Differential Prediction of Medical School Selection Factors for Rural and Non-Rural Populations

Megan R. Price

Thesis submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Master of Science

in

Industrial/Organizational Psychology

Neil M. A. Hauenstein, Ph.D., Chair
Roseanne J. Foti, Ph.D.
Hara P. Misra, Ph.D.

(April 29, 2008)
Blacksburg, Virginia

Keywords: Admissions, COMLEX, Differential Prediction, MCAT, Medical School, Rural

DIFFERENTIAL PREDICTION OF MEDICAL SCHOOL SELECTION FACTORS FOR RURAL AND NON-RURAL POPULATIONS

Megan R. Price

(ABSTRACT)

Differential predictive validity in assessing academic performance in institutions of higher education has been assessed for a number of years. Historically, this body of research focused on gender and ethnicity. This study extends that research to geographic region (e.g., rural and non-rural populations). Specifically, this study predicted relationships between preadmission variables of incoming grade point average (GPA) and medical college admissions test (MCAT) and output variables of medical school GPA and comprehensive osteopathic medical licensing exam (COMLEX). Results indicate incoming GPA and MCAT are good variables to use to predict academic performance in medical school and score on the licensing board exam. Further, rural populations presented similar scores on preadmission variables and, thus, are not at a disadvantage in the admission process. A second goal of this study was to explore differential prediction of medical school GPA and COMLEX Level 1 score for the MCAT for rural and non-rural populations. Results provide some evidence of differential prediction of COMLEX score for the physical and biological sciences MCAT sub-tests such that rural populations' performance on the COMLEX Level 1 exam was underpredicted. Hence, when rural and non-rural populations present the same physical sciences and biological sciences MCAT sub-test score, the rural sub-group is predicted to obtain a lower COMLEX score and non-rural sub-group is predicted to obtain a higher COMLEX score. Further, when the two sub-groups present different MCAT scores for the physical and biological sciences sub-test, they are likely to obtain similar scores on the COMLEX. Implications and recommendations for future research are discussed.

PREFACE

"In the photograph framed on my desk, a brawny man lifts the tail of a 1978 Ford Pinto several feet off the ground, a big grin on his face, without a hint of strain. And while this image might appear surreal, this man isn't in the latest action film or football star – he is my father. At more than six feet tall weighing 240 pounds, my Dad always seemed like a goliath to me. But 25 years after that photo was taken, the one thing more unstoppable than my father, age, reared its ugly head. As an athletic, former Naval officer who traveled the world, old age never appealed to him, nor did it seem like a plausible reality. While my Dad always said, "Never grow old," at 53 years of age, part of his foot was amputated due to longstanding untreated diabetes, and he could no longer deny the ramifications of aging. Although he always suspected he was diabetic, he lives in rural Tennessee with a limited income. Unable to afford care for more than 10 years, my Dad tells me medical care is out of reach for the medically uninsured and underinsured. Although his diabetes could have been treated earlier, he says he is going to live the rest of his life uncomfortable and immobile because he is an afterthought, instead of a priority, in a profit-hungry medical landscape. My aim is to work as a physician to help the uninsured and underinsured in rural areas, so that people like my Dad will not have to deal with the results of unchecked medical conditions. While these basic principles of medicine are currently inaccessible to millions in the United States alone, I aspire to encourage people to embrace age instead of approach it with fear. When I look at my Dad's photograph today, I am filled with the hope that in the future, I will never have to watch a patient of mine tell his son that because of an unchecked condition, his Dad's quality of life will be forever impaired."

- Excerpt from a medical school application personal statement (HRH)

ACKNOWLEDGEMENTS

There are a number of people who provided direction and support throughout this journey. First and foremost, I would like to thank my advisor, Dr. Neil Hauenstein, for his tireless commitment and guidance. This has been an amazing learning experience and I will forever be grateful for his patience and mentorship. I would also like to thank my committee members, Dr. Roseanne Foti and Dr. Hara Misra, whose feedback made substantial improvements to this project. Additionally, I would like to extend a heart felt "thank you" to Ted and Faustine Settle. Over the last seven years, my parents have been my cheerleaders – unwavering in their confidence, my safe haven – listening during difficult times, and my audience – reviewing drafts and listening to oral presentations. I would also like to thank the Edward Via Virginia College of Osteopathic Medicine and Virginia Tech Special Events Office for encouraging me to pursue my master's degree and understanding that, often, this resulted in time out of the office and away from my professional obligations. Special thanks to Kathy Thorsen and Connie Goodman in the registrar's office at VCOM for compiling the data for our study. Without them, literally none of this would be possible.

This thesis is dedicated to my husband. Shannon you have been and continue to be everything to me – my best friend, my confidant, my soul mate. Thank you for your immeasurable faith, love, commitment, and respect. With you by my side, I feel anything is possible, and I am honored to be your wife.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Differential Prediction of Medical School Selection Factors for Rural and Non-Rural Populations

INTRODUCTION

In the selection process, test fairness assesses the extent to which any predictor of criterion performance is biased against an applicant population subgroup. When a biased test is utilized, one subgroup is given an advantage and the second subgroup is placed at a disadvantage in the selection process. Both outcomes generate a pool of preferred applicants that may not be the best fit for the organization, and selection based on these biased tests may even result in legal ramifications.

This study examines the test fairness of the selection criteria for a college of osteopathic medicine. In particular, we are interested in the ability of the two most commonly used selection criteria for admission to medical school, i.e., incoming grade point average and the Medical College Admissions Test (MCAT), to predict medical school grade point average and score on the national licensing exam. Further, we explored differential prediction for MCAT score for medical school GPA and comprehensive osteopathic medical licensing exam (COMLEX) score. In the event we are able to determine the incoming GPA and MCAT score are good predictors of medical school GPA and national licensing exam score, we can feel confident about utilizing these preadmission variables in the admissions process to select the most qualified applicants.

LITERATURE REVIEW

Background

A 2002 national study, published in *Health Affairs*, reported an estimated shortage of 50,000 physicians nationwide by 2010 and a shortage of more than 200,000 physicians by 2020 (Cooper, Getzen, McKee, & Laud). The impact of this national physician shortage will be felt to a greater extent in rural regions. As evidenced by a report released by the World Organization of Family Doctors, on average rural residents throughout the world have reduced access to health care, are less healthy, and have less successful treatment outcomes when compared to their urban counterparts (WONCA, 2003). In fact, greater than 22 million Americans now live in federally designated Health Professional Shortage Areas (HPSAs), where less than one primary care physician serves 3,500 people or more. In contrast, the average primary care physician-to-population ratio in the urban United States is approximately 1:1,285. This disparity results in large part from the difficulty in generating, sustaining, and preserving an adequate and appropriately trained health care workforce. The specific needs of rural areas in the United States vary widely across communities and health care workforce solutions require sensitivity to these issues of rural diversity. "One size fits all" solutions to the challenges facing our rural communities are unlikely to facilitate advancement (Larson, et al., 2003).

The Appalachian Region is one specific rural area that continues to face a chronic shortage of medical professionals. With a total population of 22.8 million, the Appalachian Region includes all of West Virginia and parts of 12 other states and extends more than one thousand miles from the southwest of New York to northeast Mississippi (Halverson, Ma, & Harner, 2004). Residents of the Appalachian Region must often travel hours to consult specialists, and in many rural communities there is even a deficiency of primary care physicians (physicians certified in family medicine, internal medicine, pediatrics, obstetrics/gynecology, and psychiatry). In fact, according to Lyle Snider, research director of the Center for Rural Health's Division of Community Programs, Research, and Health Policy at the University of Kentucky, the rural Appalachian Region still labors under a double burden: the fewest primary care doctors and the most severe health problems (Baldwin, 1999).

In the 1990s, solutions to the physician shortages in rural areas of the United States combined with strategies for increasing the number of primary care physicians. Central to this initiative was the need to nurture an interest in primary care during secondary or even primary education. Studies of physicians' characteristics and their choice of practice location suggest that upbringing in a rural area is the main determinant of physicians working in a rural primary care practice (Clawson, 1990; Colwill, 1986; Colwill, 2003; Cullison, Reid, & Colwill, 1976a; Cullison, Reid, & Colwill, 1976b; Rabinowitz, 1998; Urbina, Hickey, McHarney-Brown, Duban, & Kaufman, 1994; Urrutia-Rojas & Aday, 1991; Wilson Report, 1993). A recent study by Daniels, VanLeit, Skipper, Sanders, and Rhyne (2007) reiterated the benefit of recruiting medical students from rural areas. Survey responses indicated returning to one's hometown was the largest predictor of rural practice choice. "This reinforces the need for outreach programs to recruit health professionals from rural areas, students who enter their professions with an awareness of rural living and the health needs of their hometown."

One step in the process of generating physicians to serve in rural areas involves introducing rural young people to the health care profession. Subsequently, these prospective medical students need to perform well academically during primary and secondary education, gain admission to an undergraduate institution, and continue to demonstrate strong academic performance during their undergraduate tenure.

Gaining acceptance to medical school is becoming increasingly more difficult each year. As competition continues to rise, successful applicants need to improve their competitive edge over others vying for the few class positions available. According to the Medical School Admissions

Requirements (MSAR), a publication produced by the American Association of Medical Colleges (AAMC) for pre-health advisors, "schools admit applicants who, on the basis of materials presented during the application process, have documented that they possess the personal characteristics desired in future physicians, the ability to successfully complete the academically rigorous curriculum, and the potential to fulfill the institution's mission and goals (pp. 40)." A strong undergraduate grade point average and a competitive Medical College Admissions Test (MCAT) score are often regarded as the best predictors of ability to complete the academic curriculum. Candidates with a lower undergraduate GPA and/or lower MCAT score are, thus, at risk for being denied admission to medical school. This may be of particular concern for rural applicants.

As evidenced by the Appalachian Regional Commission (ARC), deficiencies in educational achievement are apparent in the Appalachian Region when compared to the non-Appalachian United States. Only 68.4 percent of Appalachian adults aged 25 years or older are high school graduates, compared with 75.2 percent overall in the United States. Table 1 displays the percentage of the adult population who obtained their baccalaureate degree increased during the 1990s in Appalachia and in each sub-region, as it did in the country as a whole. However, the gap between the Appalachian region and the total U.S. population increased slightly, from 6.0 percent to 6.7 percent. The Southern Appalachian Region experienced the greatest increase in percentage of college graduates as compared to the Northern and Central Regions. In 2000, Central Appalachia had less than half the national percentage of college graduates. As identified by Haaga (2004), "this reflects a 'rich get richer' trend: growth in the proportion of college graduates was fastest in the counties classified as 'attainment' counties (using the 2000 classification), which were already above the national average in 1990. By contrast, the slowest growth in this proportion during the decade was in the distressed counties." Thus, although the number of college graduates is on the rise, the percentage of those graduates from the Appalachian region (17.7%) is lower than that of the total population (24.4%). A majority of the medical schools in the United States prefer candidates to complete an undergraduate degree before matriculation (MSAR, 2007). Thus, with less young people from the Appalachian region completing their undergraduate degree, there will a smaller population eligible to apply for medical school.

This challenge is magnified by research indicating that rural populations perform differently on the MCAT than non-rural populations. Specifically, a study of GPA and MCAT scores in a regional sample of 3,433 rural and urban medical school applicants in 2005 showed that MCAT scores of candidates from nonmetropolitan areas were significantly lower than those from metropolitan areas (Longo, Gorman, & Ge, 2005).

In summary, the research indicates (1) undergraduate GPA and MCAT score are two predictors heavily utilized by medical school admissions committees, (2) the percentage of college graduates from the Appalachian Region is smaller than the percentage of college graduates from the entire United States population, and (3) MCAT scores for candidates from rural regions are lower than those from non-rural regions. Thus, there appears to be an underlying challenge to capture aspiring physicians from rural areas. This combined with the fact that medical school candidates from rural populations are the ones most likely to practice medicine in rural areas lead to the conclusion that it will be an ongoing challenge to place physicians in the rural and Appalachian Region.

Test Fairness

The possibility that standardized tests may be unfair to distinct populations is of great concern, and is the focus of this study. Test fairness is a conclusion based on a value judgment that test scores result in equitable treatment. A decision on what constitutes a "fair" or "unfair" test depends upon what one considers to be fair and does not reflect a statistical or psychometric construct. As a result, there is disagreement over the correct statistical model of test fairness (Cleary & Hilton, 1968; Darlington, 1971; Thorndike, 1971).

In 2003, the Principles for the Validation and Use of Personnel Selection Procedures identify four possible meanings of fairness.

> The first meaning views fairness as requiring equal group outcomes (e.g., equal passing rates for subgroups of interest). The *Standards* rejects this definition, noting that it has been almost entirely repudiated in the professional testing literature. The second meaning views fairness in terms of equitable treatment of all examinees. Equitable treatment is considered for access to practice materials, testing conditions, performance feedback, retest opportunities, and other features of test administration, including providing reasonable accommodations for test takers with disabilities. There is consensus on a need for equitable treatment in test administration (although not necessarily on what constitutes equitable treatment). The third meaning views fairness as requiring that examinees have a comparable opportunity to learn the subject matter covered by the test. However, the *Standards* notes that this perspective is the most prevalent in the domain of educational achievement testing and that opportunity to learn ordinarily plays no role in determining the fairness of employee selection procedures. The fourth definition views fairness as a lack of (differential prediction). This perspective (commonly referred to as the Cleary model) views predictor use as fair if a common regression line can be used to describe the predictor-criterion relationship for all subgroups of interest; subgroup differences in regression slopes or intercepts signal differential prediction. There is broad scientific agreement on this definition of (differential prediction), but there is no similar broad agreement that the lack of (differential agreement) can be equated with fairness. (pp. 31)

Although there are multiple statistical definitions of selection test fairness, on March 11, 1975, Federal Judge Spencer Williams, U. S. District Court, Northern District of California, ruled in Cortez v. Rosen that the Cleary model is the "only one which is historically, legally, and logically required." This ruling, which sustained the use of a police examination shown to meet Cleary model requirements, is the first to address the question of relative legal merits of alternative fairness models.

Differential Prediction

Differential prediction is one operational definition of test fairness such that differential prediction exists when there is a difference in predicted performance when an individual is classified into one subgroup rather than into another. Moderated multiple regression is used to test for differential prediction where the criterion measure is regressed on the predictor score, subgroup membership, and a predictor by subgroup interaction term between the two. Slope and/or intercept differences between subgroups indicate differential prediction (Cleary & Hilton, 1968). A example graph can be found in Figure 1.

As indicated by Linn (1978), differential prediction analysis has direct bearing on issues of fairness and bias in selection. Knowledge of those differences will not solve the question of what constitutes "fair" selections between populations. But, such knowledge provides the factual basis that is needed for informed consideration of questions of fairness. A literature review of differential prediction of standardized tests (MCAT, DAT, LSAT, GRE, GMAT) for rural and non-rural populations failed to generate research articles. Thus, articles are presented below reflect more general review of the differential prediction literature.

In 2002, Saad and Sackett conducted a study that assessed the differential prediction by gender in employment-oriented personality measures. The authors first assessed adjustment, dependability, and achievement-orientation by using the United States Army's Assessment of Background and Life Experiences instrument (Peterson, et al., 1990). Then, they regressed these personality factors against five criteria factors: core technical proficiency, effort and leadership, personal discipline, general soldiering proficiency, and physical fitness and military bearing. Results indicated that differential prediction was found in one third of the 135 predictor-criterion-job combinations. The results of this study parallels findings from the ability domain, namely, that slope differences are rare, intercept differences are not uncommon, and the nature of the intercept differences shows female performance is most commonly overpredicted.

Just as personnel selection procedures are used to predict future performance or other work behavior, academic selection procedures are used to predict future academic performance. Subgroup differences across race have been reported extensively in the cognitive ability domain to the extent that this disparity is often referred to as the "achievement gap" (Bartlett, Bobko, Moiser, & Hannan, 1978; Hunter, Schmidt, & Rauschenberger, 1984; Schidmt, Pearlman, & Hunter, 1980). For example, on average African American and Hispanic test takers consistently score 1.0 and 0.7 standard deviations, respectively; below the White mean score on cognitive ability measures (Aiken, 2003; Helms, 1992; Hunter, 1986; Rushton & Jensen, 2005; Sackett, Schmitt, Ellingson, & Kabin, 2001).

Subgroup differences have been observed in the prediction of college grades from Scholastic Aptitude Test (SAT) and high school grades for men and women and for minorities and nonminorities (ETS, 1948-1992; Young, 1994). In particular, men scored higher on both sections of the SAT with a larger difference in the mathematical section whereas women earned higher grades in both high school and college. When White students were compared with Asian American, Black, Hispanic and Puerto Rican minority students, Whites outperformed minorities in both sections of the SAT with a larger difference in the mathematical section for all minorities except the Asian American group.

Medical College Admissions Test (MCAT)

The MCAT, consisting of four sub-tests: A biological science, physical sciences, verbal reasoning and a writing sample, continues to be widely used for screening and selection for a majority of the medical schools in the United States. Notwithstanding substantial research efforts, the predictive validity of the MCAT and, in particular, its sub-test domains remains unclear. There is a fair amount of disagreement across the literature regarding the predictive accuracy of MCAT scores for medical school GPA and performance on the national board exams.

In a study assessing the validity of the MCAT, the Association of American Medical Colleges (AAMC) asserted that both undergraduate GPA and MCAT score combined to predict the medical school GPA; and, MCAT scores provided a substantial increment over undergraduate GPAs. Further, the study indicated that the MCAT scores were better predictors of students' performance on the United States Medical Licensing Examination (USMLE), the national medical school board exams for required by all allopathic institutions. Thus, AAMC concluded that MCAT scores

> almost double the proportion of variance in medical school grades explained by undergraduate GPAs, and essentially replace the need for undergraduate GPAs in their impressive prediction of USMLE board scores. The MCAT performs well as an indicator of academic preparation for medical school, independent of the school-specific handicaps of undergraduate GPAs (Julian, 2005).

In sum, AAMC, the organization responsible for producing the MCAT, asserted that their standardized test provided additional information for predicting board scores over and above the undergraduate GPA.

A meta-analysis of published studies was conducted in hopes of gaining some knowledge about the predictive ability of the MCAT on medical school performance (preclinical and clinical years) and medical board licensing examinations (Donnon, Oddone Paolucci, and Violato, 2007). In addition to the results generated by AAMC, the major findings from this meta-analysis indicate the MCAT total score has a medium predictive validity coefficient for basic science/preclinical performance (r = 0.43) and clinical performance (r = 0.39). The biological sciences sub-test also has a medium predictive validity coefficient effect size for basic science/preclinical performance (r = 0.40). However, the physical sciences and verbal reasoning sub-tests have small predictive validity coefficients (r = 0.00 to r = 0.29) for the basic science/preclinical performance and clinical performance. The MCAT total score has a large predictive validity coefficient (r = 0.66) for the

United States Medical Licensing Exam (USMLE) Level 1[1]. The writing sample has little predictive validity for both medical school performance measures (preclinical and clinical) and the medical board licensing exam. In sum, the authors indicate the MCAT total score and biological sciences sub-test have predictive validity for the basic science/preclinical performance and on USMLE Step 1. The meta-analysis, however, was unable to assess whether or not the MCAT yields differential prediction for certain populations as this information was not reported in the individual studies.

Purpose

As clearly indicated, scores on most sub-tests of the MCAT predict academic performance in medical school and pass-rate on the national board exams. The purpose of this study is to explore the ability of the MCAT to predict medical school GPA and pass rate on the comprehensive osteopathic medical licensing examination (COMLEX)[2]. Although numerous published reports test the ability of the MCAT to predict pass-rate on the USMLE, there is limited research on the MCAT's ability to predict pass-rate on the COMLEX. In addition, this study will also examine the undergraduate GPA as a predictor of medical school GPA and pass-rate on COMLEX Level 1. Also, differential prediction analyses will be conducted and assess the fairness of the MCAT in terms of subgroups of rural versus non-rural. Although this study reflects the experience of only one medical school, it can provide an example to other medical schools looking to address rural physician supply concerns.

<u>*Hypothesis 1*</u>

Null Hypothesis 1: There is no relationship between the incoming GPA and/or MCAT score and medical school GPA and/or COMLEX score.

---

[1] National board examinations for both osteopathic medical schools and allopathic medical schools are administered in three levels or steps. The first level is completed after the preclinical education (after year two); the second level is taken after the first year of clinical education (after year three); and the third level is completed after the second year of clinical education (post-graduation). Level 1 of the osteopathic and allopathic national board exams reflect information presented in the biomedical curriculum. In contrast, Levels 2 and 3 primarily reflect clinical material and/or a combination of biomedical and clinical material.

[2] Allopathic medical students take the USMLE and osteopathic medical students take the COMLEX.

Alternate Hypothesis 1: There is a positive relationship between the incoming GPA and/or MCAT score and medical school GPA and/or COMLEX score.

<u>*Hypothesis 2*</u>

Null Hypothesis 2: There is no differential prediction of the MCAT for rural and non-rural populations.

Alternate Hypothesis 2: There is differential prediction of the MCAT for rural and non-rural populations.

METHODS

Measures

Measures. Data for the present study were obtained from the Edward Via Virginia College of Osteopathic Medicine (VCOM) Longitudinal Study. The database was generated for internal reporting purposes by the College Registrar. The sample included 429 osteopathic medical students (204 women and 225 men), ranging from 23 to 54 years with a mean of 28 years. The present sample includes 120 rural subjects and 310 non-rural subjects. In accordance with the Office of Management and Budget (OMB) categorizations, students were divided into three categories: metropolitan statistical areas (metro), central (core) counties with one or more urbanized areas, and outlying counties that are economically tied to the core counties as measured by work commuting (RAC, 2008). In 2003, the OMB added the micropolitan statistical area (micro) to identify a nonmetro county with an urban cluster of at least 10,000 persons or more. Noncore counties are neither micro nor metro. Agencies outside of OMB often designate nonmetro counties as being rural or small town. This study applied the OMB definition of metro/micro and noncore to the students' high school county. Of the 429 subjects, 38 self-designated themselves as Black/Non-Hispanic, 2 as American Indian or Alaskan Native, 320 as White/Non-Hispanic, 17 as Hispanic, 39 as Asian American or Pacific Islander, and 13 chose not to designate themselves in one of these categories. Unique identifiers (name, date of birth, social security number) were removed from the longitudinal study before made available to the researchers. Osteopathic medical students from the Classes of 2007, 2008, and 2009 at VCOM were included in the study. These three classes were selected as the students in each class completed at least the first two years of medical school and took COMLEX Level 1.

Researchers obtained IRB approval from VCOM prior to collecting and analyzing data. After review by the VCOM IRB Chairman, the protocol qualified for exemption as defined in 45 CFR 46.101(b)(1-6).

Predictors

Incoming GPA. Incoming GPA was calculated on a 4.0 scale by the centralized application service (AACOMAS) at the time of application. The incoming GPA was updated by the VCOM Registrar for all applicants who completed additional coursework after submission of the application and before matriculation.

MCAT score. The Medical College Admissions Test (MCAT) is a standardized test completed before or during application to most medical schools. The MCAT is divided into four sub-tests – verbal reasoning, biological sciences, physical sciences, and a writing sample. The maximum score in the first three sub-tests is 15 and minimum is 1. The writing sample ranges from J to T, with T being the maximum. The writing score was converted from J – T to 1 – 11, where J=1 and T=11. The verbal reasoning section is a "measure of the ability to understand, evaluate, and apply information and arguments presented in prose text." The biological sciences section is a measure of the ability to understand basic concepts and to solve problems in the in the areas of biology and biologically-related chemistry. The physical sciences section is a measure of the ability to understand basic concepts and to solve problems in the areas of physics and physically-related chemistry. The writing sample is a measure of skill in developing a central idea; synthesizing concepts and ideas; presenting ideas cohesively and logically; and writing clearly, following accepted practices of grammar, syntax, and punctuation consistent with timed, first-draft composition (AAMC, 2005)." MCAT scores are reported for each sub-test and Total (by summing verbal, physical science, and biological science sub-tests). VCOM does not utilize the MCAT heavily in the admissions process. Thus, a wide range of MCAT scores are represented in the longitudinal study.

Criteria

Medical School GPA. Course grades, reported on a 4.0 scale, are reported by the VCOM Medical Education office to the VCOM Registrar at the conclusion of each academic learning block. Grades are maintained by the Registrar using the Admissions and Registrar System (ARS). For this study, the medical school GPA at the conclusion of the second-year was utilized. This GPA represents the culmination of knowledge during the basic science/preclinical years.

COMLEX. The comprehensive osteopathic medical licensing examination (COMLEX) is

> designed to assess the osteopathic medical knowledge and clinical skills considered essential for osteopathic primary care physicians to practice medicine without supervision. COMLEX is constructed in the context of medical problem-solving which involves clinical presentations and physician tasks. Candidates are expected to utilize the philosophy and principles of osteopathic medicine to solve medical problems. The Clinical Presentation (Dimension I) of the COMLEX exam identifies high-frequency and/or high-impact health issues that osteopathic primary care physicians encounter in practice. The Physician Task (Dimension II) specifies the major steps osteopathic physicians generally undertake to solve medical problems. The COMLEX series is an examination sequence with three Levels. While all examination Levels have the same two-dimensional content structure, the depth and emphasis of each Level parallels the educational experiences of the candidate. COMLEX Level 1 candidates are expected to demonstrate basic science knowledge relevant to medical problems. COMLEX Level 1 is a problem- and symptom-based assessment integrating the basic medical sciences of anatomy, behavioral science, biochemistry, microbiology, osteopathic principles, pathology, pharmacology, physiology and other areas of medical knowledge as they are relevant to solving medical problems. Prior to publishing the score, the National Board of Osteopathic Medical Examiners (NBOME) conducts a thorough process of quality assurance to ensure that all candidate scores are accurate. For COMLEX Level 1, score verification involves confirmation of responses recorded by computer (NBOME, 2008)

In April 2001, the Federation of State Medical Boards of the United States, Inc. Special Committee on Licensing Examinations assessed the validity of the USMLE and COMLEX-USA. According to the committee, there is "exemplary" evidence supporting the validity of score-based inferences. This evaluation is based upon previous research indicating COMLEX-USA scores were positively related to students' grades in medical school and administrators' ratings of the students (Baker, et. al., 1999). These studies provided evidence of criterion-validity in support of COMLEX-USA scores for the purpose of licensing osteopathic physicians. The degree of evidence provided is comparable with similar studies conducted on the USMLE.

Two types of data are available from the COMLEX Level 1 exam, raw scores and the pass/fail decision. For the differential prediction analyses, the raw scores from the COMLEX Level 1 will be used as the criterion. Raw scores range from 9 to 999, with a mean of 500, a standard deviation of 79, and a minimum passing score of 400. In the event a subject took the COMLEX Level 1 exam more than once, the first score was utilized in data analysis.

Preliminary Analysis

Power Analysis. A statistical power analysis was conducted using G*Power 3 (Erdfelder, Faul, Buchner, 1996). With a Type 1 Error rate (α) = .05, sample size (N) = 430, and large effect size (f^2) = .35, the power is 1.00. See Figure 2.

RESULTS

Descriptive Statistics for Rural and Non-Rural Samples

Preadmission data for the rural and non-rural samples were mean GPAs ($overall_R = 3.48$, $science_R = 3.41$; $overall_N = 3.40$, $science_N = 3.31$) and MCAT scores ($verbal_R = 7.94$, $physical_R = 6.89$, $biological_R = 7.44$, $writing_R$ = N/O, and $total_R = 22.28$; $verbal_N = 7.55$, $physical_N = 7.19$, $biological_N = 7.77$, $writing_N$ = N/O, and $total_N = 22.52$). The rural sample had a mean OMS-II GPA of 3.55 and a mean COMLEX – Level 1 score of 490.32 (SD = 75.13). The non-rural sample had a mean OMS-II GPA of 3.53 and a mean COMLEX – Level 1 score of 482.05 (SD = 70.02). The Descriptive statistics for all variables are presented in Table 2.

Further, differences between the rural and non-rural samples were assessed for the nine predictor and criteria variables. Considering we conducted multiple independent t-tests simultaneously, we implemented the Bonferroni correction to reduce the possibility of obtaining a result by chance. Specifically, the Bonferroni correction determines the alpha value for the entire set of comparisons by reducing the alpha value for each comparison. In this study, we reduced the p-value (α) from .05 to .006 for each test resulting in a total p-value of .05. After applying the Bonferroni correction, the t-test for overall GPA ($t = 2.92$) and science GPA ($t = 3.04$) were significant ($p < 0.05$). Results of the independent t-tests are presented in Table 2.

Intercorrelation Matrix. Table 3 presents the inter-correlations among all predictors and criteria. There were two striking findings. First, neither science or overall GPA was correlated with any MCAT score. Second, the correlation between medical school GPA and the COMLEX Level 1 score was strong ($r = 0.65$). Incoming overall GPA ($r = 0.36$), incoming science GPA ($r = 0.33$), physical sciences sub-test ($r = 0.24$), biological sciences sub-test ($r = 0.25$), writing sub-test ($r = 0.12$), and MCAT total ($r = 0.23$) were all significantly correlated with the OMS-II GPA ($p < 0.05$). Incoming overall GPA ($r = 0.24$), incoming science GPA ($r = 0.21$), physical sciences sub-test (r =

0.30), biological sciences sub-test ($r = 0.29$), writing sub-test ($r = 0.12$), and MCAT total ($r = 0.28$) were all significantly correlated with the COMLEX Level 1 score ($p < 0.05$).

Prediction Models

Medical School GPA. Table 4 presents regression analysis results for medical school GPA. Overall GPA and science GPA were highly correlated ($r = 0.85$). Only the science GPA was included as a predictor because the college of osteopathic medicine believes science is the most important knowledge area for medical training. In the first prediction model, science GPA, verbal MCAT sub-test, physical sciences MCAT sub-test, biological sciences MCAT sub-test, and writing sub-test were entered simultaneously. The model accounted for 18% of the criterion variance. The physical sciences sub-test ($b = 0.03$, $p < 0.05$), biological sciences sub-test ($b = 0.03$, $p < 0.01$), and incoming science GPA ($b = 0.31$, $p < 0.01$) were significant.

In the second prediction model, science GPA and total MCAT were entered in a stepwise order. Science GPA accounted for 10% of the variance in medical school GPA ($b = 0.32$, $p < 0.01$). Adding the MCAT total accounted for an additional 5% of the criterion variance ($b = 0.02$, $p < 0.01$).

COMLEX. Table 5 presents regression analysis results for COMLEX Level 1 score. The first analysis presents the prediction model for science GPA and MCAT sub-tests entered as the first step (i.e., predictors available prior to admission) and medical school GPA is added in the second step (i.e., a predictor available after admission). In step 1, 16% of the variance in COMLEX Level 1 scores was captured and the physical sciences sub-test ($b = 8.89$), biological sciences sub-test ($b = 7.53$), and incoming science GPA ($b = 45.74$) were significant ($p < 0.01$). The addition of medical school GPA in step two captured an additional 29% of the variance. Besides medical school GPA ($b = 129.00$), only the regression weight for the physical sciences sub-test ($b = 5.34$) remained significant in step 2.

In the second prediction model, the total MCAT score was used instead of the individual sub-tests. In step 1, science GPA (*b* = 47.85) and MCAT total (*b* = 4.81) captured 13% of the variance in COMLEX scores. The addition of medical school GPA (*b* = 132.49) in step two captured an additional 29% of the variance.

Differential Prediction

Medical School GPA. Table 6 presents the differential prediction results for medical school GPA. None of the rural main effects was significant and none of the rural x predictor interactions was significant. Thus, there is no differential prediction for rural populations and second-year medical school GPA.

COMLEX. Table 7 presents the differential prediction results for COMLEX Level 1 score. The rural main effect and rural x predictor interaction were examined. Some evidence of intercept bias was found for physical sciences and biological sciences sub-tests ($p < 0.10$, 2-tailed) but not in the predicted direction (i.e., rural performance on COMLEX Level 1 score was underpredicted and urban performance was overpredicted). See Figure 3 for plot of COMLEX Level 1 score using physical sciences MCAT sub-test. See Figure 4 for plot of COMLEX Level 1 score using biological sciences MCAT sub-test.

Given the direction of the over-prediction, the most likely reason for differential prediction of COMLEX Level 1 score using physical and biological sciences sub-tests of the MCAT is due to the inclusion of minorities (Hispanics, African Americans, and American Indians) in the urban sample. Table 8 presents the differential prediction results for medical school GPA and COMLEX Level 1 score using physical and biological sciences sub-tests excluding minority subjects. When minorities were removed from the sample, the main effect was attenuated but not totally eliminated (Physical: $B_{0(Total)} = 383.31$, $B_{0\ (Non\text{-}rural)} = 377.48$, $B_{0\ (Rural)} = 390.05$; Biological: $B_{0\ (Total)} = 392.53$, $B_{0\ (Non\text{-}rural)} = 386.91$, $B_{0\ (Rural)} = 399.24$).

Although the total MCAT score has a lower correlation with OMS-II GPA ($r = 0.23$) and COMLEX ($r = 0.28$) than the physical ($r = 0.24$ and $r = 0.30$, respectively) and biological ($r = 0.25$ and $r = 0.29$, respectively) sciences sub-test, the total MCAT score correlation is significant at a p-value < 0.01 and removes impact of differential prediction for physical and biological sciences sub-tests. Thus, the best prediction model for COMLEX Level 1 score includes science GPA, MCAT total, and medical school GPA ($R^2 = 0.44$).

COMLEX Pass/Fail Analysis

A chi-square analysis was conducted to assess whether rural and non-rural samples performed differently on the COMLEX Level 1 exam. Analysis presented $X^2 = 0.31$, a result which is not significant at $\alpha = 0.05$. Thus, rural and non-rural samples did not present significantly different results on the COMLEX Level 1 exam. The chi-square analysis was limited due to a high pass rate 96% for COMLEX Level 1.

Conclusion

This study assessed the ability of GPA and MCAT score to predict medical school GPA and COMLEX Level 1 score. As indicated in the prediction model, both science GPA and MCAT score predict medical school GPA. The science GPA is a good predictor of medical school GPA whether entered alone, with the MCAT sub-tests, or with MCAT total ($p < 0.01$). The total MCAT score is also a good predictor of medical school GPA as it accounts for 5% additional variance over and above the science GPA ($p < 0.01$). Analysis of the MCAT sub-tests indicates two of the sub-tests, physical and biological sciences, were significant ($p < 0.05$ and 0.01, respectively). The science GPA and total MCAT score account for 15% of the variance in medical school GPA.

As indicated in the prediction model, science GPA, MCAT score, and medical school GPA predict COMLEX Level 1 score. The science GPA is a good predictor of COMLEX Level 1 score whether entered alone, with MCAT total or sub-tests, or with medical school GPA ($p < 0.01$). The total MCAT score is also a good predictor of medical school GPA as it accounts for 7% additional variance over and above the science GPA ($p < 0.01$). Analysis of the MCAT sub-tests indicates two of the sub-tests, physical and biological sciences, were significant ($p < 0.01$) when entered with the science GPA. However, when entered with the science GPA and medical school GPA, only the physical sciences sub-test was significant ($p < 0.05$). Medical school GPA is also a good predictor of COMLEX Level 1 score as it accounts for 31% unique variance above science GPA and MCAT score (sub-tests or total) ($p < 0.01$). The science GPA, total MCAT, and medical school GPA score account for 44% of the variance in COMLEX Level 1 score.

Differential prediction was assessed for rural and non-rural populations on the medical school GPA and COMLEX score. There was no differential prediction for medical school GPA. Thus, rural and non-rural populations perform similarly in the medical school curriculum and present similar GPAs at the conclusion of the second year.

DISCUSSION AND CONCLUSIONS

The current study examined the relationship between the two most common predictors of medical school success, incoming GPA and MCAT scores, and the two most common output variables, medical school GPA and scores on a certification examination. Further, this study explored differential prediction for rural and non-rural populations for incoming GPA and MCAT score.

Data for this research was secured at an osteopathic medical school located in the southeastern United States. Interest in this study resulted from one aspect of the medical school's mission: to prepare primary care physicians to serve the rural and underserved areas of the Appalachian Region. Rural Americans, who comprise more than 10 percent of the U.S. population, have less access to medical care than urban Americans and may lack adequate health care altogether.

Findings and Conclusions

Preliminary Analysis. Independent t-tests were conducted before analysis of the hypothesis to determine if the rural and non-rural sub-groups were significant for any the predictors or criteria. As evidenced in Table 2, the science GPA and overall GPA t-tests were significant. Specifically, the rural subgroup obtained a higher science and overall GPA than the non-rural subgroup (Science $GPA_R = 3.41$, Science $GPA_N = 3.31$, Overall $GPA_R = 3.48$, Overall $GPA_N = 3.40$). These findings may result from rural subgroup attending small liberal arts colleges and non-rural subgroups attending larger universities.

Hypothesis 1. The first hypothesis predicted relationships between the predictors (incoming GPA and MCAT score) and criteria (medical school GPA and COMLEX score). As evidenced in the correlation matrix and regression analysis, a strong relationship exists between the predictors and criteria. Thus, incoming GPA and MCAT score are good variables to use to predict medical school GPA and COMLEX score.

One interesting finding was that incoming GPA was independent from the MCAT scores. An obvious explanation for the observed independence is direct range restriction because incoming GPA was a primary admission criteria for the validation sample. However, Table 2 shows that the standard deviation for incoming science GPA was around 0.33, and this was ample variability for science GPA to predict medical school GPA. This interesting finding requires further study. However, the independence between incoming GPA and the MCAT scores is highly desirable for the purpose of prediction. Each predictor is capturing unique variance in the criterion. The findings clearly indicate that predictive accuracy would be improved if the MCAT scores were also used as a primary selection criteria.

Another interesting finding was the strength of the relationship between medical school GPA and COMLEX Level 1 score ($r = 0.65$). Validity coefficients of this magnitude are rare. Furthermore, MCAT scores added unique variance beyond medical school GPA in the prediction of COMLEX scores. This finding further supports the argument that MCAT scores be used as a primary selection criterion.

Hypothesis 2. The second hypothesis predicted differential prediction for the MCAT scores as a function of rural and non-rural populations. For the prediction of COMLEX Level 1 scores, evidence of intercept bias was found for the physical and biological sciences sub-tests of the MCAT, but the direction of under/over-prediction was opposite the predicted direction. The physical and biological sciences sub-test scores underpredicted COMLEX Level 1 scores for rural populations. An advantage of using the MCAT total score was that there was no sacrifice in predictive accuracy of COMLEX Level 1 scores, and there was no evidence of differential prediction for rural and non-rural populations. Using differential prediction as the standard for test fairness, these sub-test scores are unfair in that the common regression line results in more erroneous rejections for the rural group than for the non-rural group (see Figures 3 and 4).

There was no differential prediction of COMLEX scores using total MCAT scores. As such, the recommendation to incorporate MCAT scores as primary admission criteria can be further refined to using only MCAT total scores. Furthermore, there should be continued monitoring of differential predication in the use of MCAT total scores given that the findings for the MCAT sub-tests underpredicted rural COMLEX Level 1 scores.

Implications

Prior research indicates a potential two-pronged challenge facing the initiative to increase interest in the health care field for our rural youth in hopes they will return home to practice medicine. First, less young adults from the Appalachian Region are graduating from college as compared to young adults from outside of the Appalachian Region (Haaga, 2004); and, second, those students from rural areas are outscored on the MCAT by their non-rural counterparts. So, a smaller percentage of students from rural populations obtain their undergraduate degrees and those students are likely to perform lower on the MCAT (Longo, et al., 2005).

In contrast to the results presented above, this study indicates students from rural regions do not perform lower on the MCAT than students from non-rural regions. In fact, in relation to the MCAT scores, rural applicants are not at a disadvantage in the application process. Thus, these candidates are as competitive as their non-rural counterparts for admission to medical school. This is good news for the future of primary care as previous research indicates individuals from rural areas are more likely to practice primary care in similar areas.

There is a conflict in results from the two studies presented above regarding rural and non-rural populations' performance on the MCAT. Longo, et al., (2005) utilized seven years of applicant data from the University of Missouri – Columbia School of Medicine. *All* subjects included in the study were Missouri residents. Our sample reflects three years of enrollment data from the Edward Via Virginia College of Osteopathic Medicine, and our applicants represent rural and non-rural regions of 40 states. Thus, each study assesses two distinct, and very unique, samples. The difference in samples is reflected by the average MCAT sub-test scores for accepted applicants. As reported by Longo, et al., (2005), the average verbal reasoning MCAT sub-test score was 9.58, physical sciences MCAT sub-test score was 9.53, and biological science MCAT sub-test score was 9.74. In contrast, in our study, the average verbal reasoning MCAT sub-test score was 7.66, physical sciences MCAT sub-test score was 7.10, and biological science MCAT sub-test score was 7.68. We recommend that research be conducted on a national level to assess the performance on the MCAT for rural and non-rural populations.

As indicated by the regression analysis, the two main predictors utilized in the admissions process, MCAT score and incoming science GPA, are good predictors of medical school GPA and COMLEX score. Further, the finding that science GPA and MCAT scores are independent is a great advantage in predicting medical school criteria. Finally, no differential prediction exists for incoming science GPA and MCAT total scores that affect rural populations. Historically, the osteopathic medical school assessed in this study placed a stronger emphasis on the incoming science GPA than the MCAT score. Based on the results, the office of admissions should place equal emphasis on the MCAT scores and undergraduate GPA in their selection process. Doing so will improve the quality of students without limiting access to rural applicants.

Prior research indicates individuals most likely to practice in a primary care specialty in a rural area are those who grow up in a rural area (Clawson, 1990; Colwill, 1986; Colwill, 2003; Cullison, Reid, & Colwill, 1976a; Cullison, Reid, & Colwill, 1976b; Daniels, VanLeit, Skipper, Sanders, & Rhyne, 2007; Rabinowitz, 1998; Urbina, Hickey, McHarney-Brown, Duban, & Kaufman, 1994; Urrutia-Rojas & Aday, 1991; Wilson Report, 1993). Considering the medical school's initiative to prepare primary care physicians to serve the rural and underserved areas of the Appalachian Region, recruitment dollars should be invested in proactive recruitment targeting colleges and universities with a high percentage of rural students to increase the number of qualified rural applicants to medical school.

Further, the college takes the initiative to reach out to rural students in the primary grades – both by visiting rural elementary, middle, and high schools and by hosting these populations on the medical school campus. During these outreach events, the college encourages the students to perform well in school and engage in science courses. Many of these students do not consider the option of attending college or medical. Rather, they assume they will follow in their parents' footsteps and work as a farmer, coal miner, or factory worker. Thus, a goal of the outreach events is to engage the rural youth in a science environment and encourage these students to pursue higher education and explore a full range of professions.

Limitations

One limitation of this study is the fact that data were collected from only one osteopathic medical school across a three-year timeframe. Future research should incorporate data from multiple osteopathic medical schools. Three additional osteopathic medical schools are located in the Appalachian Region, and these institutions are likely to have a similar student demographic profile. Likewise, in the event it is not possible to obtain the required data from additional institutions, assessing the current institution over a longer time frame would also lend increased confidence to the results.

Second, the dataset (as with all data taken from medical students) is subject to self-selection bias (i.e., comprised of only individuals selected using the predictor variables). In such cases, where there is a homogenous sample, statistical theory suggests a restriction in the range of possible values of normally and nonnormally distributed variables may occur. This range restriction, in turn, would reduce correlations that may otherwise be seen in unrestricted populations (ex., all college graduates and MCAT examinees). Potential range restriction was explored for overall GPA, science GPA, and

MCAT score (total and sub-tests). For the 2003 – 2005 application cycles corresponding to the Classes of 2007, 2008, and 2009, the applicants' variance for science GPA was 0.42 and overall GPA was 0.35. For the subjects assessed in this study, the variance for science GPA was 0.33 and overall GPA was 0.28. Considering variance on the science and overall GPA was smaller for the subjects (matriculants) than for the applicant pool, there is evidence of range restriction for GPA. Based on data reported by the Association of American Medical College, the MCAT variance for all MCAT test-takers for 2002 (n = 57,571) is 5.76 for the verbal reasoning sub-test, 5.29 for physical sciences sub-test, and 5.76 for the biological sciences sub-test. For the subjects assessed in this study, MCAT variance is 3.72 for verbal reasoning sub-test, 2.29 for physical sciences sub-test, and 2.92 for the biological sciences sub-test. Considering variance on the MCAT scores for this study were nearly two points below the variance of all MCAT test-takers on each sub-test, there is evidence of range restriction for the MCAT.

Fulfilling the mission, adopted by VCOM, to prepare physicians to serve the rural and underserved regions is a challenge to many medical schools. However, actively recruiting competitive applicants from colleges within this region can result in a greater rural applicant pool. Further, accepting rural applicants based on incoming GPA and MCAT score will yield a medical school population that will successfully complete the curriculum and pass COMLEX Level 1. As a result, this rural-based population will be more likely to practice in primary care careers; thus, contributing to the great need for primary care physicians.

REFERENCES

Aiken, L. (2003). *Psychological Testing and Assessment* (11th ed.). Boston: Allyn and Bacon.

American Educational Research Association, American Psychological Association, National Council on Measurement in Education. (1999). *Standards for Educational and Psychological Testing.*

Appalachian Regional Commission. ARC Appalachian Region Economic Overview, 2007. http://www.arc.gov/index.do?nodeId=26. Accessed 10/14/07.

Association of American Medical Colleges. 2005 Explanation of Scores for Examinees. Accessed 01/08/2008. www.aamc.org.

Association of American Medical Colleges. Medical School Admissions Requirements, 2008 – 2009, United States and Canada. April 2007.

Baker, H. H., Foster, R. W., Bates, B. P., Cope, M. K., McWilliams, T. E., Musser, A., & Yens, D. (1999). Relationship Between Achievement in the First Two Years of Osteopathic Medical School with Performance on the June 1999 COMLEX Level 1 Examination. (Unpublished manuscript).

Baldwin, F. D. (1999). Access to Care: Overcoming the Rural Physician Shortage. *Appalachia.*

Bartlett, C. J., Bobko, P., Moiser, S. B., and Hannan, R. (1978). Testing for Fairness with a Moderated Multiple Regression Strategy: An Alternative to Differential Analysis. *Personnel Psychology*, 31, 233-242.

Cleary, T. A. and Hilton, T. I. (1968). Test Bias: Prediction of Grades of Negro and White Students in Integrated Colleges. *Journal of Educational Measurement*, 5, 115-124.

Clawson, D. K. (1990). The Education of the Physician. *Academic Medicine*, 65, 84-88.

Colwill, J. M. (1986). Education of the Primary Physician: A Time for Reconsideration? *Journal of the American Medical Association*, 255, 2643-2644.

Colwill, J. M. (2003). Education for and Retention in Rural Practice. *Journal of Rural Health*, 19, 233-235.

Cooper, R. A., Getzen, T. E., McKee, H. J., and Laud, P. (2002). Economic and Demographic Trends Signal an Impending Physician Shortage. *Health Affairs*, 21, 140-154.

Cullinson, S., Reid, J. C., Colwill, J. M. (1976). The Rural-Urban Distribution of Medical School Applicants. *Journal of Medical Education*, 51, 47-49.

Cullinson, S., Reid, J. C., Colwill, J. M. (1976). Medical School Admissions, Specialty Selection, and Distribution of Physicians. *Journal of the American Medical Association*, 235, 505-505.

Daniels, Z. M., VanLeit, B. J., Skipper, B. J., Sanders, M. L., and Rhyne, R. L. (2007). Factors in Recruiting and Retaining Health Professionals for Rural Practice. *Journal of Rural Health*, 23, 62-71.

Darlington, R. B. (1971). Another Look at Cultural Fairness. *Journal of Educational Measurement*, 8, 71-82.

Donnon, T., Oddone Paolucci, E., and Violato, C. (2007). The Predictive Validity of the MCAT for Medical School Performance and Medical Board Licensing Examinations: A Meta-Analysis of Published Research. *Academic Medicine*, 82, 100-106.

Educational Testing Service. (1948-1992). *College Board Scholastic Aptitude Test*. Princeton, NJ: Author.

Erdfelder, E., Faul, F., & Buchner, A. (1996). GPOWER: A General Power Analysis Program. *Behavioral Research Methods, Instruments, & Computers*, 28, 1-11.

Haaga, J. (2004). Demographic and Socioeconomic Change in Appalachia: Educational Attainment in Appalachia. Research Report. Accessed 12/04/07. http://www.arc.gov/images/reports/prbeducation/attainment.pdf.

Halverson, J., Ma, L., and Harner, E. J. (2004). Executive Summary: An Analysis of Disparities in Health Status and Access to Health Care in the Appalachian Region. Prepared for the

Appalachian Regional Commission. Accessed 12/04/07. http://www.arc.gov/index.do?nodeId=2467.

Helms, J. E. (1992). Why is there No Study of Cultural Equivalence in Standardized Cognitive Ability Testing? *American Psychologist*, 47, 1083-1101.

Hunter, J. E. (1986). Cognitive Ability, Cognitive Aptitudes, Job Knowledge, and Job Performance. *Journal of Vocational Behavior*, 29, 340-362.

Hunter, J. E., Schmidt, F. L., and Rauschenberger, J. (1984). Methodological and Statistical Issues in the Study of Bias in Mental Testing. In C. R. Reynolds and R. T. Brown (Eds.), Perspectives on Mental Testing. New York: Plenum.

Julian, E. R. (2005). Validity of the Medical College Admissions Test for Predicting Medical School Performance. *Academic Medicine*, 80, 910-917.

Larson, E. H., Johnson, K. E., Norris, T. E., Lishner, D. M., Rosenblatt, R. A., Hart, L. G. (2003). State of Health Workforce in Rural America: Profiles and Comparisons. Seattle, WA: WWAMI Rural Health Research Center, University of Washington.

Linn, R. L. (1978). Single-Group Validity, Differential Validity, and Differential Prediction. *Journal of Applied Psychology*, 63(4), 507-512.

Longo, D. R., Gorman, R. J. and Ge, B. (2005). Rural Medical School Applicants: Do Their Academic Credentials and Admission Decisions Differ From Those of Nonrural Applicants. *Journal of Rural Health*, 21, 346-350.

Medical Programs Review Panel, University of Missouri – Columbia. Wilson Report: Submitted to President George A. Russell. January 25, 1993.

National Board of Osteopathic Medical Examiners. (2001). Comprehensive Osteopathic Medical Licensing Examination – USA. Accessed 01/08/2008. www.nbome.org/examinations.htm.

Peterson, N. G., Hough, L. M., Dunnette, M. D., Rosse, R. L., Houston, J. S., Toquam, J. L., et al. (1990). Project A: Specification of the Predictor Domain and Development of a New Selection/Classification Tests. *Personnel Psychology*, 43, 247-276.

Rabinowitz, H. K. (1998). Relationship between US Medical School Admissions Policy and Graduates Entering Family Practice. *Family Practice*, 5, 142-144.

Rural Assistance Center (2008). What is Rural? Accessed 01/27/2008. http://www.raconline.org/info_guides/ruraldef.

Rushton, J. P., and Jenson, A. R. (2005). Thirty Years of Research on Race Differences in Cognitive Ability. *Psychology, Public Policy, and Law*, 11, 235-294.

Saad, S. and Sackett, P. R. (2002). Investigating Differential Prediction by Gender in Employment-Oriented Personality Measures. *Journal of Applied Psychology*, 87, 667-674.

Sackett, P. R., Schmitt, N., Ellingson, J. E., and Kabin, M. B. (2001). High-Stakes Testing in Employment, Credentialing, and Higher Education: Prospects in a Post-Affirmative-Action World. *American Psychologist*, 56, 302-318.

Schmidt, F. L., Pearlman, K., and Hunter, J. E. (1980). The Validity and Fairness of Employment and Educational Tests for Hispanic Americans: A Review and Analysis. *Personnel Psychology*, 33, 705-724.

Society for Industrial and Organizational Psychology, Inc. Principles for the Validation and Use of Personnel Selection Procedures. Fourth Edition. 2003.

Thorndike, R. L. (1971). Concepts of Culture Fairness. *Journal of Educational Measurement*, 8, 63-70.

U. S. Census Bureau. (2000). United States Census 2000 Urban and Rural Classification. Accessed 01/09/2008. http://www.census.gov/geo/www/ua/ua_2k.html.

Urbina, C., Hickey, M., McHarney-Brown, C., Duban, S., Kaufman, A. (1994). Innovative Generalist Programs: Academic Health Care Centers Respond to the Shortage of Generalist Physicians. *Journal of General Internal Medicine*, 9, 581-589.

Urrutia-Rojas, X., Aday, L. A. (1991). A Framework for Community Assessment: Designing and Conducting a Survey in a Hispanic Immigrant and Refugee Community. *Public Health Nursing*, 8, 20-26.

U.S. Equal Employment Opportunity Commission. *Guidelines on Employment Selection Procedures*. Washington, D.C.: Author, 1970.

WONCA. (2002) WONCA Working Paper on Rural Practice: Policy on Quality and Effectiveness of Rural Health Care. Accessed 12/4/07. http://www.globalfamilydoctor.com/aboutWonca/working_groups/rural_training/Quality_of_Rural_Healthcare.htm.

Young, J. W. (1994). Differential Prediction of College Grades by Gender and Ethnicity: A Replication Study. *Educational and Psychological Measurement*, 54, 1022-1029.

TABLES

Table 1: Percentage of Adult Population Who Are College Graduates, 1990 and 2000

	1990	2000
U. S. Total	20.3	24.4
Appalachia	14.3	17.7
North	14.4	17.7
Central	8.8	10.7
South	15.4	19.2

Sources: 1990 Census, STF3 file and 2000 Census, SF3 file, PRB analysis (Haaga, 2004)

Table 2: Descriptive Statistics for Rural and Non-Rural Subjects for All Variables

	Rural		Urban		t
	Mean	SD	Mean	SD	
Predictors					
Overall GPA	3.48	0.28	3.40	0.28	2.92*
Science GPA	3.41	0.32	3.31	0.34	3.04*
Verbal	7.94	1.82	7.55	1.96	1.94
Physical	6.89	1.19	7.19	1.62	-1.82
Biological	7.44	1.64	7.77	1.73	-1.86
MCAT Total	22.28	3.38	22.52	4.26	-0.62
Writing	5.28	1.84	5.64	2.02	-1.73
Criteria					
OMS-II GPA	3.55	0.34	3.53	0.32	0.10
COMLEX	490.32	75.13	482.05	70.02	1.04

Note: N_{Rural} = 120, N_{Urban} = 309. SD = Standard Deviation. Verbal = MCAT Verbal Subtest. Physical = MCAT Physical Science Sub-test. Biological = MCAT Biological Science Sub-test. MCAT Total = Total MCAT Score (Verbal + Physical + Biological). Writing = MCAT Writing Sub-test (J-T scale converted to 1-11 scale, where J = 1 and T = 11).OMS-II GPA = Medical school GPA at the conclusion of the second year. COMLEX = COMLEX Level 1 score. Two-tailed tests were utilized for GPAs (Overall GPA, Science GPA, and OMS-II GPA) and one-tailed tests were utilized for standardized tests (MCAT total and sub-tests and COMLEX). * denotes significant correlation with Bonferroni correction at p =.006 level.

Table 3: Correlation Matrix for All Variables

	Overall GPA	Science GPA	Verbal	Physical	Biological	MCAT Total	Writing	OMS-II GPA
Overall GPA								
Science GPA	.850**							
Verbal	-0.047	-0.035						
Physical	-0.023	0.003	.295**					
Biological	0.037	-0.056	.419**	.552**				
MCAT Total	-0.016	0.008	.766**	.750**	.831**			
Writing	-0.055	-0.020	.216**	.212**	.135**	.240**		
OMS-II GPA	.361**	.327**	0.079	.235**	.245**	.229**	.115*	
COMLEX	.242**	.213**	0.097	.301**	.286**	.280**	.121*	.650**

Note: N = 429. Verbal = MCAT Verbal Subtest. Physical = MCAT Physical Science Sub-test. Biological = MCAT Biological Science Sub-test. MCAT Total = Total MCAT Score (Verbal + Physical + Biological). Writing = MCAT Writing Sub-test. OMS-II GPA = Medical school GPA at the conclusion of the second year. COMLEX = COMLEX Level 1 score. * denotes significant correlation at p =.05 level. ** denotes significant correlation at p =.01 level.

Table 4: Regression Analysis of Prediction of OMS II GPA Using MCAT Sub-Tests, MCAT Total, and Science GPA

Step	Variable(s) Entered	*b*	R^2	ΔR^2	F_{change}
		Science GPA and MCAT Sub-tests			
1	Verbal	-0.006			
	Physical	0.027*			
	Biological	0.032**			
	Writing	0.013			
	Science GPA	0.305**			
			0.176	0.176	18.017**
		Science GPA and MCAT Total			
1	Science GPA	0.315**			
			0.103	0.103	48.993**
2	Science GPA	0.312**			
	MCAT Total	0.018**			
			0.153	0.050	25.073**

Note: N = 429. Verbal = MCAT Verbal Subtest. Physical = MCAT Physical Science Sub-test. Biological = MCAT Biological Science Sub-test. Writing = MCAT Writing Sub-test. MCAT Total = Total MCAT Score (Verbal + Physical + Biological). OMS-II GPA = Medical school GPA at the conclusion of the second year. *b* = The unstandardized regression coefficient. R^2 = The proportion of variance in the dependent variable accounted for by all predictors in the regression equation. ΔR^2 = The incremental variance accounted for by the predictor variables at each step. *F* = The F ratio. * denotes significant correlation at p =.05 level. ** denotes significant correlation at p =.01 level.

Table 5: Regression Analysis of Prediction of COMLEX Level 1 Score Using MCAT Sub-Tests, MCAT Total, Science GPA, and OMS-II GPA

Step	Variable(s) Entered	*b*	R^2	ΔR^2	F_{change}
	Science GPA, MCAT Sub-tests, and OMS-II GPA				
1	Verbal	-1.712			
	Physical	8.885**			
	Biological	7.530**			
	Writing	2.429			
	Science GPA	45.738**			
			0.159	0.159	16.029**
2	Verbal	-0.922			
	Physical	5.344*			
	Biological	3.439			
	Writing	0.765			
	Science GPA	6.446			
	OMS-II GPA	128.999**			
			0.449	0.29	222.407**
	Science GPA, MCAT Total, and OMS-II GPA				
1	Science GPA	47.845**			
	MCAT Total	4.805**			
			0.126	0.126	30.609**
2	Science GPA	6.494			
	MCAT Total	2.400**			
	OMS-II GPA	132.490**			
			0.440	0.315	238.879**

Note: N = 429. Verbal = MCAT Verbal Subtest. Physical = MCAT Physical Science Sub-test. Biological = MCAT Biological Science Sub-test. Writing = MCAT Writing Sub-test. MCAT Total = Total MCAT Score (Verbal + Physical + Biological). OMS-II GPA = Medical school GPA at the conclusion of the second year. *b* = The unstandardized regression coefficient. R^2 = The proportion of variance in the dependent variable accounted for by all predictors in the regression equation. ΔR^2 = The incremental variance accounted for by the predictor variables at each step. F = The F ratio. * denotes significant correlation at p =.05 level. ** denotes significant correlation at p =.01 level.

Table 6: Regression Analysis of Differential Prediction of OMS II GPA Using Overall GPA, Science GPA, MCAT Total and Individual MCAT Sub-Tests

Step	Variable(s) Entered	*b*	R^2	ΔR^2	F_{change}
1	Rural	0.019			
	Science GPA	0.318**			
			0.104	0.104	24.609**
2	Rural	0.326			
	Science GPA	0.476			
	Rural * Science GPA	-0.091			
			0.105	0.002	0.770
1	Rural	-0.009			
	Verbal	0.013			
			0.006	0.006	1.357
2	Rural	0.038			
	Verbal	0.024			
	Rural * Verbal	-0.006			
			0.007	0.000	0.101
1	Rural	-0.029			
	Physical	0.051**			
			0.057	0.057	12.816**
2	Rural	0.108			
	Physical	0.088*			
	Rural * Physical	-0.020			
			0.058	0.001	0.537
1	Rural	-0.030			
	Biological	0.048**			
			0.062	0.062	14.054**
2	Rural	0.024			
	Biological	0.060			
	Rural * Biological	-0.007			
			0.062	0.000	0.122

Table 6 Continued

Step	Variable(s) Entered	b	R^2	ΔR^2	F_{change}
1	Rural	-0.021			
	Writing	0.020*			
			0.014	0.014	3.062*
2	Writing	0.035			
	Verbal	0.038			
	Rural * Writing	-0.010			
			0.015	0.001	0.313
1	Rural	-0.019			
	MCAT Total	0.049**			
			0.053	0.053	12.015**
2	Rural	0.185			
	MCAT Total	0.035*			
	Rural * MCAT Total	-0.009			
			0.055	0.002	0.892

Note: N = 429. Verbal = MCAT Verbal Subtest. Physical = MCAT Physical Science Sub-test. Biological = MCAT Biological Science Sub-test. MCAT Total = Total MCAT Score (Verbal + Physical + Biological). Writing = MCAT Writing Sub-test. OMS-II GPA = Medical school GPA at the conclusion of the second year. b = The unstandardized regression coefficient. R^2 = The proportion of variance in the dependent variable accounted for by all predictors in the regression equation. ΔR^2 = The incremental variance accounted for by the predictor variables at each step. F_{change} = The F ratio to assess the significance of the incremental variance accounted for. * denotes significant correlation at p =.05 level. ** denotes significant correlation at p =.01 level.

Table 7: Regression Analysis of Differential Prediction of COMLEX Level 1 Score Using Overall GPA, Science GPA, MCAT Total, Individual MCAT Sub-Tests, and OMS-II GPA

Step	Variable(s) Entered	*b*	R^2	ΔR^2	F_{change}
1	Rural	-3.724			
	Science GPA	47.794**			
			0.052	0.052	11.754**
2	Rural	39.711			
	Science GPA	70.112*			
	Rural * Science GPA	-12.836			
			0.053	0.001	0.308
1	Rural	-6.932			
	Verbal	3.445			
			0.011	0.011	2.433
2	Rural	-13.399			
	Verbal	2.001			
	Rural * Verbal	0.824			
			0.011	0.000	0.039
1	Rural	-12.563			
	Physical	14.550**			
			0.097	0.097	22.935**
2	Rural	-42.529			
	Physical	6.657			
	Rural * Physical	4.316			
			0.098	0.001	0.557
1	Rural	-12.335			
	Biological	12.239**			
			0.088	0.088	20.481**
2	Rural	-14.756			
	Biological	11.679			
	Rural * Biological	0.322			
			0.088	0.000	0.005

Table 7 Continued

Step	Variable(s) Entered	b	R^2	ΔR^2	F_{change}
1	Rural	-9.872			
	Writing	4.563**			
			0.018	0.018	4.011*
2	Rural	24.700			
	Writing	15.879*			
	Rural * Writing	-6.439			
			0.024	0.006	2.516
1	Rural	-9.470			
	MCAT Total	4.998**			
			0.082	0.082	19.114**
2	Rural	-9.255			
	MCAT Total	5.015			
	Rural * MCAT Total	-0.010			
			0.082	0.000	0.000
1	Rural	-6.261			
	OMS-II GPA	141.891**			
			.424	.424	157.30**
2	Rural	38.536			
	OMS-II GPA	163.353**			
	Rural * OMS-II GPA	-12.638			
			.425	.001	.522

Note: N = 429. Verbal = MCAT Verbal Subtest. Physical = MCAT Physical Science Sub-test. Biological = MCAT Biological Science Sub-test. MCAT Total = Total MCAT Score (Verbal + Physical + Biological). Writing = MCAT Writing Sub-test. COMLEX = COMLEX Level 1 score. OMS-II GPA = Medical school GPA at the conclusion of the second year. b = The unstandardized regression coefficient. R^2 = The proportion of variance in the dependent variable accounted for by all predictors in the regression equation. ΔR^2 = The incremental variance accounted for by the predictor variables at each step. F_{change} = The F ratio to assess the significance of the incremental variance accounted for. * denotes significant correlation at p =.05 level. ** denotes significant correlation at p =.01 level.

Table 8: Regression Results for Physical and Biological Sciences Sub-Tests Without Minorities

Step	Variable(s) Entered	*b*	R^2	ΔR^2	F_{change}
1	Rural	-11.713			
	Physical	13.573			
			0.078	0.078	15.706**
2	Rural	-52.524			
	Physical	3.123			
	Rural * Physical	5.187			
			0.081	0.002	0.923
1	Rural	-9.994			
	Biological	10.883**			
			0.059	0.059	11.696**
2	Rural	-14.142			
	Biological	9.977			
	Rural * Biological	0.539			
			0.059	0.000	0.012

Note: N = 429. Physical = MCAT Physical Science Sub-test. Biological = MCAT Biological Science Sub-test. COMLEX = COMLEX Level 1 score. *b* = The unstandardized regression coefficient. R^2 = The proportion of variance in the dependent variable accounted for by all predictors in the regression equation. ΔR^2 = The incremental variance accounted for by the predictor variables at each step. F_{change} = The F ratio to assess the significance of the incremental variance accounted for. * denotes significant correlation at p =.05 level. ** denotes significant correlation at p =.01 level.

FIGURES

Figure 1: Differential Prediction for Majority and Minority Groups

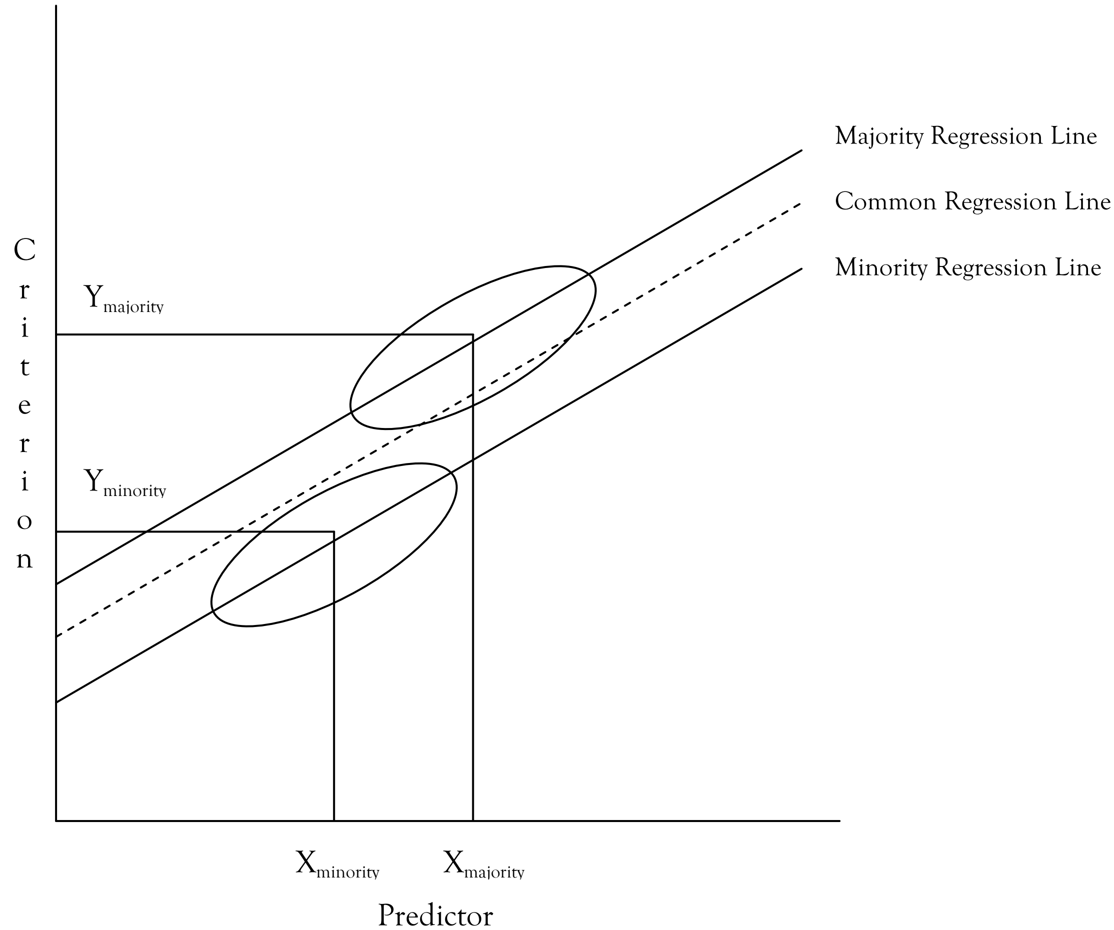

Figure 2: Power Analysis

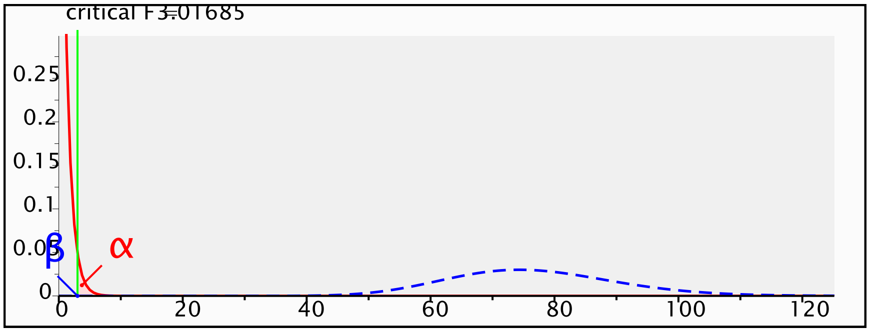

Figure 3: Differential Prediction of COMLEX Using Physical Sciences Sub-Test

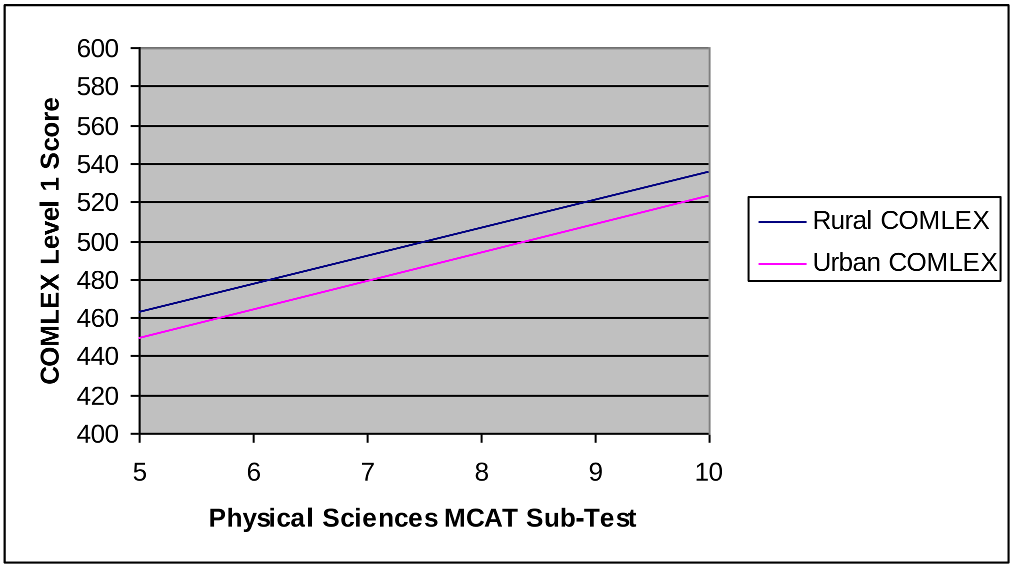

Figure 4: Differential Prediction of COMLEX Using Biological Sciences Sub-Test