that demonstrate that women have more academic difficulty.

## Age

Medical schools have long discriminated against older applicants. The cited reasons for excluding older students have been that they have shorter futures as productive physicians, have lesser academic credentials and lower motivation (Feil, Kristian, & Mitchell, 1998). Older students have traditionally been identified and considered a group at risk of academic jeopardy by medical schools (Kay & Blythe, 1984; Ramsbottom-Lucier et al., 1995). In a literature review, Sherman (1978) posited that some medical schools have even restricted the upper age limit for applicants. Some programs previously had written policies against accepting older students, although that practice is currently illegal (Kay & Blythe, 1984; Ramsbottom-Lucier et al., 1995).

While older applicants have had difficulty being admitted to medical school, they comprise an increasing proportion of the medical student population (Kick, Adams, & O'Brien-Gonzales, 2000). Despite this trend, students age 30 and over had a lower acceptance rate than those under age 25 (Feil et al., 1998). Although there is an increase in older students being admitted to medical school, little research exists regarding this group of medical students. Most of the research focusing on older students has been limited to a theoretical debate or only examined older women as entrants to medical school. The problem with the research on this topic is lack of consistent agreement on the definition of older students. Feil et al. (1998) examined the academic performance of students younger and older than 25 years old. Ramsbottom-Lucier et al. (1995) analyzed the academic performance of students and considered those over 28 as older students. Some authors have defined this group as over 30 years of age (Kick et al., 2000). The

various definitions used in older student research makes it difficult to determine the impact of age on academic performance.

There have been a limited number of studies that have examined the role of age on student's preadmission qualifications and medical school performance. Ramsbottom-Lucier et al. (1995) reported in a quantitative study that younger matriculants had significantly higher UGPA and SGPA than their older peers. They also found that the performance on the MCAT was nearly identical. They suggested that any academic disadvantage for admission as measured by the UGPA and SGPA for older matriculants may be offset by their performances on the MCAT. Feil et al. (1998) also reported similar findings in their mixed-methods study of older medical students at McGill University. They found that older applicants had lower UGPA's and MCAT scores than their younger colleagues.

Although the research on older medical students is limited, there appears to be age differences in preadmission qualifications. These differences seem to affect early medical school performance, but their influence diminished in the clinical education phase. Research indicated that older students have lower basic science scores in the first two years of medical school. It also indicated that the clinical scores during the last two years of medical school and the licensing examination scores did not differ between younger and older students (Feil et al., 1998; Ramsbottom-Lucier et al., 1995). There are many factors that may explain the reason for lower basic science performance in older students.

As part of their study, Feil et al. (1998) administered a stress profile to students in order to quantify their stresses and experiences. Older students tested lower for driven behavior and believing that achievement makes one better. The profile also revealed that



younger students focused on test material to achieve good grades and older students were more concerned with “real learning.” They suggested that older students’ lower preclinical scores could be explained by less preparation during the first year given their lower prematriculation scores and their less driven behavior. Another proposed reason was that younger students were more interested in extremely selective specialties with longer post-graduate training while older students favored primary care specialties with much shorter residency training (Xu, Veloski, & Barzansky, 1997).

The role of increased personal responsibility has also been cited as a possible reason for lower basic science performance in older students. Kick et al. (2000) qualitatively studied older students and they stated that their personal responsibilities made it difficult to study. They continued by stating that older students tended to be married and have children more often than their younger peers. In a qualitative study, Kay and Blythe (1984) found that long-standing and perhaps mature relationships as well as parenthood played an integral part in the lives of many older students. They also described that numerous marriages had ended during medical school as the stress of medical school frequently compounded marital problems. This is supported by Xu et al. (1997), who found that older graduates were more influenced by children and familial responsibilities through a qualitative study.

Although older applicants traditionally had lower pre-matriculation qualifications, research demonstrated that once admitted they proved just as capable as their younger peers by the end of their clinical education. However, there have not been any studies that evaluate the attrition rate of older students in medical school and students that do not

succeed in the basic science curriculum will never get the opportunity to narrow the gap with respect to clinical education.

Collin et al. (2008) presented one of the largest studies on medical school performance and preadmission variables. In their latent variable model, they found that students over 30 had a lower GPA, but not MCAT subtest scores. Even though previous research demonstrates that older students do not perform as well in the basic science curriculum (Feil et al., 1998), Collin et al. (2008) states that these age differences do in fact dilute over time as older students enter the clinical curriculum. Even though the difference attributed to age dissipates, students still have to be successful during the basic science curriculum in order to even experience the clinical curriculum based on the Flexner Model of medical education.

Another factor as previously discussed is the significant interactions that can occur between variables defined as student characteristics. Mills, Heyworth, Rosenwax, Carr, and Rosenberg (2009) suggest that the influence of age and sex on performance has revealed varied results as it has with other student characteristics such as ethnicity and socioeconomic status that have also been used to predict academic performance.

### **Ethnicity**

Minorities continue to be underrepresented in medical schools in the United States. However, their underrepresentation begins prior to medical school and exists when applying and gaining acceptance to such programs. In 1980, 11.7% of the population was classified as Black, but Blacks accounted for only 6% of the total entering medical school class, 3% of practicing physicians and less than 2% of medical school faculty (Shea & Fullilove, 1985). In fact, most of the Black students and Black faculty

members were concentrated in three predominantly Black medical schools (Petersdorf, 1992). Black students are applying and being admitted to medical schools more frequently and currently comprise 6% of total applicants and matriculants (Association of American Medical Colleges, 2013). Petersdorf (1992) also posited that Latinos and Native Americans constituted less than 1% of total medical school enrollment. This minority group has seen the greatest amount of growth in medical school applicants and matriculants. In 2013, Latinos account for 6% of applicants and matriculants to medical school (Association of American Medical Colleges, 2013).

A great deal has been accomplished in minority medical school enrollment since the 1950s. During the 1950s, the *Journal of Medical Education* eliminated applicants from Howard and Meharry Universities from data tables so they did not distort the figures presented. In the 1970s, the same journal still did not mention underrepresented minorities in their yearly study of applicants (Sedlacek & Prieto, 1990). Much of the progress in minority medical school admission was due to affirmative action.

Shea and Fullilove (1985) stated in a literature review that medical schools established affirmative action programs in the 1960s. This policy had a dramatic impact as minority students entering medical schools increased rapidly. From 1964 to 1974, the number of minority students increased from three percent to over 7%, but since that time minority student enrollment has leveled off (Shea & Fullilove, 1985).

Strayhorn and Frierson (1989) suggested that the plateau in minority enrollment could be attributed to a retrenchment from affirmative action efforts by medical schools due to legal issues. Shea and Fullilove (1985) stated that the decline in minority admissions began as a result of several cases that challenged the constitutional validity of

special programs for minorities. They continued by stating that the commitment of medical schools to affirmative action has slackened. This suggestion was confirmed by studies that identified a decline in minority acceptance rates.

Dr. Jordan Cohen, the President of the Association of American Medical Colleges suggested that there was a tendency at medical schools to underemphasize personal characteristics in the admission process. He continued by recommending using the MCAT and UGPA only as threshold measures to eliminate high risk applicants and not rely on them solely for admission decisions (Cohen, 2002). Dr. Cohen's statements are supported by others in the literature.

White, Dey, and Fantone (2007) state that the use of the MCAT and GPA ignores two changes influencing medical school admissions: student diversity and affirmative action. Albanese, Farrell, and Dottl (2005) posit that Dr. Cohen's suggestion seems consistent with the recent Supreme Court ruling on the University of Michigan case. In *Grutter v. Bollinger*, the Court refined its position on affirmative action programs by stating that they are constitutional if they consider race as one factor in an individualized evaluation and only to achieve the goal of class diversity (Reiter & Maccoon, 2007).

White et al. (2007) continue by stating that traditional admission measures ignore important initiatives that have changed undergraduate medical education. A continuing commitment to affirmative action has resulted in a desire to take active steps to reverse historical legacies of discrimination that left distinct populations of students underprepared for higher education. This commitment has encouraged the professional schools to consider possible inequities in their selection process.

In a literature review, Petersdorf (1992) stated that the acceptance rate for minorities compared to all other applicants has been declining even though the difference in MCAT scores between minority and majority applicants has been steadily narrowing. Shea and Fullilove (1985) examined the decline in minority admissions by analyzing the MCAT scores of minority and majority students. They reported that acceptance rates declined an average of 3% for Black applicants and 1% for majority students with MCAT scores of 5 to 7 per section. The largest area of divergence was seen with higher MCAT scores. The acceptance rate fell almost 2% for Black applicants and rose 3% for majority applicants with MCAT scores of 8 or higher per section. This report suggested that medical school admittance was much more difficult for minority students with similar pre-admission scores. However, there is research that counters the claims related to minority acceptance rates. Davis, Dorsey, Franks, Sackett, Searcy, and Zhao (2013) demonstrated that underrepresented minority students have higher acceptance rates than the rate that would be expected based on MCAT scores alone.

This plateau in enrollment is even more disturbing than it appears because of the growth in the nation's minority population. A great deal of minority physicians will be needed to serve this population effectively. This necessity has resulted in the development and implementation of numerous minority-related programs by medical schools in order to increase minority enrollment. Petersdorf (1992) found that 80% of medical schools surveyed stated they had such a program. Despite the level of concern exhibited by medical schools about minority enrollment, little research has been conducted on minorities and medical school performance.

Johnson et al. (1986) found that MCAT scores and UGPA's predicted medical school performance as well for Howard, a predominately Black medical school, as for students at predominantly White schools. Evans et al. (1975) reported similar findings and stated that MCAT scores and UGPA were significant predictors of medical school performance. Strayhorn (1999) stated that the mean MCAT score was the strongest predictor of academic performance for both Black and White students. He also suggested that the SGPA predicted academic performance only for White students. In a literature review, Sedlacek and Prieto (1990) reported that MCAT scores and UGPA's appeared to have some validity in predicting success of minority medical students.

Numerous authors have suggested that the MCAT and UGPA have some validity, but others asserted that their ability to predict success is small. Roman et al. (1979) reported that MCAT scores and UGPA accounted for only one-third of the variance in first year medical school performance for minority students. Montecinos and Pohlmann (1987) supported this finding and stated that only 14% of the variance in admission decisions for minority students was accounted for by UGPA and MCAT scores. Still others have discounted their use altogether. McGlinn and Jackson (1989) found that MCAT scores and UGPA did not predict minority student retention and their use in predicting minority student success was limited.

Although the validity of these measures has been questioned, research does show that minority students did not perform as well as majority students on the MCAT. Shea and Fullilove (1985) reported that the MCAT scores of Blacks were 1.5 standard deviations below those of non-minority students. In 2013, the disparity between minority and majority MCAT scores is still present. On average, Black students scored two points

lower than white students on every section of the MCAT. Hispanic and Latino students also scored lower than white students, but performed better than black students (Association of American Medical Colleges, 2013). One possible explanation for the disparity in performance based on ethnicity may be found in the socioeconomic status of students and the resources available to students as they attend school.

### **Socioeconomic Status**

It is relevant to discuss the socioeconomic status of students and its effect on academic performance, access, attainment and the connection with race, gender and age. Another factor in socioeconomic status is the parental possession of a college degree. The parental possession of a college degree leads to higher family incomes and affords their children more access to higher education by offering them financial resources (Riehl, 1994). First-generation students are more likely to be female, minorities and come from low-income families (Hu & Kuh, 2003; McConnell, 2000; McNeal, 1999). Fifty-nine percent of first-generation students come from minority backgrounds with a mean income of \$45,000 (Pell Institute, 2006). In essence, being a first-generation student may be a proxy for low socioeconomic status.

Financial capital as measured by the family's wealth or income can provide the physical resources for a child that aid performance and aspirations (Coleman, 1988). Qian and Blair (1999) state that parents with high income tend to pass on their resource advantages to their children in a variety of ways. Students of low income families are often disadvantaged in their access to resources such as books, clothing, and stable housing that increased family income can provide (Hofferth, Boisjoly, & Duncan, 1998).

Access to financial capital influences many areas related to higher education such as engagement, enrollment, attainment, and parental involvement.

A number of studies suggest that parents of higher socioeconomic status are more involved in their children's education than parents of lower socioeconomic status. The greater involvement cultivates more positive attitudes toward school, improves study habits and enhances academic achievement (Astone & McLanahan, 1991; Lareau, 1987; Stevenson & Baker, 1987). Lareau (1987) suggests that working class parents place less emphasis on the importance of schooling and this relates to less involvement.

Sui-Chu and Willms (1996) reject the notion that parents with low socioeconomic status are less involved in their children's schooling. Clark (1983) also found that poor children whose parents were more involved in their children's schoolwork and emphasized good study habits were more successful. Although Clark does not assert that parents with low socioeconomic status are less involved, he implies it by illuminating the importance of parental involvement and its ability to overcome lack of financial capital.

Another area related to family income is parental saving for higher education. The ability to provide the resources for children to attend college is a major obstacle even if the admission requirements for higher education are met. Previous research indicates that there are a number of background characteristics related to parental saving for higher education including family income, family size, and parental education.

Hossler and Vesper (1993) posit that parental saving for postsecondary education is a function of the financial ability to save, parental motivation to save, postsecondary aspiration for their children and the ability of their children to benefit from postsecondary education. Tierney (2002) states that in upper class families, children never question if



they are going to college; they only wonder where they will go. In low-income families, such discussion may never even occur.

Family size seems to contribute to parental saving for higher education. Family size is negatively associated with the likelihood of attending a postsecondary institution because it reduces the amount of family resources that can be allocated to educational savings (Hossler & Vesper, 1993). Stage and Hossler (1989) found that the number of children in college was negatively related to parent's savings for college.

Lack of parental saving for higher education also places first-generation students at a disadvantage when they enroll at a postsecondary institution. Pike and Kuh (2005) suggest that first-generation students tend to come from families with lower incomes and have to work more hours during college to make up for lack of familial financial support. First-generation students are more likely to work off-campus and work more hours or even work full-time during college (McConnell, 2000; Terenzini, Springer, Yaeger, Pascarella, & Nora, 1996). McConnell (2000) continues by stating that first-generation students have more personal income than other students, but less family income.

Billson and Terry (1982) demonstrated that 23% of first-generation students work over 35 hours per week compared to only 14% of second-generation students (at least one of children's parents had a college degree). They also examined students that had withdrawn from college and found that twice as many first-generation students reported working full-time. Because of the financial need to work more than their counterparts, first-generation students are also more likely to enroll in lower cost programs like community colleges and programs closer to home in order to utilize available family resources such as housing (McConnell, 2000). Anaya (2001) demonstrated that the

number of hours that a student worked for pay in a week was negatively associated with performance on the MCAT. She continued by stating that working in college could serve as a proxy for the socioeconomic status or background of a student.

Family income has also been linked to educational performance, enrollment in postsecondary education, and attrition. Riehl (1994) states there is a strong correlation between income and test scores in that those with the highest SAT scores are from families with the highest incomes. A report from The National Center for Education Statistics on first-generation students in postsecondary education demonstrated higher SAT scores are also related to high family income (U.S. Department of Education, 2005b). Tierney (2002) asserts that monetary resources can be used to purchase services such as college preparation courses and SAT courses that may position students from upper-class families to perform better. These factors could impact whether a student from a low income family could get accepted to a selective school and afford to matriculate.

Research indicates that students from lower income families or low socioeconomic status enroll in postsecondary education less frequently than their high socioeconomic counterparts (Horvat, Weininger, & Lareau, 2003; Ishitani, 2006; Rowan-Kenyon, 2007; Tierney, 2002). Low socioeconomic students are also less likely to attend college immediately after high school graduation and 40% of them actually enroll after age 24 (Rowan-Kenyon, 2007).

Although the majority of first-generation students tend to be minority, race does not seem to impact enrollment when socioeconomic status is considered. According to Horvat et al. (2003), middle-class families, Black or White, have far more in common with each other than they do with working-class and poor families of either race. Black

and White middle-class students enroll in postsecondary education at a similar and higher rate than students from working-class and poor families. Rowan-Kenyon (2007) also found that low socioeconomic students delayed college enrollment, but Black students delayed enrollment more than White students.

When first-generation students from families with a low socioeconomic status do enroll in postsecondary education, research suggests that they have a higher rate of attrition compared to their counterparts (Ishitani, 2006; McNeal, 1999). Ishitani (2003) found that students whose families had an annual income of less than \$25,000 had a 49% higher risk of attrition. Financial resources of the family are strongly associated with children's schooling and parental access to money is significantly associated with the years of schooling completed by children from high-income families (Hofferth et al., 1998). Hofman and Van Den Berg (2004) found that students with access to parental financial resources were more likely to pursue a second area of study. Parents who have a higher level of income are able to provide their children with a higher level of financial assistance. A contributing factor in first-generation student attrition may be due the need to work more hours to overcome less financial assistance from families.

Although the research suggests that student characteristics such as socioeconomic status, age, race and gender may place medical school applicants at a disadvantage with regard to cognitive criteria and admission, these students may have an opportunity to demonstrate their non-cognitive abilities during the application process.

### **Non-Cognitive Criteria**

The literature on medical school admission research has mainly focused on cognitive variables and very little has been published on non-cognitive criteria which

include interviews and letters of recommendation. However, the validity of the non-cognitive criteria has been questioned. Benbassat and Baumal (2007) stated that the validity of the interview is low or uncertain and only explains 2 to 14% of the variability in medical school outcome measures.

Reznick et al. (1993) reported that GPA and MCAT scores are predictive of performance, whereas non-cognitive tools including the traditional personal interview are not. Turnbull, Danoff, and Norman (1996) studied oral certification examinations and found that interviews had good inter-rater reliability, but the correlation between the scores assigned to a candidate in one interview and those assigned to the same candidate in a second interview with different raters. Although Turnbull et al. did not study medical school admissions, similar results have been found in medical schools.

Kreiter, Yin, Solow, and Brennan (2004) presented analogous results to Turnbull et al. (1996). They studied the interview scores of 92 applicants that were interviewed twice by different faculty members and given 4 standardized questions. The results demonstrated low to moderate reliability despite the use of a standardized interview which tends to yield higher inter-rater reliability than less structured interviews.

The low reliability may be due in part to the fact that interviewers have access to the medical school applicant's cognitive measures. Shaw et al. (1995) found that prior knowledge of an applicant's aptitude and GPA scores affected the interviewer's ratings of the applicant's non-cognitive traits. In essence, interviewers tended to rate good students higher on their interviews.

Some caution that relying on cognitive criteria may result in overlooking more valuable non-cognitive characteristics (Eva & Reiter, 2004). Salvatori (2001) stated that

personal interviews have been the tool of choice for the assessment of non-cognitive qualities that are deemed independent of academic achievement. However, it appears that non-cognitive qualities and cognitive ability may not be mutually exclusive. Eva and Reiter (2004) stated that supporters of medical school interviews argue that selecting applicants solely on the basis of GPA will exclude those who have strong interpersonal qualities. Their research suggested that when applicants were selected exclusively using GPA, these candidates also had high non-cognitive scores which demonstrate that they may not necessarily be separate entities.

Letters of recommendation or reference are also utilized by medical schools as a form of non-cognitive criteria that is thought to aid in student selection. However, Salvatori (2001) states that there is little evidence to support their use because they are difficult to standardize and are often biased. This conclusion seems logical because one would not expect non-standardized letters of reference to be more reliable when compared to standardized interviews which have been shown to have low reliability.

Edwards, Johnson, and Molidor (1990) posit that although the validity of personal interviews in predicting the performance of medical students is poor, most North American medical schools continue to interview. Despite these findings, it is unlikely that medical schools will abandon the practice of considering non-cognitive factors for selection or at least going through the motions of conducting interviews because the admission decision has already been made utilizing cognitive criteria.

## **Summary**

Admission to medical schools in the United States is extremely selective and that is often not the case in podiatric medical education (Smith & Geletta, 2010). The average

ratio of applicants to matriculants in allopathic medicine was 2.29 over the last ten years (Association of American Medical Colleges, 2013). This is contrary to podiatric medicine where the ratio of applicants to matriculants was 1.45 over the last ten years (American Association of Colleges of Podiatric Medicine, 2013). Jolly (1992) stated that as the ratio of applicants to available places increases, schools naturally become more selective. However, selective admission may not be relevant to podiatric medicine because of an applicant pool that is only slightly larger than the number of matriculants.

Smith and Geletta (2010) stated that if the size of the applicant pool prohibits selective admission, then the emphasis for admissions officers is to try and predict which applicants before you are most likely to be successful in podiatric medical school. The information for all applicants available to admissions personnel is pre-admission variables, but their predictive value has yet to be fully explored in podiatric medical literature.

Previous research has shown that pre-admission measures do have the ability to predict performance in the pre-clinical portion of allopathic medical school. It also shows that these measures are not as useful in determining clinical performance. It should be noted that previous research on pre-admission variables has utilized numerous study techniques such as quantitative, qualitative and mixed methods, but were only conducted at the investigators institution. A profession wide analysis in allopathic medicine has never been conducted to ensure generalizability of the findings. A question that has yet to be determined is whether the same pre-admission variables and applicant characteristics have the ability to predict performance in the pre-clinical portion of podiatric medical school.

## **Chapter 3**

### **Methods**

The role of pre-admission measures as it relates to performance in podiatric medical school has only been described in the literature through a pilot study that specifically examined the role of institutional selectivity on performance. The rationale for this study was to determine which institutional selection model yields the best prediction of first year podiatric medical school GPA, and to assess whether there was a statistically significant relationship between pre-admission variables and podiatric medical school performance in the basic sciences. The goal is to reduce student attrition and the costs associated with attrition. The investigator performed a structured record review and multiple-year analysis of pre-admission measures for this quantitative study.

#### **The Population of the Study**

Students enrolled in a midwestern College of Podiatric Medicine and Surgery constituted the study population. Admission and performance measures are gathered and analyzed biennially by the college for internal accreditation purposes. The admission measures for each student consisted of his or her Medical College Admission Test (MCAT) scores, undergraduate cumulative GPA (UGPA), undergraduate science GPA (SGPA), age, gender, and ethnicity. While some of the variables needed for this study were available in the data set, other variables such as the measures of institutional selectivity needed to be abstracted. The administrative records were available for cohorts of students from the graduating class of 2000 through 2015 (804 students). Institutional Review Board approval was obtained from the study institution and the University of Nebraska-Lincoln.

### **Dependent Variable**

In accordance with previous literature, first year performance, measured by first year podiatric medical school GPA/percentile performance scores (Wiley & Koenig, 1996) were used as the outcome variable. Previous investigators also utilized a binary variable representing whether or not a student changed her/his intended graduation schedule during the first year of study as a measure of success/failure (Julian, 2005). For this study a change in intended graduation schedule was not used as a dependent variable because a higher first year GPA/percentile performance score equates to more academic success in the podiatric medical program. According to Huff and Fang (1999), the first year of medical school is the crucial period when academic problems were most likely to occur.

### **Independent Variables**

The independent variables used in this study included MCAT scores, UGPA, SGPA, gender, age and ethnicity. The MCAT scores have been identified as fairly important pre-admission indicators of success in medical school (Wiley & Koenig, 1996). The following MCAT scores were used as variables: Verbal Reasoning, Physical Sciences, Biological Sciences, and Writing Samples. The UGPA and SGPA have been shown to be important predictors of success in medical schools (Hall & Bailey, 1992; Hall & Stocks, 1995) and were also used as independent variables in the current study. Most studies that examine success in medical schools have indicated that student demographics such as age, gender and ethnicity are important predictors of success (Koenig et al., 1998). The selectivity of the applicant's undergraduate school, as ranked in Baron's Admissions Selector Ratings and the Peterson's Four-Year Colleges guide,



was also used as an independent variable. In order to represent institutional selectivity, the rankings of educational institutions based on the Baron's Admissions Selector Ratings and the Peterson's Four-Year Colleges guide were utilized. The Baron's rating categorizes educational institutions into six ranks – from 1 (most competitive) to 6 (non-competitive) in the following manner: 1 = Most Competitive, 2 = Highly Competitive, 3 = Very Competitive, 4 = Competitive, 5 = Less Competitive, and 6 = Noncompetitive. The Baron's Admissions Selector Ratings has been used successfully in previous research as a predictor of first year student success (Smith & Geletta, 2010).

The Peterson's Four-Year Colleges guide categorizes educational institutions into five ranks – from 1 (most difficult) to 5 (non-competitive) in the following manner: 1 = Most Difficult, 2 = Very Difficult, 3 = Moderately Difficult, 4 = Minimally Difficult, and 5 = Noncompetitive. The Peterson's selectivity index has been used successfully in previous research and was noted to be a predictor of success on board examinations (Kleshiniski et al., 2009).

### **Analysis**

A bivariate correlation technique was used to model the relationships between first year podiatric medical school GPA and the independent variables. This technique was ideal for the purposes of this research because it allowed the investigator to assess the relationship between one research variable that can be logically designated as a dependent variable and other variables that can be designated as independent variables. The subjects with missing pre-admission measures were excluded from the pairwise correlations. The bivariate correlation was also used to screen variables for the regression model. A multivariate linear regression technique was used to model the

relationships between first year podiatric medical school GPA and the variables representing undergraduate school selectivity, MCAT, UGPA, SGPA, ethnicity, gender, age. The subjects with missing pre-admission measures were excluded from the multivariate linear regression. The multivariate linear regression technique was ideal for the purposes of this research because it allowed the investigator to assess the relationship between one research variable that can be logically designated as a dependent variable and other variables that can be designated as independent variables.

In this research the investigator explored the influence of pre-admission measures on podiatric medical school performance, specifically the first year podiatric medical school GPA. Multiple regression technique allowed the investigator to examine this relationship between the variables and that was the basis for choosing this analysis technique for the current study. The investigator used the SPSS statistical software (SPSS, Inc., Chicago, IL 2013) to perform the regression analysis on the data.

The regression model expressed the relationship between the research variables as a linear function with first year podiatric medical school GPA as the dependent variable and the applicant data set as independent variables. Modeling was performed by specifying first year podiatric medical school GPA as a linear function of the predictor variables in the following manner:

$$\hat{Y} = A + B_1X_1 + B_2X_2 + B_3X_3 + \dots B_k X_k$$

Where:

- $\hat{Y}$  = the predicted value of the dependent variable (first year podiatric medical school GPA),

- $A$  = the “baseline” value of the predicted variable which is obtained when the value of the independent variable is set to 0 (i.e., the Y intercept),
- $B_1$  to  $B_k$  represented the regression coefficient estimates (the slopes) for each of the independent variables calculated while holding constant the values of the other variables in the equation.
- $X_1$  through  $X_k$  represented the independent variables.

The model fitness and strength was assessed using analysis of variance (ANOVA). Further, the relative strength of the associations between the dependent variable and the independent variables were assessed using the regression coefficients. A test statistic based on the student's t distribution was used for each coefficient to assess the null hypothesis that they were not statistically significantly different from 0.

Prior to performing the regression analysis each of the variables were assessed for meeting the assumption required for use in a multiple regression modeling. The use of multiple regression analysis requires that the variables used should be normally distributed. This assumption was checked by tabulating and/or plotting the distributions into a histogram or a stem-and-leaf graph.

Further, the pattern of the relationships should reflect linearity and homoscedasticity. The residuals should be independent from the error scores. All of these characteristics were assessed by using scatter-plots. Finally, the interpretation of the slope parameters was only adequate in the absence of multicollinearity and singularity (unacceptably high correlations between the predictor variables). Tolerance tests are used to identify such characteristics among variables.

**Confidentiality**

The electronic data were kept on a password protected drive within the study institution and the principal investigator was the only person who had access to the data. The actual student files were kept in a locked cabinet in the Registrar's office at the study institution. The results/findings of this study were reported in aggregate and no individual student was able to be identified if the results were publicly disseminated.

## Chapter 4

### Results

The subjects for this study included 804 matriculants from the graduating classes of 2000 through 2015 admitted to the study institution as subjects. The institutional selectivity, gender and ethnic origin of the subjects are summarized in Table 5. The Barron's Admissions Selector Rating contained six categories. There were 12 (1.5%) matriculants that attended the most competitive educational institutions, 98 (12.2%) matriculants that attended highly competitive institutions, 296 (36.8%) matriculants that attended very competitive institutions, 266 (33.1%) matriculants that attended competitive institutions, 50 (6.2%) matriculants that attended less competitive institutions, and 80 (10.0%) matriculants that attended noncompetitive institutions. There were two matriculants that attended institutions that were not listed in the Barron's Admissions Selector Rating. Thirty-four students who were dismissed or withdrew in poor academic standing attended institutions in the more selective institution category compared with 58 students who attended institutions in the less selective institution category. There were 12 students that withdrew in good academic standing from the study institution.

The Peterson's Four-Year College Selectivity Index contained five categories. There were 8 (1.0%) matriculants that attended the most difficult institutions, 73 (9.1%) matriculants that attended very difficult institutions, 597 (74.3%) matriculants that attended moderately difficult institutions, 44 (5.5%) matriculants that attended minimally difficult institutions, and 80 (10.0%) matriculants that attended noncompetitive institutions. There were two applicants that attended institutions that were not listed in

Table 5

*Descriptive Statistics for Institutional Selectivity, Gender and Ethnic Origin*

Institutional Selectivity	Frequency	%
<b>Barron's</b>		
1 = Most competitive	12	1.5
2 = Highly competitive	98	12.2
3 = Very competitive	296	36.8
4 = Competitive	266	33.1
5 = Less competitive	50	6.2
6 = Noncompetitive	80	10.0
<b>Peterson's</b>		
1 = Most difficult	8	1.0
2 = Very difficult	73	9.1
3 = Moderately difficult	597	74.3
4 = Minimally difficult	44	5.5
5 = Noncompetitive	80	10.0
<b>Gender</b>		
1 = Male	570	70.9
2 = Female	234	29.1
<b>Ethnic Origin</b>		
1 = Non-white	91	11.3
2 = White	713	88.7

the Peterson's Four-Year College Selectivity Index. Ten students who were dismissed or withdrew in poor academic standing attended institutions in the most difficult and very difficult institution category compared with 67 students in the moderately difficult institution category and 15 students in the minimally difficult and noncompetitive institution categories.

The subjects were also characterized by being composed of 570 male and 234 female students. The percentage breakdown according to gender was 70.9% male and 29.1% female. The ethnic origin of accepted applicants that classified themselves as white was 713 (88.7%) and accepted applicants that classified themselves as non-white was 91 (11.3%). The mean age for the matriculants was 24.55 years ( $SD = 3.35$ ).

The descriptive statistics for the UGPA, SGPA and MCAT variables for all matriculants are summarized in Table 6. The mean UGPA was 3.26 ( $SD = 0.35$ ) and the mean SGPA was 3.12 ( $SD = 0.42$ ). The mean MCAT physical science score was 6.84 ( $SD = 1.60$ ), the mean MCAT biological science score was 7.37 ( $SD = 1.92$ ), the mean MCAT verbal reasoning score was 7.35 ( $SD = 2.01$ ) and the mean MCAT writing sample was 5.35 ( $SD = 2.00$ ). There were 95 matriculants that were admitted that did not take the MCAT. The decision to admit students that did not take the MCAT was made by the dean of the college.

The descriptive statistics for the UGPA, SGPA and MCAT variables for the matriculants who were dismissed or withdrew are summarized in Table 7. The mean UGPA was 3.08 ( $SD = 0.34$ ) and the mean SGPA was 2.90 ( $SD = 0.53$ ). The mean MCAT physical science score was 5.31 ( $SD = 1.51$ ), the mean MCAT biological

Table 6

*Descriptive Statistics for UGPA, SGPA and MCAT of All Matriculants*

	UGPA	SGPA	MCAT Physical Science	MCAT Biological Science	MCAT Verbal Reasoning	MCAT Writing Sample
<i>N</i>	804	804	709	709	709	709
<i>M</i>	3.26	3.12	6.84	7.37	7.35	5.35
<i>SD</i>	0.35	0.42	1.60	1.92	2.01	2.00
<i>Range</i>	2.28 – 4.0	2.0 – 4.0	2-12	2-12	2-13	1-11

Table 7

*Descriptive Statistics for UGPA, SGPA and MCAT for Unsuccessful Students*

	UGPA	SGPA	MCAT Physical Science	MCAT Biological Science	MCAT Verbal Reasoning	MCAT Writing Sample
<i>N</i>	104	104	91	91	91	91
<i>M</i>	3.08	2.90	5.31	5.66	5.89	5.59
<i>SD</i>	0.34	0.53	1.51	2.11	2.34	2.24
<i>Range</i>	2.33 – 3.89	2.0 – 3.90	2-9	2-11	2-11	1-10

science score was 5.66 ( $SD = 2.11$ ), the mean MCAT verbal reasoning score was 5.89 ( $SD = 2.34$ ) and the mean MCAT writing sample was 5.59 ( $SD = 2.24$ ).

The descriptive statistics for the UGPA, SGPA and MCAT variables for the students that were successful and completed the first-year are summarized in Table 8. The mean UGPA was 3.29 ( $SD = 0.34$ ) and the mean SGPA was 3.16 ( $SD = 0.41$ ). The mean MCAT physical science score was 7.06 ( $SD = 1.60$ ), the mean MCAT biological



Table 8

*Descriptive Statistics for UGPA, SGPA and MCAT for Successful Students*

	UGPA	SGPA	MCAT Physical Science	MCAT Biological Science	MCAT Verbal Reasoning	MCAT Writing Sample
<i>N</i>	700	700	618	618	618	618
<i>M</i>	3.29	3.16	7.06	7.62	7.56	5.31
<i>SD</i>	0.34	0.41	1.60	1.85	1.95	1.97
<i>Range</i>	2.28 – 4.0	2.0 – 4.0	3-12	2-12	2-13	1-11

science score was 7.62 (SD = 1.85), the mean MCAT verbal reasoning score was 7.56 (SD = 1.95) and the mean MCAT writing sample was 5.31 (SD = 1.97). The successful students had higher UGPA, SGPA, MCAT physical science score, MCAT biological science score, and MCAT verbal reasoning score. The only pre-admission measure that was higher for unsuccessful students was MCAT writing sample score.

**Bivariate Analysis**

The correlation coefficients from the bivariate analysis for the variables are summarized in Table 9. The correlation between the Barron's Admissions Selector Rating and the Peterson's Four-Year College Selectivity Index was  $r(800) = 0.742$ ,  $p < .01$ , two tails. Because of the strength and significance of this relationship, it was decided that the agreement between these two measures of selectivity be investigated using Cronbach's Alpha reliability test. Cronbach's Alpha coefficient is a measure of internal consistency between two or more variables. A high level of alpha reliability entails that the variables involved measure the same underlying concept somewhat differently, and as such, it was appropriate to construct a single composite index of the

Table 9

*Pearson Correlation Coefficients for Variables*

	P	B	S	MCAT WS	MCAT BS	MCAT PS	MCAT VR	SGPA	UGPA	Age	Year 1 GPA
P	1										
B	0.742**	1									
S	0.902**	0.959**	1								
MCAT WS	-0.137**	-0.104**	-0.125**	1							
MCAT BS	-0.066	-0.081*	-0.080*	0.592**	1						
MCAT PS	-0.102**	-0.110**	-0.114**	0.610**	0.856**	1					
MCAT VR	-0.124**	-0.110**	-0.124**	0.618**	0.789**	0.772**	1				
SGPA	0.111**	0.108**	0.116**	0.104**	0.218**	0.176**	0.121**	1			
UGPA	0.072*	0.069*	0.075*	0.090*	0.171**	0.124**	0.110**	0.856**	1		
Age	0.135**	0.144**	0.150**	-0.163**	-0.118**	-0.092**	-0.128**	-0.086*	-0.192**	1	
Year 1 GPA	-0.038	-0.061	-0.056	0.117**	0.225**	0.162**	0.160**	0.472**	0.493**	-0.165**	1

Note. B = Barron's Admission Selector Rating; P = Peterson's Four-Year College Selectivity Index; S = Composite Index for selectivity

\* $p < .05$ . \*\* $p < .01$

variables. The reliability test for the two selectivity measures resulted in  $\alpha = .81$ , which was above the standard cut-off for a high level of reliability. Because of this high reliability index it was determined that the two selectivity variables be combined to form a composite index of selectivity. The combination was achieved by averaging.

A correlation for the pre-admission measures revealed that institutional selectivity and the sections of the MCAT were significantly related in a negative direction. The interaction between the composite index for selectivity and MCAT writing sample was  $r(707) = -0.125, p < .01$ , two tails. The correlation between the composite index for selectivity and MCAT physical science was  $r(707) = -0.114, p < .01$ , two tails. The interaction between the composite selectivity index for selectivity and MCAT verbal reasoning was  $r(707) = -0.124, p < .01$ , two tails. The correlation between the composite index for selectivity and MCAT biological science was  $r(707) = -0.080, p < .05$ , two tails. The interaction between the composite index for selectivity and SGPA was  $r(800) = 0.116, p < .01$ , and correlation with UGPA was  $r(800) = 0.075, p < .05$ , two tails. The correlation between the composite index for selectivity and age was  $r(800) = 0.150, p < .01$ , two tails. There was no interaction between the composite index for selectivity and first year medical school GPA.

The MCAT writing sample was correlated with the SGPA and was  $r(707) = 0.104, p < .01$ , two tails. The interaction between the writing sample and UGPA was  $r(707) = 0.090, p < .05$ , two tails. There was also a significant negative interaction between the writing sample and age,  $r(707) = -0.163, p < .01$ , two tails. The correlation between the MCAT writing sample and first year medical school GPA was  $r(698) = 0.117, p < .01$ .

There was an interaction between the MCAT biological science and SGPA,  $r(707) = 0.218, p < .01$ . The biological science section was correlated with the UGPA and was  $r(707) = 0.171, p < .01$ , two tails. A negative significant interaction existed between the biological science section and age,  $r(707) = -0.118, p < .01$ . The correlation between the MCAT biological science and first year medical school GPA was  $r(698) = 0.225, p < .01$ .

The MCAT physical science was correlated with the SGPA and was  $r(707) = 0.176, p < .01$ , two tails. The interaction between the physical science and UGPA was  $r(707) = 0.124, p < .01$ , two tails. There was also a significant negative interaction between the physical science and age,  $r(802) = -0.092, p < .01$ , two tails. The correlation between the MCAT physical science and first year medical school GPA was  $r(698) = 0.162, p < .01$ .

There was an interaction between the MCAT verbal reasoning and SGPA,  $r(707) = 0.121, p < .01$ . The verbal reasoning section was correlated with the UGPA and was  $r(707) = 0.110, p < .01$ , two tails. A negative significant interaction existed between the verbal reasoning section and age,  $r(707) = -0.128, p < .01$ . The correlation between the MCAT verbal reasoning and first year medical school GPA was  $r(698) = 0.160, p < .01$ .

The SGPA was correlated with UGPA and was  $r(802) = 0.856, p < .01$ . There was a significant negative interaction between SGPA and age,  $r(802) = -0.086, p < .05$ , two tails. The SGPA was correlated with first year medical school GPA,  $r(698) = 0.472, p < .01$ . The UGPA was negatively correlated with age and was  $r(802) = -0.192, p < .01$ . An significant interaction existed between UGPA and first year medical school GPA and

was  $r(698) = 0.493, p < .01$ . Matriculant age was negatively correlated with first year medical school GPA and was  $r(698) = -0.165, p < .01$ , two tails.

### **Multivariate Analysis**

The estimates from the multivariate linear regression model that was used to examine the relationship between independent variables and first-year performance is depicted in Table 10. The adjusted multiple R-squared value was 0.297. Thus 29.7% of the variances in the dependent variable (first year medical school performance) can be said to be accounted for by or attributed to the combined variances of all the independent variables used in the model. The analysis of variance revealed that the overall model was significant,  $F(10, 689) = 30.54, p < .001, \eta = 0.307$ .

Table 10 also shows the regression coefficients and the associated p-values for the test of the null hypothesis that each of the slope parameters is not statistically significantly different from 0. The predictor variables in the regression model that had a statistically significant p-value were composite selectivity index, MCAT biological sciences, SGPA, UGPA, age and gender. The multivariate analysis demonstrated that MCAT physical sciences, MCAT writing sample, MCAT verbal reasoning and ethnicity were not statistically significant.

The directions of the slope parameters (i.e., all the slope parameters with statistically significant p-values) were all in the hypothesized direction. Institutional selectivity, which had its value coded “1” for high level selectivity and “6” for lower level of selectivity in the composite index, had a negative slope signifying that, controlling for all the predictor variables in the model, a lower value (high level of

Table 10

*Regression Coefficients Predicting First-Year Podiatric Medical School GPA*

Model	Beta (Standardized Slope)
UGPA	.329**
MCAT Biological Science	.212**
SGPA	.185**
Selectivity	-.117**
Gender	-.109**
Age	-.079*
MCAT Physical Science	-.097
Ethnicity	.054
MCAT Writing Sample	-.043
MCAT Verbal Reasoning	.027

$R^2 = 0.307$  (Adjusted to 0.297)  $p < .001$ .

$F(10, 689) = 30.54, p < .001, \eta = 0.307$ .

\*  $p < .05$

\*\*  $p < .01$

selectivity) is associated with higher first-year podiatric medical school GPA. Higher values of UGPA, SGPA, and MCAT biological science scores were associated with higher first-year podiatric medical school GPA when the effects of all of the other predictors in the model were held constant. The age and gender variables that were used in the model also showed that on the average, younger students and male students had a higher first-year podiatric medical school GPA as compared to older students and female students when the effects of all of the other predictors in the model were held constant.

The standardized slope parameters also measure the strength of the association between each predictor variable and the dependent variable while controlling for all of

the other predictor variables in the model. Accordingly, the strongest predictor of first-year podiatric medical school GPA was UGPA, MCAT biological score, SGPA, selectivity, gender, and age. Since the slopes of the other predictor variables were not statistically significantly different from 0 ( $p > 0.10$ ), they were ignored.

The null hypothesis statements are depicted in Table 11 with the hypothesis test outcomes for each independent variable.

Table 11

*Null Hypotheses Summary*

Independent Variable	Reject Null Hypothesis
The combined Baron's and Peterson's institutional selectivity index is not a significant predictor of first year GPA in a podiatric medical school	Yes
The MCAT section scores are not significant predictors of first year GPA in a podiatric medical school	
Biological Science	Yes
Physical Science	No
Verbal Reasoning	No
Writing Sample	No
The UGPA is not a significant predictor of first year GPA in a podiatric medical school	Yes
SGPA is not a significant predictor of first year GPA in a podiatric medical school	Yes
Ethnicity is not a significant predictor of first year GPA in a podiatric medical school	No
Age is not a significant predictor of first year GPA in a podiatric medical school	Yes
Gender is not a significant predictor of first year GPA in a podiatric medical school	Yes
Podiatric medical schools are not able to maximize their ability to predict which applicants will succeed in podiatric medical school using optimally weighted pre-admission variables	Yes

## **Chapter 5**

### **Discussion**

Few studies have examined the relationship between pre-admission variables and performance in podiatric medical school (Sesodia, Molnar, & Shaw, 2012; Yoho, Antonopoulos & Vardaxis, 2012). The published studies did not examine numerous variables or were limited in sample size. Although the relationship between pre-admission variables and performance have been studied extensively in allopathic medicine and on a limited basis in osteopathic medicine, this was the largest study based on the sample size and variables examined relating to podiatric medicine. This study was also the first study to utilize a composite index for institutional selectivity as a variable in medical school admission research.

The study utilized independent variables that included UGPA, SGPA, MCAT, gender, age, ethnicity, and undergraduate school selectivity based on the Barron's Admissions Selector Rating and Peterson's Four-Year College Selectivity Index which were converted to a composite index for selectivity. The study utilized first year podiatric medical school GPA as the dependent variable. Seven hypotheses relating to institutional and student characteristics were examined to determine if they were a significant predictor of first year podiatric medical school GPA, and an eighth hypothesis related to the combined predictiveness of the independent variables was evaluated.

#### **Institutional Selectivity**

The first hypothesis tested in this study dealt with the association between different selectivity models and their ability to significantly predict first year podiatric medical school GPA. The Barron's Admission Selector Rating and Peterson's Four-Year



College Selectivity Index were used as variables for institutional selectivity in this study and represent the two models previously used in medical school admission research (Blue et al., 2000; Kleshinski et al., 2009).

The bivariate analysis demonstrated a weak negative correlation between the Barron's Admission Selector Rating and first year podiatric medical school GPA. The interaction was not statistically significant and the direction of the slope was expected because more selective institutions were coded with lower number values in the analysis.

The bivariate analysis revealed a weak negative correlation between the Peterson's Four-Year College Selectivity Index and first year podiatric medical school GPA. The interaction was not statistically significant and exhibited less relationship to first year podiatric medical school GPA than the Barron's Admission Selector Rating. The analysis did reveal that the two models used as a measure of selectivity in this study had a strong correlation with one another, most likely because they measure similar institutional characteristics. Based on this relationship and the fact that these models appear to be measuring similar attributes, the decision was made to calculate a Cronbach's Alpha as a measure of reliability of the two selectivity models (Mishra, 2014). Based on the results of the Cronbach's Alpha, the two models were combined to form a composite index of selectivity. The use of a composite index for selectivity has not been described in prior studies related to medical school admission variable research. The composite index of selectivity was then re-analyzed in the bivariate analysis and was found to again have a weak negative correlation with first year podiatric medical school GPA that was not statistically significant.

In the multivariate linear regression model, when other variables were included, the composite index of selectivity was statistically significant. These results reinforce earlier findings reported in allopathic medicine.

This study demonstrated that institutional selectivity did not correlate well with first year podiatric medical school GPA; however institutional selectivity was statistically significant when it was examined in conjunction with other student characteristic variables. Mitchell (1990) did find that adding selectivity to other pre-admission variables could improve the predictive value for determining medical school performance. This is similar to findings by Huff and Fang (1999), although they used a different measure to define student success. They found that students that attended institutions with a lower selectivity rating were at an increased risk for academic difficulty. Smith and Geletta (2010) similarly found that institutional selectivity was able to predict success in podiatric medical school utilizing the Barron's Selector Rating. Their study reported a smaller sample size and only evaluated one selectivity index. The findings suggest that utilizing a composite index of selectivity increased the predictive value of the linear regression model in podiatric medical students.

Blue et al. (2000) reported that selectivity, specifically the Barron's Selector Rating did not add to the ability to predict performance in allopathic medicine if the MCAT and UGPA were available. This finding was similar to the results of this study because although the composite index for selectivity was statistically significant in the regression model, the predictive value was lower than the MCAT Biological Science section and the UGPA. Although there was no interaction between the composite index of selectivity and first year podiatric medical school GPA in the bivariate analysis, there

was a statistically significant interaction between selectivity and all sections of the MCAT and UGPA. This interaction has also been previously reported in allopathic medicine (Hall & Bailey, 1992; Jones & Adams, 1983).

### **Medical College Admission Test**

The second hypothesis tested in this study dealt with the association between MCAT section scores and their ability to significantly predict first year podiatric medical school GPA. All four MCAT sections were examined in the bivariate analysis and found to have a statistically significant correlation with first year podiatric medical school GPA. The strongest interaction was between the MCAT biological science section and first year podiatric medical school GPA. The weakest interaction was between the MCAT writing sample section and first year podiatric medical school GPA.

Most of the previous research focused on the MCAT biological science section which has been shown to predict success in allopathic medical school, although the predictive validity was small (Donnon et al., 2007). Gilbert et al. (2002) examined the MCAT writing sample and found that it did not improve the prediction of medical school performance at allopathic institutions. Previously published accounts related to the MCAT and its ability to predict medical school performance were supported by the current study.

The multivariate linear regression model demonstrated that the MCAT biological science score was statistically significant and had the second highest predictive value in the model. The MCAT physical science, MCAT verbal reasoning and MCAT writing sample scores were not statistically significant in the regression model. The use of MCAT scores in a predictive model has demonstrated the ability to predict medical

school grades and when combined with other variables such as UGPA, the predictive value increases (Wiley & Koenig, 1996). In the current study, all of the MCAT scores demonstrated a significant interaction with UGPA and bolster previously published claims that the MCAT, specifically the biological science section has the ability to predict first year podiatric medical school GPA in podiatric medicine.

### **Undergraduate Grade Point Average**

The third hypothesis tested in this study examined the association between UGPA and the ability to significantly predict first year podiatric medical school GPA. The results demonstrated that there was a significant correlation between UGPA and first year podiatric medical school GPA and the interaction was the highest in the bivariate analysis. The UGPA was also statistically significant in the regression model and also had the highest predictive value. This finding was consistent with numerous other published studies in allopathic medicine that demonstrated that UGPA was a strong predictor of academic success in medical school (Daubney et al., 1981; Hall & Bailey, 1992; Nowacek et al., 1987). Yoho et al. (2012) also demonstrated that UGPA was significantly correlated with academic performance in podiatric medical school. Their study included a smaller sample size and only included students that were successful.

Some authors caution that using UGPA in a predictive model could be problematic due to disparate grading practices and difference in academic rigor at undergraduate institutions (Sarnacki, 1982; Silver & Hodgson, 1997). There was a significant interaction between UGPA and the composite selectivity index in this study which demonstrated that when matriculants attended less selective schools they did have higher UGPA's. Jones and Adams (1983) suggested that UGPA may not be a standard

measure of student performance because of institutional variation and Nowacek et al. (1987) recommended using the MCAT because it can provide a standard measure of performance irrespective of institution background. The regression model demonstrated that the predictive value of the UGPA was higher than the sections of the MCAT, despite the correlation between UGPA and the composite selectivity index.

### **Science Grade Point Average**

The fourth hypothesis tested in this study examined the association between SGPA and the ability to significantly predict first year podiatric medical school GPA. The study revealed that there was a significant interaction between SGPA and first year podiatric medical school GPA. The SGPA was the third strongest predictive value in the regression model and was statistically significant. These findings were expected based on previous literature and the results related to UGPA from the current study.

Numerous authors have identified that SGPA has a statistically significant correlation with pre-clinical allopathic medical school performance and some have even suggested that SGPA is the most important predictor variable (Friedman & Bakewell, 1980; Hall & Stocks, 1995). Although the results from the current study demonstrated that SGPA was a significant variable in predicting first year podiatric medical school GPA, it was not the strongest predictor. The strongest predictor of first year podiatric medical school GPA was UGPA, but there was a significant relationship between SGPA and UGPA. The interaction between these two variables was the second highest correlation next to institutional selectivity. The obvious answer for this finding was that the UGPA takes into account all of the graded coursework at an undergraduate institution

and the SGPA is part of that calculation and the expectation was that there would be agreement amongst these two variables.

A similar trend unfolded between SGPA and the composite selectivity index which revealed that matriculants that attended less selective institutions also had higher SGPA's. The interaction was more significant between these two variables than the interaction between UGPA and composite selectivity index. This result was difficult to explain because of the high level of agreement between SGPA and UGPA.

### **Ethnicity**

The fifth hypothesis tested in this study dealt with the association between ethnicity and the ability to significantly predict first year podiatric medical school GPA. Ethnicity was not evaluated for interaction with other variables using a bivariate analysis because it was a binary variable. The results from the regression model demonstrated that ethnicity was not a significant variable in predicting first year podiatric medical school GPA.

In a previous study of podiatric medical students, Smith and Geletta (2010) found that ethnicity was a significant predictor of first year podiatric medical school GPA. The difference in findings can be attributed to the fact that the current study had a larger percentage of white students than the previous study, 88.7% and 68.4% respectively. The results confirm published accounts that non-white students are underrepresented in not just allopathic medical schools, but podiatric medical schools (Association of American Medical Colleges, 2007; Shea & Fullilove, 1985).

Although ethnicity and institutional selectivity was not examined in the bivariate analysis, previous literature has shown that minority students are more likely to attend

nonselective four-year institutions (Alon & Tienda, 2007). Previous research has also demonstrated that minority students are often financially disadvantaged and students from low socioeconomic backgrounds are more likely to also attend less selective institutions (Davies & Guppy, 1997; Hu & Kuh, 2003; McConnell, 2000; McNeal, 1999). Even though gender, ethnicity and socioeconomic status were not evaluated to determine if there was an interaction between these variables, others have suggested that the variables are linked with one another.

### **Age**

The sixth hypothesis tested in this study examined the association between age and the ability to significantly predict first year podiatric medical school GPA. There was a strong correlation between age and first year podiatric medical school GPA. The correlation was negative and demonstrated that younger matriculants have higher first year podiatric medical school GPA's. Previous research in allopathic and podiatric medicine also supported this finding regarding matriculant age.

Numerous studies have demonstrated that younger matriculants had higher UGPA, SGPA, and MCAT scores than their peers and had higher scores their first two years of allopathic medical school (Feil et al., 1998; Ramsbottom-Lucier et al., 1995). Kick et al. (2000) suggested that one explanation for this finding could be that older students had more personal responsibilities such as marriage and children which made it difficult to study. Sesodia et al. (2012) demonstrated that increasing student age reduced four-year graduation rate by 18%.

There was also a significant correlation between age and the composite selectivity index which suggested that younger students attended more selective

institutions. This finding was supported by previous research. Davies and Guppy (1997) found that younger students were more likely to attend institutions with a higher selectivity rating. The interaction between the variables related to age, composite selectivity index, UGPA and SGPA paint a picture that older podiatric medical students may attend less selective institutions because of personal responsibilities and this may affect their UGPA and SGPA and impact admission into podiatric medical school. The results from the regression model demonstrated that age was a significant variable in predicting first year podiatric medical school GPA.

### **Gender**

The last hypothesis tested in this study dealt with the association between gender and the ability to significantly predict first year podiatric medical school GPA. Gender was also not evaluated for interaction with other variables using a bivariate analysis because it was a binary variable. The results from the regression model revealed that gender was a significant predictor of first year podiatric medical school GPA although the level of significance was the second lowest of all other significant variables.

Since gender was not used as a variable in the bivariate analysis, it was difficult to correlate the results to previous studies that have examined the interaction between gender and other variables and found that woman had lower UGPA and MCAT scores (Ramsbottom-Lucier et al., 1995; Weinberg & Rooney, 1973).

The fact that gender contributed to predictiveness in the regression model with first year podiatric medical GPA was consistent with other literature. Weinberg and Rooney (1973) and Case et al. (1993) suggested that woman had lower basic science scores in allopathic medical school the first two years, but the difference was negligible.



This helps to explain that although gender was able to predict first year podiatric medical school GPA, gender was the weakest significant variable in the regression model.

### **Conclusions**

Because the sample for this study was selected from a single academic institution, any conclusions drawn from the study may not be applicable to the general population or other podiatric medical schools. However, the following conclusions about the sample in this study can be drawn.

The Barron's Selector Rating and Peterson's Four-Year Colleges guide revealed a very weak correlation with first year podiatric medical school GPA that was not significant. Due to the level of agreement amongst these variables a composite index of selectivity was created and utilized for analysis. To the author's knowledge, this was the first time a composite index for selectivity has been described in the literature as a single variable. The composite index for selectivity was not significantly correlated with first year podiatric medical school GPA. However, when other student characteristic variables were included in the regression model, the composite index for selectivity was significant and had predictive value in determining first year podiatric medical school GPA. The study also identified a significant correlation between the composite selectivity index and all sections of the MCAT, UGPA, SGPA and age.

All sections of the MCAT were significantly correlated with first year podiatric medical school GPA. The highest correlation was demonstrated between the MCAT biological science section and first year podiatric medical school GPA. The lowest correlation was between the MCAT writing sample and first year podiatric medical

school GPA. In the regression model only the MCAT biological section was statistically significant.

There was a strong significant correlation between the UGPA and first year podiatric medical school GPA. The correlation was the highest in the bivariate analysis. The UGPA also demonstrated the highest predictive value in the regression model. The SGPA was also significantly correlated with first year podiatric medical school GPA and also demonstrated significant predictive value in its ability to predict first year podiatric medical school GPA.

The study demonstrated that age was significantly correlated with first year podiatric medical school GPA and all of the other student characteristic variables. The regression model also demonstrated that age was able to predict first year podiatric medical school GPA. Although ethnicity and gender were not included in the bivariate analysis, the regression model revealed that gender was significant in helping predict first year podiatric medical school GPA and ethnicity was not a significant contributor.

The results indicated that all sections of the MCAT, UGPA, SGPA and age are correlated with first year podiatric medical school GPA. Students with higher first year podiatric medical school GPA had higher MCAT scores, higher UGPA, higher SGPA and were younger. The results also suggested that UGPA, MCAT biological science, SGPA, composite index of selectivity, gender and age had predictive value regarding first year podiatric medical school GPA. The independent variables displayed a variance of almost 29.7% in the regression model, leaving 70.3% to be explained by other variables that were not included in this model.

### **Significance of this Research**

Although research utilizing pre-admission measures and their ability to predict performance has been conducted in allopathic medicine, drawing similar conclusions regarding podiatric medicine based on those studies is presumptuous without researching applicants to podiatric medical schools. The allopathic applicant pool is larger and has higher pre-admission measures than the podiatric applicant pool, thus a large multi-year study specifically related to podiatric medicine can be applied to the study institution and the podiatric medical profession.

### **Study Institution**

The results of this study suggested that some pre-admission measures should be used in the screening of applicants to podiatric medical school because of their ability to predict performance in podiatric medical school as defined by the first year podiatric medical school GPA. The pre-admission measures that should be given the most weight are the UGPA, MCAT biological sciences score, SGPA, composite index of selectivity, gender and age. Although some applicants were admitted without MCAT scores, the study institution no longer interviews applicants unless the student has taken the MCAT examination. The use of age and gender as a means of excluding podiatric medical school applicants for admission could have legal ramifications related to discrimination.

Although this study revealed similar results to previously conducted studies in allopathic medicine, this was the first study to confirm that the same pre-admission measures have the ability to predict success in podiatric medical school despite smaller and weaker applicant pools as measured by UGPA, SGPA and MCAT scores. Previous allopathic studies that used institutional selectivity as a predictor variable also used one

specific measure for institutional selectivity and the use of a composite index for selectivity has not been previously described. This is applicable to all medical school researchers seeking to conduct admissions research.

Based on the findings of this study the institution should consider the following recommendations for future research. The study institution should explore the predictive validity of other independent variables on podiatric medical school performance such as an applicant's balance between extra-curricular activities and academics. This information could be elicited during the interview and quantified. Another variable that should be considered is socioeconomic status. Previous authors have demonstrated that student socioeconomic status has been correlated with institutional selectivity and undergraduate persistence; however this has not been explored in podiatric medicine. Inclusion of these variables may increase the predictive validity of the regression model that currently only explains 29.7% of the variance. In order to analyze additional variables, a procedure for collection of pre-admission measures would have to be established since these measures are not currently captured at the study institution.

Another institutional research recommendation would include examining other dependent variables such as national licensing examinations, clinical evaluation scores, residency placement, and professional board certification examinations to expand the definition of matriculant success. Analyzing additional dependent variables would require a national effort on behalf of the profession because currently much of this information is not released to podiatric medical schools.

**Podiatric Medical Profession**

The profession should conduct a national study similar to the current study to determine if these results are generalizable. Allopathic medicine has previously conducted this research on a national level and utilized the results of previous studies to make decisions about applicants for decades. Currently a national effort to conduct this research in podiatric medicine has been nonexistent, leaving podiatric medicine decades behind other professions. This type of research would be extremely difficult to conduct because pre-admission measures for the matriculants at all podiatric medical schools are not contained in a single national database. Currently institutions are not required to share applicant and matriculant pre-admission measures with the national organizing body of the profession.

Profession wide research would still be difficult even with the existence of a single database because a uniform dependent variable would have to be identified. The first year podiatric medical school GPA could not be used because of different grading schemes and standards exist at different institutions. A dependent variable that is uniform amongst all students would have to be selected such as national licensing examination scores, which is currently not released to the profession. The national licensing examination reports released to podiatric medical schools only provide information related whether a student passed or failed the examination.

## References

- Albanese, M. A., Farrell, P., & Dottl, S. (2005). Statistical criteria for setting thresholds in medical school admissions. *Advances in Health Sciences Education, 10*, 89-103.
- Alon, S., & Tienda, M. (2007). Diversity, opportunity, and the shifting meritocracy in higher education. *American Sociological Review, 72*, 487-511.
- American Association of Colleges of Osteopathic Medicine. (2013). Retrieved October 14, 2014, from <http://www.aacom.org/DATA/APPLICANTSMATRICULANTS/Pages/default.aspx>
- American Association of Colleges of Podiatric Medicine. (2005). *AACPM historical trends of applications: 1995-2005*. Retrieved November 19, 2007, from [http://www.aacpm.org/html/statistics/stats\\_applicants.asp](http://www.aacpm.org/html/statistics/stats_applicants.asp)
- American Association of Colleges of Podiatric Medicine. (2013). Retrieved October 14, 2014, from <http://www.aacpm.org/>
- Anaya, G. (2001). Correlates of performance on the MCAT: An examination of the influence of college environments and experiences on student learning. *Advances in Health Sciences Education, 6*, 179-191.
- Association of American Medical Colleges. (2005). *Applicants, accepted applicants, and matriculants by sex, 1995-2006*. Retrieved November 15, 2007, from <http://www.aamc.org/data/facts/>
- Association of American Medical Colleges. (2007). *Applicants, accepted applicants, and matriculants by sex, 1997-2007*. Retrieved November 15, 2007, from <http://www.aamc.org/data/facts/>

- Association of American Medical Colleges. (2012). *Medical school admission requirements, 2012-2013*. Washington, DC: Association of American Medical Colleges.
- Association of American Medical Colleges. (2013). *MCAT scores and GPAs for applicants and matriculants to U.S. medical schools, 2002-2013*. Retrieved October 15, 2014, from <https://www.aamc.org/data/facts/applicantmatriculant/>
- Astone, N. M., & McLanahan, S. S. (1991). Family structure, parental practices and high school completion. *American Sociological Review*, 56(3), 309-320.
- Barron's profiles of American colleges 2013* (30th ed.). (2012). Hauppauge, NY: Barron's Educational Series.
- Basco, W. T., Gilbert, G. E., & Blue, A. V. (2002). Determining the consequences for rural applicants when additional consideration is discontinued in a medical school admission process. *Academic Medicine*, 77(10), S20-S22.
- Beck, B. (1999). *Trends in undergraduate grades*. St. Paul, MN: Association for Institutional Research in the Upper Midwest.
- Benbassat, J., & Baumal, R. (2007). Uncertainties in the selection of applicants for medical school. *Advances in Health Sciences Education*, 12, 509-521.
- Billson, J. M., & Terry, M. B. (1982). In search of the silken purse: Factors in attrition among first-generation students. *College and University*, 58(1), 57-75.
- Blue, A. V., Gilbert, G. E., Elam, C. L., & Basco, W. T. (2000). Does institutional selectivity aid in the prediction of medical school performance. *Academic Medicine*, 75(10), 31-33.

- Bright, C. M., Duefield, C. A., & Stone, V. E. (1998). Perceived barriers and biases in the medical education experience by gender and race. *Journal of the National Medical Association, 90*(11), 681-688.
- Case, S. M., Becker, D. F., & Swanson, D. B. (1993). Performances of men and women on NBME Part I and Part II: The more things change. *Academic Medicine, 68*(10), S25-S27.
- Clapp, T. T., & Reid, J. C. (1976). Institutional selectivity as a predictor of applicant selection in medical school. *Journal of Medical Education, 51*, 850-852.
- Clark, R. (1983). *Family life and school achievement: Why poor black children succeed in school*. Chicago: University of Chicago Press.
- Cohen, J. J. (2002). Our compact with tomorrow's doctors. *Academic Medicine, 77*(6), 475-480.
- Coleman, J. S. (1988). Social capital in the creation of human capital. *The American Journal of Sociology, 94*(1), S95-S120.
- Collin, V. T., Violato, C., & Hecker, K. (2008). Aptitude, achievement and competence in medicine: A latent variable path model. *Advances in Health Sciences Education, DOI 10.1007/s10459-008-9121-7*.
- Council on Podiatric Medical Education. (2005). *Eighty-sixth annual report*. Retrieved November 19, 2007, from [http://www.apma.org/s\\_apma/bin.asp?CID=163&DID=19355&DOC=FILE.DOC](http://www.apma.org/s_apma/bin.asp?CID=163&DID=19355&DOC=FILE.DOC)
- Daubney, J. H., Wagner, E. E., & Rogers, W. A. (1981). Six-year BS/MD programs: A literature review. *Journal of Medical Education, 56*, 497-503.



- Davies, S., & Guppy, N. (1997). Fields of study, college selectivity, and student inequalities in higher education. *Social Forces*, 75(4), 1417-1438.
- Davis, D. D., Dorsey, J. K., Franks, R. D., Sackett, P. R., Searcy, C. A., & Zhao, X. (2013). Do racial and ethnic group differences in performance on the MCAT exam reflect test bias? *Academic Medicine*, 88(5), 593-602.
- Didier, T., Kreiter, C. D., Buri, R., & Solow, C. (2006). Investigating the utility of a GPA institutional adjustment index. *Advances in Health Sciences Education*, 11, 145-153.
- Donnon, T., Paolucci, E. O., & Violato, C. (2007). The predictive validity of the MCAT for medical school performance and medical board licensing examinations: A meta-analysis of the published research. *Academic Medicine*, 82(1), 100-106.
- Dunleavy, D. M., Kroopnick, M. H., Dowd, K. W., Searcy, C. A., & Zhao, X. (2013). The predictive validity of the MCAT exam in relation to academic performance through medical school: A national cohort study of 2001-2004 matriculants. *Academic Medicine*, 88(5), 666-671.
- Edwards, J. C., Johnson, E. K., & Molidor, J. B. (1990). The interview in the admission process. *Academic Medicine*, 65, 167-175.
- Eva, K. W., & Reiter, H. I. (2004). Where judgement fails: Pitfalls in the selection process for medical personnel. *Advances in Health Sciences Education*, 9, 161-174.
- Evans, D. A., Jones, P. K., Wortman, R. A., & Jackson, E. B. (1975). Traditional criteria as predictors of minority student success in medical school. *Journal of Medical Education*, 50, 934-939.

- Feil, D., Kristian, M., & Mitchell, N. (1998). Older medical students' performances at McGill University. *Academic Medicine, 73*(1), 98-100.
- Felton, J., & Koper, P. T. (2005). Nominal GPA an Real GPA: A simple adjustment that compensates for grade inflation. *Assessment & Evaluation in Higher Education, 30*(6), 561-569.
- Flexner, A. (1910). *Medical education in the United States and Canada. A report to the Carnegie Foundation for the Advancement of Teaching* (Bulletin Number 4). Boston: Updyke.
- Flowers, K. (1996). *Characteristics of MCAT examinees: 1994-1995*. Washington, DC: Association of American Medical Colleges.
- Friedman, C. P., & Bakewell, W. E. (1980). Incremental validity of the new MCAT. *Journal of Medical Education, 55*, 399-404.
- Gibley, C. W. (1974). Podiatric education: Its history and evolutionary significance. *Journal of the American Podiatry Association, 64*(5), 312-331.
- Gibley, C. W. (1987). History of podiatric medical education. *Journal of the American Podiatric Medical Association, 77*(8), 404-418.
- Gilbert, G. E., Basco, W. T., Blue, A. V., & O'Sullivan, P. S. (2002). Predictive validity of the medical college admissions test writing sample for the United States medical licensing examination steps 1 and 2. *Advances in Health Sciences Education, 7*, 191-200.
- Haist, S. A., Wilson, J. F., Elam, C. L., Blue, A. V., & Fosson, S. E. (2000). The effect of gender and age on medical school performance: An important interaction. *Advances in Health Sciences Education, 5*, 197-205.

- Hall, F. R., & Bailey, B. A. (1992). Correlating students' undergraduate science GPAs, theirs MCAT scores, and the academic caliber of their undergraduate colleges with their first-year academic performances across five classes at Dartmouth medical school. *Academic Medicine*, *67*(2), 121-123.
- Hall, M. L., & Stocks, M. T. (1995). Relationship between quantity of undergraduate science preparation and preclinical performance in medical school. *Academic Medicine*, *70*(3), 230-235.
- Hendren, R. L. (1988). Predicting success and failure of medical students at risk for dismissal. *Journal of Medical Education*, *63*, 595-601.
- Hofferth, S. L., Boisjoly, J., & Duncan, G. J. (1998). Parents' extrafamilial resources and children's school attainment. *Sociology of Education*, *71*(3), 246-268.
- Hofman, A., & Van Den Berg, M. (2004). Highbrows in university education. *Higher Education in Europe*, *29*(4), 509-521.
- Hojat, M., Erdmann, J. B., Veloski, J. J., Nasca, T. J., Callahan, C. C., Julian, E., & Peck, J. (2000). A validity study of the writing sample section of the Medical College Admission Test. *Academic Medicine*, *75*(10), S25-S27.
- Horvat, E. M., Weininger, E. B., & Lareau, A. (2003). From social ties to social capital: Class differences in the relations between schools and parental networks. *American Educational Research Journal*, *40*(2), 319-351.
- Hossler, D., & Vesper, N. (1993). An exploratory study of the factors associated with parental saving for postsecondary education. *The Journal of Higher Education*, *64*(2), 140-165.

- Hu, S., & Kuh, G. D. (2003). Diversity experiences and college student learning and personal development. *Journal of College Student Development, 44*(3), 320-334.
- Huff, K. L., & Fang, D. (1999). When are students most at risk of encountering academic difficulty? A study of the 1992 matriculants to U. S. medical schools. *Academic Medicine, 74*(4), 454-460.
- Ishitani, T. T. (2003). A longitudinal approach to assessing attrition behavior among first-generation students: Time-varying effects of pre-college characteristics. *Research in Higher Education, 44*(4), 433-449.
- Ishitani, T. T. (2006). Studying attrition and degree completion behavior among first-generation college students in the United States. *The Journal of Higher Education, 77*(5), 861-885.
- Jackson, E. W., & Dawson-Saunders, B. (1987). History of not completing courses as predictor of academic difficulty among first-year students. *Journal of Medical Education, 62*, 880-885.
- Johnson, D. G., Lloyd, S. M., Jones, R. F., & Anderson, J. A. (1986). Predicting academic performance at a predominantly black medical school. *Journal of Medical Education, 61*, 629-639.
- Johnson, D. G., & Sedlacek, W. E. (1975). Retention by sex and race of 1968-1972 U. S. medical school entrants. *Journal of Medical Education, 50*, 925-933.
- Johnson, V. E. (1997). An alternative to traditional GPA for evaluating student performance. *Statistical Science, 12*(4), 251-278.
- Jolly, P. (1992). Academic achievement and acceptance rates of underrepresented-minority applicants to medical school. *Academic Medicine, 67*(11), 765-769.

- Jones, R. F., & Adams, L. N. (1983). The relationship between MCAT science scores and undergraduate science GPA. *Journal of Medical Education*, 58, 908-911.
- Jones, R. F., & Thomae-Forgues, M. (1984). Validity of the MCAT in predicting performance in the first two years of medical school. *Journal of Medical Education*, 59, 455-464.
- Julian, E. R. (2005). Validity of the medical college admission test for predicting medical school performance. *Academic Medicine*, 80(10), 910-917.
- Kay, J., & Blythe, M. (1984). Professionalization of the older medical student. *Journal of Medical Education*, 59, 559-566.
- Kick, S., Adams, L., & O'Brien-Gonzales, A. (2000). Unique issues of older medical students. *Teaching and Learning in Medicine*, 12(3), 150-155.
- Kleshinski, J., Khuder, S. A., Shapiro, J. I., & Gold, J. P. (2009). Impact of preadmission variable on USMLE step 1 and step 2 performance. *Advances in Health Sciences Education*, 14, 69-78.
- Koenig, J. A., Sireci, S. G., & Wiley, A. (1998). Evaluating the predictive validity of MCAT scores across diverse applicant groups. *Academic Medicine*, 73(10), 1095-1106.
- Koenig, T. A., Parrish, S. K., Terregino, C. A., Williams, J. P., Dunleavy, D. M., & Volsch, J. M. (2013). Core personal competencies important to entering students' success in medical school: What are they and how could they be assessed early in the admission process? *Academic Medicine*, 88(5), 603-613.

- Kreiter, C. D., Yin, P., Solow, C., & Brennan, R. L. (2004). Investigating the reliability of the medical school admissions interview. *Advances in Health Sciences Education, 9*, 147-159.
- Lareau, A. (1987). Social class differences in family-school relationships: The importance of cultural capital. *Sociology of Education, 60*(2), 73-85.
- Lerner, H. J. (1974). Steps in the development of the profession of podiatry, as noted in its professional journal. *Journal of the American Podiatry Association, 64*(5), 279-297.
- Levy, L. A. (1977). A case for podiatric medicine in an academic health science center. *Journal of Podiatric Medical Education, 8*, 14.
- Levy, L. A. (2006). The evolution of podiatric medical practice and formal education: Chronological history. In L. A. Levy & V. J. Hetherington (Eds.), *Principles and practice of podiatric medicine* (2nd ed., pp. 1-10). Brooklandville, Md: Data Trace.
- Markert, R. J. (1985). Pre-admission academic predictors of the goals of a primary care-oriented medical school. *Medical Education, 19*, 9-12.
- McConahay, M., & Cote, R. (1998). The expanded grade context record at Indiana University. *Cause/Effect Journal, 21*(4), 47.
- McConnell, P. J. (2000). Eric review: What community colleges should do to assist first-generation students. *Community College Review, 28*(3), 75-88.
- McGaghie, W. C. (1990). Perspectives on medical school admission. *Academic Medicine, 65*, 136-139.

- McGlinn, S., & Jackson, E. W. (1989). Predicting the medical school progress of minority students who participated in a preparatory program. *Academic Medicine*, *64*, 164-166.
- McNeal, R. B. (1999). Parental involvement as social capital: Differential effectiveness on science, achievement, truancy, and dropping out. *Social Forces*, *78*(1), 117-144.
- Mills, C., Heyworth, J., Rosenwax, L., Carr, S., & Rosenberg, M. (2009). Factors associated with the academic success of first year health science students. *Advances in Health Sciences Education*, *14*, 205-217.
- Mishra, S. K. (2014). *On construction of robust composite indices by linear aggregation*. (June 19, 2008). Available at SSRN: Retrived <http://ssrn.com/abstract=11479674>
- Mitchell, K. J. (1987). Use of MCAT data in selecting students for admission to medical school. *Journal of Medical Education*, *62*, 871-879.
- Mitchell, K. J. (1990). Traditional predictors of performance in medical school. *Academic Medicine*, *65*, 149-158.
- Mitchell, K. J., Haynes, R., & Koenig, J. A. (1994). Assessing the validity of the updated medical college admission test. *Academic Medicine*, *69*(5), 394-401.
- Monroe, A., Quinn, E., Samuelson, W., Dunleavy, D. M., & Dowd, K. W. (2013). An overview of the medical school admission process and use of applicant data in decision making: What has changed since the 1980s? *Academic Medicine*, *88*(5), 672-681.
- Montecinos, C., & Pohlmann, J. (1987). Academic predictors of minority students' acceptance into medical school. *Journal of Medical Education*, *62*, 678-680.

- Nowacek, G. A., Pullen, E., Short, J., & Blumner, H. N. (1987). Validity of MCAT scores as predictors of preclinical grades and NBME part I examination scores. *Journal of Medical Education*, 62, 989-991.
- Pell Institute for the Study of Opportunity in Higher Education. (2006, December). *Straight from the source: What works for first-generation college students*. Washington, DC: Author.
- Pellegrino, E. D. (1973). The profession of podiatric medicine with the academic health science center. *Journal of Podiatric Medical Education*, 4, 10.
- Petersdorf, R. G. (1992). Not a choice, an obligation. *Academic Medicine*, 67, 73-79.
- Peterson's Four-Year Colleges 2014* (44th ed.). (2013). Albany, NY: Peterson's.
- Pike, G. R., & Kuh, G. D. (2005). First- and second-generation college students: A comparison of their engagement and intellectual development. *The Journal of Higher Education*, 76(3), 276-300.
- Qian, Z., & Blair, S. L. (1999). Racial/ethnic differences in educational aspirations of high school seniors. *Sociological Perspectives*, 42(4), 605-625.
- Ramsbottom-Lucier, M., Johnson, M. M. S., & Elam, C. L. (1995). Age and gender differences in student's preadmission qualifications and medical school performances. *Academic Medicine*, 70(3), 236-239.
- Reiter, H., Lockyer, J., Ziola, B., Courneya, C., & Eva, K. (2013). Should efforts in favor of medical student diversity be focused during admissions or farther upstream? *Academic Medicine*, 87(4), 443-448.



- Reiter, H., & Maccoon, K. (2007). A compromise method to facilitate under-represented minority admissions to medical school. *Advances in Health Sciences Education, 12*, 223-237.
- Reznick, R. K., Blackmore, D., Cohen, R., Baumber, J., Rothman, A., Smee, S., Chalmers, A., Poldre, P., Birtwhistle, J., Walsh, P., Spady, D., & Bernard, M. (1993). An objective structured clinical examination for the licentiate of the Medical Council of Canada: From research to reality. *Academic Medicine, 68*, S4-S6.
- Riehl, R. J. (1994). The academic preparation, aspirations, and first-year performance of first-generation students. *College and University, 70*(1), 14-19.
- Roman, S. A., Sorenson, J. R., Davis, W. I., & Erickson, R. (1979). Predicting minority student performance in the first medical school year. *Journal of the National Medical Association, 71*(7), 661-664.
- Rowan-Kenyon, H. T. (2007). Predictors of delayed college enrollment and the impact of socioeconomic status. *The Journal of Higher Education, 78* (2), 188-214.
- Salvatori, P. (2001). Reliability and validity of admissions tools used to select students for the health professions. *Advances in Health Sciences Education, 6*, 159-175.
- Sarnacki, R. E. (1982). The predictive value of the premedical grade-point average. *Journal of Medical Education, 57*, 163-169.
- Sedlacek, W. E., & Prieto, D. O. (1990). Predicting minority students' success in medical school. *Academic Medicine, 60*, 161-166.

- Sesodia, S., Molnar, D., & Shaw, G. P. (2012). Can we predict 4-year graduation in podiatric medical school using admission data? *Journal of the American Podiatric Medical Association, 102*(6), 463-470.
- Shaw, D. L., Martz, D. M., Lancaster, C. J., & Sade, R. M. (1995). Influence of medical school applicants' demographic and cognitive characteristics on interviewers' ratings of noncognitive traits. *Academic Medicine, 6*, 532-536.
- Shea, S., & Fullilove, M. T. (1985). Entry of black and other minority students into U. S. Medical Schools: Historical perspective and recent trends. *The New England Journal of Medicine, 313*(15), 933-940.
- Shen, H., & Comrey, A. L. (1997). Predicting medical students' academic performances by their cognitive abilities and personality characteristics. *Academic Medicine, 72*(9), 781-786.
- Sherman, J. F. (1978). The older applicant for admissions to medical school. *Journal of Medical Education, 53*, 215-216.
- Silver, B., & Hodgson, C. S. (1997). Evaluating GPAs and MCAT scores as predictors of NBME I undergraduate institution. *Academic Medicine, 72*(5), 394-396.
- Smith, K. M., & Geletta, S. (2010). The role of institutional selectivity in the prediction of podiatric medical school performance. *Journal of the American Podiatric Medical Association, 100*(6), 479-486.
- Stage, F. K., & Hossler, D. (1989). Differences in family influences on college attendance plans for male and female ninth graders. *Research in Higher Education, 30*(3), 301-315.

- Strayhorn, G. (1999). Participation in a premedical summer program for underrepresented-minority students as a predictor of academic performance in the first three years of medical school: Two studies. *Academic Medicine, 74*, 435-447.
- Strayhorn, G., & Frierson, H. (1989). Assessing correlations between black and white students' perceptions of the medical school learning environment, their academic performances, and their well-being. *Academic Medicine, 64*, 468-473.
- Stevenson, D. L., & Baker, D. P. (1987). The family-school relation and the child's school performance. *Child Development, 58*(5), 1348-1357.
- Sui-Chu, E. H., & Willms, J. D. (1996). Effects of parental involvement on eighth-grade achievement. *Sociology of Education, 69*(2), 126-141.
- Taubman, R. E. (2009). Reflections on vision 2015 and our journey to parity. *Journal of the American Podiatric Medical Association, 99*(2), 181-182.
- Terenzini, P. T., Springer, L., Yaeger, P. M., Pascarella, E. T., & Nora, A. (1996). First-generation college students: Characteristics, experiences, and cognitive development. *Research in Higher Education, 37*(1), 1-22.
- Tierney, W. G. (2002). Parents and families in precollege preparation: The lack of connection between research and practice. *Educational Policy, 16*(4), 588-606.
- Toutkoushian, R. K., & Smart, J. C. (2001). Do institutional characteristics affect student gains from college? *The Review of Higher Education, 25*(1), 39-61.
- Trail, C., Reiter, H. I., Bridge, M., Stefanowska, P., Schmuck, M., & Norman, G. (2008). Impact of field of study, college and year on calculation of cumulative grade point average. *Advances in Health Sciences Education, 13*, 253-261.

- Turnbull, J., Danoff, D., & Norman, G. R. (1996). Content specificity and oral certification exams. *Medical Education, 30*, 56-59.
- U. S. Department of Education. (2005a). *Cohort default rate guide*. Washington, DC: Author.
- U. S. Department of Education. (2005b). *First-generation students in postsecondary education: A look at their college transcripts*. Washington, DC: Author.
- Vancouver, J. B., Reinhart, M. A., Solomon, D. J., & Haf, J. J. (1990). Testing for validity and bias in the use of GPA and the MCAT in the selection of medical school students. *Academic Medicine, 65*(11), 694-697.
- Veloski, J. J., Callahan, C. A., Xu, G., Hojat, M., & Nash, D. B. (2000). Prediction of students' performance on licensing examinations using age, race, sex, undergraduate GPAs, and MCAT scores. *Academic Medicine, 75*(10), S28-S30.
- Weinberg, E., & Rooney, J. F. (1973). The academic performance of women students in medical school. *Journal of Medical Education, 48*, 240-247.
- Wiley, A., & Koenig, J. A. (1996). The validity of the medical college admission test for predicting performance in the first two years of medical school. *Academic Medicine, 71*(10), 83-85.
- White, C. B., Dey, E. L., & Fantone, J. C. (2007). Analysis of factors that predict clinical performance in medical school. *Advances in Health Sciences Education*, DOI 10.1007/s10459-007-9088-9.
- Xu, G., Veloski, J., & Barzansky, B. (1997). Comparisons between older and usual-aged medical school graduates on the factors influencing their choices of primary care specialties. *Academic Medicine, 72*(11), 1003-1007.

Yoho, R. M., Antonopoulos, K., & Vardaxis, V. (2012). Undergraduate GPAs, MCAT scores, and academic performance the first 2 years in podiatric medical school at Des Moines University. *Journal of the American Podiatric Medical Association*, *102*(6), 446-450.