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The Backgrounds and Outcomes of Allopathic Medical School Applicants: Exploring Stratification and Inequality

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THE BACKGROUNDS AND OUTCOMES OF ALLOPATHIC MEDICAL SCHOOL APPLICANTS: EXPLORING STRATIFICATION AND INEQUALITY

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CHAPTER ONE

INTRODUCTION

Medicine is considered one of the most prestigious career choices attained by only a select few. Roughly 40% of applicants to medical school will have a seat at the end of the lengthy admissions process (AAMC, 2011d). When the profession of medicine was standardized in the United States in 1910, the entry point to medicine became only subsequent to attending a university while also fulfilling requisite courses in science (Flexner, 1910). All accredited allopathic medical schools in the United States require a four-year course of study, followed by residency training in a specific specialty ranging from three to seven years (AAMC, 2011b). In total, an independently licensed physician educated in the United States will spend a minimum of 11 years in education and training programs after high school. The time required for training, rising costs of tuition, increasingly competitive admissions, and a narrow pool of applicants resulting from undergraduate access challenges culminate in a concerning climate for medical education today. America's doctors must be equipped to serve the needs of all populations in the U.S.; is the current system meeting this challenge? What is the landscape of those able to achieve a career in medicine in terms of race, sex, and socioeconomic status? Have the past efforts to diversify the profession been successful?

Stratification

Although there have been recent education gains in college participation and academic preparation for low income and minority students (Grodsky, 2007), achievement gaps in higher education at the undergraduate level remain wide due to equal or greater academic gains by middle and upper class majority students (Bastedo & Jaquette, 2011). The tendency for students from upper income levels to participate in college and graduate from college at higher rates than their low income peers leads to more societal income and achievement gaps – this is known as stratification (Lareau, 2011). Stratification has far-reaching career effects, such as superior earnings for those attending elite schools (Brewer, Eide, & Ehrenberg, 1999; Dale & Krueger, 2011), and serves to maintain systemic inequalities that make upward mobility difficult for low income and minority groups (Lucas, 2001). Participation in post-secondary education leads to higher earnings over a lifetime (Baum & Payea, 2004). Even students who complete at least some college earn, on average, higher wages over the lifespan than students who complete high school or less (Baum & Payea, 2004). Post-secondary education in the United States is characterized as both a personal investment and a mechanism for social mobility (Becker, 1962; Lamont & Lareau, 1988). The portal for graduate and professional education programs is only through post-secondary completion. As stratification increases at the post-secondary level, the available pool of applicants to professional programs narrows and becomes less socioeconomically and racially diverse (NCES, 2010).

Allopathic medicine was standardized in 1910 (Flexner, 1910) in the United States and became a profession dominated by White males from elite families in a very short period of time (Bonner, 2000). The narrowing of the portal has continued effects today, as medicine has a long, rigorous, expensive training pathway. The challenges and complexities of the healthcare system in the US coupled with the burgeoning diversity in the country's population have created a need for a diverse physician workforce (Freeman, Ferrer & Greiner, 2007). Health disparities and inequalities among low income and minority groups are a major concern for medicine, which holds among its professional ideals care for all patients regardless of background or income (Betancourt, 2006; Betancourt, Green, Carillo, & Ananeh-Firempong, 2003). Is allopathic medicine meeting the need for a diverse physician workforce in its current admissions practices and given the current pool of applicants?

Educational Debt

Following medical school (usually eight years in), a resident trainee will receive a modest salary ranging from $49,000-$63,000 per year depending on training year, area of the country, and specialty (AAMC, 2011c). The average indebtedness of a graduating medical student in 2010 was $147,364 with nearly 85% of graduates having some debt at graduation (AAMC, 2010e). This figure is only medical school debt and does not include deferred debt from the undergraduate degree, which 38% of graduating medical students still report owing (AAMC, 2010e). Students graduating medical school with medical school debt carry nearly three times the debt from their premedical education ($33,929) than their peers graduating medical school without medical school debt (AAMC, 2010e). More than a quarter of MD graduates also have non-educational consumer debt averaging $15,506 not including home mortgages (AAMC, 2010e).

The indebtedness of medical students has risen substantially in the last 20 years, and between 2001-2006 debt rose at a compound annual rate of 6.98% and 5.92% for public and private schools respectively (AAMC, 2007). More concerning is the finding of the AAMC's report on young physician indebtedness detailing that debt for public medical school graduates is rising at a faster rate than graduates of private institutions (AAMC, 2007). The increasing cost of medical education may have limiting effects on the pool of applicants, particularly those without substantial financial means. Pressure to repay loans may influence graduates to pursue more lucrative specialty care fields, rather than primary care, which is facing the greatest national shortage (Colquitt, Zeh, Killian & Cultice, 1996). Strategies in decades past focused on barriers to admission; today's challenges are far greater. While challenges remain with student preparation and the pipeline to medicine, additional barriers have emerged that also include financing a medical education, possibly after financing an undergraduate one, and limited specialty choice based on loan repayment pressures. These consequences of rising costs both affect the diversity of practitioners by specialty in medicine and the prospects for improving the diversity of the profession overall.

Low Income Students in Medicine

Education can be considered an investment, according to the human capital model, which posits that the cost of training includes forgone earnings over time (Becker, 1962). Considering the lengthy training course and the cost of an undergraduate and medical school education, who can afford this? Not surprisingly, students from low income families make up a very small percentage of allopathic medical trainees in the United States. Less than 10% of medical students come from the bottom two quintiles of household income while more than 75% come from the top quintile (Witzburg, Garrison, Case, & Jones, 2009). Data from the Matriculating Student Questionnaire administered to new students at medical schools around the country through the Association of American Medical Colleges show that from 1992 to 2008 the ratio of applicants with parents who have graduate degrees relative to applicants with parents with no college degree more than doubled for applicants' fathers (53%) and more than quadrupled for applicants' mothers (175%) (AAMC, 2010d). In the general population college degree completion for the same period increased 13% for men and 40% for women (AAMC, 2010d). This provides some evidence that applicants to medicine are increasingly coming from families of college educated parents. These data also demonstrated that African American and Hispanic applicants' parents showed increases in education relative to no college degree but still lagged far behind White and Asian parents who also made gains (AAMC, 2010d). Considering the disparities in college participation and graduation rates at the undergraduate level, these lopsided participation ratios according to parental education among medical students are not surprising. Oldfield (2010) found in his survey of medical school head deans that they overwhelmingly came from families in the top 20% of income earnings categories in the U.S., according to the Nam-Powers Scale.

Schoolcraft (2010) reported that students from the bottom two income quartiles completed their Bachelor's degrees just 24% of the time while students in the top quartile have an 88% completion rate by the age of 24. Low income students, therefore, have a proportionately smaller chance of reaching the point of even applying to medical school. Although attrition rates among medical students are appreciably minute (less than 5%), a

2010 analysis reported students from low SES backgrounds were more likely to withdraw or be dismissed from medical school in the first two years, even when controlling for Medical College Admissions Test (MCAT) scores (Schoolcraft, 2011). With such a bleak picture of the rising cost of higher education in both public and private institutions at the undergraduate and graduate levels and a paucity of participation from students with low income or lower parent education backgrounds, the lack of national attention on socio-economic diversity in medicine and medical education is concerning. The limited literature suggests that focusing on both SES and race may be a more successful approach than race alone in achieving diversity (Carnevale & Rose, 2004), thereby coming closer to meeting workforce needs (Cohen, Gabriel & Terrell, 2002; Freeman, Ferrer & Greiner, 2007).

The increasing parental education backgrounds of both Black and Hispanic accepted applicants from 1992 to 2005 indicates that socioeconomic status is climbing across the entire applicant and matriculant pools amid efforts to increase diversity, but that there is not necessarily attention to socioeconomic status (AAMC, 2010d). Whitney, Jr. (2002) surmised that class disparities have existed in medicine for decades and have received little attention from the medical establishment. Information fields on the common application that involve a comprehensive focus on socioeconomic status have lagged behind, and were just retooled for the 2012-2013 admissions cycle, another indication of the lack of focus on socioeconomic diversity by national leaders in medical education. The common application service administered by the AAMC now includes more socioeconomic parameters intended to inform admissions decisions for 2012-2013 (Begatto, personal communication, March 30, 2012; Grbic, 2011). Whether or not standardized SES data on the application will change admissions outcomes for low income students is yet to be determined, but exploring SES among applicant background factors is an important aspect of diversity that decision makers may be failing to fully consider.

Although socioeconomic issues seem to undergird much of the contemporary political discourse in the U.S. regarding health care reform, including government funded health programs and access, medical education has paid little attention to the socioeconomic status of trainees. The AAMC annual data books on applicants, faculty, and academic medical centers contain no data on SES backgrounds of practicing physicians, current students or resident trainees (AAMC, 2010a; AAMC 2010c). In early national initiatives, SES was a non-specific (largely unmeasured and unreported) secondary component of the focus on race, latently assumed to be captured in outreach efforts focusing on recruiting applicants from underserved communities of color. Given the current political landscape and the population of 49.9 million uninsured in the United States (DeNavas-Walt et al., 2011), the socioeconomic issue is timely and salient for policy and practice in medicine.

Admissions frameworks have evolved from the sole consideration of race to more robust and inclusive diversity paradigms in recent years (see Appendix A). Accepted applicant data suggests that race is considered by decision makers as a compelling interest, as evidenced by the differences in accepted students based on race, MCAT and GPA (AAMC, 2011d). This study will examine differences among applicants to medicine by race, sex, parent education, and academic parameters. I will also study these differences across institutional predictors of size, type (public/private) and selectivity. I hypothesize that admissions outcomes across these parameters will be unequal. This study will examine parent education across race, especially comparing Black, Latino and Native American applicants to other groups.

In the U.S. the relationship between race and poverty remains strong (DeNavas-Walt, Proctor, & Smith, 2011), especially for Blacks and Latinos. Property tax revenues designated by neighborhoods by which public education is structured and funded serve to increase disparities in education for many poor and minority groups (Lee, Smith, & Croninger, 1997; Roderick, Coca, & Nagaoka, 2011). Residential segregation is a condition related to both race and socioeconomic status (Charles, 2003). The extent to which race and SES (as measured by parent education) correlate among MD applicants today will be illuminated by this study.

Representation by Race and Sex

The Association of American Medical Colleges has spearheaded many efforts over the years to diversify medicine according to sex and race (see Group on Women and Medicine in Science, for example, and Project 3000 by 2000). These efforts provide a scaffold from which practitioners can identify opportunities and missteps. In the late 1990’s national AAMC efforts focused on cultural competency among physicians on the heels of the Institute of Medicine’s Report on Health Disparities called *Unequal Treatment* (Lie, Boker & Cleveland, 2006; Smedley, Stith & Nelson, 2003). Racial and gender diversity among trainees was embraced as a strategy to address health disparities and ensure care for underserved populations (Betancourt, 2006; Freeman et al., 2007). Health disparities and disparities in participation in medical education according to race remain a stark concern, but may not capture the full essence of inequalities in medicine.

The pipeline of students entering medicine does not contain enough students to reach equal proportions of physicians according to race in the U.S. population (Cooper, 2003b; Cooper, 2003c; Foster, 1996). So while the strategy of addressing disparities through race-based recruitment is justified, it is not enough.

In a typical year, applicants self-reporting race or ethnicity of Latino, African American or Native American descent comprise just under 15% of new matriculants to medical school (AAMC, 2010c). The U.S. Census estimates that African Americans, Latinos and Native Americans represent at least 30% of the population; therefore these groups are underrepresented in the medical profession according to the population (United States Census Bureau, 2010). Within academic ranks, Blacks, Latinos and Native Americans are also underrepresented comprising 7.4% of the total faculty of medical schools nationwide (AAMC, 2010c). At the full professor level, Black faculty represent only 1.3% of the professoriate and Hispanic faculty comprise 3.2% (AAMC, 2010c). Compared to White faculty who are full professors, Black faculty at the same rank are outnumbered 60 to 1 and Hispanic faculty 25 to 1, respectively. An examination of the promotion rates of 31 cohorts of professors between 1967 and 1997 demonstrated that White faculty had higher promotion rates than non-White faculty and men had higher promotion rates than women (AAMC, 2010b). Women have historically been underrepresented in medicine and have made tremendous strides in the last two decades, surpassing male applicants in 2005 (AAMC, 2010c).

Women currently comprise just under 50% of new medical students each year and are about a third of current practicing physicians in the U.S. (AAMC, 2010a, 2010c). Although women are equally represented at the student and entering professional levels, they remain underrepresented among leadership and high academic rank. Men outnumber women in full professor rank 4 to 1, and women make up 16% of deans at the institutional helm of schools (AAMC, 2010c; Gibson, 2011). Ascending the academic hierarchy and leadership has remained a challenge for women and minority groups. Understanding mechanisms that might contribute to these pervasive challenges can possibly provide direction to exploring solutions. The available opportunities in a physician's career may begin with social and academic constructions that currently define undergraduate selectivity.

Educational Roots of Stratification

The rigorous and early requirements in science and math intensify both stratification and systemic inequalities that manifest through students' access to courses in science and math beginning in middle school (Lucas, 2001). Vocational and career theories (i.e., Byars-Winston, 2006; Fouad & Byars-Winston, 2005; Karunanayake & Nauta, 2004; Lent, Brown & Hackett, 1994) stipulate that students begin formulating career intentions early, and that role models and exposure play significant roles in the development of career aspirations and plans. Students in poorly resourced primary and secondary schools are at a significant disadvantage due to limited exposure to rigorous courses in science and math prior to entering college (Hilton & Lee, 1988; Lee, Croninger & Smith, 1997). Low SES students are less likely to aspire to college or enter college, and are more likely to arrive under prepared (Hilton & Lee, 1988; Qian & Sampson Lee, 1999).

Poverty and Race

In 2010 the poverty rate in the United States was 15.1% while the median household income has decreased by 6.4% since 2007 (DeNavas-Walt et al., 2011). As the nation's population grows increasingly poor, are medicine and its leaders equipped for the challenge of providing care for the country's population? There is evidence to suggest that underrepresented minority physicians (Blacks, Latinos and Native Americans) are more likely to practice in underserved communities and provide care for medically indigent patients (Moy & Bartman, 1995; Xu, Fields, Laine, Veloski, Barzansky & Martini, 1997). The same body of evidence exists for students coming from rural areas – they have a higher likelihood of returning to those areas as providers (Brooks, Walsh, Mardon, Lewis, & Clawson, 2002). The Association of American Medical Colleges (AAMC), the governing organization for all accredited allopathic medical schools in the United States, has among its strategic priorities, "lead efforts to increase diversity in medicine, lead innovation along the medical education continuum to meet the health needs of the public, and facilitate the development of a health system that meets the needs of all for access, safety, and quality of care" (AAMC, 2011a, p. 1).

The participation in medical education from all sectors of society regardless of race or income is an important foundation for the goals of the profession as a whole. The extent to which medicine is stratified by sex, race or class has implications for both participation and leadership within the profession. The demographic composition of physicians may impact quality of care and access to care for low income and minority groups currently experiencing disparities (Smedley et al., 2002). Excluding vast segments of the population from training threatens the foundation and strategic efforts of academic medicine and the provision of quality medical care for all in the United States (Sequist & Schneider, 2006). Thus far efforts have focused heavily on representation by race. Have these efforts created more setbacks in achieving socioeconomic diversity in medicine? Is stratification in medicine happening across all racial groups? What is the current state of socioeconomic diversity in medicine?

Selectivity Matters

Medicine is a prestigious career, and being a physician in the United States carries status. Within medicine there are even more fine grain divisions within the hierarchy that add or detract from overall status such as specialty, academic pedigree, and grants or awards. Even within the ranks of students deemed fit to study medicine there are real or perceived status-conveying or qualitative differences in schools that provide both tangible and intangible advantages. For the medical education framework, both selectivity of undergraduate institution and selectivity of medical school are relevant. Selectivity of undergraduate institution and grade point average have been shown to largely predict selectivity of graduate program (Mullen, Goyette, & Soares, 2003). This study will examine whether this is also true for medicine. Medical school selectivity may have far-reaching career implications, which may not be known or apparent to students coming from low income or minority backgrounds.

An AAMC data snapshot by Schoolcraft (2012) reported that Black physicians consistently report not doing as well financially as other physicians and are half as likely as White physicians to report a financial status that is very good or excellent. Further, Black physicians report the highest mean student debt level upon graduation (Schoolcraft, 2012). One possible reason for this is Moskowitz's (1994) finding that the majority of

Black physicians train at historically Black medical schools, none of which are considered highly selective and all of which are unranked by *U.S. News and World Report* (2011). So while past access strategies may have been successful for entry into the profession, inequalities that exist within the profession remain unaddressed.

Entry into financially lucrative sub-specialties remains limited for underrepresented minorities (AAMC, 2010c). Stratification based on access to elite medical schools may provide some insight into the continued inequalities at the post-graduate and professional practice levels. The extent to which undergraduate selectivity matters for a career in medicine is quantified by this dissertation. To date there are no studies examining medical school admissions outcomes and selectivity. Students may be narrowing their career options for certain specialties or leadership considerations in medicine according to which undergraduate institution they attend.

Undergraduate Selectivity

Selectivity of institution matters at the undergraduate level for several reasons. Completion rates for bachelor's degrees rise as selectivity rises (Bowen, Chingos, & McPherson, 2009; Carnevale & Rose, 2004), and this has been found to benefit students of color specifically by both Bowen and Bok (1998) and Melguizo (2010). Obtaining a degree from a selective institution has career advantages and earning advantages over time (Brewer et al., 1999; Hoxby, 1998; Monks, 2000). Focus on selectivity has even impacted high school scholar programs that aim to give low income students entry into the social and cultural capital available at selective universities (e.g., Schuler Scholars, Venture Scholars). An important notation from undergraduate examinations of selectivity benefits is that they are based on four- or five-year *degree completion*, not necessarily performance (grade point average). Bowen and Bok's (1998) study focused on bachelor's degree completion, which may not be enough for students who intend on graduate or professional school. Completing a degree and competing for admission to medical school are conceptually different aims.

As applied to medical school admissions, the average grade point average of applicants for 2010-2011 cycle was 3.53, while the accepted student GPA was 3.67 (AAMC, 2011a). The aggregated acceptance percentage for 2009-2011 for applicants with grade point averages of 2.80-2.99 was just 13.1% – and that includes any MCAT score (AAMC, 2011d). Applicants posting GPAs between 2.60 and 2.79 were accepted just 10% of the time. In contrast, for applicants with 3.8-4.0 averages, the acceptance rate was 72.2%. Applicants with 3.6 to 3.79 grade point averages were accepted at a rate of 55.3% (AAMC, 2011d). The minimum GPA typically required for undergraduate degree conferral – 2.0 – renders a medical school applicant very poorly prepared to compete for admission no matter the MCAT score. This study helps define if and how the benefits of selectivity apply to medical school admissions and the relationships between selectivity and academic performance indicators across race, sex, and SES (using parent education). Just how much benefit is there to attending a selective institution when it comes to securing a seat in medical school? Are there differences in applicant undergraduate selectivity by race or sex? Does undergraduate selectivity influence medical school selectivity? Anecdotes abound for these questions among deans, advisers, and students, so quantitative evidence is tremendously useful for both policy and practice. Current searches for literature discussing selectivity in medical school admissions yield no results.

Medical School Selectivity

Selectivity in relation to medical schools remains a controversial and poorly defined issue. All U.S. allopathic medical schools are accredited and provide an equivalent MD degree with the ubiquitous license and practice privileges and opportunities recognized by independent state licensing boards and a national licensing board. Yet the small professional networks within specialties and the inner-competition between institutions for *U.S. News and World Report* (USNWR) or National Institutes of Health (NIH) prestige and rank seem to strongly influence opportunity. Gibson's (2011) unpublished analysis of head deans of medical schools found that 60% attended elite undergraduate institutions. Most deans had graduated, trained at, or spent professional time at institutions highly ranked by *USNWR* or Ivy League schools. Highly selective institutions dominate the education and professional pedigrees of current leaders in academic medicine. Only 19% of the deans lacked a mention of a top 25 *USNWR*-ranked institution in their publicized professional bio or appointment announcement (Gibson, 2011). In 1982 Bryll and Sukalo conducted a similar analysis of where medical school deans from 1960-1980 had attended medical school. They found a preponderance of Harvard Medical School graduates (slightly more than 10%) with the next two schools being Cornell and University of Pennsylvania. About 25% of deans in Bryll and Sukalo's (1982) analysis were Ivy League, and 13 of the 19 most prevalent schools in their study are commonly ranked among the top 20 by *USNWR* today (Gibson, 2011; *U.S. News and World Report*, 2011).

In addition to leadership implications, the specialty a student may choose for graduate medical training may be influenced by the selectivity of the medical school.

The National Residency Matching Program (NRMP) routinely reports to its institutional participants which candidates in their matched pools are from top twenty institutions (Rob Christopher, personal communication, May 1, 2009). The 2010 Program Director survey conducted by the NRMP found among the important criteria for program applicants that being a "graduate from a highly regarded U.S. Medical School" carries considerable weight – in fact as much weight as earning honors (Alpha Omega Alpha) at a student's respective institution (NRMP, 2010, p. 8). This provides a disincentive for training programs to match students from poorly 'regarded' (ranked) medical schools for their graduate medical education programs.

The consideration of institution in the resident candidacy process happens through this technical reporting, but also through small circles of specialists in academic medicine that look for each other's endorsements of candidates to a particular program in the letters of recommendation (Stephanie Kielb, personal communication, May 7, 2011). The NRMP Program Director survey (2010) found that letters of recommendation scored higher on mean importance scores than clerkship performance, clerkship honors, classroom grades, USMLE board scores, or AOA status. The professional medical societies are relatively small, so the networks within specialties within academia are even smaller. A student from a well-connected, selective school is presumed to fair better matching into the specialty of their choosing if endorsed by certain well-known faculty colleagues. This may be one mechanism by which the social or professional capital of a selective institution impacts a student's career.

Specialty options in medicine are part of the mechanisms that create inner-hierarchies in medicine because earnings differentials between specialties are so vast.

Schoolcraft's (2012) report that African American doctors are half as likely to report favorable financial status and graduate with higher amounts of debt is troubling since it may indicate that stratification continues along race or income parameters well into a physician's career. Among doctors, those with the best resources are well positioned to maintain financial and professional advantages through specialty choices, and at the very least have the widest options to be competitive for more lucrative specialties. Between 1980 and 1990 sex segregation by specialty reflected these earnings differences with more women in pediatrics, obstetrics and gynecology, and family medicine and more men in surgical fields, hospital fields and internal medicine (Boulis, Jacobs, & Veloski, 2001). Gibson (2011) found that the most prevalent specialty of head medical school deans was internal medicine sub-specialties such as endocrinology, gastroenterology, and cardiology. These medicine sub-specialties all require fellowship training – an even longer educational pathway with even more delay in full earning potential. Opportunities at the fellowship level are even more brokered through faculty relationships (personal communication, Kemi Doll, May 5, 2011). Faculty salaries in 2009 from instructor to full professor in less competitive primary care fields such as general pediatrics had median yearly earnings of $126,000-$196,000 (AAMC, 2010). More competitive surgical sub-specialties such as plastic surgery had average yearly earnings of $253,000-$409,000 (AAMC, 2010).

The compensation levels in both private and academic medicine vary drastically by specialty as well. At the instructor level the median salary range is $71,000 (ob/gyn) to $294,000 (interventional radiology) and even at the full professor level the range for median salaries is $171,000 (adolescent pediatrics) to $493,000 (neurosurgery) (AAMC, 2010). In a longitudinal study of graduates at one medical school, low income students were found to pursue lower-paying (primary care) specialties despite graduating with high debt levels (Cooter et al., 2004). The cumulative effects of selectivity of both undergraduate school and medical school may have far-reaching career choice and earnings implications that could presumably influence the process in addition to individual preparation and achievement factors through social networks and external ranking/reporting forces such as *USNWR* and the NRMP. Understanding differences in selectivity according to applicant backgrounds can help academic medicine better understand the factors influencing the current diversity challenges of the medical profession. As the population of the U.S. becomes more diverse and more families fall below the poverty line, medicine has an increasing imperative to train providers in all specialties who are well prepared to treat everyone effectively and efficiently.

The demographic trends in the U.S. show a projected growth in the Latino and Black populations by the year 2050, while the non-Hispanic White population will decrease from 72% to 53% (U.S. Census Bureau, 2007). There will be proportionately more diversity in the college-age population in the coming decades, but will this demographic growth be reflected proportionately in college enrollment and subsequent graduate and professional school participation? The college and graduate school access issues must be examined comprehensively to include both race and SES, so that access is facilitated for low SES students of all backgrounds. As participation in post-secondary education expands, attention must be devoted to understanding both individual and institutional factors of degree completion at both undergraduate and graduate levels. Although there have been national efforts to diversify medicine since the 1970's these efforts have fallen short of their goals (Ready & Nickens, 1991) and the strategies relevant four decades ago may need updating and retooling to meet the nation’s needs today.

The reasons for lack of representation for low income, minority and women students at the premedical, medical student, and professional levels may be due to cumulative educational inequalities in our current system of primary, secondary and post-secondary education. Examining the population of applicants may provide insight as to how applicant backgrounds influence academic preparations and outcomes in the process of seeking medical school admission. Focusing the inquiry at the point of admission to medical school offers an opportunity to better understand factors related to inequality in the career preparation phase and the antecedents of inequality and stratification in the medical profession.

Purpose and Research Questions

This study seeks to enlighten practitioners, policy-makers, and participants in medical education about the backgrounds and outcomes of applicants to allopathic medical schools in the U.S. with specific attention to institutional selectivity. This dissertation focuses broadly on applicant predictors of parent education, race, sex, academic preparation both descriptively and within multilevel models examining admission outcome. Institutional predictors of selectivity, size and type (public/private) are described and utilized in the multilevel models. While examining participation and demographics for applicants overall is important, this study also examines factors that may influence the selectivity of the matriculating medical institution among accepted applicants. Understanding the relationships between race, sex, parent education and preparation pathways across institutional characteristics may help the medical profession identify ways to decrease stratification and promote participation from proportionately underrepresented groups. The American Medical College Application Service (AMCAS) application captures nearly all applicants to allopathic medical schools in the United States and allows for the study to include the entire population of applicants through the AAMC, which owns and manages AMCAS.

The AMCAS opens in June of each application year and closes in November. Nearly all allopathic schools in the U.S. participate in this common application (Texas state schools are the exception). Students enter personal information, background information, educational records, up to 15 co-curricular experiences, and a personal statement. The academic portion of the application is verified by AMCAS staff for a fee of $185 which includes secure electronic transmission of the application to one school. Additional schools are $33 each. Verifiers look at original transcripts and cross check course work against credits and grades. They also standardize the grade point averages so that the various academic blocks (semester, quarter, trimester) are made equivalent for all applicants. Finally, AMCAS divides the GPA into science, non-science, and total for each year of college, post baccalaureate or graduate work. Science courses are biology, chemistry, physics and math based. The AMCAS application captures a very comprehensive snapshot of an applicant's academic and professional preparation for medical school. These data are stored in a warehouse under unique research identification numbers. The data for the study is the 2010-2011 cross-sections of applicants to U.S. medical schools that applied through a verified AMCAS application.

Three main questions guide this inquiry:

1. What are the descriptive characteristics of the medical school applicant pool according to race, sex, parent education, and academic components?
   a. What are the interrelationships between race, sex, parent education, and academic components in the applicant pool?
2. Among the applicants to medical school, what influence do individual and institutional factors have on the number of schools to which a student applies and is accepted?
   a. What is the influence of race, sex, parent education and academic components on the number of schools to which a student applies and the number of schools to which a student is accepted, controlling for different institutional characteristics?
   b. What is the influence of graduating from a public or private institution, institutional size, and institutional selectivity on the number of schools to which a student applies and the number of schools to which a student is accepted?
3. Among accepted students to medical school, what influence do individual and institutional factors have on the institutional selectivity of the matriculating medical school?
   a. What are the descriptive characteristics of accepted applicants according to race, sex, parent education, academic components, institutional type (public/private), size, and selectivity?
   b. What influence, does race, sex, parent education, and academic components have on matriculating medical school selectivity?

c. When controlling for race, sex, parent education, and academic components, what role does institutional type (public/private), size, and undergraduate selectivity have on matriculating medical school selectivity?

The hypothesis of this study is that individual and institutional factors influence outcomes in application to medical school. Further, I hypothesize that selectivity of undergraduate institution influences the selectivity of matriculating medical school. Gaining better understanding of the current applicant pool and having more robust descriptive statistics is important to practitioners and policy makers. Analysis of the candidate pool by various academic preparation factors, parent education (which is used to capture SES), sex, and race provides a more robust picture to decision-makers about applicants. Considering that medical schools generally lack diversity, it is important to answer the question – is this a selection issue? Are students from low SES backgrounds applying and not being accepted? Or are they simply absent from the applicant pool? Do low SES students apply to fewer schools or receive acceptances at fewer schools? Are low SES students equally distributed across racial categories, or disproportionately represented by certain races? Are the academic credentials of low SES students equal to those of higher SES peers? What role do institutional characteristics play in the admissions outcomes for applicants? Is there anything unique or distinctive about preparation pathways between race and parent education groups that is noteworthy to practitioners? For example, do low SES applicants come from less selective undergraduate institutions? What is the distribution of low income students in the applicant pool across racial or ethnic groups or institutional characteristics?

An interesting component will be examining number of acceptances within relative applicant characteristics. Using ANOVA I compare differences in the applicant pool across predictors. What are the number of applications and acceptances for each group according to race, sex, parent education, and academic index? How is parent education distributed across race, sex or academic index? Do MCAT scores differ by race, parent education or sex? Analyzing variance and comparing means for applications and acceptances across several predictors will provide insights into group differences. Are students from lower levels of parent education accepted to the same number of schools as their higher parent education counterparts? Are there any institutional characteristic patterns across individual predictors? More robust and descriptive breakdowns of applicant data by various groups provide a more comprehensive feedback and a national context for decision-makers.

Examining some undergraduate institutional characteristics including selectivity is useful in determining if the type of undergraduate institution matters in the medical school preparation and admission process. To answer the second question I utilize a multi-level model to examine the effects of institutional and individual characteristics on the number of schools to which a student applies and is accepted. Particularly for students from lower parent education backgrounds, what influence might the characteristics of the undergraduate institution have on their admission to medical school? Is there a difference in number of schools applied or accepted between public and private institutions across race, sex and parent education? Exploring whether the size of the institution has any effect on admission outcome, while controlling for individual predictors, is pertinent for advising and premedical preparation. I have been queried by many parents and advisers about medical school admission considerations by institutional type, size and selectivity, and this study provides an evidence-based answer.

In answering the third research question I employ a hierarchical generalized linear model (HGLM) to understand the relationship that individual and institutional characteristics have on medical school selectivity. With an HGLM it is possible to examine the effect of selectivity, size, or institutional type on matriculating school selectivity while controlling for individual characteristics. Does selectivity of undergraduate institution increase the odds of attending a highly selective medical school? Are the effects of the individual predictors equally significant across groups? These data will help practitioners understand to what extent their admissions processes are truly holistic in evaluating applicants individually.

Scope of the Data from the Application

The information contained in the AMCAS application is voluntarily entered by applicants who attest to the veracity of it upon submission. Because this study uses data from the AMCAS, it is limited to the questions asked on the application and may not represent optimal survey or data collection design. Most fields are required, but some fields are optional, such as race and ethnicity and indicating disadvantaged status. There is some variability in how applicants complete the information, which leads to a smaller sample for analysis than the entire pool. I discuss this in greater detail in Chapter Three.

The scope of the study includes only allopathic (MD-granting) medical schools in the United States. There are 17 accredited allopathic medical schools in Canada that are excluded from this analysis. Due to the examination of stratification based on institutional selectivity only U.S. schools are included. Medical school selectivity is operationalized in the model using rankings of *U.S. News and World Report*. These rank systems are relative to U.S. institutions and comparisons to schools in Canada would be less valid. Although there may be some Canadian students applying through AMCAS to U.S. schools as international applicants, most Canadian residents applying to Canadian schools do not apply through AMCAS. Similarly, osteopathic medical students are excluded from the scope of this study. I discuss this in more detail in Chapter Three.

Theoretical Grounding

Inequality in this study is framed by three educational theories: Life Course Perspective (LCP) (Shanahan, 2000), Maximally Maintained Inequality (MMI) (Raftery & Hout, 1993), and Effectively Maintained Inequality (EMI) (Lucas 2001). These three theories attempt to explain differences in educational outcomes over time and are useful as applied to a medical education framework due to the long training trajectory and rigor of medical education. Theories of social and cultural capital, as they relate to parental education and occupation, contribute to the inequality framework for this study (Bourdieu, 1986; Lareau 2011). Stratification and college choice play central roles in the framework and analysis of outcomes (Bastedo & Jaquette, 2011; Bowen & Bok, 1998). To provide a framework for the pathways of preparation to medical school, an overview of Social Cognitive Career Theory (SCCT) is incorporated into the literature review (Lent, Brown, & Hackett, 1994).

Educational Transition Theories

The LCP theory examines educational transitions and asserts that as a student becomes more independent from the family or origin, the family's influence lessens (Shanahan, 2000). The LCP provides a background from which to study the influence of parental education on medical school applicant outcomes. Does parental education impact outcomes for graduate or professional school admission? Social capital theories contribute to the discussion of parental influence on educational outcomes. MMI also examines educational transitions and theorizes that within widely distributed educational opportunities resources remain allocated along class lines (Raftery & Hout, 1993). Even as the educational levels of lower classes rise, educational levels of upper classes continue to rise as well. If resources are widely distributed, effect sizes will be small when examining outcomes among a general population (Raftery & Hout, 1993). Essentially MMI states that individuals are very likely remain in the class stratum in which they were born because expanded opportunities and elevated achievements are relative and also affect upper strata. Expanding on MMI, EMI posits that individuals from middle and upper classes will successfully procure educational resources that are quantitatively *and* qualitatively superior (Lucas, 2001). Among educational opportunities that are distributed within a population, individuals in upper class strata tend to secure superior resources, thereby maintaining their place within the hierarchy and limiting the mobility of others (Lucas, 2001). EMI is manifested through not only access to superior resources within an educational system at all phases, but also superior earnings benefits of attending selective colleges which then perpetuates the system of rewarding the highest strata (Dale & Krueger, 2002; Dale & Krueger, 2011).

Stratification

The relationship between socioeconomic status and educational achievement is a significant concept for this inquiry. The resources of a student's parents in terms of education, occupation, and income serve as important predictors of educational success and selective college attendance (Hearn, 1991; Karen, 2002; Lamont & Lareau, 1988; McDonough, 1997). This study examines whether this phenomenon exists for medical school admissions as well by utilizing parent education as a predictor. Stratification is defined as individuals remaining within the income, education and resource strata of their family of origin. A primary component of social reproduction, stratification works against social mobility by restricting resource and opportunity via neighborhoods and schools (Frank & Cook, 1995).

College Choice and Matching

Bowen, Chingos, and McPherson (2009) compared the test scores and grade point averages of college applicants to the average credentials of entering students at collegiate institutions to determine the differences. This concept is known as matching. Students attending institutions with higher averages as compared to their scores are defined as "over-matched," while students attending institutions with lower averages as compared to their scores are defined as "under-matched." The greater the institutional selectivity, the higher the graduation rates, so matching at or above selectivity for which students qualify based on academic credentials is considered an important concept in educational equity (Bowen et al., 2009). In the context of competition for graduate school, grade point averages become an important component in gaining admission (Mullen et al., 2003). Highly selective institutions also have more grade inflation, which is another reason why matching or over-matching are considered ideal (Sander, 2011). In this study I explore whether students from highly selective undergraduate institutions fared better in gaining admission to medical school. Among the applicants accepted, I examine whether attending a highly selective undergraduate institution increases the odds of attending a highly selective medical school. The earnings and medical career leadership implications of attending a highly selective institution also add to the rationale for attending the most selective school possible (Dale & Krueger, 2002; Dale & Krueger, 2011; Gibson, 2011; Sherman & Bryll, 1982). This study illuminates the benefits or limitations of selectivity in the context of medical school admission.

Social Cognitive Career Theory (SCCT)

Social Cognitive Career Theory (SCCT) is central to vocational studies and provides an essential background for the importance of exposure to career options (Lent, Brown & Hackett, 1994). Students need exposure to subject matter through course work and enrichment as well as role models to develop informed career aspirations (Byars-Winston & Fouad, 2008). A career goal comes into focus through many environmental factors such as parents and family, school and peers. SCCT will help underscore some of the barriers to medical education for low income and minority students who may lack career exposure in role models and course access. Disparities in preparation are just as salient as inequalities in admission, and SCCT provides a theoretical grounding to examine premed disparities.

Key Terms

The main data elements for analysis come from the common application to U.S. medical schools (AMCAS) provided by the AAMC data warehouse contained in the database APP_BIO_R (see Appendix B). The data items from the code book selected for use in this study that will inform specific covariates and outcomes are listed in Appendix C.

Academic index – The AMCAS application contains exhaustive information about an applicant's academic journey including types and dates for institutions attended, degrees awarded, majors and minors, courses and grades, grade point averages in science, non-science and cumulative displayed by class standing, and Medical College Admissions Test (MCAT) scores. Examining each of these components across the entire sample necessitates combining them artfully into a parsimonious standardized index. The anticipated endogenous nature of the academic record necessitates the creation of an index for use in analyses to avoid multicollinearity and suppressor effects. The academic index is 25% total gpa, 25% science gpa and 50% highest MCAT score. It is both weighted and standardized.

Underrepresented – Medical education practitioners use the term underrepresented in several contexts, but most often to refer to underrepresented minority groups of Black, Latino and American Indian or Alaska Native. This study will utilize underrepresented broadly to mean students underrepresented in the profession of medicine according to demographic groups of race and ethnicity or income in the U.S. population. Low SES, Black, Latino, and American Indian or Alaska Native are inferred when the term underrepresented groups is used alone. Where specifically applicable to sex, professional level, leadership, or other constructs, a more specific qualifier will be used alongside the term underrepresented.

Race – The racial and ethnic categories on the AMCAS application are selected by applicants and defined as follows: Black or African American, White or Caucasian, Asian, Native American or Other Race. For ethnicity students may select yes or no for Hispanic. Ethnic categories for Hispanic are: Mexican American, Puerto Rican, Cuban, Other Hispanic (presumably South American, or other Central American origin). There are both raw race codes and race category codes that are utilized in the analysis. The term race refers to both race and ethnicity.

Socioeconomic status (SES) – SES will be operationalized in the study using highest level of parent education. Prior work from the data division at the AAMC confirms that parent education is a reliable variable to examine an applicant's socioeconomic background (Grbic, 2011). Although education does not account for occupational standing and other aspects that may present advantage or disadvantage, it is the single most reliable variable available to parsimoniously capture an applicant's resource background while avoiding endogeneity and maintaining fidelity within the model.

Undergraduate selectivity – The Carnegie classifications of inclusive, selective and more selective are used to capture undergraduate selectivity in this study (Carnegie Foundation, 2004). These categories are based on test scores and admissions data that approximate the competition for admission. I am interested in exploring stratification, so utilizing a categorical scheme based on the relative accessibility of a school is consistent with the study framework.

Medical School Selectivity – Examining selectivity of medical school is operationalized by *USNWR* rankings. Although controversial and highly criticized by the medical profession (McGaghie & Thompson, 2001), it remains a salient and relevant rating system to consumers, applicants and medical institutions themselves. For example, Northwestern University's medical school and hospital strategic plan has the goal of "Top 10 by 2020" referring to ranking by *USNWR* (Northwestern Medicine, 2012).

Because this study is interested in inequalities both quantitatively and qualitatively maintained, using a rating system with perceived and public validity is quite in keeping with the research questions. Inequality within professional hierarchies pertains to both *perceived* and actual qualitative differences among resources that are highly sought by the elite and upper classes. The use of *USNWR* rankings in the NRMP's (2010) matched candidate reports further supports its use as a reasonable indicator to categorically measure selectivity.

Institutional size and type – These variables are based on the undergraduate institution of an applicant and are derived from the National Center for Education Statistics (NCES) data from the Integrated Post-secondary Educational Data Set (IPEDS). Size is captured across five categories based on total student enrollment. Type is delineated by public or private.

Contributions of the Study

Abraham Flexner, considered the founder of academic medicine, hoped for an educational system removed from "the shackles of poverty, race, color, every possible biological accident and social prejudice" (Nevins, 2010, p. 41). His modest family background and early professional time as a teacher in the south during the Reconstruction Era suggest he understood the limiting effects of poverty. Flexner believed that individuals should be able to take their place in society based on their merits and envisioned a system that rewarded merit over birth right (Nevins, 2010). Participation in medical education has historically lacked equal distribution among all societal groups and strata, but has it become worse in recent decades? Has the strong focus on representation across race in Project 3000 by 2000 (Nickens, Ready, &

Petersdorf, 1994) and the attention to the racial diversity of the medical education pipeline (Cohen, Gabriel, & Terrell, 2002) left medicine more stratified socioeconomically? Are visible and invisible hierarchies operating in medicine such that low SES students are relegated to less-selective institutions and less competitive fields thereby foreclosing them to fewer professional leadership opportunities and presumably lower lifetime earnings? Do students from higher parental education backgrounds have more access to selective medical schools? If advantages from parent education are present, are they consistent across racial groups?

Accumulated Inequalities

Disparities at the faculty level demonstrate that there are several sieves on the career path to medicine for underrepresented groups. With each transition point in the medical education pipeline from high school to junior faculty, representation across groups becomes less diverse. Information about students from low income backgrounds and their career paths is less known. Medicine's long educational trajectory and high training cost further compounds the possibility that inequality will be pervasive at senior leadership and faculty levels. These inequalities begin very early in the education process.

The scope of diversity in medicine is currently limited. Examining socioeconomic differences along with race, sex, and academic preparation may increase understanding of socioeconomic diversity and could possibly make a strong case for greater consideration in admissions. The programmatic focus and emphasis among medical school admissions practitioners and strategic leaders has largely focused on diversifying medicine according to race. The rationale for diversity is based upon representation from various groups contributing to greater educational quality in the learning process as well as increased access to care for underserved communities (Betancourt, 2006; Cohen, et al., 2002). Cooter et al. (2004) found this relationship to be true for low income students. Medical educators have not fully pioneered knowledge and strategies regarding how to cultivate a workforce that will meet the nation's primary care needs while caring for the underserved (Freeman et al., 2007). This dissertation adds a body of robust, quantitative evidence that examines diversity in medicine by exploring the relationships between race, sex and parent education across groups. Further, this dissertation explores medical school admissions outcomes as they relate to institutional characteristics of size, type, and selectivity of the undergraduate institution. Understanding the extent to which medical education opportunity may be limited due to undergraduate institution attended may also add to the discussion about equity and access. Adding information about SES, race, sex and selectivity will allow decision-makers and gatekeepers in medical education to critically examine the characteristics of incoming trainees and begin to determine if these trainees have the collective capacity to improve the nation's health as stated in AAMC's strategic priorities. Understanding the demographic and educational backgrounds of incoming trainees may be the first step in building interventions that assist the profession in more effectively addressing health disparities and heath care access inequalities in the U.S..

The following chapter outlines literature and expands on the theoretical grounding introduced earlier. After the literature is presented, a conceptual framework for the study is outlined in detail. In Chapter Three, I present more detail about the research questions with their associated predictors and discuss the study methodologies and limitations.

Chapter Four is my presentation of the data from the analyses and a summary of the study findings. In Chapter Five, I synthesize the results of the study and relate them to recommendations for current practice. Chapter Five also poses future research directions and discusses implications.

CHAPTER TWO

LITERATURE REVIEW

The historical background for medical education in the United States is germane to a contemporary discussion about access and inequalities within the profession. Few professions are as standardized as medicine, and this is in part due to its history. This chapter will begin with an historical overview of the origins of medical education in the U.S. with specific attention to consideration and participation of minority groups. The review following will cover extant literature on educational transition theories that aim to explain inequalities in educational outcomes as well as theories related to the socio-cultural context of career aspiration and development. This includes known elements of preparation and career aspiration and models of college and graduate school choice as they apply to admission to allopathic medicine. Finally, undergraduate college matching theory will provide some framework for examining selectivity in medical school admissions, which will then be followed by theories of stratification and inequality. Essentially this literature chapter aims to provide a comprehensive background as to why stratification and inequality in medicine may exist today by covering history, preparation, the admissions process and ways in which resource disparities may amplify inequality in the current system.

History of Medical Education in the U.S.

In order to understand issues specific to students underrepresented in medicine today, it is necessary to begin with an historical overview of how the United States' system of medical education developed and how the evolution has impacted participation from minority groups. Reforms in medical education codified the current medical education system, and had both disparate and limiting consequences for minority populations. The unique history informs the current state of participation from minority and low income groups and may also provide insight as to why medicine may be increasingly becoming a profession mainly reserved for students from wealthy, highly educated families.

The standardization of medical education as professional training after undergraduate degree completion largely restricted participation from both women and African Americans (Markowitz & Rosner, 1973). In the early 1900's, achieving an undergraduate degree was reserved for mainly men from wealthy families. Prior to reforms, medicine was a vast field with training regimen varying from informal apprenticeship, proprietary school, or formal coursework at a university (Beck, 2004). The current term 'practice' when referring to medicine may have roots in early forms of training across various traditions. There was no regulation or standard for medicine, and scientific medicine had not yet prevailed as the dominant practice in the 19th century (Beck, 2004). Types of practice in the 19th century included eclectic, homeopathic, chiropractic, botanical, physiomedical and Thomsonian (Rothstein, 1972). Everyone from soothsayer and bonesetter to apothecary and midwife were considered practitioners – essentially "doctors." In essence, medicine was not a profession, but a practice that varied widely by locale, tradition, and access. The lack of standardization of both training and degree conferral meant that nearly everyone with proximity had access to training of some variety – including women, African Americans, persons living in rural areas, and presumably indigenous persons. Standardization of the educational process with subsequent linkage to professional licensure changed access dramatically.

History credits Abraham Flexner as the architect of the tripartite mission of academic medicine – research, education, and patient care (Thelin, 2004). He was in fact only one among a small team of men from three major institutions: the American Medical Association (AMA), the Association of American Medical Colleges (AAMC), and the Carnegie Foundation for the Advancement of Teaching (Berliner, 1977; Chapman,1974; Hollis, 1938; Hudson, 1972; King, 1984). These three bodies successfully collaborated to elevate scientifically based allopathic medicine as a prestigious career, and in limiting it both socially and economically.

Before Flexner

Flexner is credited with the reform of modern medical education and is also largely blamed for the lack of representation of minority groups today (Bonner, 1998). Following the reforms his report catalyzed, nearly all medical institutions that educated women and African Americans closed (Beck, 2004; King, 1984). Prior to Flexner's seminal report, the editors of the AMA's journal had outlined plans to standardize medicine and reduce the number of schools (Journal of the American Medical Association [JAMA], 1901a). In 1904, the AMA formed the Council on Medical Education, to undertake the challenge of standardizing and raising premedical requirements and medical training standards (AMA, 1904b).

The archives of the JAMA contain many articles between 1888 and 1906 mentioning state regulation and licensure (AMA, 1888b, 1889, 1902a), educational reform (Dodson, 1906; Eggleston, 1890; Rauch, 1891), premedical education reform (Holmes, 1899), endowments to medicine (AMA, 1901b, 1902b), the education of women (AMA, 1902c; Ladova, 1902), and exams (Alden, 1897). Clearly a national reforms discussion was happening long before Flexner's comprehensive report. There was growing concern regarding the lack of standards in medical education and licensure and the plethora of schools operating at the time. Many physicians trained in the scientific tradition decried the prevalence of 'quackery' and 'charlatanism' which damaged their credibility (AMA, 1888a).

Bevan's JAMA article in 1908 describes the unique development of medical education in the United States as a private, for-profit venture completely unstandardized, unregulated, and with a wide variety of quality and technique. Competition between schools to enroll students made for lax standards and entrance requirements so that anyone with financial means could purchase a medical degree (Bevan, 1908). Remunerations for physician services were very low because the variety of practitioners and methodologies created strong local competition and there were no reliable methods for consumers to differentiate between the types of training a doctor had completed en route to an M.D. (AMA, 1888a). It is important to note that the AMA specifically desired to make allopathic medicine elite (Eggleston, 1890; Hall, 1896). Reducing the number of medical schools and restricting who was eligible to train was a purposeful strategy. The roots of inequality in the medical profession are by specific intention and design.

Markowitz and Rosner (1973) attribute most of the medical education reforms to the Carnegie Foundation for the Advancement of Teaching and the AMA in conjunction with the Association of American Medical Colleges (AAMC). The changes following Flexner's (1910) report are a combination of an apex of momentum toward national reform, endowment funding, and coordination of a survey effort by the AMA's Council on Medical Education. The educational requirements were then strategically linked to state licensure through cooperation of state and local authorities who enforced them through legislative means. Some states had already established medical or public health boards and already regulated licensure or pre-licensure requirements (AMA, 1889; Cox & Freeman, 1891). The reforms had significant impacts because they were tied to licensure, so medical schools that were not sanctioned or approved produced graduates unable to practice and subsequently could not enroll paying students which led to their closures. Civic and social structures inhabited by powerful men fostered the linking of powerful regulatory systems that promoted the changes the men designed.

A report printed in JAMA in 1889 reveals a total of 267 medical institutions in the United States and Canada for the years 1765-1889. By the year 1889 there were 131, detailing that "130 institutions had become extinct" (p. 308). The article reports a decrease in U.S. schools from 129 in 1886 to 118 in 1889 (AMA, 1889). The JAMA archives show that the number of schools increased again to 160 by 1906, so there is evidence that a large array of proprietary schools were being established very quickly, many without the resources to provide quality training (AMA, 1906). The 1889 JAMA article also presents statistics on the raising of entry requirements, number of faculty in various disciplines, average duration of lecture terms, and graduation rates. State legislative efforts to drive and enforce standards of reform are also mentioned. These reforms were slowly taking shape in the U.S. in the decades leading up to the Flexner era.

Two years after the AMA's Council on Medical Education was founded the committee conducted a survey of the 160 existing medical schools in the United States (AMA, 1906; Kessel, 1958). Using a rating system based on pre-entry requirements, coursework, instruction, and facilities, the council rated 82 schools as acceptable in standard and 32 as unacceptable (Kessel, 1958). At that time the AMA did not release the results of the council's survey publicly, but did inform the schools of their ratings (Kessel, 1958). Bevan's (1908) article refers to the survey results of the Council on Medical Education,

> I wish that every member of the American Medical Association could have made the inspection of the medical schools of this country with our committee last year and seen the farce of attempting to teach modern medicine, as it is being taught in many schools, without laboratories, without trained and salaried men, without dispensaries and without hospitals. (p. 567)

The schools who did not receive acceptable ratings were upset at the attack on their credibility (Kessel, 1958). The position of the AMA as a proponent of scientific medicine created a conflict of interest in fairly rating the quality of education at schools that encompassed other medical traditions, such as homeopathy. The AMA needed external backing in order to gain objectivity and credibility for its school survey. Bevan (1928) wrote in JAMA several years later that obtaining the backing of the Carnegie Foundation for the Advancement of Teaching helped the AMA bring about reform to medical education.

The Flexner Era

Enter Abraham Flexner of the Carnegie Foundation and N.P. Colwell of the AMA's Council on Medical Education, who would together repeat the AMA's initial survey and inspection of the nation's medical schools and publish them alongside recommended reforms in what we know today as the Flexner Report (Kessel, 1958). Flexner synthesized the current issues of reform and made strong recommendations for change on the grounds that fewer, better trained doctors were of great public benefit (Chapman, 1974). Flexner made several recommendations in his report that soon after established medical education as it is known today. Premedical requirements and the four year curriculum for medical education remain largely unchanged today (Lambert, Lurie, Lyness & Ward, 2010). Students wishing to gain entry into medical school must study science for two years at a university including biology, chemistry, organic chemistry, physics, and calculus (Flexner, 1910; Lambert et al., 2010). This was a minimum requirement; a few medical schools, even in 1910, required a Bachelor's degree (Flexner, 1910). Medical education was outlined as having two years of classroom and laboratory instruction following by two years of clinical observation and apprenticeship in a hospital environment. All medical schools were to be associated with universities; no proprietary schools were allowed. Flexner felt that medical schools should serve a social mission to achieve better public health, and therefore for-profit enterprises were in contradiction to the social good (Beck, 2004). Allopathic medicine is very unique in that all schools accredited by the Liaison Committee for Medical Education (LCME) are connected to universities and there are no proprietary schools. Law, for example, has private, free-standing schools.

Changes in Access to Medical Education Post-Flexner

Because attending medical school required at least two years of scientific study at a university, medical education became out of the reach of possibility for all but the most wealthy and elite men in the United States with few exceptions (Beck, 2004; Rothstein, 1972). Proprietary schools in rural areas that trained women, African Americans and students of limited financial means continued to close in the years following 1910 so that only Howard and Meharry – the Black medical colleges – remained (AMA, 1911; Pritchett, 1913). The AMA's reports routinely included the population of the towns in which schools were located to imply that smaller towns could not produce the patient hospital volume necessary to adequately train students (see for examples, AMA reports *Medical Education in United States* for years 1904 through 1914). By 1923 all women's medical colleges had either closed or merged with existing schools (Beck, 2004). Flexner's recommendations fueled and further justified an era of reforms that were already underway and that would not end until 1944 (Kessel, 1958).

School Closings and Enrollments

In 1904 the nation had 160 medical schools with more than 28,000 students (Hiatt & Stockton, 2003). In 1910, the year Flexner's report was published, there were only 130 schools, so closures due to state regulations and reforms had already begun (King, 1984). By 1914, the number of schools had fallen to 100 and would continue to decline to 85 in 1920, 76 in 1930, and to an ultimate low of 69 by 1944 (Hiatt & Stockton, 2003; Kessel, 1958; King, 1984). Student enrollment in 1934 was 24,402, only a small decrease in the lamented overproduction of physicians years earlier (AMA, 1934). One of the strongest arguments for reform – too many doctors for the population – was not remedied by Flexner era reforms. The *composition* of trainees changed drastically, the *population* did not. The number of trainees was not reduced as drastically as Flexner had recommend – he advocated for a total of 2,000 graduates per year and 31 schools (Flexner, 1910). Bear in mind that the four-year course of training meant that Flexner's overall recommendation was for a total of 8,000 students.

Impact of Reforms on Minority Groups

Medical education reforms are documented as having impacted both women and African Americans. However, numbers of women trainees recovered to previous Flexner era levels by 1920, just ten years later. According to the AMA's annual report in 1934, the percent of women graduates was 4% in 1905, 2.6% in 1910 and 1915, and between 4% and 5.4% in the years following 1920-1934 (AMA, 1934). The number of female trainees remained very low over the next few decades and women were only 6.9% of graduates in 1965 (AAMC, 2010d). The AAMC data indicates that numbers began rising in subsequent cohorts and were 9.2% in 1970, 16.2% in 1975, 24.9% in 1980, and 30.8% in 1985. The percentage of women graduates increased every year following, with few exceptions, and was 48.3% in 2010 (AAMC, 2010d; Cooper, 2003a). As social notions of women's intellectual and professional inferiority faded, opportunities for women in higher education and medicine increased, thereby increasing the numbers in the nation's schools. While challenges remain in the representation of women in medicine with regard to leadership, teaching, promotion, and research, the student enrollment and graduation numbers are encouraging and nearly equitable compared to the population at large (AAMC, 2010b, 2010c). In short, women are no longer considered minorities among medical trainees. The story for African Americans is less encouraging.

African American Enrollment

In the years between 1920 and 1964, less than 3% of students entering American medical schools were Black (Hasbrouck, 1996). In 2010, African American graduates represented just 6.75% of the total percentage of graduates (AAMC, 2010a, 2010e). Through the years in reforms and changes in the numbers of schools and students, the percentage of African American trainees in the first year class has never exceeded 7.5% (Petersdorf et al., 1990).

Many scholars, actually dating back to Flexner himself, were concerned with the lack of minority representation in medicine (Bonner, 1998; Savitt, 2006). Flexner's rationale for the Black medical schools was that it was better they had fewer schools of equal quality than many of inferior quality (Flexner, 1910; Savitt, 2006). For his time Flexner was progressive in applying a uniform educational quality standard to non-White institutions. Plessy v. Ferguson (1896) upholding separate but equal was the law at the time. The de facto implementation of this ruling often meant that schools educating African Americans were well below the standard of those educating Whites. Although Flexner's reforms caused many schools to close restricting opportunity for Blacks, his choice to apply equal accreditation standards from a uniform body to the Black medical schools ensured their recognized excellence and subsequent survival. Standardizing the premed requirements also enabled aspiring Black physicians to complete comparable preparations that eliminated at least some bias in the selection process.

Although the number of physicians trained at schools other than Howard and Meharry was small, the fact that Black students were able to enter medical schools prior to forced integration is telling. In 1994, Moskowitz concluded that the Black medical schools had historically been the prime training ground for Black doctors and remained so. Nevertheless the excellent standard of training enabled Black physicians to make many significant contributions to their respective fields in the years that followed, such as Charles R. Drew, an African American professor at Howard, who discovered blood plasma and was the founding director of the American Red Cross Blood Bank in 1941 (Moskowitz, 1994). Pioneering graduates eventually spread to other institutions such as Hopkins, Harvard, and Stanford and eventually opened doors for other underrepresented students that followed.

A prominent contemporary scholar who brought attention to racial representation issues in medicine was Herbert W. Nickens. He was among the first of leaders in the AAMC to raise awareness of the racial compositions of U.S. medical schools and galvanize efforts to address representation. His three-phase plan, Project 3000 by 2000, aimed to increase enrollment for African Americans (and other underrepresented groups) nationwide (Nickens, 1994; Nickens, Ready & Petersdorf, 1994). Since Nickens (1994), there have been institutional guidelines and efforts aimed at addressing underrepresentation among minority groups. These have included recommendations for office structures in medical schools as well as accreditation guidelines (AAMC, 1998; Liaison Committee on Medical Education, 2010). Despite these advancements, the number of Black, Latino and Native American students applying to and graduating from medical school remains significantly disproportionately fewer compared to the national population than both White and Asian groups (AAMC, 2010e).

Changes in Defining Minority

It should be noted that the definition of minority groups in medicine has changed throughout history. In the late 1800's and early 1900's minority groups were women and African Americans. The two largest schools training Black physicians were Howard University College of Medicine, organized in 1869 and Meharry Medical College, founded in 1876. The existence of these schools, in addition to the practice of including a "colored" category on the U.S. census prompted the tracking of enrollments by the AMA. Women's medical colleges, many of which either closed or merged with existing schools in the early 1900's also enabled the tracking of enrollments by sex.

In the 1930's the U.S. government added "Hispanic" to the census, at which time the AAMC began to track their participation among the ranks of students and faculty. In subsequent years demographic tracking became more sophisticated, with additional subgroups added in both Asian and Hispanic categories. It was not until the late 1960's that Dr. Nickens began to examine the representation among various racial and ethnic groups in medicine according to the population at large (Nickens et al., 1994). From this analysis the term URM, which stood for "underrepresented in medicine," was coined (Petersdorf et al., 1990). URM was an aggregate term which stood for the groups calculated to be most underrepresented in the profession according to population census data: African Americans, Mexican Americans, Puerto Ricans, and American Indians and Alaska Natives. Colloquially the term URM came to mean "underrepresented minority," referring to the four groups, as opposed to "minority" which stood for all non-White groups, including Asian and Asian Indian.

URM Definition Change

The term URM and the data aggregation in AAMC publications were used to track progress until 2004. The AAMC changed its policy and no longer defined underrepresented for its member schools as a direct result of the two U.S. Supreme Court decisions Grutter v. Bollinger (2003) and Gratz v. Bollinger (2003) (see The status of the new AAMC definition of “underrepresented in medicine” following the Supreme Court's decision in Grutter, 2004). Following this policy change, individual medical schools began constructing and defining underrepresented according to the contexts and missions of their institutions. This change was intended to encourage schools to follow the court’s recommendation that efforts be narrowly tailored and mission-driven. Generally the definition change has meant that most schools consider any designation of Hispanic as underrepresented, rather than only Mexican and Puerto Rican. Following the Supreme Court rulings in 2004 almost every school included Cuban, South American, Central American, and Other Hispanic among their targeted underrepresented groups (see for examples Medical School Admissions Requirements [MSAR], the AAMC’s yearly guidebook for applicants, for the years 2005, 2006, and 2007). The term underrepresented in medicine (URM) has no uniform categorical definition between schools. A few institutions also included some Asian or Pacific Islander subgroups as underrepresented, such as Vietnamese, Korean, Tongan or Samoan. Although the AAMC still tracks demographic data for all groups, it no longer reports national enrollment statistics in the URM aggregate, making it more difficult to track progress using existing data.

The change in the 2000 U.S. Census allowing individuals to indicate more than one racial or ethnic group has also further complicated the data, as many students identify as more than one category. This change has further complicated the landscape for tracking progress in the enrollment of underrepresented students because students are in more than one category of race, ethnicity, or both. Today the term URM generally refers to all groups of Hispanic, African American, Native American and Alaska Native students.

History of Exclusion by the American Medical Association

Medical education has had significant challenges in training a diverse workforce, but those challenges did not end with degree completion for many minority physicians. An examination of the history of medical education is not complete without including a brief history of professional exclusion that followed. In 2008 the AMA's board of trustees published an official apology for over a century of exclusionary policies and practices against Black physicians (Davis, 2008). Medicine was incredibly segregated in training and delivery until 1968 when the AMA officially condemned racial exclusion by state medical societies (Baker, Washington, Olakanmi, Savitt, Jacobs, Hoover, … Wynia, 2008). Not only was there inequality in the profession, but also an extensive and well-documented history of experimentation on Blacks for medical research that occurred despite the existence of well-trained Black physicians (Byrd & Clayton, 2000; Washington, 2006). Career advancement barriers were steep considering the social attitudes toward African Americans as inferior members of a different species (Washington, 2006).

Black physicians could not join medical societies, which were the main organizational structure by which hospitals recognized doctors for privileges (Kessel, 1958; Nickens, 1985). Society membership also provided access to resources necessary for practice, such as malpractice insurance, business licenses and building permits (Kessel, 1958). The exclusion was a major limiting factor for Black doctors, because it restricted the entry of Black physicians into academic medical centers to further their careers and also limited their economic prosperity (Nickens, 1985). Kessel (1958) also posits that lack of access to medical society membership pushed minority group trainees toward less lucrative, non-surgical fields which were less dependent on hospitals for service provision, such as psychiatry. The enrollment disparities as well as the lack of representation of African Americans in surgical and sub-specialty fields persist today (AAMC, 2010b, 2010c).

The history of professional exclusion also informs the current state of participation for minority groups in medical education as it relates to the ways in which education and professional training build human, social and economic capital (Bourdieu & Passeron, 1977; Coleman, 1988; Lamont & Lareau, 1988). Excluding the two historically Black medical schools, 99% of students in U.S. medical schools were White as recently as 1966 (Nickens & Cohen, 1996). As a result, medical training and practice until the early 1970's was largely segregated, making the professional networks of Black trainees and graduates also segregated. If Black doctors were largely clustered at a few institutions during their training years, and their access to economic gains by virtue of their investments in training were limited by institutional racism, then it follows that the social, human and economic returns from medical training were presumably negatively impacted. Because of wide professional exclusion, Black physicians did not achieve the commensurate gains of their White peers and may not have enjoyed the full social and economic benefits of higher education and professional training. Schoolcraft (2010) reported that Black physicians are less likely to report a favorable personal financial status as compared to their White and Asian peers.

Representation in Medicine Today

In 2010, there were 42,742 applicants to medical schools in the United States for a total of 18,665 seats (Association of American Medical Colleges, 2010e). Within this pool, applicants self-reporting race and/or ethnicity of Latino, African American or Native American descent were 7.7%, 8.1% and 1% respectively (Association of American Medical Colleges, 2010e). Students in the aforementioned categories comprised just under 15% of matriculants to medical school in 2010 (Association of American Medical Colleges, 2010e). The U.S. Census estimates that African Americans, Latinos and Native Americans represent at least 30% of the population; therefore these groups remain underrepresented in the medical profession today (United States Census Bureau, 2010). Disparities in health are well documented among racial and ethnic minority populations and pervade all phases of illness from access to care, diagnosis, treatment, and morbidity (Brian, Adrienne & Nelson, 2002; Hasnain-Wynia et al., 2007).

Current Enrollments in Medical Education

In 2012 there were 136 MD-granting (allopathic) schools in the U.S. graduating 18,838 students per year (Association of American Medical Colleges [AAMC], 2010c, 2010e). In 2006, the Center for Workforce Studies at the AAMC called for a 30% increase in medical trainees to meet a predicted physician shortage (Salsberg & Grover, 2006). In 2006 there were only 126 schools, so six years later there were at least seven newly accredited allopathic medical schools since the AAMC released its guidelines (AAMC, 2010c). In the published report, the AAMC specifically outlined the need for workforce diversity, emphasizing the inclusion of underrepresented groups among the expanded enrollees without mention of low income students (AAMC, 2010c). As in a century ago, the decisions and policies of large organizations continue to have an impact on the trainees from underrepresented groups. Cooper (2003b, 2003c) analyzed the existing pools of Black, Latino and Native American students and suggested that enrollments even then would not keep pace with the growing or existing populations. Libby, Zhou and Kindig (1997) estimated that current numbers of Black, Hispanic and Native American residents would need to at least double to be on track to meet population growth demands. Foster (1996) examined enrollment progress for underrepresented students and found that reaching population parity was unrealistic given the current pipeline and associated preparation and enrollment challenges.

An analysis of enrollment by Carlisle, Gardner and Liu (1998) found that enrollment of underrepresented students nationally peaked in 1994 and 1996 numbers indicated 5% decline attributed to states where diversity-promoting policies were being negated by state opposition and judicial decision – California, Texas, Louisiana and Mississippi. Cohen (2003) and Cooper, Getzen, McKee and Laud (2002) have cautioned against the premature abandonment of affirmative action in medical school admissions, as it would ostensibly further limit care for many minority, underserved, and uninsured patients. From a national policy standpoint, there is disconnect in calling for increased enrollments from underrepresented groups while simultaneously acknowledging shortages in the pipelines and facing strong political opposition to the use of race in admissions. If the enrollment call is based on providers to care for underserved patients, perhaps the analysis in this dissertation can provide stronger impetus for the inclusion of low income students to fill that need and further expand the scope of diversity.

Recruitment to Address Disparities

Training physicians from underrepresented groups is one of many strategies for addressing disparities in health and lack of access to care (Cohen, Gabriel & Terrell, 2002; Moy & Bartman, 1995; Xu et al., 1997; United States Department of Health and Human Services Health Resources and Services Administration Bureau of Health Professions, 2006). Petersdorf, et al. (1990) reported that minority graduates were more likely to indicate plans to practice in urban or rural areas, socioeconomically deprived areas, and to choose primary care specialties. Pathman and Konrad (1996) found that minority students serving in the National Health Service Corps preferred urban areas with large minority populations for their placements. Komaromy, Grumbach and Drake (1996) found that Black and Hispanic physicians play a vital role in caring for underserved and minority populations. Training physicians from minority backgrounds is one strategy for addressing health disparities and to care for the uninsured (Cantor, Miles, Baker & Barker, 1996; Kington, Tisnado & Carlisle, 2001). Diversity among medical trainees is also considered an important educational benefit which in turn better prepares graduates to serve patients from all backgrounds (Elam, Johnson, Wiggs, Messmer, Brown & Hinkley, 2001; Guiton, Chang & Wilkerson, 2007; Saha, Guiton, Wimmers & Wilkerson, 2008; Whitla, Orfield, Silen, Teperow, Howard & Reede, 2003). Diversity in medical education can also be considered a part of the current initiatives at many colleges and universities to ensure that due diligence is enacted to achieve educational equity (Renner, 2003). The inclusion of low SES students is either assumed to already be included or included but largely undefined. Ensuring educational access for low income students may be a largely untapped resource in examining workforce shortages, care for the underserved, and eliminating health disparities.

Medical Career Aspirations and the Preparation Pathway

The inequalities and lack of representation in medicine according to race and SES are aptly framed by theories of inequality, social capital, and career/vocational development. In order to pursue medicine, an individual must first have awareness of medicine as a career (Lent, Brown & Hackett, 1994). Awareness is typically derived from personal experience or exposure to medicine in some form. Exposure and knowledge of how to pursue a career are related to contextual factors of family of origin, school, neighborhood, and region (Lent, Brown & Hackett, 1994). Hence these theories are well suited to the framework for exploring race and socioeconomics of applicants to medicine (Byars-Winston & Fouad, 2008).

Social Cognitive Career Theory (SCCT)

Social Cognitive Career Theory (SCCT) is useful in understanding how an interest in medicine is constructed and pursued (Lent, Brown & Hackett, 1994). SCCT frames career research with a socio-cultural context exploring various influences on the development of career interest and pursuit. Literature on SCCT also explores how other aspects, such as perceived barriers, social contexts, self efficacy, or race can influence career choice (Byars-Winston, 2006; Dahling & Thompson, 2010; Farmer & Chung, 1995; Lent, Brown & Hackett, 2000). Medicine has a very long preparation and training path and it is critical to examine this path specific to the unique obstacles of underrepresented students. SCCT has several facets including coping efficacy, family context, career self efficacy beliefs and career outcome expectations (Gushue & Whitson, 2006; Restubog, Florentino & Garcia, 2010). Although there are no studies directly examining how experiences of racism or classism impact interest in medicine specifically, enough studies exist that examine interest in math and science from which to extrapolate. Students aspiring for careers in medicine need role models, encouragement, exposure to the profession, strong commitment to medicine as a career, strong belief in their personal ability to achieve medicine as a career, coping skills to persist through difficult course work, and awareness of how well they are meeting requirements to achieve medicine (Ali, McWhirter & Chronister, 2005; Byars-Winston & Fouad, 2008; Cordero, Porter, Israel & Brown, 2010; Dahling & Thompson, 2010; Navarro, Flores, & Worthington, 2007).

Career development theories can help explain how socio-cultural forces may impact underrepresented students' aspirations for medicine as well as the resources available for preparation. For students from underrepresented minority or low SES backgrounds, many of the career development components may be missing or lacking. An analysis that examines some of these contextual factors among applicants may provide insight as to whether and how these deficits can be addressed at the undergraduate level by providing data about where applicants with specific backgrounds have been most successful.

Bandura's (1994) theory of self efficacy on which many components of SCCT are based, outlines four major learning mechanisms for developing self efficacy (a) performance and practice, (b) vicarious experience (observation) and modeling, (c) verbal persuasion by trusted mentors and peers, and (d) physiological feedback. The SCCT literature as it relates to math and science provides insights as to the barriers and supports available to underrepresented students interested in medicine.

Performance and Practice: Course-taking and School Structure

Research on the high school to college pipeline demonstrates disparities by race in relation to aspiration, preparedness, achievement, and enrollment (Engberg & Wolniak, 2009; Hu & St. John, 2001; Hurtado, Inkelas, Briggs & Rhee, 1997; Perna, 2000; Perna & Titus, 2005; Qian & Blair, 1999). Bryk, Lee and Smith (1990) determined that achievement is largely attributable to high school course-taking: Students who enroll in college preparatory tracks are more likely to succeed. Since Marion and Coladarci (1996, as cited in Davenport, Davison, Kuang, Ding, Kim & Kwak, 1998) found that course taking behaviors are related to career choice, the classes taken in high school can already determine whether a student is taking a direct path or a detoured path toward medicine. The difference in course taking by race is not necessarily in the number of math units taken, but in the type of courses (Bryk et al., 1990). Davenport et al. (1998) found significant differences in the types of courses taken between all ethnic groups, but relatively no differences in the total units. Their study showed that White and Asian students earned more units in standard and advanced courses, while Hispanic and Black students earned more credits in preformal or functional course sequences. Qian and Blair (1999) found that the type of school (public versus private) was insignificant in the college aspirations of all groups except African Americans. This further supports the work of Lee, Croninger and Smith (1997) who concluded that Black and Hispanic students are better served by smaller learning environments with academically focused narrow course tracks, which most private schools tend to offer.

The difference in college readiness can influence whether or not students actually enroll in college, but more importantly for students who do enroll, poor high school preparation can be reflected in grades and impact choice of major, retention in the premed track and graduation (Lovecchio & Dundes, 2002). This has implications for the pipeline to medicine since the largest predictor of post baccalaureate participation is grades (Ethington & Smart, 1986; Kallio, 1995; Weiler, 1994b). Preparation in science and math is even more salient, because the American Medical College Application Service (AMCAS) disaggregates the grade point average by science/math and all other courses. If underrepresented students take fewer college preparatory math courses in high school, their academic performances as undergraduates are possibly imperiled, further hindering their chances of successfully entering medicine. Without exposure to rigorous science and math prior to college, students do not have the opportunity for performance mastery that leads to self efficacy towards math and science related subjects and tasks. Further, exposure to challenging coursework in math and science builds self efficacy, which in turn strengthens commitment to career choice (Ferry, 2000; Scott & Mallinckrodt, 2005). The limited exposure some students may have to challenging science and math coursework creates fewer opportunities for mastery experiences that build self efficacy. This makes underrepresented students more susceptible to changing their career course in college because previous confidence-building experiences are lacking (Thurmond & Cregler, 1999).

Vicarious Experience and Modeling: The Role of Career Exposure

Role models are crucial in the development of self efficacy as applied to the career pathway (Erkut & Mokros, 1984; Karunanayake & Nauta, 2004). Students must be exposed to different types of careers and see individuals with whom they can relate in those careers in order to nurture a belief that they can enter a career (Erkut & Mokros, 1984). Role models in professional math and science careers are most likely to be found in adults who have achieved some level of post-secondary training. The disparities in student educational achievement by race can be understood in terms of the differences in both household income and parent educational achievement (United States Department of Education National Center for Education Statistics [NCES], 2010a). It follows that students from households with little or no post-secondary education and lower incomes have less access to science and math career role models than their more well-resourced peers. This can help explain why course-taking and the structure of schools may play an important role in compensating for social and human capital deficits (McDonough, 1997). A math teacher serves not only as an educator, but as a trusted adult mentor who can provide support for career aspirations in tangible ways.

Social Capital from Parental Education and Occupation

Students build confidence in a particular career based on access to role models, so what impact does a lack of role models have on students? Especially in formative years, parents serve as the primary role models for their children, and parental education and income do influence educational outcomes for children (Davis-Kean, 2005). Individuals with more education tend to have higher earnings over a lifetime (Baum & Payea, 2004), so parents with more education are presumably able to provide better resources based on socioeconomic status. The context in which a student is situated by virtue of family or origin, parental characteristics and occupations, neighborhood, school, etc. is called habitus (Bourdieu, 1986). Bourdieu described how an individual's habitus is a form of capital. Achievement and socioeconomic status are positively related and perpetuated by educational systems that reward participants of better means while emphasizing meritocracy. Higher earning professionals have greater mobility and residential choice, thus enabling them to secure better schools and neighborhoods for their children. The resources a student has access to through the networks of parents are a form of capital – social capital (Bourdieu, 1986; DiMaggio & Mohr, 1985; Lamont & Lareau, 1988). These connections operate in the background to influence career opportunities for students based on types of schools, enrichment programs, and interpersonal relationships.

Verbal Persuasion: Support from Trusted Adults

Gushue and Whitson (2006) studied African American ninth graders and found that parent and teacher support are related to career decision self efficacy, which is the personal belief in the ability to achieve a specific career. In addition, teacher support was also related to career outcomes expectations, the extent to which students believe they will actually reach their stated career goals (Gushue & Whitson, 2006). Ferry, Fouad and Smith (2000) found similar results when they examined undergraduate students' career-related choice behavior in math and science. Parental encouragement had significant direct effects on grades in math and science and the outcome expectancies of students (Ferry et al., 2000). Byars-Winston and Fouad (2008) also found that parental expectation and support had a strong influence in predicting the goals of college students. For students from underrepresented groups, the emotional support of family and close friends may play a very strong role in maintaining a commitment to medicine in the face of barriers. Dahling and Thompson (2010) found that choice self efficacy (specifically confidence in changing majors) was positively influenced by four contextual elements: family supportiveness, peer supportiveness, financial status, and job market outlook.

Physiological Feedback: Identity Impact on Career Efficacy

The way an individual responds to the environment can provide feedback about career decisions and aspirations. Bandura (1994) theorized that physiological cues can either build or detract from self efficacy toward a task. While one individual may experience sweaty palms as a sign of excitement to perform well, another may interpret the same cue as nerves leading to poor performance. In exploring literature on racial identity and SCCT, stereotype threat is particularly relevant in relating socio-cultural experiences and how those experiences, based on identity, may impact career aspirations and efficacy. Stereotype threat (ST) is defined as a condition when a person is at risk of confirming a negative stereotype about their group while engaged in a domain-identified task (Steele, 1997). Pressure to perform so as to not confirm the stereotypical expectation can lead to anxiety which then inhibits performance and confirms the negative stereotype (Steele & Aronson, 1995).

Further study by Steele (1997) found that individuals facing stereotype threat are prone to lower their domain identification, which has implications for developing an interest in and committing to pursue a career in medicine. Female math students in Steele's (1997) study under the strongest ST conditions disidentified with math and math-related careers more sharply than those under mild threat or no threat. Major, Spencer, Schmader, Wolfe and Crocker (1998) and Osborne (1997) confirmed that disengagement and disidentification are responses to ST. The work of Ogbu (1991) with African American youth suggests that negative educational experiences cause minority students to disengage and disidentify in secondary educational settings as well. Disidentification with education has been identified as a barrier to Latino male participation at both secondary and post-secondary levels as well (Saenz & Ponjuan, 2009). Identity and belongingness challenges may also be pertinent to students from low SES backgrounds, particularly as related to the undergraduate college experience. Exploration of individual and institutional characteristics and admissions outcomes may provide some insight as to which institutional settings possibly minimize belongingness threats most effectively for students from underrepresented groups. Developing an interest in medicine and preparing for medicine are important steps to achieving an MD; I now turn to the preparation pathway.

The Path to Medicine

The experiences students have in college, such as coping with racism and exclusion or achievement barriers, inform and affect their career choices and aspirations. Pascarella (1984) and Pascarella and Terenzini (1991) have demonstrated that students' career goals and educational aspirations are influenced by the college experience. Because the pipeline for medical training has been described as "leaky" (Lovecchio & Dundes, 2002) many institutions have developed programs specifically to nurture interest in medicine and enhance preparation resources for underrepresented groups. Any student aspiring for a career in medicine has a long training pathway ahead and must navigate difficult preparatory components in order to compete.

Preparation for a career in medicine is time and resource intensive. When a student applies to medical school it represents having made it through the preparation process from high school and through the undergraduate years. Cooper (2003b) examined race, ethnicity and income on applications to medical school and found that disparities in representation by race will most likely continue due to low numbers in the pipeline and the rapidly growing Hispanic population in the U.S.. Black, Hispanic, and Native American students have lower high school graduation rates than their White and Asian counterparts, so the pool is narrowed very early in the educational continuum (NCES, 2011). The gap in college readiness as indicated by course-taking, college entrance exams, and achievement scores in reading and math has also widened for Black, Hispanic and Native American students since the mid 1980's (Cooper, 2003b). For students who enroll in college, barriers exist along the preparation track that specifically impacts the underrepresented minority pool. These barriers may also exist for low SES students.

A student applies to medical school after completing all necessary premedical coursework in chemistry, organic chemistry, biology and physics. College grade point averages for accepted students typically range between 3.6 and 4.0 on a 4.0 scale (AAMC, 2011). Applicants must also take the Medical College Admissions Test (MCAT) and achieve a competitive score. Accepted students average MCAT scores between 30 and 32 (roughly 80th to 90th percentile), while the overall average MCAT score is 25 (roughly 45th to 50th percentile) (Association of American Medical Colleges, 2011). Strong extracurricular experiences in leadership, research, and community service are also customary, as are glowing letters of recommendation from physicians and professors (AAMC, 2011; McGaghie, 1990a). Applicants must be invited to interview (at their own expense) and perform well in the interview setting to make it to final selection in the admissions process. Several factors are considered in the process, as previously mentioned, including elements of diversity as well as the institutional fit of the student and school (Albanese, Mikel, Skochelak, Huggett & Farrell, 2003; McGaghie, 1990a). Because the preparation pathway is both arduous and competitive, many underrepresented candidates are dissuaded from medicine long before making an application for admission.

Graduate School Choice and College Choice Frameworks

When a student reaches the point of applying to medical school, very little is known about the background factors and preparation factors that influence an applicant's choice set beyond descriptive statistics about academic preparation. Using the phases similar to those from undergraduate education, there are three distinct areas of predisposition, search and choice (Hossler & Gallagher, 1987). Predisposition is different in nature from undergraduate college choice in that the decision to pursue graduate school is entertained after having completed undergraduate education, rather than during high school. The pool of individuals who develop a predisposition is therefore more limited and more specialized than the high school student population. Both research and data show that the predisposition phase may differ for graduate students depending on the type of program in which they are interested as indicated by age, length of time between degrees, parental education and personal income (NCES, 2010a). The search process is likely to be different in that it is largely driven by field-specific or profession-specific aspects and personal characteristics that may become more salient with age, such as significant others and parental status. Finally, the choice aspect of graduate school is difficult to assess because literature is largely based on surveys asking students at a particular institution why they chose that institution. The collection of survey data when the outcome is already known provides some useful information about why applicants believe they made their matriculation choices, but not much about their initial choice sets. Capturing data after matriculation voids the exploration of the factors that may have influenced the overarching choice process for applicants. If only matriculants are studied, than students who did not choose the institution or were not accepted by the institution are unknown as well as their accompanying characteristics and personal factors. This study does not include the school choice sets for applicants because I was advised that the data would be extremely difficult to obtain, as it is not routinely included among variables in APP_BIO_R data (personal communication, Gwen Garrison, November 6, 2011).

Matching Theories and Medical Education Implications

Medical education is no longer the path to one of the most financially rewarding careers in the United States. As previously discussed, debt levels for graduating students have risen substantially over the past ten years (AAMC, 2007), while income levels for physicians have fallen (Studer-Ellis, Gold & Jones, 2000). Despite decreased overall financial and lifestyle rewards, medicine remains a prestigious career and an important mechanism by which underrepresented students can achieve higher socioeconomic status and knowledge through which they may open doors for participation for relatives and subsequent generations. Participation in higher education in general has been shown to increase earnings over a life time (Ellwood & Kane, 2000). Research by Bowen and Bok

(1998) has shown that institutional selectivity of the school attended is related to differential future earnings. This may be applicable to medicine as well, since selectivity may play a role in the residency training options by virtue of access to elite networks within academic medicine. If selectivity of institution attended has an effect on earnings at the undergraduate level, investigating it at the graduate level is a worthy enterprise. There is certainly a strong representation from the highest levels of leadership (deans) of graduates from very selective institutions (Gibson, 2011).

The extent to which low income and underrepresented minority students have access to selective schools may predetermine the career paths of students and limit their opportunities for leadership in medicine. This may lead to an entire profession lacking in diversity of thought and practice and ultimately a more drastic disconnect between medical providers and the general population. Access to education and career options through the postsecondary portal is one of the greatest social justice challenges facing our society today (Engberg & Allen, 2011). For medicine it is more than a social justice issue, but a workforce capacity issue to ensure that medical training programs graduate providers with the skills to care for all populations, including the poor and indigent (Freeman, Ferrer & Greiner, 2007; Moy & Bartman, 1995). Access to training overall is critical, but understanding selectivity hierarchies and their implications within medicine is also important due to the implications for leadership and specialty influence.

Researchers and policy makers in medical education have focused heavily on racial inclusion and access to training opportunities according to race (Nickens et al., 1994), but there has been little attention focused on access disparities related to socioeconomic status. At the undergraduate level, access has been shown to be limited for low income students – even academically talented students – (Bozick, Lauff & Wirt, 2007; Engberg & Allen, 2011), so opportunities at the subsequent graduate level must also experience the same challenges. Similar to the pipeline for racial minorities, if students are "lost" before enrolling at the undergraduate level, then they are definitely absent from the pool of available students applying to medicine. Considering the challenges facing the profession today, medicine cannot afford to lose talented individuals who may bring solutions and innovations to the table. Unless something is done, high achieving low income students will remain underrepresented non-participants in the provision of healthcare and health innovation.

The selectivity of undergraduate institution attended is related to future earnings, opportunities, and career benefits (Carnevale, 2010; Dale & Krueger, 2002; Soares, 2007). In graduate admissions undergraduate selectivity and GPA have been shown to predict the selectivity of the graduate school (Mullen, Goyette & Soares, 2003). Not only does undergraduate selectivity increase the odds of bachelor degree completion, but it also improves the odds of attending graduate school (Carnevale & Rose, 2004). The extent to which racial minorities and low income students have access to selective undergraduate schools may determine their options for medical school. It may be students who already have significant advantages in accessing higher education in the first place that also receive the additional benefits possibly correlated with selectivity. In medicine, this is a very salient issue considering that specialty choice (related to career lifetime income) may also be influenced by selectivity as well. The fact that 75% of medical students come from the top levels of income suggests that participation from low income students is minimal (Witzburg et al., 2009). The degree to which medicine is segregated and stratified by income has major implications for the collective capacity of the medical profession to provide care for all patients. A lack of understanding of the social determinants of health and lack of cultural knowledge and experience may contribute to poor outcomes in health for underserved populations (Will Ross, annual meeting presentation, 2011). These poor outcomes add significant cost to the system and will soon become the fate of a large majority, rather than the plight of a few.

Access to selective institutions may be related to the habitus of a student including neighborhood, parental education and occupation, and income. There are several types of capital which students from higher income families possess that low income students lack. These are more than just income and wealth disparities, but access to education, career knowledge, and inside information about systems that generate advantages in the competition for seats in graduate school. Investments in human capital can be defined as the resource an individual possesses to influence future productivity (Becker, 1962). The ability to access higher education is considered a form of human capital due to the time and expense, as well as the initial delayed earnings in order to procure greater future earnings. The long term trajectory of training means that knowledge of the road ahead and all that is required to attain specific opportunities along that road produce cumulative effects. For example, having physicians in the immediate family may provide ways to learn about requirements for academic programs or specialties that are 'unpublished' or 'informal' rules.

If a student is interested in a surgical sub-specialty, they must do research and make strong connections with folks in the field through conference attendance and presentations. Where is this published? Who knows this? Individuals on the inside of medicine are in much more advantaged positions of advising than those outside it. Even if a physician is not knowledgeable of a specialty, they likely have networks to access the knowledge. Knowledge of the rules found within a social network that facilitate successful future planning and the navigation of the professional and social network are called cultural capital (Massey, Durand & Malone, 2003). Massey et al. were accurate in attributing success in higher education to knowledge passed on from forbears – and this is true for medicine. This knowledge is likely captured and operationalized in the current study's model as parental education and occupation encompassing both systemic navigation experience, inside knowledge, and professional networks providing access to privileged information (Bourdieu, 1977; Ellwood & Kane, 2000; Lamont & Lareau, 1988; Perna & Titus, 2005). For medicine, cultural and human capital advantages may serve to exacerbate the lack of representation for low income and racial minority students.

College Choice Frameworks

The contribution of college choice frameworks as they relate to theories of social, human, cultural and economic capital is particularly salient for this inquiry (McDonough, 1994; Perna, 2006). The underlying assumption is that education contributes to human capital in ways that motivate students to persist, delay earnings, and even take on educational debt (Perna, 2006). The cost of attendance is a long term investment in a better future as well as upward social mobility (Becker, 1962). Qian and Blair (1999) found that among all racial and ethnic groups college aspirations were high, but achievement levels, parental education, and human capital effects differed. The literature on educational aspirations demonstrates that while African American and Hispanic students have similar college aspirations as their peers, their enrollment decisions differ (Hurtado et al., 1997; Perna, 2006). The human capital construct helps inform how students approach the college process and ways in which various factors might interact. Ways in which student background and family or neighborhood resources have been shown to influence the transition from high school to college can provide important structure for addressing the transition from college to graduate school.

Perna's (2006) conceptual model of college choice is a comprehensive and appropriate bridge from which to link undergraduate and graduate college choice. Perna's model includes four contextual layers the first of which is the individual's habitus. These factors are personal resources and characteristics such as race and family income, as well as attitudes and other elements of the direct family environment. This study will explore race, sex and SES as individual characteristics among MD program applicants. In many ways Perna's model uses a similar structure to that of Bronfenbrenner's (1994) ecological model of human development working from the most proximal influences at the center, then moving toward more distal factors. The next layer is school and community context, which for the graduate population can be encompassed in college environmental factors and the college experience for undergraduates. This layer is aptly framed by the multilevel modeling using college characteristics to explore factors in admissions outcomes while controlling for individual characteristics. The greater context of higher education and the broader social, economic, and policy influences make up layers three and four. For graduate students these are federal and state funding for graduate education, the ebbs and flows of differing demands in various professions, and the policy climate for issues such as diversity and equitable access to education. For medicine, enrollment has been heavily influenced by national policies in past decades from the Flexner (1910) era reforms, Nickens era call for more equitable representation (Nickens, Ready & Petersdorf, 1994), and today's current call for enrollment expansion (Salsberg & Grover, 2006). Taking into account the individual, institutional, and political factors that influence enrollment provides a broad framework for graduate school choice. After discussing these areas of the literature on graduate school, limitations of the model as they relate to training in medicine specifically will be addressed.

Individual Habitus

The first layer of the model, individual habitus, includes demographic characteristics as well as cultural and social capital. The knowledge about graduate school, as well as relationships (social capital) that support the interest and pursuit continue to remain important. Aspects of a student's background, such as parental income and education, are strong factors in undergraduate college choice. Some studies have shown that these factors have little or no effect on post baccalaureate enrollment (Mare, 1980; Stolzenberg, 1994). To further investigate these findings, Mullen et al. (2003) studied graduate students using data from the Baccalaureate and Beyond Longitudinal Study (1993/1997) stating that the apparent change in parental effects in undergraduate enrollment to no effects in graduate enrollment strongly motivated their research approach. Recognizing the differences in types of graduate education and suspecting that these differences may have masked effects; Mullen et al. (2003) disaggregated graduate enrollments by program type. For professional and doctoral students, parents' education remained influential, while having no effect on master's students (Mullen et al., 2003). The model revealed that the role of parental education works indirectly through cultural and social capital mechanisms such as career values, educational expectations, and characteristics of the undergraduate institution (Mullen et al., 2003). Students with parents who had high educational levels enrolled in more selective institutions and liberal arts colleges, making their odds of graduate school attendance higher (Lang, 1987; Mullen et al., 2003). Academic achievement as measured by the undergraduate grade point average was confirmed as a strong, independent predictor of graduate school attendance (Mullen et al., 2003). This study of MD program applicants will provide more information as to whether the same selectivity principles and GPA predictors apply in medicine.

Achievement and Institution Attended

Research confirms the role of grades in graduate school enrollment (Ethington & Smart, 1986; Hearn, 1987; Kallio, 1995; Weiler, 1994a). This is not surprising since grades are a proxy for academic achievement and quality that have relatively comparable meaning across institutions. Studies of stratification in the academic hierarchy by Lang (1984, 1987) further complement the work of Mullen et al. (2003), Millett (2003), and Hearn (1987) by concluding that undergraduate GPA and undergraduate institutional rank are the strongest determinants of the rank of graduate school a student will attend. Lang (1984) determined that social class, sex, and race are not universally rewarded for equal levels of academic achievement. This suggests that elements of social, cultural and human capital remain salient in graduate education opportunity and participation. Connections among the elite and well-resourced have added impacts that coupled with achievement facilitate career access and educational opportunities. Lang's (1987) follow up study of controlled mobility within the academic hierarchy found that the stratification as determined by race, sex and social class leads to occupational stratification. This is particularly apparent in the professional training fields where entry into the profession is restricted by access to professional school. If obtaining a medical education is largely determined by undergraduate GPA and rank of undergraduate institution (Lang, 1987), then access to these preparatory resources, largely shown to be influenced by the habitus of earlier years (Perna, 2006), are determined very early in a student's education, and apparently not solely on the basis of merit or achievement. The current study's use of multi-level modeling will hopefully provide better understanding of how institutional selectivity of undergraduate institution relates to medical school selectivity while controlling for various individual characteristics.

Access Stratified by SES

A closer look at NCES (2010a) data on graduate students for the years 2007-2008 provide findings that confirm the role of stratified access along class, race, and institutional type. For medical trainees in either MD or DO programs, 41.8% attend private institutions while 56.8% attend public institutions. Students with incomes in the lowest quartile represented only 34.2% of enrollees at private schools compared to 52.4% of public schools. Only seven of the top 20 medical schools are public institutions, according to rankings by *U.S. News and World Report* (2011). There are only two public medical schools in the top ten: University of California San Francisco and University of Washington. The social capital attainment of attending a highly ranked medical school can determine the entire career trajectory for a doctor because – as previously discussed –

it may provide access to specialty-based networks as well as determine wider opportunities for post-graduate training.

Age at Program Entry

Age may also be an indicator of length of time to complete an undergraduate degree as indicated by attending full time and not having to work or take time off before pursuing graduate study. The average age of MD or DO trainees is 26, compared to 31 for doctoral degrees, except in education, which has an even higher average age of 40.7 (NCES, 2010a). Slightly more than 40% of MD and DO students are younger than 25, while less than 10% are 30 or older. Master's degrees of all types have an average age between 31 and 33. This further supports the evidence that econometric theory in measuring impacts on graduate enrollment is most applicable to master's students because their age makes them more likely to be workforce participants. It also may explain why Mullen et al. (2003) did not find parental effects for master's level students. These students may be more independent from their parents by virtue of being older and presumably in a more advanced developmental life stage - middle adult (27+ years old) versus young adult (18-26 years old) (Erikson & Erikson, 1997). Furthering this life stage argument, NCES (2010a) data show that only 6.1% of professional students in MD or DO programs are married with dependents compared to 18.8% of doctoral students (except in education) and between 19-29% of master's students depending on program. The career trajectories of master's level students might make them qualitatively different than doctoral or professional students in having taken a less direct route to graduate school. This might be reflected in students with well-educated parents making decisions both earlier and in more informed ways as manifested as early as high school course taking and choosing highly ranked colleges for undergraduate education. Thus, doctoral and first professional degree students tend to be younger, non-workforce participants without partners or dependents.

The Role of Income and Debt

One major area of study has been the impact of indebtedness on graduate school enrollment for which results are mixed. Some scholars concluded that debt and the decision to enroll in graduate school are unrelated using both local and national samples (Baum & Saunders, 1998; Nettles, 1989; Schapiro, O'Malley & Litten, 1991; Weiler, 1991). Other researchers found that undergraduate debt had a negative influence on the decision to apply to graduate school (Fox, 1992; Tsapogas & Cahalan, as cited in Millett, 2003; Wilder & Baydar, as cited in Millett, 2003). Wilder and Baydar (as cited in Millett, 2003) utilized samples from among Graduate Record Exam takers in 1986-1987. While they did not find that debt influenced acceptance or enrollment, they found modest negative effects for applying to graduate school. Millett (2003) also found undergraduate debt to be a deterrent for application and enrollment in graduate programs within one year of completing the undergraduate degree. She reported that students who have $5,000 or more of debt are significantly less likely to apply to graduate school or first professional school than their peers who did not have any educational debt. Millett also found that the lower the educational attainment of a student's parents, the greater the debt – a compounding negative effect for students from low SES backgrounds. As can be expected, Millett also found a relationship between family income level and undergraduate debt with 50.4% of students with $15,000 or more debt being from families earning $24,999 or less per year, as opposed to only 4.1% of students with

$15,000 or more debt being from families of incomes $100,000 or higher. As discussed in Chapter One, the indebtedness of medical graduates is on the rise and portends to continue to have disproportionate negative effects on students from low SES backgrounds.

Personal Earnings

Weiler (1994a) applied an econometric model and incorporated a variable to account for forgone earnings during time toward degree completion. He found that forgone earnings did affect master's program enrollees, but not graduate or professional program enrollees. This may be due to the willingness to accept large loans for professional trainees, or the prevalence of graduate assistantships for doctoral students, as well as reasons previously discussed about the appropriateness of fit of econometric models to different types of post baccalaureate programs. NCES (2010a) data reveal that the personal earnings (not parental incomes) of professional students in MD and DO programs are relatively low, with 70.4% of enrollees reporting personal incomes in the lowest quartile-below $13,170. This suggests a possible overall intention among medical trainees to continue school beyond the baccalaureate and not pursue gainful employment intermediately. It also means that the forgone earnings of professional trainees are extremely low, making that variable in several models qualitatively different than that of master's trainees regardless of the undergraduate field on which the projected earnings are based. In contrast, only 25% of graduate students overall have incomes in the lowest quartile and doctoral students come from the lowest quartile 23.2% of the time, while master's students ranging from about 15-25% (NCES, 2010a). This in combination with the length of time between bachelor's degree completion and beginning a graduate program completes the evidentiary picture that the paths of first professional degree students are different.

Years between Study

MD and DO students enroll in less than a year following completion of a bachelor's degree 44.6% of the time and 1-2 years following completion 33.8% of the time (NCES, 2010a). This compared to doctoral students (except education) that enroll in less than a year only 21.5% of the time and in 1-2 years 22.6% of the time. More doctoral students enroll between 3-6 years (30%) or 7 years or more (25.9%) than in the first two years. The length of time between degrees may point to more intentionality for MD and DO students leading to a much more direct route to training. This is another piece of evidence suggesting that SES background – in the form of educational and cultural capital – may be a significant factor in the preparation and successful matriculation for medical students.

Parent-related Factors

Data from the NCES (2010a) again support the findings of Millett (2003) that parental effects continue to play a role in graduate enrollment for professional students. Specifically among MD and DO enrollees, the percentage of students enrolled reporting high school or less as the highest level of education attained by either parent is 7.3%. This is *strikingly* different from master's or doctoral students, whose reported percentages for parent education of high school or less are between 21-24% and 17-35% respectively. Law school enrollment and enrollment in other health sciences are not nearly as stark as MD and DO programs for the same category of reported parental education of high school or less at 13.9% for law and 16.9% for other health sciences. No other graduate training area has such a small percentage of its population reporting the lowest level of parent education, and medicine's percentage is nearly half of that of law trainees. The majority of MD and DO students come from households where at least one parent has a graduate or professional degree (55%). The percentage of enrollees in MD and DO programs is also abysmally low for students coming from homes where one parent has some college education, but less than a bachelor's degree – 7.8%. In essence, 85% of MD and DO enrollees have at least one parent with a bachelor's degree or higher. This same statistic is 65% for other health professions and 73% for law students. This provides some support for earlier analysis that the rigidity and difficulty of premed requirements through the undergraduate years has deleterious effects for the medical education pipeline in particular. Students who have parents with high school education or less (or even some college) may enter undergraduate education under prepared to achieve in science and math, or unaware of the long-term consequences of course performance or college choice on their career goals. This may explain why MD and DO students with parental education of high school or less represent nearly half the percentage of enrollees than of their law school peers from similar parental education backgrounds.

There are distinct differences in legal education versus medical education which may explain the disparities. Legal education is less standardized and prescriptive (law schools do not have to be affiliated with hospitals or undergraduate universities). Pre-law course requirements are less rigid and do not include science or math. Law school admissions do not require financing in-person interview costs, and few schools require an additional application and fee beyond the common application. This is not to suggest that legal education is a bastion of access and equality, but merely to delineate why educational disparities – particularly in math and science – may have more drastic and cumulative effects for medicine. Medical school, by all accounts is less accessible for students with limited financial means and other types of capital deficits by virtue of parent education.

Race and Sex

NCES (2010a) data for the year 2007-2008 show that 52.8% of MD or DO trainees are men. This is higher than the percentage of men in law (48.3%) and other health sciences (37.1%). Only 5% of trainees in MD or DO programs are Black, while 7.8% are Hispanic, 17.2% are Asian and 67.2% are White. I presume that less than .5% of trainees are American Indian, because the statistic rounds to zero. Percentages of Black, Hispanic, and Native American trainees in the other professional degree programs are not necessarily more encouraging with Black and Hispanic students making up about 13% of law enrollees and roughly 10% of other health professions. Data from the AAMC provides a more complex picture for MD enrollees according to race, ethnicity and sex. There were 18,665 new matriculates in 2010 (AAMC, 2010e). Of these students 57.1% were White, 20.4% were Asian, 8.2% were Hispanic, 6.3% were Black, 2.7% reported more than one race, .41% were American Indian, Alaska Native, Native Hawaiian or Pacific Islander. Within the Hispanic designation, the students were 39% Other Hispanic, 25% Mexican, 24% Puerto Rican, 7% Cuban, and 4% multiple Hispanic.

Sex Ratios within Race

All of the groups have sex ratios very nearly equal except for Black students where only 38% of students are men (AAMC, 2010a, 2010e). American Indian and

Alaska Native students have the next most lopsided breakdown by sex in the opposite direction at 58% men, followed by White students with 55% men. No other race or ethnic group has as large a gap in sex ratio of trainees. The striking sex difference among Black men in the medical education pipeline was raised by Ready and Nickens (1991) as they discussed educational disparities that contribute to the problem. The highest number of Black men matriculates occurred in 1971 when 626 Black men enrolled (Ready & Nickens, 1991). Since then there has been a steady decline in the number of Black men enrolling, and most of the overall gains since the 1970's have been due to increases in Black women enrolling (Ready & Nickens, 1991). Ready and Nickens commented that the number of Black men enrolling reached a low of 486 in 1971 and predicted that gains would not be substantial in future cohorts absent well-orchestrated interventions. Just 444 Black men enrolled in 2010, confirming the predictions of Ready and Nickens (AAMC, 2010e).

Last year 717 Black men were first time applicants and 341 were re-applicants to medical school compared to 1,339 first time applicants and 665 re-applicants for Black women. Acceptance numbers were 768 for Black women and 468 for Black men. This is a 37.8% acceptance rate for Black women versus a 44% acceptance rate for Black men. This suggests that perhaps nationwide there is a consciousness about the scarcity of Black men in the applicant pool because a greater percentage of them are accepted compared to their female counterparts. Barriers outlined by Ready and Nickens (1991) include educational disparities for Black men in applications to medical school, degrees in life sciences at the undergraduate level, attending college, graduating high school. They also note challenges due to the greater percentage of Black children from homes with family income below the poverty level, further exacerbating access to quality education.

Finally, amidst the complexity of factors Ready and Nickens (1991) outline the broader societal context of racism in society for Black men that may indicate greater barriers. They note the National Center for Health Statistics' (as cited in Ready & Nickens, 1991) findings that the lifetime odds of being murdered for a Black man are 5%. Mauer's Sentencing Project study (as cited in Ready & Nickens, 1991) provides further evidence one in four black men between the ages of 20-29 is either in jail, on parole or on probation, a figure 30% higher than the number participating in higher education in 1990. Hu and St. John (2001) found that persistence rates for African American men were 2.7% lower than for African American women, and that African American students at research universities were 4.7% less likely to persist than those at other types of 4-year institutions. Persistence rates for freshman declaring health majors have been found to be higher for women than men (Leppel, 2001). Social phenomenon such as Racial Battle Fatigue (Smith, 2004) and Stereotype Threat (Steele, 1997) may also play a prominent role in further limiting the persistence of Black men in higher education. The current study may provide relevant descriptive and inferential data on intersecting groups, such as Black men, to better understand applicant journeys to identify best practices or opportunities.

School and Community Context

The school and community context of Perna's (2006) model includes structural supports and barriers, types of resources and availability of resources. One resource identified in SCCT as important in career pursuit for minorities are mentors and role models, which underrepresented students may find lacking in science and medicine due to low numbers of faculty. AAMC (2010b) data reveal that just 3% of medical school full-time faculty are Black and just 4% are Hispanic. Although about half of the Hispanic students entering medical school are Mexican or Puerto Rican, these groups are only 30% of Hispanic faculty. For undergraduate institutions the data are also disparate. Just 6.4% of faculty are Black, 3.8% are Hispanic and .5% are Native American (NCES, 2010b). Among professional staff overall, including faculty, administrators, graduate students and instruction personnel are 10% Black, 5.7% Hispanic and .6% Native American.

Role Models

The lack of same-race role models may be a barrier in career development (Bright, Duefield & Stone, 1998; Haas & Sullivan, 1991; Zirkel, 2002). Zirkel found that academic role models matched with students by sex and race were strongly related to students' future plans and achievement-relevant activity engagement 24 months later. Karunanayake and Nauta (2004) found in their sample of undergraduate students that 55% of African Americans and 33% of White students reported a predominance of same race, non-family member role models. Aggregate results showed that 96% of students included a family member among their career role models, supporting research already discussed about parental encouragement and the role of family support in career efficacy (Karunanayake & Nauta, 2004). These findings reinforce the role of social capital within families – students with parents who have completed graduate education have a role model and guide built into the family context.

Social Connection

Other college resources exist in the form of social connections. Hearn (1987) found that in addition to academic achievement and parental support, faculty-student interaction and major department context both played significant roles in aspirations and plans for graduate school. The interactions and department contexts were observed beyond background characteristics of students, which provide some impetus for the exploration of the role of the institution in graduate program entry. A few studies exist that have specifically examined the choices and behaviors of graduate students (Malaney, 1986; Malaney, 1987; Olson & King, 1985; Whitehead, Novak & Close, 2002). These studies also reveal that there are different considerations for different groups based on race and sex. For non-White students in Malaney's (1986) sample, being at the undergraduate institution already or attending a career day were influential in the decision to apply. Location and availability of financial aid were also significantly different for non-White students. This demonstrates that decisions to continue to graduate school might be more based on exposure to careers and integration into campus or community for underrepresented students, which is congruent with SCCT models. Kallio (1995) found that the college choice decisions of graduate students are based on residency status, academic program characteristics, work and spouse concerns, financial aid and campus social environment. These findings are not surprising, and Kallio (1995) calls for more research on the weights of these various factors among much larger samples of graduate students in order to better understand decisions.

Perna's (2004) study of post baccalaureate students from the Baccalaureate and Beyond Longitudinal Study (1993/1997) found that adding social and human capital variables to a general econometric model added explanatory power in understanding students' decisions to enroll and further recommends additional studies of graduate populations using this combined technique. This dissertation hopefully begins to answer that call by examining backgrounds and outcomes of applicants to allopathic medicine while also exploring institutional characteristics such as selectivity, size and type.

Higher Education and Broader Social and Economic Policy

The larger context for underrepresented students aspiring toward careers in medicine is more favorable today than in years past. Leadership from the AAMC has ensured attention and resources to facilitate greater participation in medical education from underrepresented minority groups. The Holistic Review Project, a newly expanded set of tools for enrollment management professionals in medicine, has been influential in continuing a national discussion regarding representation and diversity in medicine (Association of American Medical Colleges, 2008a, 2010f). Scholars have also called attention to the myopic focus of medical school admissions on grades, science majors, and test scores, which may not be the best predictors of a successful career (McGaghie, 1990b; Smith, 1998). MCAT scores and GPAs account for only part of the variance in performance in medical school (Donnon, Paolucci & Violato, 2007; Elam, Johnson & Johnson, 1993; Sarnacki, 1982), and expanding the use of important non-cognitive predictors has been shown to positively impact underrepresented student enrollment (Ballejos, 2010).

The medical school admissions community acknowledges today more than ever that selection factors must include consideration of a wide array of interpersonal variables. While this is an accepted fact, it is difficult to determine whether admissions processes are implementing this creed. Indexes of MCAT scores and GPAs disaggregated by race suggest that committees are employing holistic methods, but examining only two academic variables is an incomplete picture (AAMC, 2010e). The accepted student data suggests that race remains a consideration in admission, but the extent to which SES is considered is unknown, as is the extent to which race and SES overlap.

The challenges for students questing toward medicine begin in the educational process very early, as evidenced by school structure and course-taking that both have strong influences on achievement and subsequent participation in higher education at the undergraduate level. Medicine's fate as a more representative profession begins with reliance on high school teachers, parents, community leaders, and enrollment management professionals at the undergraduate level. Science professors and pre-health advisers also play a strong role in facilitating or deterring participation from underrepresented students. Preparation and exposure programs sponsored by medical schools are vast, although presumably not enough (AAMC, 2009). The AAMC's call for expansion of medical school enrollment with attention to diversity in 2006 represents national policy that should be conducive to well-prepared underrepresented students participating in medical education. The question remains as to whether or not the pipeline is producing enough well-prepared students, and whether holistic admissions methods truly include low SES students from all races and institutional types. Federal policies outlining continued need-based financial aid continue to support the participation of students from low income groups. Elements of social, human, and economic capital presumably remain limiting factors in medical education for underrepresented groups and will be further explored in this study.

Limitations of Graduate School to Medical School Comparisons

Understanding the graduate school choice process for applicants and the influences of preparatory factors can inform practitioners in the field (namely those in enrollment management) and help them better identify and target underrepresented groups. The literature on graduate school choice and college choice can be extrapolated and applied to medicine to inform the direction of inquiry for a study of all applicants, although limitations apply. In addition to samples derived from one or two institutions to study graduate enrollment or graduate school plans, researchers have used the National Educational Longitudinal Study (NELS:88) to assess aspirations toward graduate education as well as the Baccalaureate and Beyond Longitudinal study (1993/1997) study to examine actual enrollment behaviors. As the waves of these studies progressed, successive cohort samples became smaller, making it necessary and statistically prudent for researchers to examine the combined post-baccalaureate group (master's, doctoral, and professional students) rather than each group separately. It may also be that the research question was only interested in *any* schooling experiences beyond the baccalaureate degree, so disaggregating program types was of little interest.

The NCES separates first professional degrees from doctoral and master's trainees, but this also has limited applicability to medicine because it includes other health professions degrees and well as law degrees. Some of the data is separated by professional program type, but not all. The nature of preparation for the two largest professional areas, law and medicine, differs substantially. The main difference is in preparation through course requirements. Medicine, unlike law, has a rigid set of prerequisites an applicant must successfully complete (regardless of major) in order to be considered. Premed coursework is rooted in math and science. Law schools are not as prescriptive in their course requirements, and rely more heavily on work experience and an entrance exam score (Law School Admissions Council, 2011). The implications of course requirements significantly impacts and reduces the pre-medicine candidate pool (Lovecchio & Dundes, 2002; Thurmond & Cregler, 1999). Medical schools examine an overall GPA, science GPA, MCAT score and consider interviewing an important tool in vetting potential candidates. Few doctoral or law programs interview as part of their admissions processes (Law School Admissions Council, 2011).

Because the graduate literature largely focuses on post baccalaureate training, which includes all types of master's degrees as well as terminal degrees, the application of existing studies is somewhat limited in medicine, which is a sub-category of first professional degrees. The current study is particularly interested in medical education, which the NCES considers first professional degree students in the data. According to NCES (2010a) first professional degree students made up 8.7% of all graduate students in 2007-2008, while Master's students were 65.3% and doctoral students were 15.1%. Given these percentages, it makes sense that many studies have focused on post-baccalaureate educational endeavors combined rather than separating students by specific program type. The number of students with graduate status in post-baccalaureate certificate programs or who are enrolled in courses without being in a degree or certificate program is 10.9%, which is larger than first professional degree percentage. First professional degree students make up 20.6% of full-time/full-year attendees in the graduate student population (NCES, 2010a). Attending all year, full-time most likely indicates that the cost of attendance is significantly higher for these students than for students who attend either part-time or part-year. Medical students are discouraged from working and most students do not have jobs throughout the four years of medical school. Graduate assistantships are very rare in medical school (unless a student is seeking more than one degree simultaneously).

Limitations of Econometric Modeling for Medical Students

Econometric models posit that students weigh costs and benefits of training in making choices about education (Becker, 1962). For first professional degree students the nature of the training is more likely to ensure graduates a higher paying job. Law schools place students in internships during the final year to provide work experience and frequently provide job placement in firms for graduates. Medical graduates will most certainly have jobs waiting for them because all are required to enter residency (post-graduate) training for a minimum of three years, and residents receive a modest salary, which of course increases upon finishing residency and entering practice. Health professions graduates in fields such as pharmacy, physical therapy, and advanced nursing have equally promising job prospects – such is the nature of professional training.

However, the job market for the wide array of master's level programs as well as doctoral programs is more varied in the types of jobs for graduates (utility of the degree based on field) as well as less structured in terms of placements upon graduation. Professional options for a master's degree in public health, social work or education are less directly tracked into specific job fields. Because there are more master's graduates, competition for these jobs is likely to also be higher. Some of the jobs for which master's graduates are seeking may also allow qualified candidates with bachelor's degrees, which are even more prevalent, further increasing potential competition. Master's students make up 52.3% of the full-year/full-time graduate student population while doctoral degree (Ph.D.) students are 24.2% (NCES, 2010a). I hypothesize that these two groups are most appropriately fitted to econometric modeling used in many of the studies, especially those concerning the influence of debt. Weiler (1991) confirmed that master's students' enrollment decisions were debt sensitive, but doctoral and professional students were unaffected. The differences in types of attendance and types of post baccalaureate training offered might explain why previous studies examining the impact of undergraduate debt on graduate school enrollment or persistence have yielded mixed results. For students with a more uncertain job outlook and greater competition, it makes sense that their enrollment and persistence be more sensitive to tuition prices, as confirmed by Andrieu and St. John (1993), and the amount of debt incurred in undergraduate years (Weiler, 1991). For these reasons, some of the econometric principles explored in the graduate school literature may have limited applicability to students aspiring toward careers in medicine.

Examining Selectivity

The examination of selectivity in this study is situated within existing research about undergraduate fit or "match" that led to subsequent best practice advice for students to attend the institution with the highest selectivity possible (Bowen & Bok, 1998). This study seeks to understand the role of undergraduate selectivity in medical school admissions when controlling for demographic factors and academic performance. Early hypotheses about "fit" postulated that minority students would be more likely to graduate if they matriculated at colleges where the institutional profile more closely mirrored their standardized test scores than if the student attended a school where the average test scores were higher than their own (Alon & Tienda, 2005; Bowen & Bok, 1998). This turned out to be incorrect, and Bowen and Bok (1998) demonstrated that all students (not just Black students) graduated at higher rates when they chose more selective schools, even when controlling for scores and individual characteristics. Graduation rates for Black students were lowest at the least selective institutions, which is concerning considering the increasing challenges related to access in higher education. Inclusive, less selective schools may be the only viable college participation options for low income students, whose continuation would then be imperiled by virtue of attending a less selective school with lower graduation rates. Further, if undergraduate selectivity is demonstrated by the current study to have an effect on medical school admissions and medical school selectivity, then access issues to medicine for low income and underrepresented minority groups are even more bleak. Alon and Tienda (2005) furthered the research by determining that Black, White, Asian and Latino students all achieved higher graduation rates when attending more selective schools. The effect was even greater for minority students than for White students.

The selectivity guidelines that evolved through the study of the fit hypothesis pose an interesting question for medical education because their measured outcome is graduation rates. As previously discussed, persistence toward timely graduation and preparation for graduate school are conceptually different. Graduate school preparation requires strong academic performance far above the academic standards required for graduation. At most universities this is 2.0 GPA, and for many graduate programs the required GPA is 3.0 in order to graduate. Medical school applicants have an average GPA of 3.53 and successful applicants average 3.65. Clearly the chasm between graduation standards and medical school standards is wide. So, this poses the question, what role does selectivity have in medical school admissions? Is there a benefit to attending a highly selective institution where entrance to medical school is concerned? Does this benefit, if true, have any limitations? Does this benefit apply across all groups? This study will help enrich the advising of students in terms of how they can institutionally situate themselves for the most advantages if they want to become doctors. Considering allopathic medical schools have a 95% graduation rate (AAMC, 2011d), being admitted is nearly akin to earning a medical degree. So if selectivity plays a role in being accepted to a program, this may have important implications for diversifying the profession.

At the undergraduate level, Carnevale and Rose (2004) found that 74% of the students at 146 of the nation's most selective schools come from the top socioeconomic quartile and only 10% come from the bottom quartile. This mirrors the findings in medical education participation of Witzburg et al. (2009) that 75% of matriculants are from families in the top quintile of income. It appears that medical education may passively perpetuate and possibly exacerbate the effects of income and status inequalities in our society by doing little to proactively keep the doors open for students of limited means. Coupled with rising costs and professional landscape uncertainties of healthcare reform in the U.S., medicine may be in for even greater access challenges in years to come. While there has been strong focus on racial representation, low income students have remained largely invisible and unmentioned in the discussion at the undergraduate and graduate level despite being more underrepresented than racial minorities (Garrison, personal communication, November 7, 2011). This body of research aims to bring light to issues of both racial and socioeconomic under representation in medicine and provide insights as to how models for addressing each may or may not overlap or fit. Especially in light of the health crises facing our nation, ensuring representation from all strata in society is crucial.

Theories of Educational Inequality

The previous sections have discussed the varied contexts and influences on career development and aspiration for medicine related to personal and family characteristics, early education experiences, and various forms of capital. I have covered graduate school choice and the various models examining decision-making processes for students participating in post-secondary and graduate/professional education. Theories about undergraduate college attendance as they relate to selectivity have also been covered. I now turn to theories focusing on systemic factors related to educational progression over the lifespan. These theories focus on outcomes of educational transitions and the implications of socioeconomic status in educational pursuits.

Life Course Perspective

The life course perspective posits that as an individual progresses educationally the influence of parental background becomes less salient (Shanahan, 2000). Shanahan first focuses on historical perspective that describes ways development to adulthood has become more varied and individualized compared to decades past. His main focus is demonstrating how young people face “a structured set of opportunities and limitations that define pathways into adulthood” (p. 668). The differences in times past were determined largely by inequalities of race, sex, and socioeconomic status (Shanahan, 2000), but modern times have created varied opportunities that made individual agency regarding social psychological factors more salient in life outcomes (Mortimer, 1996). Parental influence on educational attainment decreases over time, as students are able to seek opportunities outside their family of origin. Some of the literature previously discussed supports the decreased influence of parental education in the decision to attend graduate school as LCP suggests. Through social connection, achievement and planning, a student *may* gain access to resources that are outside the initial family habitus. Although commenting on personal agency and goal setting, Shanahan (2000) acknowledges the diminished prospects of minority groups through life course transitions through various societal forces such as racism. The NCES data discussed previously on graduate and professional students certainly supports a complicated picture for mechanisms by which family income and parental education seem to be limiting factors in participation in graduate education for some areas, but not others. The educational implications of the relationship between life histories and social organization within society are Shanahan's concluding charge to fellow researchers.

The current study may provide some insight on how the stratification in society severely limits an individual's access to social connections outside their own habitus. The previous discussion of Perna's (2006) habitus model applied to graduate and medical education has outlined some of the factors that will be explored by this study. Residential segregation in our country is at an all-time high, as are inequalities in public education – largely a product of residential segregation (Charles, 2003). Shanahan (2000) may have latently assumed that individuals are aware of opportunities outside their life circumstances, which may not be the case. He also may have assumed that individuals are mobile and able to access social networks outside their own habitus, which may also be untrue in today's largely segregated and income-stratified society.

Maximally Maintained Inequality

Raftery and Hout (1993) explored the cumulative advantages engendered in educational transitions for upper class students compared to working class students. Using cohorts of students in Ireland to compare outcomes during restricted educational opportunity and again following egalitarian educational access reforms, Raftery and Hout found that making education more widely accessible to working class students did not result in greater educational equality. As secondary education became universally accessible, the effects of social background on educational transitions decreased. However, absent expansion or similar access reforms in post-secondary education, opportunities were not redistributed among social classes. Wealthy students continued to achieve higher levels of education and economic inequalities remained salient due to differences in educational attainment.

Raftery and Hout (1993) posit that students use the rational choice model to make decisions at transition points as to whether or not to continue school. Deferred earnings, time to complete education, and current job market outlook influence whether students remain enrolled (this is akin to the econometric modeling discussed previously). Thus for working class students, rational choice often dictates entering the workforce at earlier ages and being unable to forgo earnings in order to participate in post-secondary education. For wealthy students enjoying the benefits of their families' previous educational investment (a form of human capital), it makes sense to pursue higher education. For working class students, immediate needs may be more pressing and their lack of both cultural and social capital may prevent participation in higher education. Cultural capital deficits may mean a student lacks knowledge to be able to make the initial investment in education, while social capital deficits may mean that a student lacks access to networks and individuals that can show them how to navigate the systems involved in achieving higher education. In other words, equal opportunity must also address the unequal circumstances from which students come in order to truly achieve equal outcomes. Thus with current models, inequality is maximally maintained through facilitating higher participation rates in postsecondary education by wealthy students whose resources position them with the practical and systemic knowledge to succeed.

Effectively Maintained Inequality

Lucas (2001) focused on educational transitions and cumulative advantages as well, but also examined qualitative differences and the role of parental social capital (in the form of education) on students' educational opportunities. Synthesizing school tracking mechanisms with educational transitions, Lucas argues that upper and middle class parents advocate for systemic practices that benefit their children even at the expense of low income children. Early achievement and placement through standardized exams affords upper and middle class children better positioning within educational systems creating differences in quality and rigor within the same school. The qualitative differences with simultaneous quantitative equivalencies are supported by the literature (Lee, Croninger et al., 1997; Trusty, 2002) that demonstrates no difference in the number of courses taken, but substantial differences in the types of courses taken by White and Asian students versus Black and Latino students. The U.S. Supreme Court decision in

Parents Involved in Community Schools v. Seattle School District No. 1 (2007) highlights the class antagonism issue to which Lucas (2001) refers. Middle and upper class parents opposed the district's use of race in school assignments and the associated bussing of children to schools in neighborhoods other than their residences in Washington State. The district was attempting to minimize the impact of race and poverty on school achievement, yet the middle and upper class parents of children benefitting from neighborhood school assignment fought the practice. The case is obviously more complex, but at its core are (middle and upper class) parents fighting for the status quo in education. It is distribution and access to education that contribute to inequality, and qualitative differences between and within schools that serve to maintain inequalities. Parents with greater amounts of social capital tend to advocate for systems that perpetuate inequalities, because those systems are the ones that have served them well.

Lucas's (2001) theory may also be applied to participation in higher education as it relates to selectivity of undergraduate and graduate institutions. Although underrepresented students may participate in higher education, they may receive an education that is qualitatively inferior – or at least perceived to be – than their middle and upper class majority peers. Following the undergraduate degree, if selectivity continues to have effects, underrepresented students will again face disadvantage within a system that strives to enroll students from more selective institutions. During medical school, perceived and real qualitative differences again have some influence in determining residency choice and match and subsequent fellowship and faculty opportunities. At each transition point, students from greater means with more forms of capital may have higher chances of achieving superior outcomes than their peers from low SES backgrounds.

Conceptual Framework

The framework for this study is built upon the preceding body of literature related to: (1) pathways into medicine via social and cognitive forces, (2) graduate school and college choice including preparation and decision making, and (3) educational inequalities that occur across the lifespan in various points of transition and from various capital deficits or advantages. Drawing upon knowledge of graduate school choice rooted in layers of habitus, this study quantitatively analyzes individual and institutional characteristics in applications and admissions outcomes. This cross-sectional study examines the transition point of undergraduate education to medical school specifically examining the role of parent education, sex, race, and academic preparation among applicants. In order to more fully explore relationships between undergraduate selectivity and medical school selectivity, this study uses a model that controls for individual characteristics to explore selectivity, among other institutional factors as it relates to MD applicant outcomes. Differences in applicant behaviors and admission outcome are explored through descriptive analysis and multivariate methodologies that examine academic preparation factors, race, sex, and parent education. Selectivity of medical school is then modeled among applicants along with undergraduate institutional characteristics such as selectivity, type of institution (public/private), and size. The study explores how salient background factors at the individual and institutional level influence medical school applications and admissions. The national cross-section of data from the common application to medical school provides a robust platform from which to answer the study's key questions. I will now provide an overview of the methodology for the study.

CHAPTER THREE

RESEARCH METHODS

The questions posed by this study are best addressed through multivariate techniques that will help describe the characteristics of individuals and how they relate to differences in application and admission to medical school. A review of the planned methodology of the study follows including explanation of the models and variables followed by a discussion of limitations. The hypothesis is that there are differences in the backgrounds of students who are successful gaining entry to medical school versus those who are not. Among those accepted to medicine, characteristics of the undergraduate institution, including selectivity, influence the outcomes of acceptance and selectivity of medical school attended beyond the individual predictors. The following research questions frame the current study:

1. What are the descriptive characteristics of the medical school applicant pool according to race, sex, parent education, and academic components?
    a. What are the interrelationships between race, sex, parent education, and academic components in the applicant pool?
2. Among the applicants to medical school, what influence do individual and institutional factors have on the number of schools to which a student applies and is accepted?

a. What is the influence of race, sex, parent education and academic components on the number of schools to which a student applies and the number of schools to which a student is accepted, controlling for different institutional characteristics?

b. What is the influence of graduating from a public or private institution, institutional size, and institutional selectivity on the number of schools to which a student applies and the number of schools to which a student is accepted?

3. Among accepted students to medical school, what influence do individual and institutional factors have on the institutional selectivity of the matriculating medical school?

a. What are the descriptive characteristics of accepted applicants according to race, sex, parent education, academic components, institutional type (public/private), size, and selectivity?

b. What influence, does race, sex, parent education, and academic components have on matriculating medical school selectivity?

c. When controlling for race, sex, parent education, and academic components, what role does institutional type (public/private), size, and undergraduate selectivity have on matriculating medical school selectivity?

Exploring the backgrounds and characteristics of applicants first requires a full descriptive analysis and examination of the data. Next two multi-level models are employed to parse out the effects of institutional selectivity and academic factors on admission. Controlling for academic factors and exploring the role of institutional characteristics will answer important questions that can inform future decision making for students pursuing admission to allopathic medicine. Is there an institutional type with a higher admissions yield even when controlling for academic performance? Which types of institutions produce the most academically competitive applicants? What role does institutional selectivity of the undergraduate institution have, if any, in receiving at least one acceptance to medical school? Does selectivity of undergraduate institution predict selectivity of matriculating medical school?

For the analysis of the backgrounds of applicants I provide a full complement of descriptive data including means, ANOVA, independent t-test, and Chi Square. Correlation is analyzed to determine multicollinearity. Questions 1 and 2 utilize descriptive techniques and a hierarchical linear model (HLM). HLM is utilized to examine individual and institutional characteristics on the number of acceptances, which is the dependent variable. For question 3 a hierarchical generalized linear model (HGLM) is used to examine the individual and institutional influences on medical school selectivity as a binomial outcome. The two models provide a body of quantitative evidence which answers the research questions.

Context and Data Sources

The applicants seeking admission to allopathic medical school for the entering class of 2011 applied during the 2010-2011 cycle – June 2010 through June 2011. The common application, known as AMCAS, is administered by the AAMC and used by nearly all applicants. Upon completion of the proposal hearing, I applied for Loyola Institutional Review Board approval for this study. Once IRB clearances were obtained, I submitted a data request to the AAMC's data warehouse. After signing a data use agreement, I received the data via secure email. The data warehouse maintained by the AAMC contains thousands of points of data about most allopathic trainees in the U.S.

from the MCAT and premedical questionnaire instruments to the medical school application, residency application, and faculty roster. Each individual is assigned a research identification number encrypted from their AAMC identification number. The security of the data is ensured through this encryption, and the warehouse databases are cross-linked with code so that queries can be written which connect the various components longitudinally (Gwen Garrison, personal communication, November 6¸ 2011).

The data subset from which this study's variables were derived is called APP_BIO_R which stands for applicant biographical information restricted. The variables in APP_BIO_R come directly from the AMCAS application, which students submit when applying for medical school. For the complete list of variables and their associated definitions contained in this data subset (please see Appendix B, the APP_BIO_R Codebook). The full array of variables that were requested for this study is listed in Appendix C. These are the variables from which I derived the data for this study.

The Integrated Post-Secondary Educational Data Set (IPEDS) from the National Center for Education Statistics provided the variables for institutional type and size. This public data set is collected and maintained by the U.S. Department of Education using self-reported institutional information from the country's higher education institutions. The IPEDS variable for institutional type is called "control of institution" and is coded as 1=public, 2=private not-for-profit, 3=private for profit, and -3=not applicable. The undergraduate selectivity data was obtained using FICE codes from the AMCAS data and either crosswalking or manually coding them to Carnegie classifications. Medical school selectivity was operationalized with *U.S. News and World Report* Rankings for 2011-2012 for medical schools and was also coded manually.

National Cross-section

The data for this study include the cross section of applicants to U.S. allopathic schools for 2010-2011 admissions cycle. Contained within this population are re-applicants whose quantitative and qualitative measures are assumed to remain constant in the application pool from year to year. Given that the overall acceptance rate is 38%, a sizeable number of students will end up reapplying. There is no practical way of verifying whether the pools of re-applicants are similar from year to year. The recent expansion of medical school seats in the last five years has increased total enrollment (across all trainees) from 73,113 in 2006 to 79,070 in 2010 (AAMC, 2011d). The number of first year seats has increased from 17,361 in 2006 to 18,665 in 2010. The percentage of re-applicants each year has remained very constant at about 25% (AAMC, 2011a). Examining this data does not provide strong evidence to suggest that schools are accepting a higher percentage of the applicant pool, even despite significant expansion in the last two years.

Sample

The total number of applicants verified through AMCAS for the 2010-2011 cycle is 43,919 (AAMC, 2011a). This number represents all students who submitted their applications and were successful in having their applications verified and subsequently distributed to schools of their choosing. The pool was 53% male and 47% female and included applicants from all 50 states plus US territories. A sample copy of the application is included in Appendix D. The data yielded a sample size between 41,814 to 38,303 for various analyses due to missing data or coding issues on specific variables.

Variables

The central variables to the study are race, sex, parent education, academic index, undergraduate selectivity, undergraduate institutional size, undergraduate institutional type, and medical school selectivity.

Race/ethnicity

Race is operationalized in this study by using the self-report information that an applicant entered on the AMCAS application. Sub-groups were combined into larger groups for Asian and Latino indicators. For the multilevel analyses it was most prudent to represent in the larger categories. The categories were dummy coded using numbers so they could be analyzed in SPSS. For applicants indicating more than one race, two classifications were specified that remained separate from the other groups. Because applicants are allowed to choose unlimited multiple categories, the race variable had considerable overlap within the sample. Mixed race students remained distinctly separate and were then coded as including at least one underrepresented racial group (Latino, Black, Native American, Native Hawaiian, or Alaska Native) in combination with any other race (URM combo). All other mixed race combinations that remained were then coded as non-underrepresented in combination (Non URM combo). Applicants who declined to report anything for race were captured in a separate category as unknown.

Sex

The sex variable is used to explore differences within the pool overall and across the other predictors of race, parent education, and institutional characteristics. It is also very helpful to have as a control for the multilevel models. Students entered male/female on the AMCAS application, and this was the origin of the sex variable. It was dummy coded male=0, female=1. Sex differences in academic preparation are also presented.

Socioeconomic Status (SES)

Parental education, occupation, and AMCAS fee waiver indicator were explored in hopes of creating an SES index for this study. These components are self-reported by applicants on the application. After working with several combinations of indicators, the simplest and most statistically parsimonious variable is parental education, which is used in the analyses as a categorical variable. SES is conceptualized as highest parental education. If the applicant has one parent, the variable is derived from the one parent. If an applicant has two, the highest of the two is used. The AAMC recently developed a standardized tool for the SES of applicants to be included in the 2012-2013 admissions cycle (Grbic, 2011). The scale is too new for use in this study, but will be considered for future analyses. Nearly ten percent of the pool had missing data for parent education, so I created a separate category for unknown.

Disadvantaged status and fee waiver. The yes/no optional disadvantage question on the AMCAS application contains a text box wherein applicants may describe their reasons for selecting yes. Because disadvantage is left to the applicant's discretion, there are no concrete criteria for indicating disadvantaged based on income, household composition, parental education, etc. Some students may indicate disadvantage due to long term illness where others may discuss attending a poor high school or being from a low income family. The disadvantage question can be considered a qualitative question, rather than quantitative. However, the AMCAS does offer a fee assistance program

(FAP), and obtaining information on which students were awarded a fee waiver would be more useable for analysis, since the fee waiver is based on 300% of the federal poverty level and an applicant's income is verified by submitting tax forms to staff who administer the FAP at the AAMC. This indicator was explored for descriptive analysis, but not practically implementable for an SES variable due to large portions of missing data and the inherently qualitative criteria for disadvantaged.

Household income unreliable. The household income information is self-reported by applicants and not verified or compared to financial aid or tax documentation, therefore the AAMC's data division does not include it among variables available in the APP_BIO_R database. Previous examination of this variable entered by applicants in AMCAS as compared to the same students entering the information at the point of matriculation on the Matriculating Student Questionnaire (MSQ) indicated that income was significantly underestimated at the point of application (Witzburg, Garrison, Case, & Jones, 2009). This may be due to students believing that financial aid or scholarships are influenced by their answers about family income on the application. It may also be the case that students simply do not know their parents' incomes. The answer set for household income previously employed on the AMCAS application had an upper limit of 75,000-100,000, which the majority of the applicants selected (75%) according to Witzburg et al. (2009). The given scale was far too heteroscedastic to create an index. The varying age of students also makes the data unreliable in that some students are reporting personal income while others are reporting parental (Garrison, personal communication, November 22, 2011). These concerns necessitate that an applicant-reported monetary variable of income not be used, or at least not alone. This limitation was addressed by using parental education as a proxy for the SES resource profile of applicants from their families of origin.

Academic Index

The academic components of the application include grade point average overall, grade point average in science (biology, chemistry, physics and math), and MCAT scores. I standardized these elements and weighted them to create index that is used in the model as a single variable. The highest MCAT score is weighted 50%, the science GPA is weighted 25%, and the cumulative GPA is weighted 25%. These weights were chosen based on the usage of these components by admissions committees. The MCAT, as a standardized element across the entire pool, is typically given more weight. Grade point average overall is important, but performances in the prerequisite courses and sciences courses is important. The academic components are interrelated, so combining them is necessary to preserve the validity of the model and avoid multicollinearity. The index also makes interpretation of the results much simpler and straightforward as applicants are a standardized distance from each other for comparison purposes.

Undergraduate Selectivity

The primary undergraduate college code was used to determine selectivity of the undergraduate institution for each applicant. This was done with Carnegie Classifications of inclusive, selective and more selective. These are derived from college entrance exam scores and admissions yields, which serve to approximate exclusivity. The institution and transcript components of the application are verified by staff at the AAMC after being entered (self-reported) by the applicant via secure transmission of transcripts. After examining the data I chose to use the primary college code for all applicants, which is the institution from which a student received their bachelor's degree. A portion of applicants will have attended more than one university or may have completed post-baccalaureate work. In order to be consistent across the sample, I did not consider additional institutions attended for the selectivity variable. My guiding principle was to preserve as much of the sample as possible without sacrificing the integrity of the model.

Undergraduate Institutional Size and Type

The FICE codes from the primary undergraduate college were used to extract the institutional size and public/private information from IPEDS via crosswalk. The IPEDS variable I use to operationalize size is a categorical variable called institutional size category. Campus enrollments are reduced with the following five categories: under 1,000 students; 1,000-4,999; 5,000-9,999; 10,000-19,999; 20,000 or more. These data were entered into the model at level two for the multilevel models with the largest group (20,000 or more) as the comparison group. I recoded the IPEDS institutional control variable as public=0, private=1.

Medical School Selectivity

The matriculating medical school code was translated into the school name and then manually coded for selectivity using *U.S. News and World Report* rankings for medical schools 2010-2011. Highly selective medical schools were defined as those in the top 25 for 2010-2011. Use of the National Institutes of Health rankings for medical schools was explored, but upon comparison, the correlation between NIH and *USNWR* was .89. I chose to use undergraduate and medical school ranks because they are more widely recognized and may make results more accessible to general readers.

Data Analysis

The data set was reviewed and relevant variable answer sets were cleaned and recoded where necessary and as previously described. Statistical Package for the Social Sciences (SPSS) was used for variable recoding as well as descriptive and basic multivariate analyses. HLM software was used for the multilevel analyses.

Descriptive Statistics

I analyzed the data completing a full survey exploring the ranges and values across each planned variable to provide answers to question one. The applicant pool was explored using ANOVA and several crosstabs with race, sex, parent education, academic index, institutional type and institutional selectivity for descriptive reporting. Applicants were analyzed according to the independent variables described in question one based on the dependent variables of the number of schools applied and number accepted to answer question two. An HLM was employed for question two, while the selectivity questions in question three were addressed using an HGLM.

Multilevel Model

The hierarchical linear model (HLM) allowed for exploration of the roles of individual and school-based characteristics in modeling admission outcome. The nature of educational settings portend to multilevel modeling, which accounts for nesting and effectively controls for differences based on the individual, classroom, or institution (Raudenbush & Bryk, 2002). Ordinary least squares (OLS) regression analyses assume the independent nature of each observation, which in classroom settings can violate the assumptions of the model because there is an anticipated effect of learners on each other.

An HLM is more effective at parsing out variance in admissions outcomes related to individual variables and institutional variables.

Exploratory ANOVA. To begin investigating influences on admissions outcomes (number of schools to which a student applied and number of acceptances received), the first step was to understand the components of variance. A one-way ANOVA was used to partition the variance and examine how much difference was associated within undergraduate institutions and how much was between institutions (Raudenbush & Bryk, 2002). Using the admissions outcome as the dependent variable, the grand mean (β_0) and error term (r_0) were calculated. The grand mean was then partitioned into the institutional effect (γ_{00}) and the person effect (τ_{00}).

The initial variance in admissions outcomes was modeled with the following equations:

$$Y = \beta_0 + r_0$$

$$\beta_0 = \gamma_{00} + \tau_{00}$$

The estimation of the grand mean of admissions outcomes was tested for significance so that an estimation of variance could be calculated with a p-value and standard error indicating that it was (or was not) significantly different from zero. The final estimation of variance components was the most important piece of information from the ANOVA phase. Sigma squared (σ^2) was the predicted variance within institutions for admissions outcomes. Tau (τ_{00}) was the predicted variance between institutions for admissions outcomes. The p-values indicated that there was a significant variance between institutions and provided justification to move forward and include predictors at level one. Adding variables at level one added more explanatory power for the variance in the model to better explain the differences in admissions outcomes.

The intraclass correlation coefficient. To provide additional context for the model, Raudenbush and Bryk (2002) recommend calculating the intraclass correlation coefficient (ICC). The ICC is a ratio of the predicted variance between institutions divided by the sum of the predicted variance between institutions and within institutions (p. 36). This helps demonstrate how much of the variation within admissions outcomes is associated with factors between institutions, in this case how much of the variation in admissions outcomes is associated with the difference of attending one type of college versus another. The ICC for the model helped quantify how much variation in admissions outcomes was between institutions.

Multilevel Model and Random Coefficient

Adding predictors at level 1 furthered the exploration of possible relationships between individual characteristics and admissions outcome. Hierarchical models accommodate categorical and continuous variables. This worked well since I explored both categorical and continuous predictors on the number of schools accepted (HLM) and the odds of matriculating to a highly selective medical school (HGLM). This model utilized several level 1 predictors including race, academic index, parent education, and sex.

The level 1 random coefficient equation modeled slope and intercept for admissions outcome as described above. The model was as follows:

Level 1: $Y_{ij} = B_{0j} + \beta_{1j} * (\text{academics})_{ij} + \beta_{2j} * (\text{parent ed})_{ij} + \beta_{3j} * (\text{sex})_{ij}\ \beta_{4j} * (\text{race})_{ij} + r_{ij}$

Level 2: $\beta_0 = \gamma_{00} + \tau_{00}$

$\beta_1 = \gamma_{10} + \tau_{11}$

$\beta_2 = \gamma_{20}$

$\beta_3 = \gamma_{30}$

$\beta_4 = \gamma_{40}$

β_0 is the grand mean for number of acceptances across institutions for an applicant who has the average academic index, has a parent with a doctorate degree, is male, and is White. β_1 is the academic index effect across institutions. β_2 is the parent education effect across schools compared to a parent with a doctorate. β_3 is the effect of being female across institutions. β_4 is the race effect across institutions compared to White.

Variance components. Sigma squared for the model was the predicted variance within schools. To move the model forward a change in sigma squared from the ANOVA model to the random coefficient model was anticipated.

ANOVA σ^2 – Random Coefficient σ^2/ANOVA $\sigma^2 = \Delta\, \sigma^2$

A change in this value meant that by adding individual level predictors the model accounted for more variance. The change in sigma squared indicated the explanatory power of individual predictors.

Tau sub zero zero (τ_{00}) was the predicted overall variance between schools with average admissions outcome. The change in τ from the ANOVA model to the random coefficient model demonstrated that the model was explaining more variance between schools. This is also called the change in percent variance (PRV).

ANOVA τ_{00} – Random coefficient τ_{00} /ANOVA $\tau_{00} = \Delta\, \tau_{00}$

The change in tau further indicated that there are differences between schools.

Full HLM – School Level Characteristics

Investigating undergraduate school characteristics in the applicant pool helped explain more of the remaining variance in admissions outcomes between schools. The model explored whether an institution's type (public or private), size, and selectivity helped explain more of the variance in admissions outcome.

Institutional predictors in the full model were modeled thusly:

Level 1: $Y_{ij} = \beta_{0j} + \beta_{1j} * (\text{academics})_{ij} + \beta_{2j} * (\text{parent ed})_{ij} + \beta_{3j} * (\text{sex})_{ij}\ \beta_{4j} * (\text{race})_{ij} + r_{ij}$

Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01} * (\text{type})_{1j} + \gamma_{02} * (\text{size})_{2j} + \gamma_{03} * (\text{selectivity})_{3j} + \tau_{0j}$

$\beta_1 = \gamma_{10}$

$\beta_2 = \gamma_{20}$

$\beta_3 = \gamma_{30}$

$\beta_4 = \gamma_{40}$

The intercept term across schools was γ_{00}. In general, the average institutional level model provided a grand mean for acceptance using the average for academic index and the reference groups for the level 1 and level 2 predictors (White, male, parent with doctorate, more selective, public, and 20,000 or more campus enrollment). The coefficients indicated whether race, sex, parent education and academic index had negative or positive effects on admissions outcome while controlling for institutional type, size, and selectivity and vice versa.

Variance Components

The final variance components for the full model were reduced from the random coefficient model. The PRV for the model increased, and the full model left about half the variance unexplained. Institutional level predictors accounted for more variance in the number of acceptances. For parsimony I refrained from modeling slopes as outcomes, but may examine them in the model at a later point.

HGLM Model Predicting Selectivity

To examine the matriculating school selectivity, I repeated the hierarchical linear model with a slightly different technique designed for binomial outcomes. When assumptions of linearity and normality are not fulfilled, a generalized model provides a modeling framework for multilevel data with nonlinear structures and non-normally distributed errors (Raudenbush & Bryk, 2002). To examine outcomes related to selectivity of matriculating medical school, a categorical outcome was most appropriate (0=not selective, 1=highly selective). Although selectivity was coded numerically by rankings, it was best categorized as a qualitative variable that described an institution rather than precisely measured it on a scale. Gibson's (2011) analysis of head deans of medical schools found that 81% had spent professional time at an institution in the top 25 of *USNWR*. This provided some impetus for using a highly selective/not selective dichotomous outcome.

For the final research question an HGLM provided the statistical modeling to examine predictors for selectivity of medical school among accepted applicants. The multilevel model controlled for individual and institutional predictors and yielded odds ratios for each. Each predictor (if significant) increased or decreased the odds (compared to a reference group) of matriculating to a highly selective medical school vs. not selective medical school.

Exploratory Model

The general model began with an unconditional model as follows:

$\eta_{ij} = \beta_{0j}$

$\beta_{0j} = \gamma_{00} + \upsilon_{0j}, \upsilon_{0j} \sim N(0, \tau_{00})$

The basic model produced the average log-odds of selectivity across schools (γ_{00}) and the variance between schools (τ_{00}) within school-average log-odds of selectivity. The typical undergraduate selectivity ranking for a school with random effect was $\upsilon_{0j} = 0$. At this stage the goal was to examine whether the odds of ending up at a selective medical school differ across schools by comparing them to the average. The model showed that odds differed significantly across schools within the applicant pool, so adding predictors for the full model would help explain differences.

Full Model

$\eta_{ij} = \beta_{0j} + \beta_{1j}\,(\text{race})_{ij} + \beta_{2j}\,(\text{sex})_{ij} + \beta_{3j}\,(\text{parent ed})_{ij} + \beta_{4j}\,(\text{academic})_{ij}$

$\beta_{0j} = \gamma_{00} + \gamma_{01}\,(\text{type})_j + \gamma_{02}\,(\text{size})_j + \gamma_{03}\,(\text{selectivity})_j + \upsilon_{0j}\ ,\ \beta_{pj} = \gamma_{p0}$

I examined log-odds predictive values of what type of applicant characteristics at level 1 increased or decreased the odds of matriculating to a highly selective medical school. I also added the level 2 institutional predictors and examined whether there were school effects that influenced the odds of attending a highly selective medical school. This essentially meant the probability of an outcome of highly selective (1) versus not selective (0) for each variable. So the referent group was the applicant who was White, male, had a parent with a doctorate and the average academic index who attended a public institution of 20,000 or more that was more selective. The model showed whether undergraduate selectivity positively increased the odds of an applicant matriculating to a highly selective medical school while controlling for other predictors.

Limitations

As with any research endeavor this study had limitations that were addressed, acknowledged and mitigated where possible. Understanding threats to validity and outlining a plan for addressing those threats was an important aspect of this study. When identified, threats were explored and addressed in good faith.

Missing Data

The number of students declining to indicate race or ethnicity on the application has been steadily increasing every year. The race/ethnicity question on the AMCAS application is optional. In 2002, non-responses were less than 1% at 269, but in 2010 non-responses for the race question were 1,275 or 4% (AAMC, 2011d). Reasons for this declining response rate were unknown, and introduced some challenges with respect to missing data. Since the applicant pools for non-White students were comparatively smaller than for White students, the missing data was problematic. I conducted missing data analysis in SPSS and did not identify any patterns within the missing data that were problematic in relation to other aspects. For the race category specifically, I coded a separate variable for missing data and included it in the analysis to preserve the cases. Having an unknown category also determined what the model looked like for applicants who declined to answer the race question. The exploration of this issue was interesting and useful for this study. What was the acceptance rate for students who declined to disclose their race? Were non-responders more likely to be at selective schools? To what group within the pool were the non-responders most similar? The analysis and exploration provided insight about which types of students are more likely to decline answering the race question. Due to HLM's inability to deal with missing data, it was prudent to code all missing data as a separate category.

Parent education was missing for a large portion of the applicant pool – roughly 5%. For the HLM and HGLM analyses the missing data was controlled for with an unknown category as well. I explored imputing parent education, but was not confident in the imputations and opted to manage the missing parent education data with a separate category to maintain fidelity.

Considerations and Threats to Validity

Economic downturn of the country. The economic depression in the United States potentially introduced a historical bias to the data. There were presumably some students with highly educated parents reporting lower incomes at the point of application than in previous years. This was another reason to forgo examining income by numbers and utilize parental education to conceptualize SES in the study, as education seemed less sensitive to recession. The high levels of unemployment nationally have not affected Americans in all income sectors equally and have had the most devastating effects in the lowest two deciles of income (Sum & Khatiwada, 2010). Although less than 10% of applicants come from families with incomes in the bottom two quintiles, the state of the economy is something of which to be mindful during this analysis (Grbic, Garrison, & Jolly, 2010). The disproportionate recession effects on lower income families may have prevented some students from applying who would have otherwise been represented in the pool. It was reasonable to expect that macro-economic effects had some distribution across income strata while affecting lower strata more drastically. Stratification effects may have been suppressed because fewer low income students were present in the pool or students with highly educated parents attended less selective schools due to relative economic hardship.

Interaction of economics and race. Black and Latino groups may have been disproportionately affected by the state of the economy because their unemployment rates were much higher than their White counterparts. While about 8% of Whites and Asians were unemployed, 16.5% of Blacks and 12.6% of Hispanics reported unemployment, according to the Bureau of Labor Statistics report issued in November 2011. Higher unemployment among Blacks and Latinos may have amplified ways in which inequalities and disparities manifested in the data for those groups, such as applying to fewer schools or matriculating to less selective medical schools that may be more affordable. Some of the data may have been more skewed due the current economic downturn. Those effects, if they occurred were very relevant to the examination of stratification and inequality among applicants to medicine and were not antithetical to the conceptual framework.

It was important to understand how students within all economic strata were being affected by the current U.S. economic depression. While this threat was something of which I was mindful, I expected it to manifest across the pool. I examined fee assistance program indicators and disadvantaged indicators for aberrant patterns and did not identify any striking anomalies. The economic downturn had more potential to affect earnings, which was another reason to use parent education in the model.

Osteopathic schools. The Doctor of Osteopathy (DO) degree is awarded by accredited schools in the American Association of Colleges of Osteopathic Medicine (AACOM) that are expanding in the wake of the projected shortage of physicians

(Salsberg & Grover, 2006). AACOM (2011) estimated that nearly one in five entering medical students was training at an osteopathic school and in 2011 there were 14,087 applicants to DO schools. In 2011 there were 26 colleges (20 private, 6 public) of osteopathic medicine in 25 states with another three planned for expansion (AACOM, 2011). It was possible for students to apply to DO and MD programs and about 70% of applicants to osteopathic schools reported applying to at least one allopathic school (Meron & Levitan, 2010). The 2010 report by Meron and Levitan of the 2009 pool was limited in its response rate of only 21.4%, but it did suggest that among respondents who applied to both, roughly a quarter are accepted to MD programs. Of those accepted to MD programs in the overlapping applicant pool, 88% chose to enroll in an MD program. Applicants accepted to both MD and DO programs chose to matriculate to DO schools just 9.6% of the time.

These data suggested that the overlap between the pools was substantial and when given the option, accepted applicants generally preferred MD programs. The MCAT scores and grade point averages of both accepted and denied applicants to DO schools were lower than the scores of both accepted and denied MD applicants (Meron & Levitan, 2010). The rate of accepted students at DO schools was also higher than MD schools, 55% versus 38%. These data suggest that DO programs were less selective (according to numbers related to academic preparations) than MD programs.

The applicant pool for AACOM on race and ethnicity suggested that there were not proportionately higher numbers of Black, Latino or Native American applicants to AACOM schools, but the overlap in the applicant pools by race is undeterminable. While the MD pool had 7.1% Black, 7.6% Latino and .2% Native American, the DO pool contained 4.7% Black, 5.4% Latino, and .3% Native American (Association of American Medical Colleges, 2010; Association of American Colleges of Osteopathic Medicine, 2010). The largest comparison ratio was Native American where there were 40 DO applicants and 114 MD applicants, or a possible 35% overlap. Because there were no data on the race and ethnicity self-descriptions of the combined pool, there was no way to determine whether the pools actually overlapped or if there were two separate pools applying. The focus on selectivity within this study is most appropriately examined within the MD applicant pool, so the remaining DO applicants were not a primary concern. It may be worth investigating the differences in the applicant pools to MD and DO schools in the future.

Sample Limitations

This study included limitations based on the population being examined and the current state of the country in severe economic depression. In addition to the exclusion of osteopathic applicants, the sample also excluded Canadian medical applicants applying only to the 17 schools in Canada and applicants who applied through the Texas Medical and Dental School Application Service (TMDSAS) to only state schools in Texas.

Selectivity data for medical school comparisons was drawn from *USNWR* rankings. Selectivity data for undergraduate institutions utilized Carnegie classifications. Both of these typologies apply to institutions which are based in the United States, so applications to Canadian schools were impractical and problematic. I anticipated some criticism from choosing a very unscientific ranking system (McGhagie, 2001), but the use of a reporting system based on perceived prestige and quality was in keeping with the inequalities being explored by this study. It seemed most valid to use *USNWR* since it offered publically recognizable medical school rankings. Due to its wide use by residency programs for consideration of applicants and its widely touted (although scientifically disputed) claims, *USNWR* seemed the most appropriate ranking system to operationalize selectivity in this study.

The information analyzed was from the point of application to medical school, which had limitations based on respondent bias and non-responses. Although there are strict rules and harsh consequences for falsifying the AMCAS application, students have full liberty to enter the information and only the academic portion is verifiable. Transcripts and test scores were presumed to be accurate and standardized across the pool to account for differing academic schedules such as quarters, semesters, trimesters, etc. The personal information, race/ethnicity options, parental information, family background, and experiences information were all self-reported and not subject to verification. There was an inherent bias in the application because respondents were seeking admission to a competitive professional school. The social desirability bias of the application experience was expected to have some effect on the information provided.

Limitations of the Model

The HLM must abide by certain assumptions in order to maintain as much validity as possible. There needs to be enough initial variance to partition in the first place, and enough variance must remain after the random coefficient model to move forward with the full HLM. Whether there was enough variance was entirely a subjective interpretation. The largest threat to validity was endogeneity and multicollinearity. The applicant pool to medicine is very homogenous. Some of the race groups and institutional groups in the sample were quite small. There was enough variance between observations (applicants) in the sample to model predictors. Academic variables were transformed into an index and standardized to avoid multicollinearity. Creating an index meant making decisions about the proportions of the gpa and MCAT components. It is possible that the influence of academics was over- or under-estimated based on the index weights. This was minimized by standardizing to a normal curve so the utilization of the index in the model was consistent across the sample.

The potentially multicollinear variables (race and SES for example) could have generated suppressor or amplifier effects if not treated judiciously in the model. Every effort was made to understand highly correlated variables and create the most parsimonious model possible so as not to draw in any variables that were unnecessary or too related. There were differences across groups for individual and institutional predictors. To guard against endogeneity, the model was checked to ensure variance in outcomes within each singular predictor (ANOVA and Levene's test). Obviously there were possible correlations between predictors. Every effort was made to check the correlations between the variable parameters and the error terms to ensure that the model was an appropriate fit. The goal in working with the data was to answer the research questions. To this end a flexible approach was applied to ensure that the best methods were utilized and any potential threats addressed to the greatest extent possible.

The analysis provided in this study will guide practitioners and policy makers about the current state of diversity in the 2010-2011 allopathic medicine applicant and matriculant populations. Through advanced statistical techniques the role of selectivity and other background factors in admissions outcomes was explored. These data provided more details about stratification and inequality in higher education and the current state of diversity, broadly framed with race, sex, and parent education for the future of medicine. I now turn to the data and begin analysis.

CHAPTER FOUR

RESULTS

This chapter contains the results from the analysis of the background factors of applicants and the influences of those characteristics on acceptance to medical school. A full descriptive analysis of the data outlines the applicant pool and presents group differences. The data are divided into applicant stage aspects including: population characteristics, academic profiles, institutional characteristics and application/acceptance. Following my presentation of descriptive analyses, I will address the remaining research questions using HLM and HGLM. The hierarchical linear models examine the relationships of individual and institutional characteristics on acceptance to medical school and the selectivity of matriculating medical school.

Applicant Phase

Population Characteristics

Sex. The sex breakdown of the total applicant pool had slightly more males than females. As reported in Table 1, roughly 53% of the pool identified as male and four applicants chose not to answer the sex question.

Table 1. Sex of Applicants

	Frequency	Percent
Male	22,066	52.8
Female	19,744	47.2
Total	41,810	100.0
Missing	4	0.0
Total	41,814	41,814

Race. Applicants self-identified their race using a two question format on the AMCAS application. There were considerable overlaps in the categories, which necessitated separating all applicants who indicated more than once race or a Hispanic ethnicity into a combination category. I then further disaggregated the applicants with race combinations into those including at least one underrepresented group (URM combo) (1.5%) and those not including an underrepresented group (Non URM combo) (2%). The pool was 21% Asian, 7.6% Black, 6.5% Latino, 56.6% White, 4.5% unknown race, and .4% Native (Native Hawaiian, Native American, or Alaska Native). Note the large percentage of students for whom race was unknown. Underrepresented applicants comprised a total of 14.5% alone and 16% if those in combination with another race (URM combo) were included.

Table 2. Race of Applicants

	Frequency	Percent
Asian	8,765	21.0
Black	3,169	7.6
Hispanic	2,710	6.5
White	23,646	56.6
Native/Hawaiian	175	0.4
URM Combo	615	1.5
Non URM Combo	843	2.0
Unknown	1,891	4.5
Total	41,814	100.0

Parent education. Medical school applicants generally came from highly educated parents as shown in Table 3. Just 8.6% of applicants came from homes where parent education was a high school diploma or less. Within that least educated category, just .9% of applicants came from homes where a parent completed primary school or less and 1.5% of applicants reported a parent who had no high school diploma or equivalent. Applicants with at least one parent completing a Bachelor's degree or some graduate work made up 25.6% of the pool. The total applicants with a parent at the master's and doctoral degree levels was 49.1% combined. More than a quarter (27.7%) of the pool had at least one parent with a doctorate or post doctorate degree. Note that nearly 10% of the pool did not enter parent education information, which was why for other elements in the analysis this was included as a separate category for unknown.

Table 3. Highest Parent Education

Education Level	Frequency	Percent
High School or Less	3,611	8.6%
Some College	2,818	6.7%
BS Degree/Some Grad School	10,711	25.6%
Master's Degree/Some doctoral studies	8,940	21.4%
Doctorate/Post Doctorate	11,581	27.7%
Unknown	4,153	9.9%
Total	41,814	100.0%

Sex and parent education. There were significant differences in the distribution of applicants by sex across the parent education categories (χ^2=69.611, $p < .001$). Table 4 shows a larger percentage of male applicants reported parent education of high school or less (52.1%), while a larger percentage of females reported parent education of some college (52.7%). Male applicants reported higher levels of parent education at the Bachelor's, Master's, Doctorate and post-doctorate levels. A larger percentage of male applicants declined to report parent education (54.8%).

Table 4. Sex and Parent Education Crosstabulation

		Male	Female	Total
HS or Less		1881	1730	3611
	% within	52.1%	47.9%	100.0%
Some College		1333	1484	2817
	% within	47.3%	52.7%	100.0%
BS Degree/Some Grad		5623	5087	10710
	% within	52.5%	47.5%	100.0%
Masters Degree/Some Doc		4594	4345	8939
	% within	51.4%	48.6%	100.0%
Doctorate/Post Doc		6361	5220	11581
	% within	54.9%	45.1%	100.0%
Unknown		2274	1878	4152
	% within	54.8%	45.2%	100.0%
Total		22066	19744	41810
	% within	52.8%	47.2%	100.0%

χ^2=69.611, *df*=5, $p < .001$

Race and sex. Examination of sex across race categories revealed some discrepancies (see Table 5). The Chi Square test revealed significant differences in the distribution of sex across racial categories (χ^2=600.351, $p < .001$). For Black applicants, 65.9% of the pool were female, the most lopsided ratio in the entire pool with the next closest ratio occurring for White students at 56.4% male. Like Black applicants, Native applicants also had more females than males at 54.6%.

Table 5. Race and Sex Crosstabulation

		Male	Female
Asian		4,553	4,212
	% within	51.90%	48.10%
Black		1,080	2,089
	% within	34.10%	65.90%
Hispanic		1,340	1,370
	% within	49.40%	50.60%
White		13,342	10,303
	% within	56.40%	43.60%
Native/Hawaiian		79	95
	% within	45.40%	54.60%
URM Combo		310	305
	% within	50.40%	49.60%
Non URM Combo		412	431
	% within	48.90%	51.10%
Unknown		950	939
	% within	50.30%	49.70%
Total		22,066	19,744
	% within	52.80%	47.20%

χ^2=600.351, *df*=7, $p < .001$

Parent education and race. Examining differences within the pool by parent education and race outlined some patterns that may explain potential differences in outcomes for applicants (see Table 6). There were significant differences between race groups across parent education (χ^2=1675.92, $p < .001$). Note that 31% of applicants within the Asian pool had at least one parent with a doctorate or more. This was surpassed only by the non-underrepresented race combination (Non URM combo) group at 34.9%, which was comprised of combinations of White and Asian classifications. The underrepresented groups of applicants, including those in combination, had the highest percentages of a parent with a high school diploma or less with Hispanics highest at 17.7%. White applicants had the lowest percentage in the high school or less category at just 5.9%. Another finding were the unknown race applicants who appeared most similar to White and Asian applicants with 29% of them having at least one parent with a doctorate or more and only 6.7% having a parent with high school or less.

Table 6. Race and Parent Education Crosstabulation

		HS or less	Some college	BS degree/ Some Grad	Masters degree/ Some Doc	Doctorate/ Post doc	Unknown	Total
Asian		934	456	1981	1850	2714	830	8765
	% within	10.70 %	5.20%	22.60%	21.10%	31.00%	9.50%	100.00%
Black		527	364	788	600	525	365	3169
	% within	16.60 %	11.50 %	24.90%	18.90%	16.60%	11.50%	100.00%
Hispanic		480	262	561	406	595	406	2710
	% within	17.70 %	9.70%	20.70%	15.00%	22.00%	15.00%	100.00%
White		1395	1528	6552	5350	6743	2078	23646
	% within	5.90%	6.50%	27.70%	22.60%	28.50%	8.80%	100.00%
Native/ Hawaiian		30	18	58	16	28	25	175
	% within	17.10 %	10.30 %	33.10%	9.10%	16.00%	14.30%	100.00%
URM combo		82	59	178	93	134	69	615
	% within	13.30 %	9.60%	28.90%	15.10%	21.80%	11.20%	100.00%
Non URM combo		37	53	177	214	294	68	843
	% within	4.40%	6.30%	21.00%	25.40%	34.90%	8.10%	100.00%
Unknown		126	78	416	411	548	312	1891
	% within	6.70%	4.10%	22.00%	21.70%	29.00%	16.50%	100.00%
Total	Count	3611	2818	10711	8940	11581	4153	41814
	% within race	8.60%	6.70%	25.60%	21.40%	27.70%	9.90%	100.00%

χ^2=1675.92, *df*=35, *p* < .001

Summary of race, sex, and education data. Descriptive analyses of the applicant pool revealed significant differences by race, parent education and sex. Medical school applicants generally reported high levels of parent education with 82.9% having at least one parent with a Bachelor's degree or higher. Sex differences within race were most uneven among Black applicants where females comprised 65.9% of the pool. Asian and non-URM combo students had the greatest percentages of at least one parent with a doctorate or more at 31% and 34.9% respectively. A discussion of academic characteristics follows.

Academic Characteristics

In this section I examine MCAT scores, academic index, and science major among medical school applicants. These characteristics are also analyzed by groupings of sex, race and parent education to further explore differences within the pool.

MCAT Scores

The scores for the Medical College Admissions Test were normally distributed as would be expected for a standardized exam. The MCAT scale is based on 0-45, with three sections making up a total of 15 possible points each. Scores above 40 are considered 100th percentile for the standardized reporting of scores. The exam is not scored by cohort, but rather results are statistically comparable across multiple examinations. Figure 1 shows that the mean score was 28.5 with a standard deviation of 5.233 (n = 41,131). Note that 683 individuals (1.6%) the pool of verified applicants through AMCAS did not report MCAT scores. These may have been students in articulation agreement programs who were required to submit an application but were not required to take the exam. It may also be applicants who submitted applications and did not follow through in taking the exam following submission.

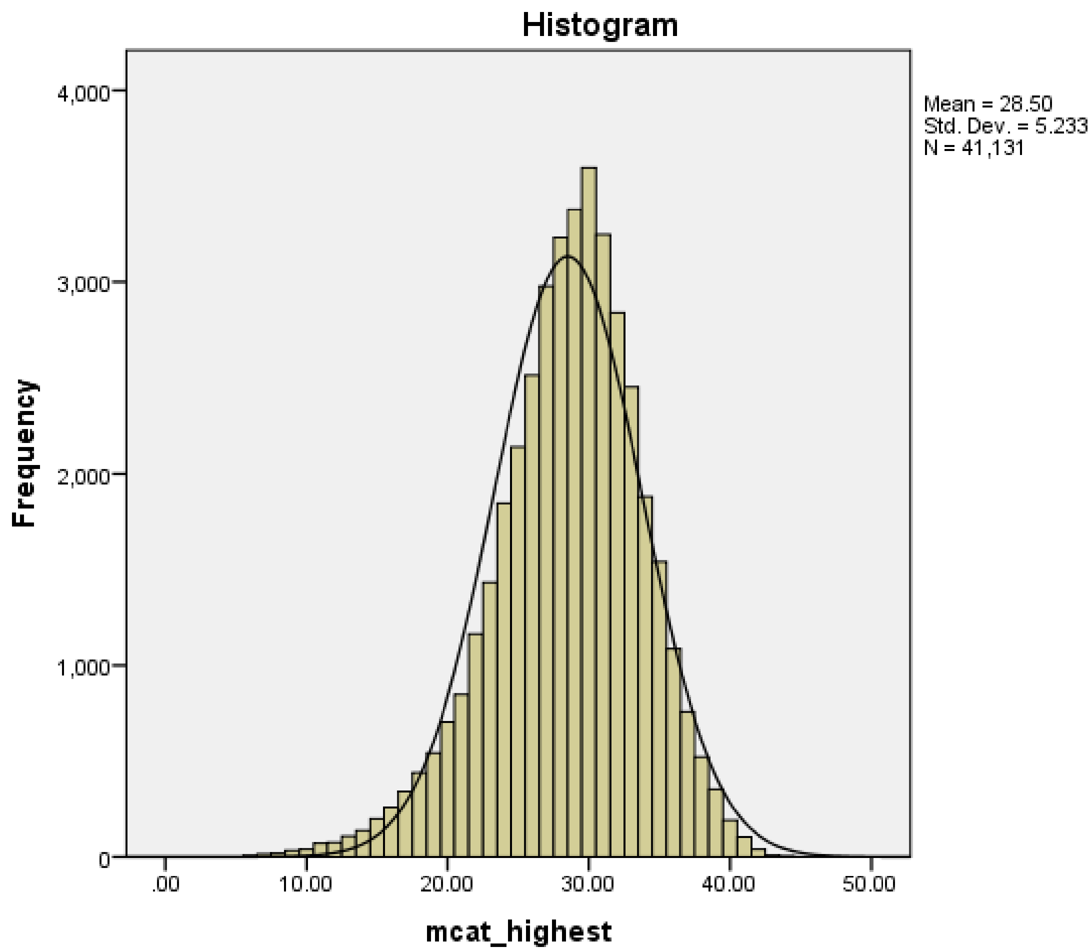

Figure 1. Highest MCAT score for all applicants

Sex and MCAT. An independent samples t-test demonstrated significant differences in scores between male and female applicants (F = 97.187, $p < .000$). The mean MCAT score for male applicants was more than two points higher than the mean score for female applicants at 29.53 (SD = 4.94) compared to 27.34 (SD = 5.3). In order to examine the mean differences more closely, I bracketed the MCAT scores to examine these differences in further detail (see Table 7). The resultant Chi Square test confirmed that there were significant differences in the sex composition across score categories (χ^2=1754.304, $p < .001$). Male applicants were 73.1% of scorers in the highest bracket of

37 or higher. As scores increased past 28 (approximately the mean), the ratio of males to females by score bracket increased.

Table 7. Independent Samples t-test for Sex and MCAT

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Differ-ence	Lower	Upper
Equal variances assumed	97.187	.000	43.207	41125	0.000	2.18459	.05056	2.08549	2.28369
Equal variances not assumed			43.032	39747.735	0.000	2.18459	.05077	2.08509	2.28410

Table 8. Means for MCAT by Sex

	N	Mean	Std. Deviation	Std. Error Mean
male	21760	29.5332	4.94588	.03353
female	19367	27.3486	5.30497	.03812

Table 9. MCAT Score and Sex Crosstabulation

		Male	Female	Total
4-12		68	191	259
	% within	26.3%	73.7%	100.0%
13-15		142	299	441
	% within	32.2%	67.8%	100.0%
16-18		331	706	1037
	% within	31.9%	68.1%	100.0%
19-21		752	1338	2090
	% within	36.0%	64.0%	100.0%
22-24		1804	2634	4438
	% within	40.6%	59.4%	100.0%
25-27		3616	4014	7630
	% within	47.4%	52.6%	100.0%
28-30		5475	4733	10208
	% within	53.6%	46.4%	100.0%
31-33		5162	3379	8541
	% within	60.4%	39.6%	100.0%
34-36		2965	1540	4505
	% within	65.8%	34.2%	100.0%
37 +		1445	533	1978
	% within	73.1%	26.9%	100.0%
Total		21760	19367	41127
	% within total	52.9%	47.1%	100.0%

χ^2=1754.304, *df*=9, $p < .001$

Race and MCAT. The ANOVA results in Table 10 revealed significant score differences on the MCAT across race groups (F = 943.72, $p < .000$). Table 11 shows mean MCAT scores for Black applicants were the lowest at 22.28 (SD = 5.35). The next lowest mean scores were from Native students with a mean of 25.58 (SD = 4.91). Non URM combo applicants had the highest mean MCAT scores at 29.97 (SD = 4.52) followed by Asians 29.46 (SD = 5.14). Post hoc tests revealed significant differences across race and MCAT score within the pool with mean differences between groups as wide as 7.59 points (see Table 12). Asian applicants had significantly higher scores than all other groups, while Black applicants had significantly lower scores than all other groups.

To further examine specific, practicable differences in scores by race, I used the same segmentation of MCAT scores presented above (see Table 9). There were significant differences in the race distributions across different MCAT score brackets (χ^2=7076.77, $p < .001$). Crosstabulation also showed that a large number of Asian applicants had scores in higher brackets, while Black and Hispanic applicants more frequently had scores in lower brackets. Note the large percentage (10%) of Black applicants that scored a 15 or below. Hispanic applicants were at 2.9% comparatively for the same lowest two scores brackets.

Table 10. ANOVA Race and MCAT

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	155897.352	7	22271.050	943.724	0.000
Within Groups	970466.763	41123	23.599		
Total	1126364.116	41130			

Table 11. Mean MCAT Scores by Race

	N	Mean	Std. Deviation	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
Asian	8602	29.4607	5.14287	29.3520	29.5694	6.00	44.00
Black	3136	22.3807	5.35661	22.1932	22.5683	6.00	41.00
Hispanic	2670	26.3007	5.28355	26.1002	26.5012	6.00	41.00
White	23272	29.1717	4.57411	29.1129	29.2305	7.00	45.00
Native/Hawaiian	172	25.5872	4.91072	24.8481	26.3263	11.00	36.00
URM combo	609	26.6092	5.28824	26.1884	27.0300	9.00	39.00
Non URM combo	832	29.9724	4.52009	29.6648	30.2799	7.00	44.00
Unknown	1838	29.4548	5.39782	29.2079	29.7018	6.00	43.00
Total	41131	28.5039	5.23311	28.4534	28.5545	6.00	45.00

Table 12. Tukey Post Hoc Tests for Race and MCAT

		Mean Difference	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Asian	Black	7.07997*	6.7728	7.3871
	Hispanic	3.15996*	2.8338	3.4862
	White	.28900*	.1032	.4748
	Native/Hawaiian	3.87350*	2.7396	5.0074
	URM combo	2.85151*	2.2341	3.4689
Black	Asian	-7.07997*	-7.3871	-6.7728
	Hispanic	-3.92001*	-4.3077	-3.5323
	White	-6.79097*	-7.0711	-6.5109
	Native/Hawaiian	-3.20647*	-4.3596	-2.0534
	URM combo	-4.22846*	-4.8805	-3.5764
	Non URM combo	-7.59162*	-8.1658	-7.0174
	Unknown	-7.07410*	-7.5066	-6.6416
Hispanic	Asian	-3.15996*	-3.4862	-2.8338
	Black	3.92001*	3.5323	4.3077
	White	-2.87096*	-3.1718	-2.5701
	Non URM combo	-3.67161*	-4.2562	-3.0870
	Unknown	-3.15409*	-3.6004	-2.7078

White	Asian	-.28900*	-.4748	-.1032
	Black	6.79097*	6.5109	7.0711
	Hispanic	2.87096*	2.5701	3.1718
	Native/Hawaiian	3.58450*	2.4576	4.7114
	URM combo	2.56251*	1.9581	3.1669
	Non URM combo	-.80065*	-1.3202	-.2811
Native/Hawaiian	Asian	-3.87350*	-5.0074	-2.7396
	Black	3.20647*	2.0534	4.3596
	White	-3.58450*	-4.7114	-2.4576
	Non URM combo	-4.38515*	-5.6185	-3.1518
	Unknown	-3.86763*	-5.0417	-2.6935
URM combo	Asian	-2.85151*	-3.4689	-2.2341
	Black	4.22846*	3.5764	4.8805
	White	-2.56251*	-3.1669	-1.9581
	Non URM combo	-3.36316*	-4.1484	-2.5779
	Unknown	-2.84565*	-3.5341	-2.1572
Non URM combo	Black	7.59162*	7.0174	8.1658
	Hispanic	3.67161*	3.0870	4.2562
	White	.80065*	.2811	1.3202
	Native/Hawaiian	4.38515*	3.1518	5.6185
	URM combo	3.36316*	2.5779	4.1484
Unknown	Black	7.07410*	6.6416	7.5066
	Hispanic	3.15409*	2.7078	3.6004
	Native/Hawaiian	3.86763*	2.6935	5.0417
	URM combo	2.84565*	2.1572	3.5341

*p < .000

Table 13. MCAT Score and Race Crosstabulation

		Score Range										Total
		4-12	13-15	16-18	19-21	22-24	25-27	28-30	31-33	34-36	37 +	
Asian		30	77	159	329	760	1317	2076	2060	1222	572	8602
	% within	0.3%	0.9%	1.8%	3.8%	8.8%	15.3%	24.1%	23.9%	14.2%	6.6%	100.0%
Black		139	176	383	597	752	590	307	133	43	16	3136
	% within	4.4%	5.6%	12.2%	19.0%	24.0%	18.8%	9.8%	4.2%	1.4%	0.5%	100.0%
Hispanic		25	53	122	249	466	622	583	342	150	58	2670
	% within	0.9%	2.0%	4.6%	9.3%	17.5%	23.3%	21.8%	12.8%	5.6%	2.2%	100.0%
White		42	103	305	731	2120	4490	6439	5252	2664	1126	23272
	% within	0.2%	0.4%	1.3%	3.1%	9.1%	19.3%	27.7%	22.6%	11.4%	4.8%	100.0%
Native/ Hawaiian		1	3	7	24	33	43	34	16	11	0	172
	% within	0.6%	1.7%	4.1%	14.0%	19.2%	25.0%	19.8%	9.3%	6.4%	0.0%	100.0%
URM combo		4	14	20	65	100	125	136	94	37	14	609
	% within	0.7%	2.3%	3.3%	10.7%	16.4%	20.5%	22.3%	15.4%	6.1%	2.3%	100.0%
Non URM combo		2	2	6	18	60	152	202	202	137	51	832
	% within	0.2%	0.2%	0.7%	2.2%	7.2%	18.3%	24.3%	24.3%	16.5%	6.1%	100.0%
Unknown		16	13	36	78	148	291	432	442	241	141	1838
	% within	0.9%	0.7%	2.0%	4.2%	8.1%	15.8%	23.5%	24.0%	13.1%	7.7%	100.0%
Total		259	441	1038	2091	4439	7630	10209	8541	4505	1978	41131
	% within	0.6%	1.1%	2.5%	5.1%	10.8%	18.6%	24.8%	20.8%	11.0%	4.8%	100.0%

χ^2=7076.77, *df*=63, *p* < .001

Parent education and MCAT. Analysis of variance showed the disparities in test scores were significantly different when compared across parent education (F = 293.15, *p* < .000). The average MCAT score was significantly higher as the level of parent education increased. Applicants reporting parent education of high school or less had the lowest mean scores (25.82, SD = 5.41) while applicants coming from a parent with a doctorate or higher had the highest mean scores (29.96, SD = 4.8). Post hoc tests revealed significant differences between every classification of parent education with a range of mean difference in scores as wide as 4.14 points (see Table 13). There was a consistent pattern in the post hoc results that demonstrated an increase in MCAT score with every increase in level of parental education. Applicants with a parent with high school education or less scored lower than all other parent education groupings. Applicants with parent education of some college scored higher than high school, but lower than the other categories. The pattern continues with applicants with a parent with a Master's scoring higher than Bachelor's, some college or high school, but lower than the doctorate category. Applicants with parents with doctorates or higher scored higher than all the other categories of parent education.

I included a scores bracket crosstabulation for closer examination of practical differences between scores by race (see Table 14), and the Chi Square test revealed highly significant differences (χ^2=2760.43, p < .001). The results for applicant MCAT scores across parent education categories showed 44% of applicants scoring 37 and above came from a parent with a doctorate or more. For the same MCAT bracket of 37 or more, applicants with parent education of some college or less were just 6%. Of the applicants scoring in the bottom bracket (4-12) 57% were from a parent with a Bachelor's degree or less. Applicants with parents holding bachelor's degrees or less were 57% of the second lowest bracket (13-15).

Table 14. ANOVA MCAT and Parent Education

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	66143.660	9	7349.296	293.157	0.000
Within Groups	930377.925	37112	25.069		
Total	996521.585	37121			

Table 15. Means for MCAT by Highest Parent Education

	N	Mean	Std. Deviation	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
HS or Less	3566	25.8270	5.41165	25.6493	26.0047	6.00	42.00
Some College	2790	26.7538	5.23002	26.5596	26.9479	7.00	41.00
BS Degree/Some Grad	10595	28.1848	5.03064	28.0890	28.2806	6.00	45.00
Masters Degree/Some Doc	8811	29.2655	4.98670	29.1613	29.3696	6.00	44.00
Doctorate/Post Doc	11360	29.9699	4.82798	29.8811	30.0587	7.00	44.00
Unknown	4009	27.1187	5.50176	26.9484	27.2891	6.00	42.00
Total	41131	28.5039	5.23311	28.4534	28.5545	6.00	45.00

Table 16. Tukey Post Hoc Tests for Parent Education and MCAT

		Mean Difference	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
HS or Less	Some College	-.92679*	-1.2914	-.5621
	BS Degree/Some Grad	-2.35783*	-2.6371	-2.0785
	Masters Degree/Some Doc	-3.43849*	-3.7248	-3.1521
	Doctorate/Post Doc	-4.14292*	-4.4198	-3.8660
	Unknown	-1.29176*	-1.6239	-.9597
Some College	HS or Less	.92679*	.5621	1.2914
	BS Degree/Some Grad	-1.43104*	-1.7380	-1.1240
	Masters Degree/Some Doc	-2.51170*	-2.8251	-2.1983
	Doctorate/Post Doc	-3.21613*	-3.5210	-2.9113
	Unknown	-.36497*	-.7207	-.0093
BS Degree/Some Grad	HS or Less	2.35783*	2.0785	2.6371
	Some College	1.43104*	1.1240	1.7380
	Masters Degree/Some Doc	-1.08066*	-1.2887	-.8726
	Doctorate/Post Doc	-1.78509*	-1.9799	-1.5902
	Unknown	1.06607*	.7986	1.3336
Masters Degree/Some Doc	HS or Less	3.43849*	3.1521	3.7248
	Some College	2.51170*	2.1983	2.8251
	BS Degree/Some Grad	1.08066*	.8726	1.2887
	Doctorate/Post Doc	-.70443*	-.9092	-.4996
	Unknown	2.14673*	1.8719	2.4216
Doctorate/Post Doc	HS or Less	4.14292*	3.8660	4.4198
	Some College	3.21613*	2.9113	3.5210
	BS Degree/Some Grad	1.78509*	1.5902	1.9799
	Masters Degree/Some Doc	.70443*	.4996	.9092
	Unknown	2.85116*	2.5861	3.1162

*p < .000

Table 17. MCAT and Parent Education Crosstabulation

		HS or Less	Some College	BS/Some Grad	Masters /Some Doc	Doctorate/ Post Doc	Unknown	Total
4-12		56	39	53	32	25	54	259
	% within	21.60%	15.10%	20.50%	12.40%	9.70%	20.80%	100.00%
13-15		96	38	120	70	49	68	441
	% within	21.80%	8.60%	27.20%	15.90%	11.10%	15.40%	100.00%
16-18		195	103	258	155	145	182	1038
	% within	18.80%	9.90%	24.90%	14.90%	14.00%	17.50%	100.00%
19-21		331	239	564	334	348	275	2091
	% within	15.80%	11.40%	27.00%	16.00%	16.60%	13.20%	100.00%
22-24		650	425	1239	742	837	546	4439
	% within	14.60%	9.60%	27.90%	16.70%	18.90%	12.30%	100.00%
25-27		804	601	2124	1511	1717	873	7630
	% within	10.50%	7.90%	27.80%	19.80%	22.50%	11.40%	100.00%
28-30		739	697	2779	2245	2819	930	10209
	% within	7.20%	6.80%	27.20%	22.00%	27.60%	9.10%	100.00%
31-33		480	424	2091	2077	2820	649	8541
	% within	5.60%	5.00%	24.50%	24.30%	33.00%	7.60%	100.00%
34-36		161	173	976	1135	1728	332	4505
	% within	3.60%	3.80%	21.70%	25.20%	38.40%	7.40%	100.00%
37 +		54	51	391	510	872	100	1978
	% within	2.70%	2.60%	19.80%	25.80%	44.10%	5.10%	100.00%
Total		3566	2790	10595	8811	11360	4009	41131
	% within	8.70%	6.80%	25.80%	21.40%	27.60%	9.70%	100.00%

χ^2=2760.43, *df*=45, *p* < .001

Academic index. The academic index is a composite standardized variable generated from science GPA, overall GPA and MCAT score. Figure 2 shows normal distribution for the academic index with a mean of .02 and standard deviation of .644. In this section I report differences in academic index by race, sex, and parent education.

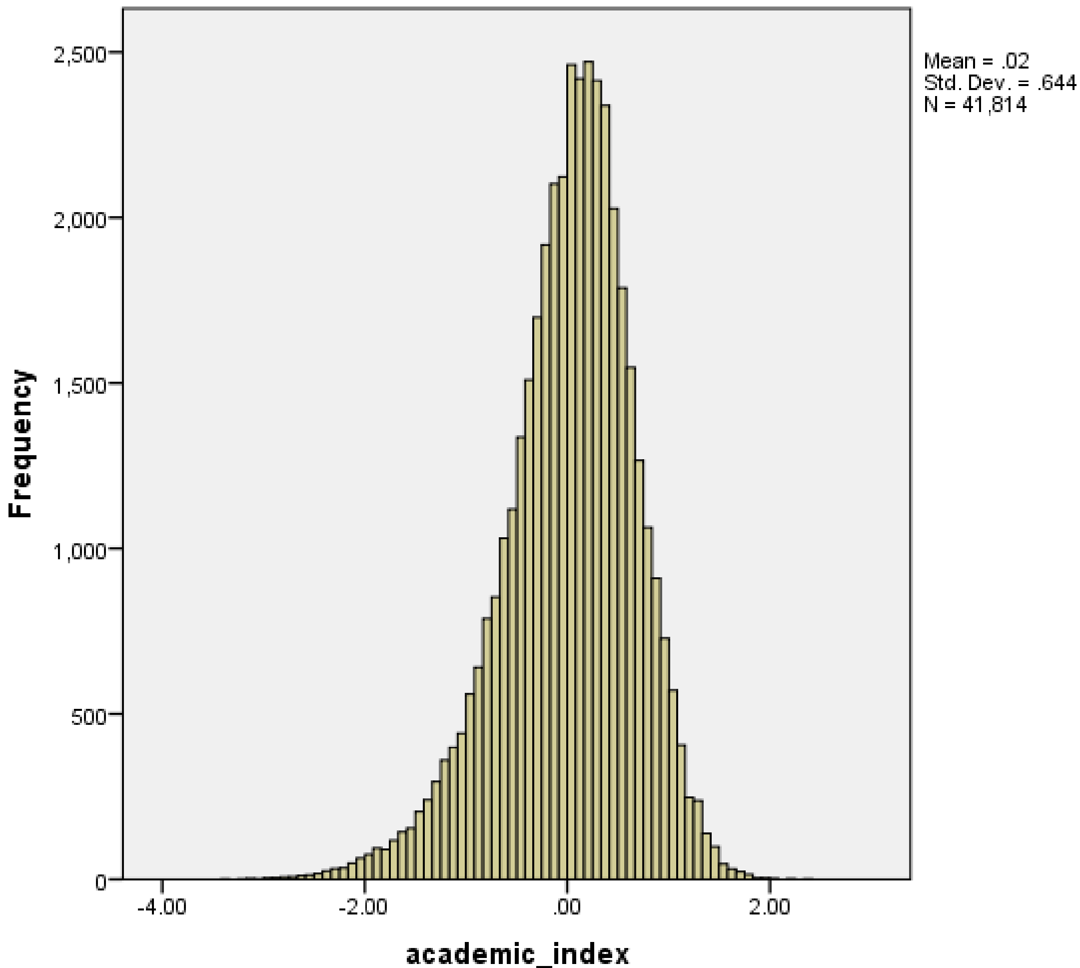

Figure 2. Academic Index for all applicants

Race. Analysis of variance demonstrated group differences in academic preparation by race. ANOVA confirmed that indices differed across racial groups and this finding was highly significant (F = 843.041, $p < .000$). Non URM combo and Asian applicants had the highest mean academic indices at .1773 and .1186 respectively. Black and Native applicants had the lowest mean indices at -.6881 and -.2808 respectively. Post hoc tests revealed significant differences across academic index and racial groups for nearly every comparison with a mean difference as high as .865 (see Table 17). Asian applicants had higher academic indices compared to all other groups. Black applicants had lower academic indices compared to all other groups. Hispanic applicants had lower indices than all other groups except Black.

Table 18. ANOVA Academic Index and Race

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2146.040	7	306.577	843.041	0.000
Within Groups	15203.008	41806	.364		
Total	17349.048	41813			

Table 19. Means for Academic Index by Race

				95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Lower Bound	Upper Bound	Min	Max
Asian	8765	.1186	.63056	.1054	.1318	-3.18	2.37
Black	3169	-.6881	.65416	-.7109	-.6653	-3.35	1.56
Hispanic	2710	-.2739	.70624	-.3005	-.2473	-3.12	1.64
White	23646	.0988	.56867	.0916	.1061	-2.94	2.25
Native/Hawaiian	175	-.2808	.62524	-.3740	-.1875	-2.21	2.02
URM combo	615	-.2096	.64305	-.2606	-.1587	-2.52	1.39
Non URM combo	843	.1773	.55848	.1396	.2151	-2.54	1.82
Unknown	1891	.1288	.64271	.0998	.1578	-2.53	1.93
Total	41814	.0160	.64414	.0098	.0222	-3.35	2.37

Table 20. Tukey Post Hoc Tests for Race and Academic Index

			95% Confidence Interval	
		Mean Difference	Lower Bound	Upper Bound
Asian	Black	.80673*	.7688	.8446
	Hispanic	.39254*	.3524	.4327
	Native/Hawaiian	.39940*	.2599	.5389
	URM combo	.32829*	.2520	.4045
Black	Asian	-.80673*	-.8446	-.7688
	Hispanic	-.41419*	-.4620	-.3664
	White	-.78692*	-.8215	-.7523
	Native/Hawaiian	-.40733*	-.5493	-.2654

	URM combo	-.47844*	-.5590	-.3979
	Non URM combo	-.86542*	-.9363	-.7946
	Unknown	-.81687*	-.8700	-.7638
Hispanic	Asian	-.39254*	-.4327	-.3524
	Black	.41419*	.3664	.4620
	White	-.37273*	-.4098	-.3357
	Non URM combo	-.45123*	-.5233	-.3791
	Unknown	-.40268*	-.4575	-.3479
White	Black	.78692*	.7523	.8215
	Hispanic	.37273*	.3357	.4098
	Native/Hawaiian	.37959*	.2409	.5183
	URM combo	.30848*	.2338	.3831
	Non URM combo	-.07850*	-.1426	-.0144
Native/ Hawaiian	Asian	-.39940*	-.5389	-.2599
	Black	.40733*	.2654	.5493
	White	-.37959*	-.5183	-.2409
	Non URM combo	-.45809*	-.6099	-.3063
	Unknown	-.40954*	-.5540	-.2651
URM combo	Asian	-.32829*	-.4045	-.2520
	Black	.47844*	.3979	.5590
	White	-.30848*	-.3831	-.2338
	Non URM combo	-.38698*	-.4839	-.2900
	Unknown	-.33843*	-.4233	-.2536
Non URM combo	Black	.86542*	.7946	.9363
	Hispanic	.45123*	.3791	.5233
	White	.07850*	.0144	.1426
	Native/Hawaiian	.45809*	.3063	.6099
	URM combo	.38698*	.2900	.4839
Unknown	Black	.81687*	.7638	.8700
	Hispanic	.40268*	.3479	.4575
	Native/Hawaiian	.40954*	.2651	.5540
	URM combo	.33843*	.2536	.4233

*p < .000

Sex. Sex differences in academic index were highly significant according to the independent t-test results (F = 43.543, $p < .000$). Male applicants had higher mean academic indices than female applicants at .1141 compared to -.0934 respectively. In the combination of GPA, science GPA and MCAT for the index, there were differences between sex categories.

Table 21. Independent Samples t-test Sex and Academic Index

	Levene's Test		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	43.543	.000	33.318	41808	.000	.20749	.00623	.19529	.21970
Equal variances not assumed			33.227	40762.574	.000	.20749	.00624	.19525	.21973

Table 22. Academic Index by Sex

	N	Mean	Std. Deviation	Std. Error Mean
Male	22066	.1141	.62077	.00418
Female	19744	-.0934	.65204	.00464

Parent education. Differences in academic index across parent education were highly significant (F = 602.403, $p < .000$). Applicants who did not report parent education had the lowest mean for academic index (-.3746), while applicants from a parent with a doctorate or more had the highest mean academic index (.1597). Post hoc comparisons revealed highly significant differences between groups for nearly every combination with a range for mean differences as high as .534 (see Table 22). The same pattern for MCAT scores and parent education held true for academic index. For each categorical increase in parent education, academic index increased. Applicants with parent education of high school or less had lower indices than all other categories and applicants with a parent with a doctorate or higher had higher indices than all other categories.

Table 23. ANOVA Academic Index and Parent Education

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1165.898	5	233.180	602.403	0.000
Within Groups	16183.150	41808	.387		
Total	17349.048	41813			

Table 24. Means for Academic Index by Parent Education

				95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Lower Bound	Upper Bound	Min	Max
HS or Less	3611	-.1943	.65527	-.2157	-.1730	-2.75	1.77
Some College	2818	-.1081	.64179	-.1318	-.0844	-2.96	2.25
BS Degree/Some Grad	10711	.0335	.59986	.0221	.0448	-2.90	2.03
Masters Degree/Some Doc	8940	.1144	.59346	.1021	.1267	-2.78	1.99
Doctorate/Post Doc	11581	.1597	.57963	.1492	.1703	-2.98	2.37
unknown	4153	-.3746	.78832	-.3986	-.3506	-3.35	2.22
Total	41814	.0160	.64414	.0098	.0222	-3.35	2.37

Table 25. Tukey Post Hoc Tests for Academic Index and Parent Education

			95% Confidence Interval	
		Mean Difference	Lower Bound	Upper Bound
HS or Less	Some College	-.08622*	-.1308	-.0417
	BS Degree/Some Grad	-.22782*	-.2619	-.1937
	Masters Degree/Some Doc	-.30875*	-.3437	-.2738
	Doctorate/Post Doc	-.35405*	-.3878	-.3203
	Unknown	.18028*	.1399	.2206
Some College	HS or Less	.08622*	.0417	.1308
	BS Degree/Some Grad	-.14160*	-.1791	-.1041
	Masters Degree/Some Doc	-.22253*	-.2608	-.1842
	Doctorate/Post Doc	-.26783*	-.3051	-.2306
	Unknown	.26650*	.2232	.3098
BS Degree/Some Grad	HS or Less	.22782*	.1937	.2619
	Some College	.14160*	.1041	.1791
	Masters Degree/Some Doc	-.08093*	-.1063	-.0555
	Doctorate/Post Doc	-.12624*	-.1500	-.1025
	Unknown	.40810*	.3757	.4405
Masters Degree/Some Doc	HS or Less	.30875*	.2738	.3437
	Some College	.22253*	.1842	.2608
	BS Degree/Some Grad	.08093*	.0555	.1063
	Doctorate/Post Doc	-.04530*	-.0703	-.0203
	Unknown	.48903*	.4557	.5223
Doctorate/Post Doc	HS or Less	.35405*	.3203	.3878
	Some College	.26783*	.2306	.3051
	BS Degree/Some Grad	.12624*	.1025	.1500
	Masters Degree/Some Doc	.04530*	.0203	.0703
	Unknown	.53433*	.5023	.5664
Unknown	HS or Less	-.18028*	-.2206	-.1399
	Some College	-.26650*	-.3098	-.2232
	BS Degree/Some Grad	-.40810*	-.4405	-.3757
	Masters Degree/Some Doc	-.48903*	-.5223	-.4557
	Doctorate/Post Doc	-.53433*	-.5664	-.5023

*p < .000

Science major. Applicants reporting a science major comprised 57.6% of the pool. Slightly less than half the applicants to medicine chose to major in subjects other than science. In most cases this did not exempt applicants from completing required coursework defined as 'premed.' Applicants may take longer to complete their

Bachelor's degrees when taking on additional courses to complete premed requirements that do not overlap with their coursework for their majors.

Race and science major. Examining the choice of science major by race provides some insight into applicant behaviors (see Table 26). The Chi Square test demonstrated highly significant group differences between race and science major (χ^2=33.66, $p < .001$). The highest proportion of science major within race was Black applicants at 61.4% followed by URM combo applicants at 59.7%. The largest percentage of non-science majors was Hispanic applicants (44.9%), followed by Native applicants at 44.6%, and then White and unknown race applicants both at 43%.

Table 26. Science Major and Race Crosstabulation

		Non science major	Science major	Total
Asian		3638	5127	8765
	% within	41.50%	58.50%	100.00%
Black		1224	1945	3169
	% within	38.60%	61.40%	100.00%
Hispanic		1218	1492	2710
	% within	44.90%	55.10%	100.00%
White		10157	13489	23646
	% within	43.00%	57.00%	100.00%
Native/Hawaiian		78	97	175
	% within	44.60%	55.40%	100.00%
Urm combo		248	367	615
	% within	40.30%	59.70%	100.00%
Non urm combo		350	493	843
	% within	41.50%	58.50%	100.00%
Unknown		816	1075	1891
	% within	43.20%	56.80%	100.00%
Total		17729	24085	41814
	% within total	42.40%	57.60%	100.00%

χ^2=33.66, df=7, $p < .001$

Sex and science major. There were significant differences between male and female applicants and science major or non-science major groupings (χ^2=11.19, p < .001). Males comprised 51.8% of non-science majors and 53.5% of science majors.

Table 27. Sex and Science Major

		Male	Female	Total
Non Science		9187	8540	17727
	% within	51.8%	48.2%	100.0%
Science		12879	11204	24083
	% within	53.5%	46.5%	100.0%
		22066	19744	41810
	% within total	52.8%	47.2%	100.0%

χ^2=11.19, *df*=1, p < .001

Parent education and science major. There were significant differences by science major and parent education categories (χ^2=1091.531, p < .001). The highest proportions of science majors within parent education categories occurred at the lowest levels of parent education. Applicants reporting highest parent education of Bachelor's degree majored in science 63% of the time, while 54.7% applicants reporting a parent with a doctorate were science majors. Applicants with a parent with a high school education or less had the highest percentages of majoring in science.

Table 28. Science Major and Parent Education Crosstabulation

		Non Science Major	Science Major	Total
HS or Less		1209	2402	3611
	% within	33.5%	66.5%	100.0%
Some College		988	1830	2818
	% within	35.1%	64.9%	100.0%
BS Degree/Some Grad		3996	6715	10711
	% within	37.3%	62.7%	100.0%
Masters Degree/Some Doc		3710	5230	8940
	% within	41.5%	58.5%	100.0%
Doctorate/Post Doc		5182	6399	11581
	% within	44.7%	55.3%	100.0%
Unknown		2644	1509	4153
	% within	63.7%	36.3%	100.0%
Total		17729	24085	41814
	% within	42.4%	57.6%	100.0%

χ^2=1091.531, *df*=5, *p* < .001

Summary of Academic Characteristics

Descriptive analyses demonstrated significant differences in academic characteristics in the pool of applicants to medical school. Levels of academic preparation according to MCAT score and academic index significantly differed by race, sex and parent education. Applicants with higher levels of parent education tended to have higher MCAT scores and academic indices. White and Asian applicants had higher MCAT scores than Black and Hispanic applicants. Male applicants outnumbered female applicants in the highest MCAT scores bracket (37 or higher) more than two to one. Black applicants were the largest percentage within race group of science majors. Applicants with lower levels of parent education majored in science more frequently than applicants reporting parent education of master’s degree or higher. These differences among applicants were highly significant.

Application and Acceptance

In this section I examined group differences in the applicant pool to medical school. Applicant characteristics of sex, parent education, and race were analyzed descriptively for differences in number of applications and number of acceptances to medical school.

Number of Applications

The range in number of applications submitted across the pool was very broad from 1-123 with a mean of 13.93 and standard deviation of 11.13. Figure 3 shows the histogram for number of applications per applicant which was not normally distributed. Table 29 provides a segmented breakdown of number of applications with fairly even distribution of groups for easier visual interpretation of group differences in applicant behaviors. Ten percent of the pool applied to just one school. This finding may represent applicants applying as a formality who already had a guaranteed acceptance through an articulation agreement, pre-matriculation program or recruitment program. In 2011 the cost of one application was $160 and each additional school was $32. The financial range that applicants expended in fees was $160 - $3,936. The average amount spent by applicants was $576 for about 14 applications. The missing data for 311 applicants is a result of applicants who submitted their applications and paid the fee for them to be verified – the data set only contains verified AMCAS data. These candidates more than likely withdrew their applications from every school after verification.

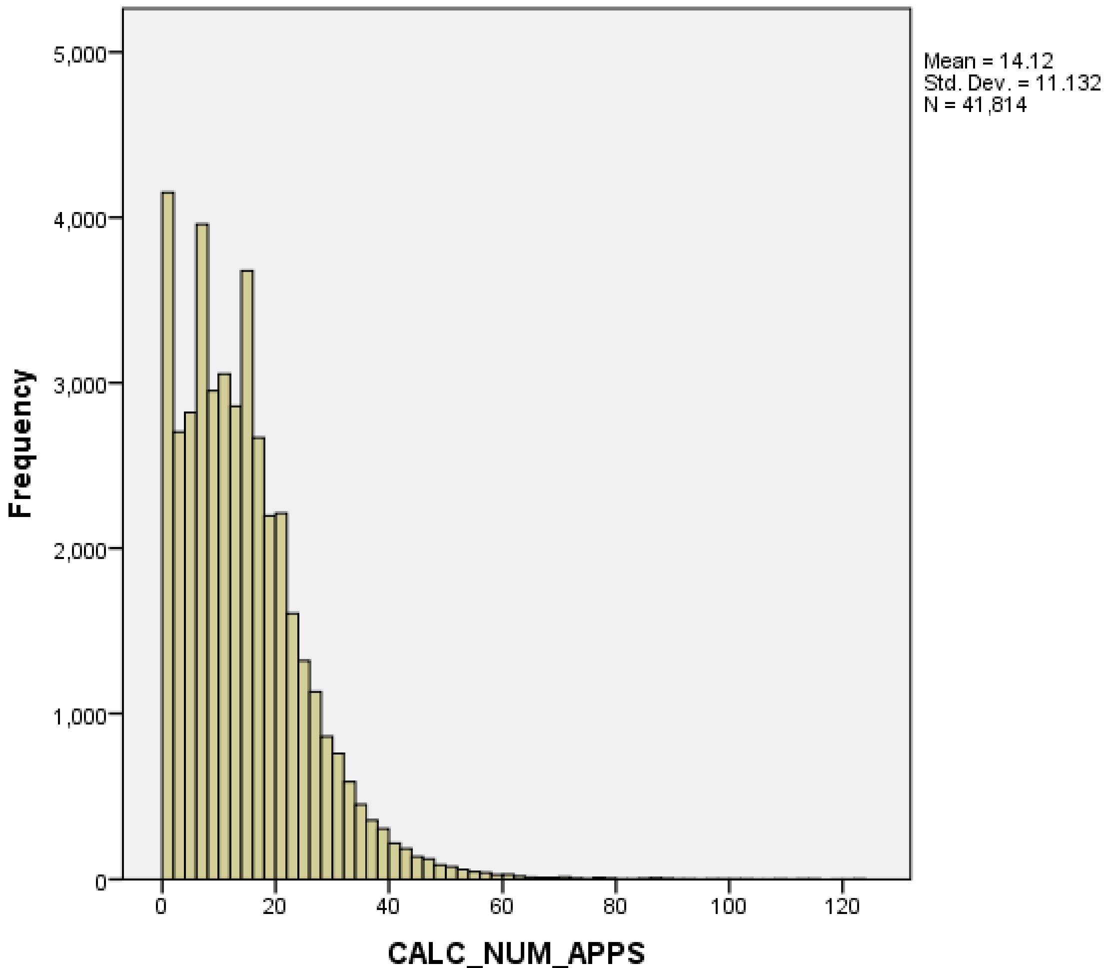

Figure 3. Total number of applications submitted for all applicants

Table 29. Number of Applications

	Frequency	Percent
1	4151	10.0
2-4	4079	9.8
5-7	5404	13.0
8-10	4544	10.9
11-13	4320	10.4
14-16	5056	12.2
17-20	4672	11.3
21-26	4547	11.0
27 or more	4730	11.4
Total	41503	100
Missing	311	
Total	41814	

Sex and number of applications. Independent samples t-test confirmed highly significant differences between sex and the number of applications submitted for medical school (F = 13.259, $p < .000$). Male applicants, on average, submitted more applications with a mean of 14.38 (SD = 11.29) compared to female applicants with a mean of 13.83 (SD=10.94).

Table 30. Sex and Number of Applications

	N	Mean	Std. Deviation	Std. Error Mean
Male	22066	14.38	11.292	.076
Female	19744	13.83	10.944	.078

Table 31. Independent Samples T-test Sex and Number of Applications

	Levene's Test		t-test for Equality of Means					95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	13.259	.000	5.056	41808	.000	.551	.109	.337	.765
Equal variances not assumed			5.064	41542.377	.000	.551	.109	.338	.764

Race and number of applications. The number of applications submitted significantly differed by race, as shown by the ANOVA results (F = 278.128, *p* < .000). Black and Hispanic applicants applied to fewer schools and Asians and Whites applied to more schools. Asian students had the highest mean number of applications (18.4) and the largest standard deviation (13.13) with the next highest means reported by non-URM combo (16.93, SD = 11.73) and unknown race applicants (14.96, SD = 11.39). Black applicants had the smallest mean (11.88) and standard deviation (9.05) followed by Native students who had a mean of 12.14 and a standard deviation of 13.29. Post hoc comparisons revealed significant differences between nearly all mean comparisons by race group (see Table 32). Asian applicants on average applied to six schools more compared to Black applicants and five schools more than White applicants (p < .000). Black applicants applied to significantly fewer schools than nearly all groups except Native, while Non URM combo applicants applied to more schools than all groups except for Asian.

Table 32. ANOVA Race and Number of Applications

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	230545.692	7	32935.099	278.128	0.000
Within Groups	4950548.753	41806	118.417		
Total	5181094.445	41813			

Table 33. Mean Number of Applications by Race

				95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Lower Bound	Upper Bound	Min	Max
Asian	8765	18.40	13.134	18.12	18.67	1	123
Black	3169	11.88	9.059	11.57	12.20	1	101
Hispanic	2710	13.75	10.983	13.34	14.16	1	106
White	23646	12.74	10.007	12.61	12.86	1	122
Native/Hawaiian	175	12.14	13.285	10.16	14.12	1	120
URM combo	615	13.51	12.220	12.54	14.48	1	114
Non-URM combo	843	16.93	11.735	16.14	17.72	1	110
Unknown	1891	14.96	11.398	14.44	15.47	1	103
Total	41814	14.12	11.132	14.01	14.22	1	123

Table 34. Tukey Post Hoc Tests for Race and Number of Applications

			95% Confidence Interval	
		Mean Difference	Lower Bound	Upper Bound
Asian	Black	6.512***	5.83	7.20
	Hispanic	4.646***	3.92	5.37
	White	5.658***	5.25	6.07
	Native/Hawaiian	6.252***	3.73	8.77
	URM combo	4.883***	3.51	6.26
	Non URM combo	1.466**	.28	2.66
	Unknown	3.439***	2.60	4.28

Black	Asian	-6.512***	-7.20	-5.83
	Hispanic	-1.866***	-2.73	-1.00
	White	-.853**	-1.48	-.23
	URM combo	-1.629*	-3.08	-.18
	Non URM combo	-5.045***	-6.32	-3.77
	Unknown	-3.073***	-4.03	-2.11
Hispanic	Asian	-4.646***	-5.37	-3.92
	Black	1.866***	1.00	2.73
	White	1.012***	.34	1.68
	Non URM combo	-3.179***	-4.48	-1.88
	Unknown	-1.207**	-2.20	-.22
White	Asian	-5.658***	-6.07	-5.25
	Black	.853**	.23	1.48
	Hispanic	-1.012***	-1.68	-.34
	Non URM combo	-4.192***	-5.35	-3.04
	Unknown	-2.220***	-3.01	-1.43
Native/ Hawaiian	Asian	-6.252***	-8.77	-3.73
	Non URM combo	-4.786***	-7.53	-2.05
	Unknown	-2.814**	-5.42	-.21
URM combo	Asian	-4.883***	-6.26	-3.51
	Black	1.629*	.18	3.08
	Non URM combo	-3.417***	-5.17	-1.67
Non URM combo	Asian	-1.466**	-2.66	-.28
	Black	5.045***	3.77	6.32
	Hispanic	3.179***	1.88	4.48
	White	4.192***	3.04	5.35
	Native/Hawaiian	4.786***	2.05	7.53
	URM combo	3.417***	1.67	5.17
	Unknown	1.972***	.61	3.34
Unknown	Asian	-3.439***	-4.28	-2.60
	Black	3.073***	2.11	4.03
	Hispanic	1.207**	.22	2.20
	White	2.220***	1.43	3.01
	Native/Hawaiian	2.814*	.21	5.42
	Non URM combo	-1.972***	-3.34	-.61

*p < .05, **p < .01, ***p < .000

Parent education and number of applications. Considering the cost of applying it was prudent to examine parent education and number of applications for differences. ANOVA demonstrated highly significant differences (F = 225.557, $p < .000$). The data showed that students with parents with higher levels of education generally submitted more applications. Applicants reporting a parent with post-doctoral education had the highest mean applications at 16.25 (SD= 11.81). Note that the Fee Assistance Program administered the AAMC likely had some influence on these numbers to mitigate the effects of number of applications based on parent education and the probable financial backing of a highly educated parent. The FAP provided for free application to 13 schools for students up to 300% of the U.S. federal poverty level. This could help explain how applicants reporting parent education of high school or less had 13.5 mean applications. Applicants not reporting parent education had the lowest mean for applications submitted at 10.11 (SD = 9.98).

Post hoc comparisons revealed significant differences between most categories of parent education and number of applications submitted (see Table 35). On average applicants with a parent with a doctorate or more submitted 2.7 more applications than applicants reporting parent education of high school or less or Bachelor’s degrees and 3.7 more applications than applicants reporting a parent education of some college. Applicants with a parent with some college education submitted fewer applications than all other parent education groups.

Table 35. ANOVA Parent Education and Number of Applications

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	136090.593	5	27218.119	225.557	.000
Within Groups	5045003.852	41808	120.671		
Total	5181094.445	41813			

Table 36. Number of Applications by Parent Education

	N	Mean	Std. Deviation	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
HS or Less	3611	13.50	10.730	13.15	13.85	1	122
Some College	2818	12.51	10.060	12.13	12.88	1	113
BS Degree/Some Grad	10711	13.47	10.745	13.27	13.67	1	113
Masters Degree/Some Doc	8940	14.75	10.979	14.53	14.98	1	118
Doctorate/Post Doc	11581	16.25	11.815	16.03	16.46	1	123
Unknown	4153	10.11	9.985	9.81	10.41	1	103
Total	41814	14.12	11.132	14.01	14.22	1	123

Summary of Application Data

Descriptive analyses demonstrated differences in numbers of applications submitted according to sex, race and parent education. The average number of applications was 14.12. Male applicants submitted more applications (14.38) than female applicants (13.87) on average. Asian applicants submitted the highest number of applications on average (18.4), while Black applicants had the lowest mean for applications (11.88). Applicants with a parent with some college education had the lowest mean number of applications (12.5) while applicants with a parent with a doctorate or more submitted the highest number of applications on average (16.25). I will now report acceptance outcome for applicants overall and by sex, race and parent education.

Table 37. Tukey Post Hoc Tests for Number of Applications and Parent Education

		Mean Difference	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
HS or Less	Some College	.995**	.21	1.78
	Masters Degree/Some Doc	-1.251***	-1.87	-.63
	Doctorate/Post Doc	-2.747***	-3.34	-2.15
	Unknown	3.392***	2.68	4.10
Some College	HS or Less	-.995**	-1.78	-.21
	BS Degree/Some Grad	-.964***	-1.63	-.30
	Masters Degree/Some Doc	-2.246***	-2.92	-1.57
	Doctorate/Post Doc	-3.742***	-4.40	-3.08
	Unknown	2.397***	1.63	3.16
BS Degree/Some Grad	Some College	.964***	.30	1.63
	Masters Degree/Some Doc	-1.283***	-1.73	-.83
	Doctorate/Post Doc	-2.779***	-3.20	-2.36
	Unknown	3.360***	2.79	3.93
Masters Degree/Some Doc	HS or Less	1.251***	.63	1.87
	Some College	2.246***	1.57	2.92
	BS Degree/Some Grad	1.283***	.83	1.73
	Doctorate/Post Doc	-1.496***	-1.94	-1.06
	Unknown	4.643***	4.06	5.23
Doctorate/Post Doc	HS or Less	2.747***	2.15	3.34
	Some College	3.742***	3.08	4.40
	BS Degree/Some Grad	2.779***	2.36	3.20
	Masters Degree/Some Doc	1.496***	1.06	1.94
	Unknown	6.139***	5.57	6.71
Unknown	HS or Less	-3.392***	-4.10	-2.68
	Some College	-2.397***	-3.16	-1.63
	BS Degree/Some Grad	-3.360***	-3.93	-2.79
	Masters Degree/Some Doc	-4.643***	-5.23	-4.06
	Doctorate/Post Doc	-6.139***	-6.71	-5.57

*p < .05, **p < .01, ***p < .000

Number of Acceptances

The majority of applicants who were accepted to medical school were accepted to just one school. The mean acceptance for the entire pool is .93, or slightly less than one school. Fifty-three percent of applicants were unsuccessful at gaining an acceptance. Figure 4 shows the skewed distribution of acceptances within the pool. Nearly 10% of applicants had two acceptances and nearly 5% of applicants had three. Just under 4% of applicants were accepted to five or more schools. These applicants could be considered the most elite and competitive of the applicant pool.

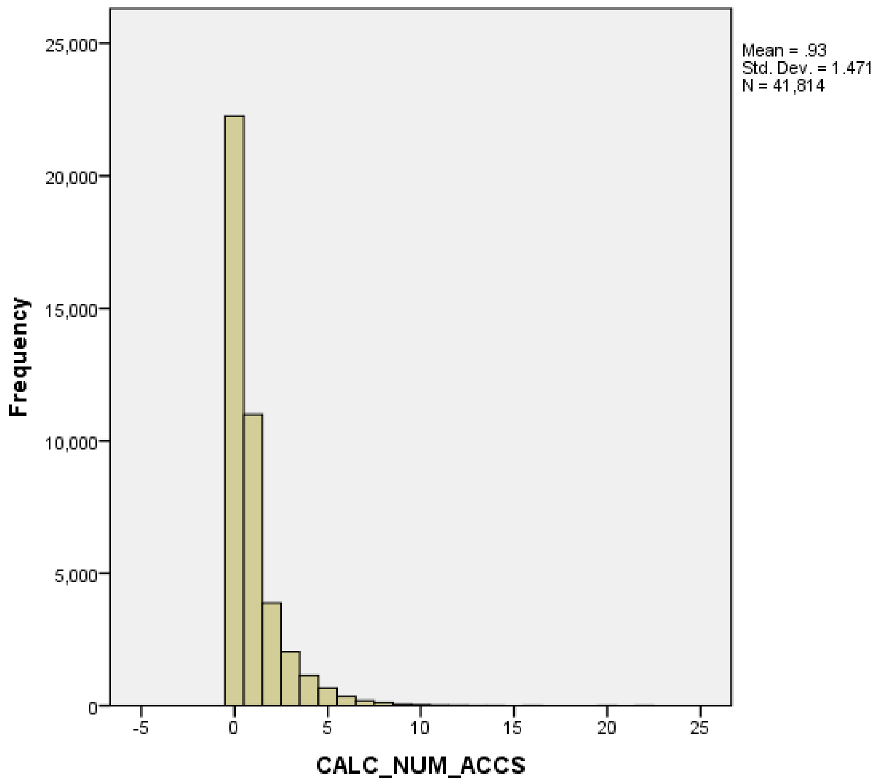

Figure 4. Total number of acceptances for all applicants

Table 38. Acceptances

	Frequency	Percent
Not accepted	22253	53.2
1 school	10992	26.3
2 schools	3884	9.3
3 schools	2046	4.9
4 schools	1152	2.8
5 or more	1487	3.6
Total	41814	100

Acceptance by sex. An independent samples t-test demonstrated significant differences in number of acceptances by sex (F = 91.393, $p < .000$). Female applicants had a higher mean acceptance than males at .97 (SD=1.55) compared to .89 (SD= 1.38) respectively. To examine differences more closely I created groups of up to five or more acceptances and explored them by sex. The Chi Square test demonstrated significant differences between male and female applicants across acceptance groups (χ^2=86.812, *df*=5, $p < .001$). The elite acceptance group of five or more was 55% female. Females outnumbered males among applicants accepted to three and fi=our schools as well.

Table 39. Acceptances by Sex

	N	Mean	Std. Deviation
Male	22066	.89	1.386
Female	19744	.97	1.559

Table 40. Independent Samples t-test Number of Applications and Sex

	Levene's Test		t-test for Equality of Means				
						95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	91.393	.000	-5.993	41808	.000	-.115	-.058
Equal variances not assumed			-5.954	39749.340	.000	-.115	-.058

Table 41. Sex and Acceptances Crosstabulation

		Male	Female	Total
Not accepted		11687	10562	22249
	% within	52.5%	47.5%	100.0%
1 school		6110	4882	10992
	% within	55.6%	44.4%	100.0%
2 schools		2018	1866	3884
	% within	52.0%	48.0%	100.0%
3 schools		1018	1028	2046
	% within	49.8%	50.2%	100.0%
4 schools		564	588	1152
	% within	49.0%	51.0%	100.0%
5 or more		669	818	1487
	% within	45.0%	55.0%	100.0%
Total		22066	19744	41810
	% within	52.8%	47.2%	100.0%

χ^2=86.812, *df*=5, *p* < .001

Acceptance by race. Differences in acceptance across race groups were highly significant as demonstrated by ANOVA (F = 13.136, *p* < .000). The highest mean acceptance by racial group was Hispanic applicants with a mean of 1.14 (SD=1.76). The next highest was non-URM combo with a mean of 1.1 (SD=1.59). The lowest mean acceptance by racial group was Native Hawaiian at .62 followed by applicants not reporting their race at .88. Post hoc comparisons showed significant differences in acceptances by racial categories for most of the comparisons (see Table 42). Hispanic applicants, on average, had higher mean acceptances than all other groups. Mean differences between White and Asian applicants were not significant. Black applicants had significantly fewer acceptances than Hispanic applicants and Non URM combo applicants, but comparative differences for White, Black, Native, and URM combo applicants were not significant.

The categorical groupings also revealed differences in number of acceptances as demonstrated by the Chi Square test (χ^2=365.08, $p < .001$). Table 43 shows the highest proportion within racial group for unaccepted applicants was Native applicants at 64.6% followed by Black applicants at 61.8%. The highest percent within race of acceptance to just one school was White applicants at 28%.

Among the pools by race, acceptance rates were as follows: Asians 45%, Blacks 38.1%, Hispanics 49.5%, Whites 48.4%, Native 35.4%, URM combo 47.6%, non URM combo 51.2%, and unknown race 42.6%. The overall race groupings suggested that Black and Native applicants were the least successful at navigating the preparation and application process for medicine when examining acceptance outcomes. The elite acceptance group (five or more acceptances) comprised just 3.6% of total applicants and I calculated that it was 10.8% Black, 10.7% Hispanic, 21% Asian and 47.4% White. This suggests that a larger proportion (albeit small raw number) of Black and Hispanic applicants are represented among elite accepts, despite their mean application numbers and mean acceptances being lower.

Table 42. ANOVA Race and Number of Acceptances

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	198.518	7	28.360	13.136	.000
Within Groups	90257.673	41806	2.159		
Total	90456.191	41813			

Table 43. Mean Number of Acceptances by Race

	N	Mean	Std. Deviation	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
Asian	8765	.89	1.457	.86	.92	0	22
Black	3169	.91	1.711	.85	.97	0	16
Hispanic	2710	1.14	1.767	1.07	1.20	0	16
White	23646	.92	1.386	.90	.94	0	20
Native/Hawaiian	175	.62	1.206	.44	.80	0	10
URM combo	615	1.08	1.779	.94	1.22	0	14
Non URM combo	843	1.10	1.592	1.00	1.21	0	9
Unknown	1891	.88	1.486	.81	.94	0	14
Total	41814	.93	1.471	.91	.94	0	22

Table 44. Tukey Post Hoc Tests for Race and Number of Acceptances

		Mean Difference	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Asian	Hispanic	-.250***	-.35	-.15
	URM combo	-.190*	-.38	.00
	Non URM combo	-.216**	-.38	-.06
Black	Hispanic	-.229***	-.35	-.11
	Non URM combo	-.195*	-.37	-.02
Hispanic	Asian	.250***	.15	.35
	Black	.229***	.11	.35
	White	.219***	.13	.31
	Native/Hawaiian	.516***	.17	.86
	Unknown	.263***	.13	.40
White	Hispanic	-.219***	-.31	-.13
	Non URM combo	-.185**	-.34	-.03
Native/Hawaiian	Hispanic	-.516***	-.86	-.17
	URM combo	-.455**	-.84	-.07
	Non URM combo	-.482**	-.85	-.11
URM combo	Asian	.190*	.00	.38
	Native/Hawaiian	.455**	.07	.84

Non URM combo	Asian	.216**	.06	.38
	Black	.195*	.02	.37
	White	.185**	.03	.34
	Native/Hawaiian	.482**	.11	.85
	Unknown	.229**	.04	.41
Unknown	Hispanic	-.263***	-.40	-.13
	Non URM combo	-.229**	-.41	-.04

*p < .05, **p < .01, ***p < .000

Table 45. Race and Number of Acceptances Crosstabulation

			Accept-ances	Total	3 schools	4 schools	5 or more	
Asian		4813	2236	810	399	194	313	8765
	% within	54.9%	25.5%	9.2%	4.6%	2.2%	3.6%	100.0%
Black		1959	617	198	137	97	161	3169
	% within	61.8%	19.5%	6.2%	4.3%	3.1%	5.1%	100.0%
Hispanic		1367	684	232	170	97	160	2710
	% within	50.4%	25.2%	8.6%	6.3%	3.6%	5.9%	100.0%
White		12184	6612	2311	1163	671	705	23646
	% within	51.5%	28.0%	9.8%	4.9%	2.8%	3.0%	100.0%
Native/ Hawaiian		113	37	17	2	3	3	175
	% within	64.6%	21.1%	9.7%	1.1%	1.7%	1.7%	100.0%
Urm combo		322	159	46	35	16	37	615
	% within	52.4%	25.9%	7.5%	5.7%	2.6%	6.0%	100.0%
Non URM combo		411	216	94	49	32	41	843
	% within	48.8%	25.6%	11.2%	5.8%	3.8%	4.9%	100.0%
Unknown		1084	431	176	91	42	67	1891
	% within	57.3%	22.8%	9.3%	4.8%	2.2%	3.5%	100.0%
Total		22253	10992	3884	2046	1152	1487	41814
	% within total	53.2%	26.3%	9.3%	4.9%	2.8%	3.6%	100.0%

χ^2=365.08, *df*=35, *p* < .001

Acceptance and parent education. Results for acceptance by parent education indicated there may be advantages to having a highly educated parent. ANOVA (F = 184.027, $p < .000$). Applicants with lower levels of parent education were accepted to fewer schools than applicants with a doctorate or post doctorate educated parent. The lowest mean acceptances by parent education were among applicants reporting a parent with high school education or less (.69) or some college education (.69). The highest mean acceptance by parent education was 1.20 for applicants reporting a parent with doctorate or post-doctorate degree followed by 1.05 for applicants with a parent with a Master's degree. Note applicants with parent education unknown had the lowest mean acceptance at .59.

Post hoc comparisons revealed differences in mean acceptances across most parent education classifications (see Table 46). The pattern that emerged for parent education and number of applications remained consistent for number of acceptances as well. Applicants with parent education of high school and some college had lower acceptances than the applicants with higher educational levels. Applicants with a parent with a doctorate or higher were accepted to more schools on average than applicants from all the other categories of parent education and .507 more schools on average than applicants from a parent with only a high school education or less ($p < .000$). The mean acceptance for the entire pool was .93, so a mean difference of .507 was a sizeable discrepancy.

To further examine group differences I used the same acceptance groupings as above and the Chi Square test revealed differences between acceptance groups and parent education were highly significant (χ^2=1170.52, $p < .001$). Applicants with a parent with at least a doctorate were strongly represented in the crosstab among the five or more elite accept group at 41%. This may indicate that applicants with highly educated parents were the most competitive in the national pool because they benefitted from social, economic, and cultural capital accumulated through education (Bourdieu, 1986).

Table 46. ANOVA Parent Education and Acceptance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1947.945	5	389.589	184.027	.000
Within Groups	88508.246	41808	2.117		
Total	90456.191	41813			

Table 47. Mean Acceptance and Parent Education

				95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Lower Bound	Upper Bound	Min	Max
HS or Less	3611	.69	1.365	.65	.74	0	14
Some College	2818	.69	1.230	.64	.73	0	10
BS Degree/Some Grad	10711	.82	1.365	.79	.84	0	20
Masters Degree/Some Doc	8940	1.05	1.558	1.01	1.08	0	22
Doctorate/Post Doc	11581	1.20	1.649	1.17	1.23	0	16
Unknown	4153	.59	1.029	.56	.62	0	10
Total	41814	.93	1.471	.91	.94	0	22

Table 48. Tukey Post Hoc Tests for Parent Education and Mean Number Acceptances

			95% Confidence Interval	
		Mean Difference	Lower Bound	Upper Bound
HS or Less	BS degree/some grad	-.126***	-.21	-.05
	Masters Degree/Some Doc	-.354***	-.44	-.27
	Doctorate/Post Doc	-.507***	-.59	-.43
	Unknown	.105**	.01	.20
Some College	BS Degree/Some Grad	-.130***	-.22	-.04
	Masters Degree/Some Doc	-.358***	-.45	-.27
	Doctorate/Post Doc	-.511***	-.60	-.42
BS Degree/Some Grad	HS or Less	.126***	.05	.21
	Some College	.130***	.04	.22
	Masters Degree/Some Doc	-.228***	-.29	-.17
	Doctorate/Post Doc	-.381***	-.44	-.33
	Unknown	.231***	.16	.31
Masters degree/some doc	HS or Less	.354***	.27	.44
	Some College	.358***	.27	.45
	BS Degree/Some Grad	.228***	.17	.29
	Doctorate/Post Doc	-.153***	-.21	-.09
	Unknown	.459***	.38	.54
doctorate/post doc	HS or Less	.507***	.43	.59
	Some College	.511***	.42	.60
	BS Degree/Some Grad	.381***	.33	.44
	Masters Degree/Some Doc	.153***	.09	.21
	Unknown	.612***	.54	.69
Unknown	HS or Less	-.105**	-.20	-.01
	BS Degree/Some Grad	-.231***	-.31	-.16
	Masters Degree/Some Doc	-.459***	-.54	-.38
	Doctorate/Post Doc	-.612***	-.69	-.54

**p < .01, ***p < .000

Table 49. Parent Education and Acceptance

		Number of Schools						Total
		0	1	2	3	4	5 +	
HS or Less		2308	791	243	114	61	94	3611
	% within	63.9%	21.9%	6.7%	3.2%	1.7%	2.6%	100.0%
Some College		1746	660	206	92	50	64	2818
	% within	62.0%	23.4%	7.3%	3.3%	1.8%	2.3%	100.0%
BS Degree/Some Grad		6075	2703	959	454	223	297	10711
	% within	56.7%	25.2%	9.0%	4.2%	2.1%	2.8%	100.0%
Masters Degree/Some Doc		4428	2416	901	494	331	370	8940
	% within	49.5%	27.0%	10.1%	5.5%	3.7%	4.1%	100.0%
Doctorate/Post Doc		5101	3327	1325	777	439	612	11581
	% within	44.0%	28.7%	11.4%	6.7%	3.8%	5.3%	100.0%
Unknown		2595	1095	250	115	48	50	4153
	% within	62.5%	26.4%	6.0%	2.8%	1.2%	1.2%	100.0%
Total		22253	10992	3884	2046	1152	1487	41814
	% within	53.2%	26.3%	9.3%	4.9%	2.8%	3.6%	100.0%

χ^2=1170.52, *df*=25, $p < .001$

Summary of Acceptance Data

The mean number of acceptances for applicants to medical school was .93. Variances in this mean acceptance differed significantly across sex, race and parent education. Female applicants had significantly higher mean acceptances (.97) than male applicants (.89). Hispanic applicants had significantly higher mean acceptances (1.14) compared to the other racial groups. Applicants from doctorate and post doctorate educated parents had higher mean acceptances (1.20) than applicants from parents with bachelor's degrees or lower (≤.82). Descriptive statistics for individual characteristics within the applicant pool revealed vast differences across the pool. I now turn to institutional characteristics to examine differences.

Undergraduate Institution Characteristics

This section explores differences in the pool of applicants to medical school by institutional size, institutional type (public/private) and institutional selectivity across sex, race and parent education. These school level covariates are examined later in the hierarchical linear model to determine the effect, if any, on acceptance and matriculating medical school selectivity.

Institutional Size

The descriptive data for schools revealed that 53.5% of applicants came from very large institutions with student populations of 20,000 or more. Less than 1% of applicants came from colleges with student populations under 1,000. Small, selective liberal arts colleges, which typically had a 1,000-4,999 campus population range, represented 15.3% of the applicant pool.

Table 50. School Size

	Frequency	Percent
Under 1,000	352	0.8
1,000 - 4,999	6391	15.3
5,000 - 9,999	4000	9.6
10,000 - 19,999	8705	20.8
20,000 and above	22366	53.5
Total	41814	100

Sex and institutional size. Chi Square tests confirmed significant differences across school size by sex (χ^2=131.141, p < .001). Female applicants were more represented at schools in size categories with student body sizes of 9,999 or less, while male applicants comprised larger percentages of the applicants from schools in the categories of 10,000 students or more.

Table 51. School Size and Sex Crosstabulation

		Male	Female	Total
Under 1,000		171	181	352
	% within	48.6%	51.4%	100.0%
1,000 - 4,999		3072	3317	6389
	% within	48.1%	51.9%	100.0%
5,000 - 9,999		1996	2003	3999
	% within	49.9%	50.1%	100.0%
10,000 - 19,999		4480	4225	8705
	% within	51.5%	48.5%	100.0%
20,000 and above		12347	10018	22365
	% within	55.2%	44.8%	100.0%
Total		22066	19744	41810
	% within	52.8%	47.2%	100.0%

χ^2=131.141, df=4, p < .001

Race and institutional size. Differences between race groups across undergraduate school size were highly significant (χ^2=1229.16, p < .001). Table 52 for race across school size showed that a higher percentage of Black applicants than Hispanic, White or Asian attended very small (under 1,000), small (1,000-4,999) or mid-size (5,000-9,999) schools. Less than half of the Black applicants attended very large (20,000+) schools, which was the smallest percentage of any of the racial groups. Asian students were most prominently from very large institutions with 66.8% from schools with student populations greater than 20,000.

Table 52. Race and Undergraduate School Size

		School Size					
		Under 1,000	1,000 - 4,999	5,000 - 9,999	10,000 - 19,999	20,000 and above	Total
Asian		24	632	664	1591	5854	8765
	% within	0.3%	7.2%	7.6%	18.2%	66.8%	100.0%
Black		39	585	436	738	1371	3169
	% within	1.2%	18.5%	13.8%	23.3%	43.3%	100.0%
Hispanic		13	312	256	600	1529	2710
	% within	0.5%	11.5%	9.4%	22.1%	56.4%	100.0%
White		243	4301	2258	5045	11799	23646
	% within	1.0%	18.2%	9.5%	21.3%	49.9%	100.0%
Native/Hawaiian		3	25	28	19	100	175
	% within	1.7%	14.3%	16.0%	10.9%	57.1%	100.0%
URM combo		9	85	67	151	303	615
	% within	1.5%	13.8%	10.9%	24.6%	49.3%	100.0%
Non URM combo		3	114	76	144	506	843
	% within	0.4%	13.5%	9.0%	17.1%	60.0%	100.0%
Unknown		18	337	215	417	904	1891
	% within	1.0%	17.8%	11.4%	22.1%	47.8%	100.0%
Total		352	6391	4000	8705	22366	41814
	% within total	0.8%	15.3%	9.6%	20.8%	53.5%	100.0%

χ^2=1229.16, *df*=28, *p* < .001

Parent education and school size. There were differences in parent education and institutional size categories as the Chi Square test was highly significant (χ^2=50.64, *p* < .001). Applicants across each parent education category appeared to attend each size designation of undergraduate institution in fairly equitable percentages, yet differences were statistically significant. Like the overall pool, institutions of 20,000 students or more were the highest proportion of every parent education category at 52.1%-54.8%, followed by 10,000-19,999 at 20.2%-21.7%.

Table 53. Parent Education and School Size Crosstabulation

		School Size					Total
		Under 1,000	1,000 - 4,999	5,000 - 9,999	10,000 - 19,999	20,000 and above	
HS or Less		34	541	342	728	1966	3611
	% within	0.9%	15.0%	9.5%	20.2%	54.4%	100.0%
Some College		33	446	297	574	1468	2818
	% within	1.2%	15.8%	10.5%	20.4%	52.1%	100.0%
BS Degree/Some Grad		106	1580	1000	2152	5873	10711
	% within	1.0%	14.8%	9.3%	20.1%	54.8%	100.0%
Masters Degree/Some Doc		44	1401	834	1897	4764	8940
	% within	0.5%	15.7%	9.3%	21.2%	53.3%	100.0%
Doctorate/Post Doc		98	1823	1102	2508	6050	11581
	% within	0.8%	15.7%	9.5%	21.7%	52.2%	100.0%
Unknown		37	600	425	846	2245	4153
	% within	0.9%	14.4%	10.2%	20.4%	54.1%	100.0%
Total		352	6391	4000	8705	22366	41814
	% within total	0.8%	15.3%	9.6%	20.8%	53.5%	100.0%

χ^2=50.64, *df*=20, p < .001

Institutional Type

The breakdown of institutional type for the applicant pool was 58.5% public and 41.5% private. Just 1.5% of applicants to medicine attended a college classified as a Historically Black College or University (HBCU). Just one applicant in the entire pool came from a Tribal College.

Table 54. Type of Institution

	Frequency	Percent
Public	24,463	58.5
Private	17,351	41.5
Total	41,814	100

Institutional type and sex. Chi-Square analysis revealed significant differences in institutional type by sex (χ^2=159.286, p < .001). Within category by sex, male applicants attended public institutions at a higher percentage than female applicants 61.4% versus 55.3% respectively.

Table 55. Institutional Type and Sex Crosstabulation

		Public	Private	Total
Male		13544	8522	22066
	% within	61.4%	38.6%	100.0%
Female		10916	8828	19744
	% within	55.3%	44.7%	100.0%
Total		24460	17350	41810
	% within total	58.5%	41.5%	100.0%

χ^2=159.286, *df*=1, p < .001

Institutional type and race. Chi Square demonstrated significant differences in public versus private institution across race categories (χ^2=102.775, p < .001). Comparisons within race groups showed that Asian applicants had a slightly higher percentage of attendance at public colleges at 61.5% surpassed only by Native applicants at 67.4%. Black applicants attended private institutions 43% of the time while Hispanic applicants attended private schools 38.6% of the time.

Table 56. Race and Institutional Type Crosstabulation

		Public	Private	Total
Asian		5391	3374	8765
	% within	61.5%	38.5%	100.0%
Black		1805	1364	3169
	% within	57.0%	43.0%	100.0%
Hispanic		1663	1047	2710
	% within	61.4%	38.6%	100.0%
White		13689	9957	23646
	% within	57.9%	42.1%	100.0%
Native/Hawaiian		118	57	175
	% within	67.4%	32.6%	100.0%
URM combo		365	250	615
	% within	59.3%	40.7%	100.0%
Non URM combo		471	372	843
	% within	55.9%	44.1%	100.0%
Unknown		961	930	1891
	% within	50.8%	49.2%	100.0%
Total		24463	17351	41814
	% within total	58.5%	41.5%	100.0%

χ^2=102.775, *df*=7, $p < .001$

Institutional type and parent education. There were significant differences across institutional type and parent education categories (χ^2=845.208, $p < .001$). Applicants reporting a parent with a bachelor's degree or less attended public schools at higher percentages than the total applicant pool, while applicants with a parent with a Master's degree or more attended private schools at higher percentages than the total pool. Applicants with a parent holding a doctorate or higher comprise the largest within group percentage of private school attendees at 51.4%, roughly 10% higher than the total pool's percentage of private school attendance.

Table 57. Parent Education and Institutional Type Crosstabulation

		Public	Private	Total
HS or Less		2403	1208	3611
	% within	66.5%	33.5%	100.0%
Some College		1853	965	2818
	% within	65.8%	34.2%	100.0%
BS Degree/		6769	3942	10711
Some Grad	% within	63.2%	36.8%	100.0%
Masters Degree/		5058	3882	8940
Some Doc	% within	56.6%	43.4%	100.0%
Doctorate/Post Doc		5624	5957	11581
	% within	48.6%	51.4%	100.0%
Unknown		2756	1397	4153
	% within	66.4%	33.6%	100.0%
Total		24463	17351	41814
	% within	58.5%	41.5%	100.0%

χ^2=845.208, *df*=5, $p < .001$

Applications and Institutional Type

An independent t-test revealed highly significant mean differences in the number of applications submitted based on institutional type (F = 8.373, $p < .004$). Applicants from public schools submitted 13.49 (SD=11.41) applications on average versus a mean of 15 (SD=10.66) applications for applicants from private schools.

Table 58. Institutional Type and Number of Applications

	N	Mean	Std. Deviation
Public	24463	13.49	11.411
Private	17351	15.00	10.664

Table 59. Independent Samples t-test Institutional Type and Applications

	Levene's Test		t-test for Equality of Means				95% Confidence Interval of the Difference	
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Equal variances assumed	8.373	.004	-13.695	41812	.000	-1.510	-1.726	-1.294
Equal variances not assumed			-13.854	38815.448	.000	-1.510	-1.723	-1.296

Acceptance and Institutional Type

There were highly significant differences in number of acceptances by institutional type according to independent t-test results (F= 1187.975, $p < .000$). The mean number of acceptances for applicants from private institutions was 1.19 (SD=1.72) while the mean number of acceptances for applicants attending public colleges was .74 (SD=1.23).

Table 60. Institutional Type and Acceptance

	N	Mean	Std. Deviation
Public	24463	.74	1.231
Private	17351	1.19	1.720

Table 61. Independent Samples t-test Institutional Type and Acceptances

	Levene's Test		t-test for Equality of Means				95% Confidence Interval of the Difference	
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Equal variances assumed	1187.975	.000	-31.509	41812	.000	-.455	-.483	-.426
Equal variances not assumed			-29.825	29486.445	.000	-.455	-.484	-.425

Institutional Size and Applications

There were significant differences in number of applications submitted across institutional size categories (F=1.73.12, $p < .000$). Means for number of applications submitted increased as institutional size increased across categories. Applicants from schools under 1,000 students submitted just 9.95 (SD= 9.19) applications on average compared to applicants from schools of 20,000+ submitting 15.31 (SD=11.87) applications on average. Post hoc comparisons were significant in every size category comparison for mean differences in applications submitted by school size with the largest mean difference (about five applications) occurring between the smallest and largest size categories. Applicants from very small colleges of less than 1,000 students submitted fewer applications than all applicants from other institutional size categories. Applicants from campuses with student populations 20,000 or more submitted more applications than applicants all the other institutional size categories.

Table 62. ANOVA Institutional Size and Number of Applications

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	84419.015	4	21104.754	173.126	.000
Within Groups	5096675.430	41809	121.904		
Total	5181094.445	41813			

Table 63. Means for Institutional Size and Number of Applications

	N	Mean	Std. Deviation	95% Confidence Interval for Mean Lower Bound	Upper Bound	Min	Max
Under 1,000	352	9.95	9.199	8.98	10.91	1	54
1,000 - 4,999	6391	11.69	9.303	11.46	11.92	1	87
5,000 - 9,999	4000	12.90	9.721	12.59	13.20	1	110
10,000 - 19,999	8705	13.56	10.622	13.34	13.79	1	114
20,000 and above	22366	15.31	11.876	15.16	15.47	1	123
Total	41814	14.12	11.132	14.01	14.22	1	123

Table 64. Tukey Post Hoc Tests for Institutional Size and Number of Applications

		Mean Difference	95% Confidence Interval Lower Bound	Upper Bound
Under 1,000	1,000 - 4,999	-1.739*	-3.39	-.09
	5,000 - 9,999	-2.947***	-4.62	-1.27
	10,000 - 19,999	-3.614***	-5.25	-1.98
	20,000 and above	-5.363***	-6.98	-3.75
1,000 - 4,999	Under 1,000	1.739*	.09	3.39
	5,000 - 9,999	-1.208***	-1.82	-.60
	10,000 - 19,999	-1.875***	-2.37	-1.38
	20,000 and above	-3.624***	-4.05	-3.20
5,000 - 9,999	Under 1,000	2.947***	1.27	4.62
	1,000 - 4,999	1.208***	.60	1.82
	10,000 - 19,999	-.667**	-1.24	-.09
	20,000 and above	-2.416***	-2.93	-1.90
10,000 - 19,999	Under 1,000	3.614***	1.98	5.25
	1,000 - 4,999	1.875***	1.38	2.37
	5,000 - 9,999	.667**	.09	1.24
	20,000 and above	-1.749***	-2.13	-1.37
20,000 and above	Under 1,000	5.363***	3.75	6.98
	1,000 - 4,999	3.624***	3.20	4.05
	5,000 - 9,999	2.416***	1.90	2.93
	10,000 - 19,999	1.749***	1.37	2.13

*p < .05, **p < .01, ***p < .000

Institutional Size and Acceptance

Analysis of variance confirmed significant differences for institutional size and number of acceptances to medical school (F=19.284, $p < .000$). Applicants from institutions of under 1,000 students had the smallest mean acceptance at .63 (SD=1.02), while applicants from institutions of 10,000-19,999 had the highest mean acceptance at 1.03 (SD=1.58). Applicants from very large institutions (20,000+) had a mean acceptance just under the total applicant pool mean of .90 (SD=1.43) compared to .93 (SD=1.47). Post hoc comparisons revealed significant differences in nearly every categorical comparison of institutional size and acceptance (see Table 65). Applicants from very small schools had fewer acceptances compared to all the other size categories. Applicants from schools between 5,000-9,999 and 10,000-19,999 had more acceptances than applicants from very small (less than 1,000), small (1,000-4,999) or very large (20,000 or more) institutions.

Table 65. ANOVA Institutional Size and Acceptance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	166.583	4	41.646	19.284	.000
Within Groups	90289.609	41809	2.160		
Total	90456.191	41813			

Table 66. Means for Institutional Size and Acceptance

	N	Mean	Std. Deviation	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
Under 1,000	352	.63	1.027	.52	.73	0	7
1,000 - 4,999	6391	.88	1.395	.85	.92	0	12
5,000 - 9,999	4000	1.00	1.568	.95	1.04	0	14
10,000 - 19,999	8705	1.03	1.585	.99	1.06	0	16
20,000 and above	22366	.90	1.431	.88	.92	0	22
Total	41814	.93	1.471	.91	.94	0	22

Table 67. Tukey Post Hoc Tests Institutional Size and Acceptance

		Mean Difference	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Under 1,000	1,000 - 4,999	-.257**	-.48	-.04
	5,000 - 9,999	-.370***	-.59	-.15
	10,000 - 19,999	-.400***	-.62	-.18
	20,000 and above	-.273**	-.49	-.06
1,000 - 4,999	Under 1,000	.257**	.04	.48
	5,000 - 9,999	-.113***	-.19	-.03
	10,000 - 19,999	-.143***	-.21	-.08
5,000 - 9,999	Under 1,000	.370***	.15	.59
	1,000 - 4,999	.113***	.03	.19
	20,000 and above	.097***	.03	.17
10,000 - 19,999	Under 1,000	.400***	.18	.62
	1,000 - 4,999	.143***	.08	.21
	20,000 and above	.127***	.08	.18
20,000 and above	Under 1,000	.273**	.06	.49
	5,000 - 9,999	-.097***	-.17	-.03
	10,000 - 19,999	-.127***	-.18	-.08

*p < .05, **p < .01, ***p < .000

Institutional Selectivity

Sex and Selectivity. A Chi Square test confirmed significant differences in institutional selectivity categories across sex (χ^2=37.896, p < .001). Female applicants comprised a larger percentage of applicants from inclusive institutions, while males were greater percentages in both selective and more selective institutional categories. Male applicants from more selective undergraduate institutions comprised 36.2% of the applicant pool.

Table 68. Institutional Selectivity and Sex Crosstabulation

		Male	Female	Total
Inclusive		1115	1214	2329
	% within	47.9%	52.1%	100.0%
	% of Total	2.7%	2.9%	5.6%
Selective		5833	4847	10680
	% within	54.6%	45.4%	100.0%
	% of Total	14.0%	11.6%	25.5%
More Selective		15118	13683	28801
	% within	52.5%	47.5%	100.0%
	% of Total	36.2%	32.7%	68.9%
Total		22066	19744	41810
	% of Total	52.8%	47.2%	100.0%

χ^2=37.896, *df*=2, $p < .001$

Race and institutional selectivity. Differences by race group across institutional selectivity categories were significant according to Chi Square results (χ^2=1896.231, $p < .001$). A large percentage of Black applicants came from inclusive institutions. About 5% of the total applicant pool applied from inclusive schools, and within those 5%, 18% were Black applicants. Black applicants also represented the smallest portion of applicants at more selective universities at just under 50%, while Asian applicants came from more selective schools 79.1% of the time. Hispanic students and Native students were also more widely represented at inclusive schools at 9% and 14.9% respectively.

Table 69. Race and Institutional Selectivity

		Inclusive	Selective	More Selective	Total
Asian		286	1542	6937	8765
	% within	3.3%	17.6%	79.1%	100.0%
Black		569	1035	1565	3169
	% within	18.0%	32.7%	49.4%	100.0%
Hispanic		245	876	1589	2710
	% within	9.0%	32.3%	58.6%	100.0%
White		1012	6421	16213	23646
	% within	4.3%	27.2%	68.6%	100.0%
Native/Hawaiian		26	42	107	175
	% within	14.9%	24.0%	61.1%	100.0%
URM Combo		40	203	372	615
	% within	6.5%	33.0%	60.5%	100.0%
Non URM Combo		23	160	660	843
	% within	2.7%	19.0%	78.3%	100.0%
Unknown		128	403	1360	1891
	% within	6.8%	21.3%	71.9%	100.0%
Total		2329	10682	28803	41814
	% within total	5.6%	25.5%	68.9%	100.0%

χ^2=1896.231, df=14, $p < .001$

Parent education and selectivity. Differences by parent education category across undergraduate institution selectivity were significant (χ^2=1672.068, $p < .001$). Applicants with at least one parent having a doctorate degree came from more selective colleges 80.1% of the time. Applicants with a parent with a Master's degree attended more selective schools 73.4% of the time. Among applicants with parents that have less than a Bachelor's degree, percentages attending inclusive institutions were 9.2% (some college) and 9.7% (high school or less). Just 2.9% of applicants with a parent with a doctorate and 4.4% of applicants with a parent with a Master's attended an inclusive institution.

Table 70. Selectivity and Parent Education Crosstabulation

Parent Education		Inclusive	Selective	More Selective	Total
HS or Less		350	1261	2000	3611
	% within	9.70%	34.90%	55.40%	100.00%
Some College		260	986	1572	2818
	% within	9.20%	35.00%	55.80%	100.00%
BS Degree/Some Grad		619	3089	7003	10711
	% within	5.80%	28.80%	65.40%	100.00%
Masters Degree/Some Doc		393	1981	6566	8940
	% within	4.40%	22.20%	73.40%	100.00%
Doctorate/Post Doc		341	1966	9274	11581
	% within	2.90%	17.00%	80.10%	100.00%
Unknown		366	1399	2388	4153
	% within	8.80%	33.70%	57.50%	100.00%
Total		2329	10682	28803	41814
	% within total	5.60%	25.50%	68.90%	100.00%

χ^2=1672.068, *df*=10, $p < .001$

Applications and selectivity. Differences in number of applications across institutional selectivity category were highly significant (F=13.22.972, $p < .000$). Applicants from more selective institutions applied to 15.94 (SD=11.55) schools on average compared to applicants from selective or inclusive schools which were 10.23 (SD=8.89) and 9.42 (SD=8.92) mean applications respectively. Post hoc comparisons confirmed that there were significant differences between all categories (see Table 71). Applicants from more selective schools submitted 6.5 more applications on average than applicants from inclusive schools ($p < .000$) and 5.7 more applications on average than applicants from selective schools ($p < .000$).

Table 71. ANOVA Institutional Selectivity and Number of Applications

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	308363.102	2	154181.551	1322.972	0.000
Within Groups	4872731.343	41811	116.542		
Total	5181094.445	41813			

Table 72. Institutional Selectivity and Number of Applications

				95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Lower Bound	Upper Bound	Min	Max
Inclusive	2329	9.42	8.925	9.06	9.78	1	113
Selective	10682	10.23	8.891	10.06	10.40	1	103
More Selective	28803	15.94	11.551	15.81	16.07	1	123
Total	41814	14.12	11.132	14.01	14.22	1	123

Table 73. Tukey Post Hoc Tests for Selectivity and Number of Applications

			95% Confidence Interval	
		Mean Difference	Lower Bound	Upper Bound
Inclusive	Selective	-.809**	-1.39	-.23
	More Selective	-6.518***	-7.06	-5.97
Selective	Inclusive	.809**	.23	1.39
	More Selective	-5.709***	-6.00	-5.42
More Selective	Inclusive	6.518***	5.97	7.06
	Selective	5.709***	5.42	6.00

**p < .01, ***p < .000

Acceptance and selectivity. ANOVA showed there were highly significant differences in acceptance across institutional selectivity categories (F=663.155, $p < .000$).

The mean acceptance for applicants from inclusive institutions was .46 (SD=.91) compared to applicants from more selective institutions who had a mean of 1.10 (SD=1.61). Selective schools had a mean acceptance of .56 with a standard deviation of .99. Post hoc comparisons were all significant and demonstrated that differences occurred between applicants from inclusive schools compared to both selective and more selective schools (see Table 74).

The Chi Square test for acceptance groupings and selectivity was significant (χ^2=1471.615, $p < .001$). Table 75 shows that across applicants receiving one acceptance, 70.6% came from more selective schools. Among the most elite applicants receiving five or more acceptances, 90.7% were from more selective institutions.

Table 74. ANOVA Institutional Selectivity and Acceptance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2781.190	2	1390.595	663.155	.000
Within Groups	87675.002	41811	2.097		
Total	90456.191	41813			

Table 75. Institutional Selectivity and Acceptance

				95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Lower Bound	Upper Bound	Minimum	Maximum
Inclusive	2329	.46	.912	.43	.50	0	11
Selective	10682	.56	.996	.55	.58	0	14
More Selective	28803	1.10	1.615	1.08	1.12	0	22
Total	41814	.93	1.471	.91	.94	0	22

Table 76. Tukey Post Hoc Tests Selectivity and Acceptance

			95% Confidence Interval	
		Mean Difference	Lower Bound	Upper Bound
Inclusive	Selective	-.101**	-.18	-.02
	More Selective	-.638***	-.71	-.57
Selective	Inclusive	.101**	.02	.18
	More Selective	-.537***	-.58	-.50
More Selective	Inclusive	.638***	.57	.71
	Selective	.537***	.50	.58

**p < .01, ***p < .000

Table 77. Institutional Selectivity and Acceptances Crosstabulation

		Inclusive	Selective	More Selective	Total
Not accepted		1602	6792	13859	22253
	% within	7.2%	30.5%	62.3%	100.0%
1 school		532	2700	7760	10992
	% within	4.8%	24.6%	70.6%	100.0%
2 schools		116	689	3079	3884
	% within	3.0%	17.7%	79.3%	100.0%
3 schools		45	276	1725	2046
	% within	2.2%	13.5%	84.3%	100.0%
4 schools		13	108	1031	1152
	% within	1.1%	9.4%	89.5%	100.0%
5 or more		21	117	1349	1487
	% within	1.4%	7.9%	90.7%	100.0%
Total		2329	10682	28803	41814
	% within total	5.6%	25.5%	68.9%	100.0%

χ^2=1471.615, df=10, $p < .001$

Summary of Institutional Characteristics

The descriptive data of institutional type, size and selectivity showed differences across the applicant pool by individual characteristics of sex, race and parent education. Applicants with higher levels of parent education attended more selective schools.

Applicants from more selective schools submitted more applications, on average, than applicants from selective or inclusive institutions. Applicants attending private institutions submitted more applications and were accepted to more schools, on average, than applicants from public schools. Applicants accepted to five or more schools were from more selective schools 90% of the time. I now turn to the HLM to examine these differences simultaneously, implementing the controls allowable in a statistically robust model.

Hierarchical Linear Models

The hierarchical linear model (HLM) allowed for exploration of the influences of individual and school-based characteristics in modeling acceptance to medical school so that these differences could be explored simultaneously. An HLM allowed for partitioning of variance in acceptance related to individual variables and institutional variables to better understand which characteristics had influence. The hierarchical general linear model HGLM) allowed for exploration of individual and institutional predictors for non-linear outcomes. This study utilized HGLM to examine predictors among accepted students for matriculating to a highly selective medical school. The nature of educational settings portend to multilevel modeling, which accounts for nesting and effectively controls for differences based on the individual, classroom, or institution (Raudenbush & Bryk, 2002). I will first present results for the HLM followed by HGLM.

HLM Results

In this section I report analysis for examining individual and institutional influences on acceptance to medical school. Recall the research question: Among the applicants to medical school, what influence do individual and institutional factors have on the number of schools to which a student is accepted? The HLM explored the influence of race, sex, parent education and academic components on the number of schools to which a student was accepted, controlling for different institutional characteristics. At level two the HLM explored the influence of graduating from a public or private institution, institutional size, and institutional selectivity on the number of schools to which a student was accepted.

ANOVA model. One-way ANOVA was used to partition the variance and examine how much difference was associated within undergraduate institutions and how much was between institutions (Raudenbush & Bryk, 2002). The initial variance in acceptance was modeled with the following equations:

$$Y = \beta_0 + r_0$$

$$\beta_0 = \gamma_{00} + \tau_{00}$$

Using the number of acceptances as the dependent variable, the grand mean (β_0) was .6859 and the error term (r_0) was .0167. The grand mean was then partitioned into the institutional effect (γ_{00}) 1.9141 and the individual effect (τ_{00}) .1561. The estimation of the grand mean of number of acceptances was tested for significance so that an estimation of variance could be calculated with a p-value and standard error indicating that it was (or was not) significantly different from zero. The results (see Table 78) indicated that the ANOVA was highly significant ($p < .001$).

Table 78. ANOVA Model Results

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. df	*p*-value
For INTRCPT1, β_0					
INTRCPT2, γ_{00}	0.685932	0.016737	40.983	1358	<0.001
	Standard Deviation	Variance Component			
INTRCPT1, u_0	0.39505	0.15607	1358	7702.1789	<0.001
level-1, *r*	1.38351	1.91409			
$\sigma^2 = 1.91409$					

The intraclass correlation coefficient. To provide additional context for the model, Raudenbush and Bryk (2002) recommend calculating the intraclass correlation coefficient (ICC). The ICC is a ratio of the predicted variance between institutions divided by the sum of the predicted variance between institutions and within institutions. This helps determine how much of the variation in the number of medical school acceptances was associated with factors between institutions, in this case how much of the variation in number of acceptances was associated with the difference of attending one type of college versus another. The ICC for the model was .0753 which means that about 7% of the variance in acceptances could be attributed to differences between institutions.

Multilevel Model and Random Coefficient

This model utilized several level 1 predictors including race, academic performance, parent education, and sex to further explore differences in admission outcomes. The level 1 random coefficient equation modeled slope and intercept by the coefficients previously mentioned. The HLM output conducted five iterations before producing a reliability estimate and fitting the model. The model was as follows:

Level 1:

$Number\ of\ Acceptances_{ij} = \beta_{0j} + \beta_{1j}*(less\ than\ BS\ degree_{ij}) + \beta_{2j}*(BS\ degree_{ij}) + \beta_{3j}*(MS\ degree_{ij}) + \beta_{4j}*(unknown\ education_{ij}) + \beta_{5j}*(academic\ index_{ij}) + \beta_{6j}*(Asian_{ij}) + \beta_{7j}*(Hispanic_{ij}) + \beta_{8j}*(Black_{ij}) + \beta_{9j}*(Native_{ij}) + \beta_{10j}*(Unknown\ race_{ij}) + \beta_{11j}*(Non\ URM\ combo_{ij}) + \beta_{12j}*(URM\ combo_{ij}) + \beta_{13j}*(Hawaiian_{ij}) + \beta_{14j}*(Female_{ij}) + r_{ij}$

Level 2:

$\beta_{0j} = \gamma_{00} + u_{0j}$

$\beta_{1j\text{-}14j} = \gamma_{10\text{-}140}$

Variance components. Sigma squared for the model was 1.4845; this was the predicted variance within schools. If the model increased explanatory power for the predictors at level one, a change in sigma squared from the ANOVA model to the random coefficient model was anticipated.

ANOVA σ^2 – Random Coefficient σ^2/ANOVA $\sigma^2 = \Delta\ \sigma^2$

A change in this value meant that by adding individual level predictors the model accounted for more variance. The change in sigma squared was .3075 indicating some explanatory power of individual predictors.

Tau sub zero zero (τ_{00}) was the predicted overall variance between schools with average admissions outcome. The change in τ from the ANOVA model to the random coefficient model also helped determine if the model was explaining more variance between schools. The percent variance explained (PRV) from model to model was calculated as follows.

ANOVA τ_{00} – Random coefficient τ_{00} /ANOVA $\tau_{00} = \Delta\ \tau_{00}$

The change in tau was .4151, indicating that adding predictors helped explain 41% more of the variance between schools.

Table 79. Random Coefficient HLM Results

Predictors	Coefficient
INTRCPT1, β_0 INTRCPT2, γ_{00}	0.696649**
Less than BS degree β_1, γ_{10}	-0.115835**
BS degree β_2, γ_{20}	-0.139324**
MS degree β_3, γ_{30}	-0.058854**
Unknown education β_4, γ_{40}	-0.03153
Academic index β_5, γ_{50}	1.163558**
Asian β_6, γ_{60}	-0.122266**
Hispanic β_7, γ_{70}	0.621612**
Black β_8, γ_{80}	0.88724**
Native β_9, γ_{90}	0.286172*
Unknown race β_{10}, γ_{100}	-0.146883**
Non URM combo β_{11}, γ_{110}	0.015899
URM combo β_{12}, γ_{120}	0.49331**
Hawaiian β_{13}, γ_{130}	-0.04728
Female β_{14}, γ_{140}	0.24486**
INTRCPT1, u_0	0.30213**
level-1, r	1.21841**
$\sigma^2 = 1.48452$	
INTRCPT1, β_0 = 0.09128	

*p<.05, **p<0.001

Full HLM – Individual and School Level Characteristics

Investigating undergraduate school characteristics in the applicant pool explained some of the remaining variance in number of acceptances. The model explored how an institution's type (public or private), size, and selectivity influenced the number of acceptances for applicants while controlling for individual characteristics (race, sex, parent education, and academic index).

Institutional predictors in the full model were modeled thusly:

Level 1:

$$Number\ of\ Acceptances_{ij} = \beta_{0j} + \beta_{1j}*(less\ than\ BS\ degree_{ij}) + \beta_{2j}*(BS\ degree_{ij}) + \beta_{3j}*(MS\ degree_{ij}) + \beta_{4j}*(unknown\ education_{ij}) + \beta_{5j}*(academic\ index_{ij}) + \beta_{6j}*(Asian_{ij}) + \beta_{7j}*(Hispanic_{ij}) + \beta_{8j}*(Black_{ij}) + \beta_{9j}*(Native_{ij}) + \beta_{10j}*(Unknown\ race_{ij}) + \beta_{11j}*(Non\ URM\ combo_{ij}) + \beta_{12j}*(URM\ combo_{ij}) + \beta_{13j}*(Hawaiian_{ij}) + \beta_{14j}*(Female_{ij}) + r_{ij}$$

Level 2:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}*(Inclusive_j) + \gamma_{02}*(Selective_j) + \gamma_{03}*(Under\ 1{,}000_j) + \gamma_{04}*(1{,}000\ to\ 5{,}000_j) + \gamma_{05}*(5{,}000\ to\ 10{,}000_j) + \gamma_{06}*(10{,}000\ to\ 20{,}000_j) + \gamma_{07}*(Private_j) + u_{0j}$$

$$\beta_{1j\text{-}14j} = \gamma_{10\text{-}140}$$

Variance Components

The final variance components for the fully conditional level 2 model were further reduced from the random coefficient model from level 1. Institutional level predictors accounted for slightly more variance and revealed that there were significant predictors at level two explaining some of the variance in acceptances in the model. The difference in tau values indicated that about 41% of the variance was explained in the model by adding individual predictors. The PRV increased to about 50% for the full model, suggesting that adding institutional predictors helped explain more variance in admission outcome.

Table 80. Model Components Summary

	ANOVA	Random Coefficient	Full
$Sigma^2$	1.91409	1.48452	1.48471
Tau_{00}	.15607	.09128	.07187
Difference in variance from ANOVA		.4151	.5049
PRV		41.51%	50.49%

Level 1 Findings

The grand mean in number of acceptances controlling for all other variables was .0913 (β_0). I found a highly significant positive effect for academic index on the number of medical school acceptances ($\beta_5 = 1.155$, $p < .001$). On average applicants with a parent with less than a Bachelor's degree had significantly fewer acceptances compared to applicants with a parent with a doctorate or more ($\beta_1 = -.102$, $p < .001$). Applicants with parents with Bachelor's or Master's degrees also had significantly fewer acceptances ($p < .001$) compared to applicants with a parent with a doctorate or more: $\beta_2 = -.131$ and $\beta_3 = -.055$ respectively.

Females, on average, were accepted to a significantly higher number of medical schools compared to their male counter parts ($\beta_{14} = .240$, $p < 001$). Black ($\beta_8 = .895$, $p < .001$), Hispanic ($\beta_7 = .625$, $p < .001$), Native American ($\beta_9 = .298$, $p = .026$) and URM combo ($\beta_{12} = .498$, $p < .001$) applicants were admitted to a significantly higher number of medical schools on average, compared to White applicants. Asian ($\beta_6 = -.123$, $p = .001$) and unknown race ($\beta_{10} = -.149$, $p = .001$) applicants were admitted to significantly fewer medical schools on average compared to White applicants.

Summary of Level 1 findings. The full model helped explain the roles of academics, parent education, sex and race on an applicant's number of acceptances while controlling for institutional differences. Academics had a positive relationship on acceptance on average. Black, Hispanic, Native American and URM combo applicants were accepted to more schools on average compared to White applicants. Asian applicants were accepted to fewer schools on average compared to White applicants. Female applicants, on average, were accepted to more schools compared to male applicants. Applicants from parents with Master's, Bachelor's, or less than Bachelor's degrees were accepted to fewer schools on average compared to applicants from parents with doctorates or more. I will now discuss results for institutional predictors.

Level 2 Findings

The intercept term across schools (γ_{00}) was the average number of acceptances across schools which are public, very large (20,000 or more students), and highly selective while controlling for all the level one predictors. In general, the average institutional level model was highly significant and indicated that institutional predictors had some influence on admissions outcome. The school level effects for individual predictors ($\beta_{1\text{-}14}$) were modeled. Essentially the model controlled for these individual characteristics among students in the sample across all predictors within level 2.

Selectivity. Applicants from inclusive institutions were accepted to significantly fewer schools, on average, compared to applicants from more selective institutions controlling for all other effects in the model ($\gamma_{01} =$ -.1608, $p < .001$). Applicants from selective undergraduate schools were also accepted to significantly fewer schools, on average, compared to applicants from more selective institutions ($\gamma_{02} = -.2063$, $p < .001$).

Size and type. Applicants coming from undergraduate institutions with under 1,000 students were accepted to significantly fewer schools on average than applicants attending institutions of 20,000 students or more (γ_{03}.= -.1867, $p = .013$). This was the only school size category that was significant in the model. Applicants from private institutions, on average, were accepted to significantly more medical schools compared to applicants from public institutions ($\gamma_{07}= .186$, $p < .001$).

Table 81. HLM Results

Predictors Level 1	Coefficients
Less than BS degree, β_1, γ_{10}	-0.102574**
BS degree, β_2, γ_{20}	-0.131015**
MS degree, β_3, γ_{30}	-0.055812**
Unknown education, β_4, γ_{40}	-0.014597
Academic index, β_5, γ_{50}	1.155593**
Asian, β_6, γ_{60}	-0.123761**
Hispanic, β_7, γ_{70}	0.625552**
Black, β_8, γ_{80}	0.895704**
Native β_9, γ_{90}	0.298505*
Unknown race β_{10}, γ_{100}	-0.149119
Non URM combo β_{11}, γ_{110}	0.011884
URM combo β_{12}, γ_{120}	0.498222**
Hawaiian β_{13}, γ_{130}	-0.046318
Female β_{14}, γ_{140}	0.240165**
INTRCPT1, u_0	0.26808**
level-1, r	1.21849**
$\sigma^2 = 1.48471$	
Predictors Level 2	Coefficients
INTRCPT2, γ_{00}	0.75044**
Inclusive, γ_{01}	-0.160808**
Selective, γ_{02}	-0.206385**
Under 1,000, γ_{03}	-0.186774*
1,000 to 5,000, γ_{04}	-0.066683
5,000 to10,000, γ_{05}	-0.071872
10,000 to 20,000, γ_{06}	0.007712
Private, γ_{07}	0.186034**

*p < .05, **p < .001

Summary of HLM findings. Using an HLM I found significant individual effects across race, sex, parent education and academics. Academics had a positive effect on the number of acceptances. Black, Hispanic, Native American and URM combo applicants had more acceptances on average compared to White applicants. Applicants reporting parent education at Master's, Bachelor's or less than Bachelor's degrees had fewer acceptances on average when compared to applicants with a parent with a doctorate or higher. When controlling for these individual predictors, institutional predictors had significant influences on the number of acceptances to medical school. Applicants from inclusive and selective institutions had fewer acceptances, on average, compared to applicants from more selective schools. On average, applicants from private institutions had higher acceptances compared to applicants from public colleges. Undergraduate institutional size was significant only for applicants from schools under 1,000, who received fewer acceptances, on average, than applicants from schools of 20,000 students or more.

HGLM Model for Medical School Selectivity

For the HGLM I examined the pool of students accepted to medical school who matriculated within the same year. Recall question 3 of this study: Among accepted applicants to medical school, what influence do individual and institutional factors have on the institutional selectivity of the matriculating medical school? The HGLM explored differences in matriculating school selectivity by race, sex, parent education, and academics at level one and size, type and undergraduate school selectivity at level two. I will first present the unconditional model followed by the full model.

HGLM. To examine the matriculating medical school selectivity as an outcome, I used the same predictors as the HLM with a slightly different technique designed for comparing categorical outcomes. When assumptions of linearity and normality are not fulfilled, a generalized model provides a framework for multilevel data with nonlinear structures and non-normally distributed errors (Raudenbush & Bryk, 2002). For examining outcomes related to selectivity of accepted applicants matriculating to medical school, a categorical outcome was most appropriate. Although selectivity was reported numerically by rankings, it was best categorized as a more qualitative variable that described an institution rather than precisely measured it numerically. The HGLM was conducted using a dichotomous outcome (0=not selective, 1=highly selective).

As in the HLM, this multilevel model controlled for individual factors of race, sex, parent education, and academics while examining the role of undergraduate selectivity, institutional size, and public/private institutional type on the selectivity of matriculating medical school among accepted applicants. The multinomial model controlled for individual factors while also nesting them by school which produced a school selectivity effect.

Unconditional Model

The model began with an unconditional model as follows:

Level 1:

$$\text{Prob}(\textit{Highly selective medical school}_{ij}=1|\beta_j) = \phi_{ij}$$
$$\log[\phi_{ij}/(1 - \phi_{ij})] = \eta_{ij}$$
$$\eta_{ij} = \beta_{0j}$$

Level 2:

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

Level-1 variance = $1/[\phi_{ij}(1-\phi_{ij})]$

Mixed model:

$$\eta_{ij} = \gamma_{00} + u_{0j}$$

The average log-odds of selectivity across schools was -1.97 (γ_{00}) and it was highly significant ($p < .001$). The average accepted student had a negative likelihood of matriculating to a highly selective medical school. The variance between schools (τ_{00}) within school-average log-odds of selectivity was also significant for the model (χ^2=

5750.456, $p < 0.001$). At this level the goal was to examine whether the odds of ending up at a selective medical school differed across schools by comparing them to the population. The highly significant variance components and odds ratios confirmed differences across schools within the applicant pool. Based on these results I moved to the full HGLM.

Table 82. Unconditional HGLM Results

Fixed Effect	Coefficient	Standard Error	Approx. *d.f.*	*p*-value
For INTRCPT1, β_0				
INTRCPT2, γ_{00}	-1.97754	0.05434	990	<0.001

Random Effect	Standard Deviation	Variance Component	*d.f.*	χ^2	*p*-value
INTRCPT1, u_0	1.02896	1.05875	990	5750.456	<0.001

Full HGLM

Level 1:

$\text{Prob}(\textit{Highly selective medical school}_{ij}=1|\beta_j) = \phi_{ij}$

$\log[\phi_{ij}/(1 - \phi_{ij})] = \eta_{ij}$

$\eta_{ij} = \beta_{0j} + \beta_{1j}*(\textit{Less BS degree}_{ij}) + \beta_{2j}*(\textit{BS degree}_{ij}) + \beta_{3j}*(\textit{MS degree}_{ij}) + \beta_{4j}*(\textit{Unknown education}_{ij}) + \beta_{5j}*(\textit{Female}_{ij}) + \beta_{6j}*(\textit{Academic index}_{ij}) + \beta_{7j}*(\textit{Asian}_{ij}) + \beta_{8j}*(\textit{Hispanic}_{ij}) + \beta_{9j}*(\textit{Unknown race}_{j}) + \beta_{10j}*(\textit{Black}_{ij}) + \beta_{11j}*(\textit{Hawaiian}_{ij}) + \beta_{12j}*(\textit{Native}_{ij}) + \beta_{13j}*(\textit{Non URM combo}_{ij}) + \beta_{14j}*(\textit{URM combo}_{ij})$

Level 2;

$\beta_{0j} = \gamma_{00} + \gamma_{01}*(\textit{Inclusive}_j) + \gamma_{02}*(\textit{Selective}_j) + \gamma_{03}*(\textit{Under 1,000}_j) + \gamma_{04}*(\textit{1,000 to 5,000}_j)$

$+ \gamma_{05}*(\textit{5,000 to 10,000}_j) + \gamma_{06}*(\textit{10,000 to 20,000}_j) + \gamma_{07}*(\textit{Private}_j) + u_{0j}$

$\beta_{1j\text{-}14j} = \gamma_{10\text{-}140}$

Level-1 variance = $1/[\phi_{ij}(1-\phi_{ij})]$

Mixed Model:

$$\eta_{ij} = \gamma_{00} + \gamma_{01}*(Inclusive_j) + \gamma_{02}*(Selective_j) + \gamma_{03}*(Under\ 1{,}000_j) + \gamma_{04}*(1{,}000\ to\ 5{,}000_j) + \gamma_{05}*(5{,}000\ to\ 10{,}000_j) + \gamma_{06}*(10{,}000\ to\ 20{,}000_j) + \gamma_{07}*(Private_j)$$

$$+ \gamma_{10}*Less\ BS\ degree_{ij}$$
$$+ \gamma_{20}*BS\ degree_{ij}$$
$$+ \gamma_{30}*MS\ degree_{ij}$$
$$+ \gamma_{40}*Unknown\ education_{ij}$$
$$+ \gamma_{50}*Female_{ij}$$
$$+ \gamma_{60}*Academic\ index_{ij}$$
$$+ \gamma_{70}*Asian_{ij}$$
$$+ \gamma_{80}*Hispanic_{ij}$$
$$+ \gamma_{90}*Unknown\ race_{ij}$$
$$+ \gamma_{100}*Black_{ij}$$
$$+ \gamma_{110}*Hawaiian_{ij}$$
$$+ \gamma_{120}*Native_{ij}$$
$$+ \gamma_{130}*Non\ URM\ combo_{ij}$$
$$+ \gamma_{140}*URM\ combo_{ij}$$
$$+ u_{0j}$$

The full model examined log-odds predictive values of what types of applicant characteristics at level 1 increased the odds of matriculating at a highly selective school (versus not selective), the probability that any of the categorical outcomes were not zero. The referent group was the applicant who was White, male, had a parent with a doctorate, and had the average academic index who attended public undergraduate institution of 20,000 or more that was highly selective. The odds ratio for the average applicant in the overall model was .11, which is interpreted as 89% less likely to matriculate to a highly selective medical school.

Individual predictors. The largest odds ratio predicting whether students ended up at a highly selective medical school was academic index. For every unit on the standardized index, an accepted applicant's odds increased more than 10 times of matriculating to a highly selective medical school versus not selective school ($p < .001$).

Being female indicated a 34% greater likelihood of ending up at a highly selective medical school compared to males ($p < .001$). Accepted applicants with parent education below a bachelor's degree were 15% significantly less likely to matriculate to highly selective medical schools compared to accepted applicants with a parent with a doctorate or higher ($p < .05$). Accepted applicants with a parent with bachelor's or master's degree were 17% and 13% less likely respectively to matriculate to highly selective medical schools compared to candidates with a parent with a doctorate ($p < .001$ and $p < .01$).

Hispanic and Black accepted applicants were 1.8 and 3.5 times more significantly likely to matriculate to highly selective medical schools compared to White students ($p < .001$). Native American accepted students were 2.4 times more likely to attend a highly selective medical school compared to White students ($p < .001$). Students who declined to indicate race on the application were almost 30% more likely to matriculate to highly selective medical schools than their counterparts who indicated White ($p < .01$). URM combo accepted applicants were slightly more than 2 times as likely to matriculate to highly selective medical schools compared to White students ($p < .001$).

Institutional predictors. Whether an applicant attended a public or private undergraduate institution did not significantly influence the odds of matriculating to a highly selective medical school. Accepted applicants from inclusive and moderately selective undergraduate institutions were 42% and 50% significantly less likely to matriculate to highly selective medical schools compared to those from highly selective undergraduate institutions ($p < .01$ and $p < .001$). Accepted applicants from undergraduate institutions of 5,000-10,000 students were 34% less likely to matriculate to highly selective medical schools compared to those from 20,000+ schools ($p < .05$).

Table 83. HGLM Results

Predictor Level 1	Coefficient	Odds Ratio
Less BS degree, β_1 , γ_{10}	-0.161299	0.851037*
BS degree, β_2, γ_{20}	-0.17908	0.836039*
MS degree, β_3, γ_{30}	-0.137606	0.871442*
Unknown education, β_4, γ_{40}	0.130295	1.139164
Female, β_5, γ_{50}	0.295618	1.343956**
Academic index, β_6, γ_{60}	2.414155	11.18032**
Asian, β_7 , γ_{70}	-0.025935	0.974399
Hispanic, $\beta_{8,}$ γ_{80}	1.031558	2.805434**
Unknown race, β_9 , γ_{90}	0.254857	1.290278*
Black, β_{10}, γ_{100}	1.519969	4.572083**
Hawaiian, β_{11}, γ_{110}	0.015747	1.015872
Native, β_{12}, γ_{120}	1.242697	3.464944**
Non URM combo, β_{13}, γ_{130}	0.19422	1.214363
URM combo, β_{14}, γ_{140}	1.140217	3.127446**
Predictor Level 2	Coefficient	Odds ratio
INTRCPT2, γ_{00}	-2.200921	0.110701**
Inclusive, γ_{01}	-0.536387	0.584858*
Selective, γ_{02}	-0.694203	0.499472**
Under 1,000, γ_{03}	0.194347	1.121452
1,000 to 5,000, γ_{04}	-0.150446	0.860324
5,000 to10,000, γ_{05}	-0.417321	0.65881*
10,000 to 20,000, γ_{06}	-0.018195	0.981969
Private, γ_{07}	0.198319	1.219351

Summary of Results

The descriptive, HLM and HGLM analyses provided evidence of the differences in acceptance and matriculation outcomes according to race, sex, parent education, academic preparation, undergraduate institution type, size, and selectivity. Hispanic applicants had more acceptances on average compared to all other racial groups. Female applicants applied to fewer schools but were accepted to more schools than their male counterparts. On average, applicants with higher levels of parent education applied to more schools and were accepted to more schools. Academic preparation by index and

MCAT score increased as parent education increased. Applicants from schools with larger student populations applied to more schools. Applicants from private schools had more acceptances, on average, than applicants from public institutions. Accepted applicants from inclusive and selective institutions were significantly less likely to attend highly selective medical schools compared to their counterparts from more selective undergraduate institutions. This study demonstrated vast differences in the applicant and matriculant pools according to individual and institutional predictors. A discussion of the data follows.

CHAPTER FIVE

DISCUSSION

Allopathic medicine is one of the most arduous, rigorous, and well respected professions in the United States. The present study was an analysis of background factors of applicants applying to medicine and aimed to explore inequalities among applicants. The uniform system of medical education that requires completion of an undergraduate degree results in limited opportunities for many populations. National reforms enacted by powerful leaders in medicine at the turn of the 20th century ostensibly reduced the numbers of racial minorities and women, rural populations, and low income populations in medicine (Bonner, 2000). The demographics of practicing physicians in the United States today are a result of social stratification and compounded educational inequalities at the secondary and post-secondary levels. The low numbers of some racial minorities and students from low income backgrounds indicate that diversity in medicine is lacking (Carlisle, Gardner & Liu, 1998; Cohen, Gabriel, & Terrell, 2002).

As a critical service profession ultimately responsible for the health of the nation, and with a creed to ‘do no harm,’ the paucity of diversity in allopathic medicine is concerning. Diversity among providers leads to better patient outcomes, greater attention to cultural issues in the treatment process, reductions in disparities in health outcomes and access, innovation in thought and practice, and increased satisfaction among patients (Brian, Adrienne & Nelson, 2002). Medicine is especially prone to the effects of accumulated disparities in educational outcomes due to its focus on math and science, inflexible rigorous preparation, and reliance on preparation factors heavily influenced by social and cultural capital (Bonner, 2000; Coleman, 1998). Aspiring trainees with access to career mentoring, research opportunities and insider knowledge about preparation are likely to navigate the waters to admission more efficiently and effectively.

This study examined the effects of stratification and inequality in medicine by analyzing background characteristics of applicants. The research questions explored the characteristics of applicants as well as the influence of individual and institutional characteristics on being accepted to medical school. The study used a national cross sectional sample derived from the AAMC's AMCAS applicants for the 2011 cycle. Individual characteristics of race, sex, parent education, and academic preparation were described in the applicant pool and then analyzed using a hierarchical linear model (HLM). Undergraduate institutional factors of size, type (public/private), and Carnegie classification of selectivity were captured in the descriptive analysis of the applicant pool and the linear model at level two after controlling for individual attributes at level one. Specific focus was dedicated to investigating the role of undergraduate institutional selectivity in the admissions process, as well as whether selectivity in undergraduate school influenced the selectivity of matriculating medical school among accepted applicants. A hierarchical linear model with a binary outcome (employing log-odds ratios) for attending a highly selective versus not selective medical school quantified the elite school undergraduate institution advantage.

Theoretical Framework

Several theories informed the theoretical framework for the study. The history of medical education in the United States provided some context for the current composition of doctors and trainees. Historical review also outlined explicit mechanisms by which leaders of prominent organizations purposely designed medicine to be elite and exclusive. Theories of social inequalities related to educational transitions and achievement provided some context for examining parent education and selectivity across demographic factors. Theories of social and cultural capital undergird selectivity and the examination of institutional characteristics along with parent education. Self-efficacy and career exploration outlined some of the potential inequalities in preparation by sex, race and parent education.

Discussion of Findings

The research questions were centered on exploring demographic differences in the applicant pool to medicine using both descriptive analysis and hierarchical linear modeling of number of acceptances. This study identified marked differences across the applicant pool by race, sex, parent education and academic preparation. The interrelationships of these individual predictors were also salient. The final research question examined the role of undergraduate selectivity using medical school selectivity as an outcome. I will first discuss the predictors as analyzed in questions one and two, then conclude with a discussion of selectivity.

Race

The pool of applicants to medicine by race is disproportionate to the U.S. population. According to 2010 Census data the population is 63% White, 16.9%

Hispanic, 13.1% Black, 5.1% Asian, 2.4% mixed race, 1.4% and Native American/Native Hawaiian. The applicant pool to medicine is most disproportionate for Asians who have more than a four-fold representation in the pool to medicine at 21% compared to 5.1% for the US population. Reasons for this are largely unknown. Asian students may have more consistent exposure and participation in science and math throughout schooling or may benefit from social structures and norms that push them toward science and math more than their peers (Peng & Wright, 1994; Sue & Okazaki, 1990). The heterogeneity of Asian ethnicities within the pool was not examined and the pan-Asian grouping may be inaccurately characterizing overrepresentation of all Asian groups. This is a salient issue for further research. Mixed race applicants are also over-represented when compared to the general population at 3.5% versus 1.5% respectively. White students are slightly underrepresented in the pool, while Black, Latino and Native students have ratios of underrepresentation ranging nearly 2:1 or 3:1.

The history of exclusion in both higher education and medicine offers some context for Black, Latino, and Native groups and their low levels of application and enrollment in medicine. Access to medical education was restricted to those completing undergraduate degrees. These reforms promoted medicine to White men (who were the majority of college students at the time) while limiting training opportunities for all other groups (Bonner, 2000). Even as some access increased, minority groups remained outside the gates for certain licensures and hospital privileges for decades (Davis, 2008; Nickens, 1985).

The educational disparities in the U.S. at the secondary level result in vast inequalities at the undergraduate level where 72.9% of Bachelor's degrees in 2010 were earned by White students (NCES 2012a). The portal to medicine is only through completion of requirements through a bachelor's degree, so many potential future physicians are lost at the transition between high school and college and attrition from college. Population percentages of Black and Hispanic college graduates in 2010 were 10%, and 8.8% respectively (NCES, 2012a). Native American students were just .8% of Bachelor's degrees awarded in the US (NCES, 2012a). The lack of access and equity at the undergraduate level compounds the racial disparities in the applicant pool to medicine.

Application and acceptance. There were significant differences in applications and acceptances by race. Black applicants applied to fewer schools than all other racial groups except Native applicants. Native and Black applicants had the lowest overall acceptance percentages within their respective pools. Mean acceptances for Black applicants were slightly higher than the overall mean, but mean acceptances for Native applicants were the lowest of all racial groups. These findings are in keeping with theories of inequality (MMI, EMI) that posit sustained systemic advantages in gaining access to education for those applicants who come from family backgrounds that have had access to education in the past (Lucas, 2001; Raftery & Hout, 1993). For applicants from potentially marginalized groups the findings overall suggest that the cumulative effects of privilege manifested as forms of social and cultural capital may translate into advantages in seeking admission to competitive graduate programs (Bourdieu, 1986; Lamont & Lareau, 1988).

Academic preparation. Black applicants had lower academic indices and MCAT scores, and applied to fewer schools compared to their peers, further evidence that they had fewer advantages and resources on average. Native applicants also had lower scores and indices and applied to fewer schools compared to White and Asian applicants. The socio-cultural background of applicants to medicine matters in the process of admission and matriculation (Dahling & Thompson, 2010; Whitney, Jr., 2002). Career choices and aspirations are derived from experiences and nurtured by supportive structures in personal and educational environments (Farmer & Chung 1995). Both Black and Native applicants were shown in the data to be least successful and navigating the application process to medicine. Underrepresented minority applicants may be most susceptible to the cumulative effects of socio-cultural disparities in their participation in higher education. They may have fewer mentors (Erkut & Mokros, 1984), experience more stereotype threat (Gainor & Lent, 1998; Steele & Aronson, 1995), and perceive more barriers to their career aspirations than their peers (Luzzo, 1993).

Hispanic applicants. There were mixed findings for Hispanic applicants. They submitted more applications, on average, than White, Black and Native applicants but fewer than Asian or mixed race applicants. Hispanic applicants were the smallest percentage of science majors within race – a possible indicator of social and cultural capital and/or insider knowledge of navigating premed (discussed in more detail later). Recall that Hispanic applicants also had the highest mean acceptance across all groups. Hispanic applicants had higher academic indices than Black applicants, but lower than White, Asian and non URM combo applicants. Post hoc tests showed that Hispanic applicants mean MCAT scores were almost four points higher than mean scores for Black applicants.

The mixed results for Hispanic applicants may possibly be explained by the policy decision of the AAMC to stop defining underrepresented minority among member schools (AAMC, 2004). Previously the AAMC defined only Mexican and Puerto Rican sub-groups as underrepresented in medicine. Project 3,000 by 2,000, for example, targeted African American, Puerto Rican, Mexican, and Native American students (Cohen, 2000). After the discontinuation of a national definition of underrepresented, most member schools expanded their criteria to include all sub-groups of Hispanic including Central American and South American (classified as "other Hispanic"), and Cuban (see MSAR annually published by AAMC, 2009 through 2012). Within the Hispanic applicant pool, Mexican and Puerto Rican applicants comprised just under 40%. The change in definition more than doubled the Hispanic applicants defined as underrepresented. In practice this equated to broader recruitment efforts and consideration of all Hispanic students in the national calls to diversify medicine. Brazilian, Peruvian, Honduran and Colombian students, for example, received the same holistic considerations as underrepresented applicants who were Mexican and Black.

Hispanic applicants, on average, had higher levels of parent education than Native or Black applicants. Each sub category of Hispanic applicants also had higher percentages of at least one parent with a doctorate or more than Black or Native applicants. Cuban (36%), Mexican (20%), Puerto Rican (29%) and Other Hispanic (25%) were all higher compared to Black (18%) or Native applicants (18%). Hispanic applicants appeared to have slightly more access to social and cultural capital, on average, via family background than Black or Native applicants. Treating the Hispanic group as monolithic in the consideration of underrepresented may mean that Hispanic applicants are benefitting from pro-diversity policies due to increased consideration while also having more advantages in preparation resources than Black or Native applicants overall.

Evidence of holistic review. The HLM showed significantly higher coefficients for acceptances for Hispanic, Black, Native American and URM combo applicants compared to White applicants. This is evidence of individualized holistic review among admissions practitioners (Witzburg & Sondheimer, 2013). These data are robust due to the controls employed by the model, so the effects are consistent across predictors. Scholars in medicine have been advocating for strong consideration in admissions for groups underrepresented in medicine (Carlisle, Gardner & Liu, 1998; Nickens, 1994; Nickens & Cohen, 1996). Accreditation of U.S. Allopathic schools by the Liaison Committee on Medical Education also requires attention to student body diversity in its standards (LCME, 2010). Recruiting more underrepresented minorities has also been touted as one strategy to address the growing racial health disparities in the U.S. (Cantor, Miles, Baker & Barker, 1996). Higher mean acceptances for underrepresented groups confirms that schools are considering race and gender in admissions decisions – this is a very positive finding.

Sex

The data demonstrated that inequalities remain between male and female applicants to medicine, but results were somewhat mixed. Males have outnumbered females in the applicant pool every year since data has been collected except for 2005 where females slightly outnumbered males (AAMC, 2010c). This is somewhat disproportionate since females earned about 57% of Bachelor's degrees in 2011, and that percentage continues to grow (NCES, 2012b). The matriculant pool has always contained more males than females overall (AAMC, 2010c). Males on average attended more selective undergraduate institutions and had higher levels of parent education. Male applicants had higher MCAT scores, on average, than female applicants – a difference of more than two points.

Based on applicant data, males had more advantages, but female applicants applied to fewer schools and were accepted to more schools on average than male applicants. Despite coming from less selective undergraduate institutions on average, and having lower academic indices on average, female applicants had higher likelihoods of attending highly selective medical schools. This suggests that institutional policies and interventions encouraging greater equity in medicine may have been successful for diversifying allopathic medicine by sex. Schools seem to value diversity among trainees and have fairly even percentages of male and female students.

Diversifying the profession by sex has likely been effective due to the large numbers of women completing bachelor's degrees, which is expected to continue to grow (NCES, 2012b). If there are sufficient numbers of women participating in post-secondary education, interventions to increase enrollment in medical school are a matter of promoting medicine as a profession. The challenges based on race and SES may be more complex, as the percentages for bachelor's degree completion are smaller and more disproportionate to the population.

Although admissions outcomes for female applicants are positive, significant disparities in career development, specialty choice, and leadership remain for women in medicine. Women are outnumbered as full professors 4 to 1 and make up just 16% of deans at the helms of medical schools (AAMC, 2010c; Gibson 2011). Surgical fields remain dominated by men, which proliferates the earnings inequalities among specialties as well as by sex (AAMC, 2010a). The positive findings at the admissions phase should not detract from the work that remains to foster greater inclusion in medicine for academic promotion, specialty diversity, and leadership.

Academic Preparation

The largest coefficient in the model was academic index, a composite variable including MCAT score and undergraduate GPA both science and total. The average GPA for applicants to medicine for 2011 was 3.53 (SD = .34) – practicably higher than an A- average in coursework. Matriculants in 2011 had an average GPA of 3.67 (SD = .26). Even with the standard deviations the GPAs for applicants and matriculants were extremely high. This bias toward the utmost nearly perfect GPA may influence many potentially well prepared applicants to incur delay in their applications or to never apply at all. There is a national call for more physicians (Salsberg & Grover, 2006), and it seems impracticable that qualified potential trainees should expend thousands more dollars and hours to recuperate a few tenths of a point in their grade point averages before applying. Do the additional classes they take make them better doctors? Do the tenths of points in grades make a difference, or only deter and delay applicants? There are schools that holistically review candidates and do not solely use numbers, but the ranking systems and external reporting of grades create unhealthy competition between schools that further stratifies medicine – and not for the better (Thompson, 2000).

The strong influence of academic index in the model is consistent with extant literature on post-baccalaureate participation. Ethington and Smart (1986), Kallio (1995), and Weiler (1994b) found that grades were the largest predictor in students pursuing graduate education. The significant results for the academic index highlight that disparities in access to preparation and mastery experiences in science and math may disproportionately affect underrepresented groups (Ellwood & Kane, 2000). Students with resources and insider system knowledge can more easily protect their GPAs and afford test preparation. Further, students with higher levels of social and cultural capital may begin their undergraduate educations planning to pursue graduate studies and therefore be more mindful of their grades. Students with higher levels of parent education majored in science less often, and they were also among the higher MCAT scorers in the pool. Having greater access to resources via parents may also facilitate a more manageable pace and course load for premed course work, i.e. taking a class over the summer, extending undergraduate years beyond the traditional four without financial worry, or accessing off campus resources such as tutoring to support academic performance.

MCAT score gaps. The MCAT score gaps among race, sex, and parental education are concerning. Standardized test scores in medicine are no different than those in other areas of higher education – very closely correlated with socially and structurally conferred privilege. On average, male applicants scored higher than female applicants, White and Asian applicants scored higher than Black, Latino and Native American applicants. MCAT scores increased as categories for parent education level increased. The exposure, time and forewarning required to perform well on standardized exams are often a function of resources and not actual ability. There is no evidence that higher MCAT scores predict better doctors, and yet schools continue to attribute higher

MCATs to better candidates. The MCAT was shown to predict 50% of the variance in performance in the first two years of medical school (the classroom years), which was slightly better than GPA (Donnon, Paolucci & Violato, 2007; Julian, 2005). The first two years of an MD program are a fraction of the outcomes in medical training, and one of the least considered elements of an application for any student applying to a residency program according to program directors (Green, Jones & Thomas, 2009).

The score gaps across individual predictors may also be partially explained by stereotype threat (Steele, 1997). The act of taking a standardized exam may activate a stereotype threat for applicants who may fear that their performance will confirm a negative stereotype about their group, thereby increasing anxiety and creating a higher likelihood of performance decrements. In addition to potentially having fewer resources, students from underrepresented groups may also face the additional challenges of stereotype threat.

Role of MCAT in financial aid. The financial aid implications for higher MCAT scores are also concerning. Much of the aid for medical school is somewhat determined on the basis of 'merit' which means that students with higher scores are likely to have larger offers of financial aid. These students are likely from the most educated (and therefore likely more wealthy) households among the applicant pool. The time to train and debt incurred from choosing a medical career then continues to disproportionately affect underrepresented minority and low income students more drastically, as they are likely to have more loans during their training due to not having the higher scores that yield the limited, yet very coveted medical school scholarships. A survey of practicing physicians revealed that African American doctors were less likely to report favorable financial status than their White peers (Schoolcraft, 2012). The disparities incurred during training continue long into career years.

Parent Education

The disparities in levels of parent education are not surprising given the resources required to train in medicine. The cost of an undergraduate degree, extracurricular activities that require time and expense, and the delayed earnings over the long training trajectory are all plausible reasons why students from highly educated parents comprise the majority of the pool. Most applicants (74.4%) come from households where at least one parent has obtained a bachelor's degree or higher. This percentage is 31.6% for the U.S. population (NCES, 2012a). Nearly 50% of applicants to medicine had a parent with at least a Master's degree compared to 11.6% for the U.S. population (NCES, 2012a). The most striking disparity was the 27.7% of applicants who had a parent with a doctorate or post doctorate, which for the general U.S. population is only 3.2% in 2013 (NCES, 2012a). Less than 1% of applicants reported parent education of less than elementary school, and less than 5% reported parent education less than high school. More than 88% of the US population has completed a high school education (NCES, 2012a).

Social capital and career exploration. The advantages of parent education extend beyond financial support from careers that likely have higher salaries as education increases (Perna & Titus, 2005). Preparation and application are expensive, but cultural capital is equally salient. Insider knowledge of navigating higher education and admissions to professional school are also likely strong advantages held by applicants with highly educated parents who have navigated the waters of higher education before and who are more likely to have social networks that include physicians and educators – if they themselves are not (Dahling & Thompson, 2010; Lareau, 2011). As parent education increased, the percentage of science majors decreased. One of the 'insider' strategies for premedical preparation is to protect the GPA by not taking too many difficult courses during undergrad, so this may indicate that students with highly educated parents employed more strategy in their premed preparation compared to their peers from parents with less education.

It may also be that students from more educated parents had more opportunities to contemplate their paths and explore interests prior to college, so they may have chosen different majors based on broader life exposure (Ferry, Fouad & Smith, 2000; Lent, Brown & Hackett, 2000). Social Cognitive Career Theory (SCCT) provides some explanation for this phenomenon. Students with more options to explore their interests at earlier ages may have arrived on campus with more articulated interests and more confidence in their paths/plans. SCCT reinforces that students experience contextual supports and barriers to career choice via environment (Lent, Brown & Hackett, 2000). Students from parents with more education may have felt less pressure to choose a major directly related to job outlook. If they intended to pursue graduate or professional studies at the beginning of their undergraduate experience, then why not major in piano performance or Germanic languages?

Recall the highest percentage of science majors within race were Black applicants. They may have attended colleges with poor advising services, have experienced barriers to accessing advising, or received advising that was general versus individualized. A proportionately larger percentage of Black applicants in the pool came from very small colleges of 1,000 students or less. Applicants from these very small colleges had significantly fewer applications and acceptances compared to the categorically larger schools. On average, applicants coming from these smaller undergraduate institutions may have had less access to cultural capital (Lang, 1984). Attending a less selective undergraduate institution likely indicates fewer graduates continuing to graduate school, which could mean that advisors at those schools are less familiar with admissions to graduate and professional school (Ethington & Smart, 1986; Lang, 1987).

Institutional Selectivity

There were also marked disparities among matriculants for selectivity of undergraduate institution. Applicants from more selective institutions submitted about five more applications to medical school than those from inclusive or selective institutions. Mean acceptances by institutional selectivity also differed drastically demonstrating significant advantage for applicants from more selective undergraduate schools. Applicants from private undergraduate institutions applied to and were accepted to more schools on average than applicants from public institutions. These differences confirmed the hypothesis of vast inequalities between groups applying to medicine based on race, gender, parent education, academic preparation and factors related to the type of undergraduate institution attended. These inequalities provided evidence that students with more cultural, educational and social capital had advantages in gaining entry in the profession of medicine (Bourdieu, 1977; Coleman, 1988; Lareau, 2011).

Comparatively larger percentages of Black and low SES applicants coming from institutions classified as inclusive (colleges with lower average SAT scores that accept a large proportion of students who apply) support theories of social inequality that educational disparities have a compounding effect for students with lower levels of social capital (Bourdieu, 1986; Lucas, 2001). Open enrollment institutions are far less likely to have extracurricular opportunities that help applicants prepare to compete for admission such as laboratory research, organizational leadership via a multitude of well-funded student organizations, extensive alumni networks for connections, etc. (Ethington & Smart, 1986; Hearn, 1987). They are also less likely to increase access to social and cultural capital via peer networks.

Selectivity and parent education. Students attending more elite colleges are presumed to have the highest levels of access to social and cultural capital that are critical to the non-academic portions of preparation for medicine (Bourdieu & Passeron, 1977; Carnevale & Rose, 2004; Dale & Krueger, 2002). As expected, applicants with parents with lower levels of education were not as prevalent in the pool or successful in gaining admission compared to their peers from parents with doctorates. Students from doctoral level educated parents were most represented at highly selective schools, positioning them for the advantageous externalities gained from elite school association. Less than 4% of the applicants were accepted to five or more schools, and among this group more than 90% attended more selective undergraduate institutions.

Odds ratios for parent education demonstrated that applicants from parents with master's degrees, bachelor's degrees, and less than bachelor's degrees were about 15% less likely to matriculate to highly selective medical schools compared to applicants with a parent with a doctorate or post doctorate. Academic index was a strong predictor in applicants gaining acceptance in the HLM and remained a strong predictor of medical school selectivity in the HGLM. Each unit on the standardized index was associated with an applicant being more than ten times likely to attend a highly selective medical school. Sander (2011) found that applicants to law school from highly selective institutions benefitted from grade inflation – yet another advantage of undergraduate selectivity. These findings are consistent with theoretical underpinnings discussed previously. Applicants in positions of advantage retained an edge and had the most favorable admissions and matriculation outcomes.

Institutional Size and Type

The size of the institution amidst other predictors in the HLM was significant only for one category – under 1,000 students – as compared to very large universities (over 20,000). Applicants from very small schools had significantly fewer acceptances. This finding is consistent with the theoretical grounding for the need for cultural and social capital in medicine. A college campus that is too small may not offer the necessary advantages in cultural capital that preparation for medicine demands such as research experience, and a broad menu of extracurricular activities to bolster the application (McGaghie, 1990a). It may also be that very small colleges are obscure and unknown to admissions decision makers and lack the benefits of a previous positive institutional reputation. Just .8% (352 applicants) came from schools under 1,000 students. Another possible reason for fewer acceptances from applicants from very small colleges may be a lack of advising, since the campuses are small and produce few applicants they may be less likely to have a dedicated and knowledgeable pre-health adviser.

Private schools conferred advantage in gaining acceptance to medicine in the HLM. Students from higher levels of parent education attended private schools in higher percentages. This is likely another effect of social and cultural capital in navigating the waters of higher education. Students with parents with more education have advantages to be able to attend schools that may be more expensive. Whether a school was public or private was not significant in predicting selectivity of medical school among accepted students.

Selectivity and Stratification

This study found a strong influence for undergraduate selectivity on admission to medicine and a relationship between undergraduate selectivity and medical school selectivity. There were several aspects of the data that confirmed that students with the most resources and access to highly selective undergraduate institutions would retain those advantages in medical school admissions. The most privileged students were positioned to maintain that advantage due to having attended more selective undergraduate colleges and having a significantly higher likelihood of attending a highly selective medical school over their peers attending inclusive and selective schools. These findings support theories of EMI (Lucas, 2001) and MMI (Raftery & Hout, 1993) that suggest that cumulative effects of various forms of privilege encourage social reproduction of that privilege. Once individuals reach a level of status within a system, they gain advantages that assist them in maintaining that status (Raftery & Hout, 1993). The achieved status also serves to increase opportunity for gaining even higher levels of advantage by reinforcing systemic norms that continue to advantage some and disadvantage others (Lucas, 2001).

In this study, students with highly educated parents had advantages in their access to elite undergraduate institutions, presumably from better preparatory resources in high school. Attending elite undergraduate institutions served to facilitate more advantages in seeking admission to medicine. Parent education continued to provide advantage throughout the process through access to networks for successful preparation, but also presumably financial backing for the actual cost of applying (Lareau, 2011). Higher odds of matriculating to a highly selective medical school provide more access to networks for entry into competitive specialties as well as future leadership opportunities. These results reinforce the influence of social and cultural capital in brokering advantage for access to medicine (Bourdieu & Passeron, 1977; Davis-Kean, 2005; Whitney, Jr., 2002).

Undergraduate selectivity has been shown to increase access to graduate school (Mullen, Goyette & Soares, 2003), increase perceptions of status and prestige in academia (Lang, 1987), increase return on college investment via career earnings (Brewer, Eide & Ehrenberg, 1999; Dale & Krueger, 2011) and provide a pedigree for avenues to leadership (Gibson, 2011; Sherman & Bryll, 1982). This study demonstrated an advantage for undergraduate selectivity in the admissions process to medicine even when controlling for strong predictors like parent education and academic index. Not only were applicants to medicine more prevalent from more selective institutions, but they were also accepted to more schools on average.

Applicants from inclusive and selective schools were about 50% less likely in the model to matriculate to highly selective medical schools versus not selective schools compared to applicants from more selective undergraduate institutions. Selectivity, or rather the favorable bias of admissions decision-makers towards it, is one of the elements perpetuating inequalities in higher education (McGaghie & Thompson, 2001). Students with pedigrees have access to career avenues that have larger returns and greater leadership capacities, thereby helping them be positioned to influence policies and institutional norms that continue to reward selectivity.

Selectivity and Parent Education across Race

The advantages of undergraduate selectivity and parent education were confirmed by this study. These advantages were salient across racial groups. There was substantial diversity across race groups and parent education categories as well as institutional selectivity and type. Although 16.6% of Black applicants had parent education of high school or less, an equivalent percentage (16.6%) had a parent with a doctorate or more. Hispanic applicants reported a parent with high school education or less 17.7% of the time, and had a parent with a doctorate or more 22% of the time. Although Black applicants were more represented at inclusive institutions compared to other groups, nearly half of them came from more selective schools (49.4%). Almost 59% of Hispanic applicants and 61% of Native applicants came from more selective schools.

Disparities by race are present for parent education and institutional characteristics, but a substantial portion of students from racially underrepresented groups are coming from backgrounds with high levels of social and cultural capital. Elite accepts (five schools or more) were just 3.6% of total applicants. Within that group Black and Hispanic students comprise a larger proportion (almost 11% each) than their proportion in the overall pool 7.6% (Black) and 6.5% (Hispanic) respectively. These data suggest that once students gain access to cultural and social capital via their undergraduate institutions and/or parent education they benefit from the accumulated advantages. These findings are consistent with EMI and MMI that achieving higher levels within a system serve to maintain those advantages and facilitate more advantages (Lucas, 2001; Raftery & Hout, 1993).

Evidence of holistic review was demonstrated in the HGLM as well. Hispanic, Black, Native, URM combo and female applicants all had favorable odds ratios for matriculating to highly selective medical schools compared to their White and male counterparts respectively. Highly selective medical schools presumably have advantages in matriculating the most qualified and diverse candidates within the applicant pool. All the top ten *USNWR* ranked medical schools have percentages of underrepresented minority enrollments above the national pool percentage (MSAR, 2010). The top schools are mostly private institutions with large endowments who may be able to provide larger financial aid packages. Again, the advantage of perceived prestige among institutions follows the same theoretical framework for sustained advantages outlined for individuals. Schools at the top remain at the top and have greater access to resources to maintain their positions.

Socioeconomic Diversity

For the last several decades allopathic medical schools have given little attention to the socioeconomic disparities in medical education and have done little to address the underrepresentation of low income students (Grbic, 2011). Only in the last two years has there been a quantifiable marker in the common application to more closely and objectively identify students from socioeconomically disadvantaged populations (Grbic, Garrison & Jolly, 2008). The data show that the students least likely to be successful gaining admission are those from inclusive or selective institutions, those from backgrounds where parents have lower levels of education, or racial minority groups such as Black, Latino and Native American – or some combinations of these factors. These students are also those likely to have lower MCAT scores and academic indices upon which schools primarily initially weigh their candidacies. There is evidence of holistic review for underrepresented groups in this study, which is encouraging. The creation of an indicator for low SES students on the AMCAS application provides admissions decision makers with the tools to diversify their classes according to SES using holistic review. Whether or not the indicator will make a difference in additional consideration for low SES applicants remains to be studied. This study provides ample support that there is a need for more attention to socioeconomic diversity, as there are vast disparities among applicants by SES.

Implications

This study has outlined stratification and inequality among applicants to medicine on several individual and institutional predictors. I now offer possible solutions and discuss implications of the findings. Based on the data, I offer the following ideas to address disparities and inequalities among applicants to medicine: (1) Mitigate selectivity bias by blinding institution of applicants during the admissions process. (2) Improve and individualize the premed experience to retain more students in undergraduate years. (3) Employ academic thresholds to widen consideration for well-prepared applicants. (4) Commit to only need based aid and lower the cost of applying and preparing wherever feasible. (5) Modify outreach and pipeline programs to better address the needs of low SES students and innovate models for community colleges and inclusive institutions. (6) Invest in high school preparation to facilitate greater participation at the post-secondary level, as it remains the only portal to medicine; and finally, (7) limit the forces and pressures working against access and equity by eliminating school ranking. A broader discussion of these implications follows.

Mitigate Selectivity Bias

The descriptive data in this study showed that applicants from more selective schools tended to be the most advantaged applicants in the preparation process with highly educated parents and presumably the highest levels of social and cultural capital as a result. Admissions decision makers in the study, on average, seemed to look more favorably on applicants from highly ranked undergraduate schools because applicants from these schools received more acceptances. This bias further exacerbates inequalities in medicine by restricting access to the insider networks within the profession for students who did not already have them. It only further stratifies medicine and compounds the educational disparities already present within the applicant and preparatory pools. If a medical school prides itself on training excellent physicians, why should the undergraduate school of a candidate matter? Selectivity has not been shown to correlate with outcomes for better doctors, and yet it has strong influence on admissions even when controlling for academic preparation. The preference for applicants from more selective schools may further restrict access to an already unattainable profession for many.

Admissions decisions may have more equitable outcomes if the undergraduate institutions were blinded for all or part of the process. Removing undergraduate information may allow reviewers, interviewers, and school representatives interacting with applicants during the process to have more neutral expectations and more accurate assessments. When decision makers are presented with a detail perceived as favorable, they tend to look for and identify more strengths (Reeves, 2012). Conversely, when a detail is perceived to be less favorable or negative, individuals tend to fixate on and identify more weaknesses (Reeves, 2012). An applicant's strengths may be more accurately and fairly assessed if the institutional pedigree were removed from the process.

Improve the Premed Experience

The culling process of premed (Lovecchio & Dundes, 2002) presents a strong need for increased campus resources to help students navigate the preparation waters toward medicine. Institutional forces such as stereotype threat and deficits in social and cultural capital can be mitigated with support mechanisms that ensure that all students experience community and have resources to successfully complete the premed courses. Historically premed course tracks have been designed to 'weed out' students (Thurmond & Cregler, 1999). Institutions need to restructure premed pathways with increased flexibility and attenuation to each student's previous background with course work. High school exposure to math and science differs greatly among students (Lee, Croninger & Smith, 1997) and their efficacy toward science and math differs as a result (Maple & Sage, 1991). If premed pathways were tailored rather than uniform, medicine may retain more applicants in the undergraduate preparation phase.

The emphasis on premed course work, which arguably contains some of the most difficult courses in any campus catalog, also may deter students. These courses were defined by Flexner (1910) more than 100 years ago. Revisiting the premed courses has been a matter of national discussion for decades, and yet there has been no uniform change (Emanuel, 2006; Gross, Mommaerts, Earl & De Vries, 2008; Gunderman &

Kanter, 2008). Kanter called for more evidence-based scholarship that the premed courses are necessary in the first place and for better alignment of courses with medicine's overall professional goals and values. One longitudinal study of a medical humanities program found that students who did not take any premed courses did just as well as their peers in medical school who took traditional premed tracks (Rifkin, Smith, Stimmel, Stagnaro-Green, & Kase, 2000). If premed courses are a deterrent for talent as well as barriers to diversifying the profession, *and* they are potentially unnecessary for success in medical training and career, leaders in academic medicine have an imperative to re-examine and change the requirements. Medicine can no longer afford to 'weed out' talent in the pipeline.

Being a premed is competitive and individualistic, rather than collaborative and cooperative at most institutions. The difficult experience of premed dissuades many potential doctors long before they apply (Thurmond & Cregler, 1999). The effect of this 'wash out' is drastic considering the small numbers of low income and underrepresented minorities participating in higher education in the first place. If more collaborative structures, such as learning communities and peer mentor networks, existed for premed students, competition may decrease and potentially marginalized students may be encouraged to stay on track toward medicine.

The current systems of admissions for MD programs are relatively uniform and inflexible. The premed preparation components follow similar uniformity and rigidity. Any applicant interested in medicine must take several credits worth of specific premedical courses plus demonstrate significant contributions and achievements in community service, research endeavors, civic engagement, and other extracurricular areas. Effective preparation for a career in medicine comes at high costs of both time and money. As the cost of an undergraduate education increases, deciding on medicine at a later point during undergrad may increase time and money required to compete for admission. For students from low income families, this may make medicine less attractive and feasible. Students with lower levels of social and cultural capital may gain access and knowledge about careers for the first time while in college. If exposure to medicine as a career happens later in the educational progression for low income students, and deciding to pursue medicine later costs them more (in time and tuition), this may mean there will continue to be a small number of low income students applying. Both earlier exposure and more flexibility in required components among applicants may facilitate more applicants from low SES backgrounds.

Use Thresholds for GPA and MCAT

The influence of the MCAT could be mitigated by using a threshold, rather than an interval score. If schools created a tiered system wherein above a certain test score a student was 'qualified' and below it they weren't, then the effects of scores would flatten somewhat and the inequalities in the pool would presumably be somewhat lessened. Standards would be maintained while also encouraging more students to apply. The same concept should be applied to GPAs so that qualified students are not discouraged from applying because their grades are less than perfect. The mean GPA for applicants and accepted applicants, including the standard deviation, is well above 3.0. Most medical schools are pass fail, which equates to a "C-" on the grading scale. Certainly students with GPAs across much wider ranges are well prepared for medicine and should be encouraged to apply. Particularly if disparities in GPAs are related to levels of social and cultural capital of applicant backgrounds, all the more reason to widen the standard to capture more talent from across a wider socioeconomic range of applicants.

Recall that mean differences in academic indices were significant across parent education groups with indices increasing with each level of parent education. If admissions practitioners are making initial consideration decisions largely based on test scores and GPAs, they may be missing very talented students from lower SES backgrounds. It seems practicable to expand the MCAT and GPA ranges and limit their use to the specific aim for which they are relevant in assessing candidacy. Since MCATs do not correlate to clinical acumen or people skills – both critical elements of successful training in medicine – scores should not be the sole predictors of admission.

Stereotype threat. Mitigating stereotype threat among underrepresented premed students is a difficult task. In general, more cooperative and collaborative structures and less emphasis on competition may help (Cohen & Garcia, 2008; Rosenthal & Crisp, 2006). Forewarning about stereotype threat has also been shown to mitigate some of the effects on performance (Johns, Schmader & Martens, 2005). Greater access to resources that increase familiarity with the MCAT may help students feel more confident and prepared. Admissions policies that emphasize multiple domains of expertise may also mitigate stereotype threat by encouraging applicants to see themselves as competent and prepared across multiple domains, rather than just one (McGlone & Aronson, 2006). Decreasing competition and emphasizing shared identities within supportive premed communities may narrow gaps in scores.

Commit to only need based aid. Not using MCAT scores to determine financial aid and committing to only need-based aid would also help lessen the accumulated inequalities of trainees. Many undergraduate institutions have made commitments to offering need-based aid (Pallais & Turner, 2006), and medical schools should do the same. Financial aid based on test scores and GPAs is likely to benefit the students in the applicant pool who already have advantages via higher parent education levels and more selective institutions.

Need based aid may also decrease the loan burden of students interested in primary care. Cooter et al. (2004) found that students from low SES backgrounds went into primary care more often despite graduating with higher levels of debt. Primary care doctors have lower earnings, on average, compared to other specialties. The potential of higher debt and lower earnings sustains inequality within the medical profession (AAMC, 2010a). In addition to need based aid, state or federal programs offering loan forgiveness for providers in primary care fields would potentially alleviate some of the inequalities in medicine.

Lower the cost of preparation. Increasing access to quality preparation resources may also serve to lessen inequalities generated from vast differences in MCAT scores. Students with fewer preparatory resources are at a disadvantage due to less opportunity for practice and mastery, as well as fewer structural supports to guide their preparation. The self-efficacy generated from confident practice may serve to raise test scores if preparation materials are made more widely available. Open sourced online platforms such as Khan Academy have promise for increasing access to quality preparatory materials for low income students. Wherever possible the cost of preparation and application should be scrutinized and lowered so as not to further disadvantage low income students.

There are few resources to assist applicants with the cost of preparation. This study demonstrated that parent education influences the number of schools to which a student applies and is accepted. The cost of preparation may be a significant barrier for students from lower income families. The AAMC has a fee assistance program (FAP) that reduces the cost of the MCAT and allows for AMCAS applications to 13 schools for free. The FAP only addresses part of the cost burden. There are no assistance programs for preparation for medicine, for MCAT preparation classes and materials, for plane tickets to travel to interviews, or for purchasing a suit to wear on interview day. These costs can be daunting for students lacking parental support during their undergraduate or post baccalaureate years. The average cost for all expenses to apply to medical school is about $3,000, not including an MCAT prep course, which raises the total to about $5,000. Finding ways to reduce the cost of applying, or to provide application aid to low income students may facilitate a greater presence of low income students in the pool.

Innovate programs for low SES students. Specific outreach to low income students in medicine lags far behind race-based initiatives at nearly all medical schools nationally. In fact, programs using only race-based criteria may be contributing to disparities in social and cultural capital among aspiring doctors by offering experiences (research, summer exposure, mentorship) to students who may have access to that already by virtue of their families of origin but happen to be racially underrepresented. The data demonstrate that among the most elite within the pool (applicants with five or more acceptances), Black and Latino applicants are a greater proportion compared to their presence in the overall pool. Addressing diversity must include a robust array of parameters narrowly tailored to the goals of a program. If allopathic medicine is interested in diversifying by SES, more attention to enrichment program criteria based on SES should be implemented.

Many programs that have been historically race-based have expanded their criterion and eligibility to include SES factors, but the mechanisms for recruitment and the other associated inputs to program advertisement, development and delivery have not changed. Adding SES criteria to a race based program does not expand access for students from disadvantaged backgrounds via socioeconomic factors if the program itself does not adapt. Tailoring programming for low SES students means including more discussions around system navigation. Understanding challenges for first generation students and providing strategies to help students successfully meet those challenges is an important aspect that should be integrated into programming. Addressing identity from a more complex and intersectional perspective will also help programs expand their scope to meet the needs of more students.

The needs of students underrepresented in medicine are vastly different depending on the potentially marginalized identities they carry (Bright, Duefield & Stone, 1998). Navigating an institution as a poor White student is obviously different than if a student were poor and Black, or wealthy and Black for that matter. Curriculum for outreach programs, chosen mentors at medical institutions, and parent or school outreach at earlier education points on the continuum must also adapt and expand as eligibility for programs expands. For example, in addition to selecting mentors based on racial identity, programs should also identify mentors who are first generation college students and foster connections based on expanded criteria. When administrators are recruiting participants, they should examine socioeconomic demographics of target schools from which to recruit in addition to race. Wherever the scope was previously defined by race, consideration for SES should be added and implemented in practice.

Community college models. Over half of students enrolled in higher education in the U.S. are at community colleges (NCES, 2011a). This remains a fertile recruitment ground for medicine that is largely ignored, untapped, and dismissed before potential can be realized. Medicine's pipeline programs are narrowly tailored for middle and upper class students who follow the typical undergraduate education pattern of being full time at a four year college. Community college models are distinctly absent from the pipeline program landscape. In fact many medical schools frown on students having done any course work at a community college and consider that a negative marker in the academic record. Few medical schools have partnerships with their surrounding community colleges and associated four year institutions to which those students may transfer to capture students aspiring to medicine.

Innovating pathways for low income and racial minority students from community colleges has strong potential to increase the pool to medicine by increasing bachelor's degree completion among underrepresented groups – this is an absolutely critical aspect of increasing representation in medicine. Leadership teams designing programs to diversify medicine have employed a student-by-student model of outreach programming that is difficult to track and has very low-yield for a specific medical school due to the number of educational transitions a student makes between high school, undergrad, and medical school. Programs are often constructed with full time students in mind: utilizing full time summer blocks, very low (if any) stipends, and/or necessitating relocating temporarily to participate. These programs are not easily accessible for working students, students with dependents, students shouldering responsibilities for their families of origin while in college, or students coming to medicine from other careers. Community colleges tend to have higher populations of students with these characteristics and life circumstances.

Identifying students at the community college level from underrepresented backgrounds and providing enrichment, mentorship, career exposure, and other components of preparation would increase the pool of students from said backgrounds. Assisting in partnerships that facilitate community college students transferring to four year institutions and completing their degrees en route to medicine is also a critical component of expanding the gates of opportunity. The models and typologies must change and adapt to welcome students currently left outside the gates. Admissions policies penalizing students who started at community colleges must also be examined and changed. The cultural and social gaps between existing outreach programming and the consistently underrepresented populations in medicine must be narrowed through innovation, expansion, and creative means of engagement.

Inclusive institutions. The data showed Black and Latino applicants were more prevalently represented among the small numbers of students in the inclusive institution category. These students have persisted beyond high school, clearly a marker of desire and motivation despite the potential educational disparities in their journeys to that point. Medical schools may have legitimate concerns about the quality of instruction and rigor of courses at inclusive institutions. Creating programs and partnerships with inclusive colleges to address any potential gaps in preparation and rigor would facilitate more students from inclusive institutions successfully gaining entry to medicine. Ensuring that elements of SCCT are present in programming is critical so participants can explore interests and develop specific career aspirations. Programs must focus on gaps in social and cultural capital among applicants, such as access to mentors and role models, opportunities for performance and mastery experiences in science and math, preparation materials for the MCAT, and opportunities to demonstrate leadership, civic engagement and other non-cognitive skills. Investing in partnerships with inclusive colleges would help extend both concrete resources and system navigation guidance to provide underrepresented students with greater access to medical school.

Invest in high schools. The precursor to post-secondary education is high school. The inequalities among high schools in the U.S. definitely compound the stratification and inequality evident in medicine today. Drop-out rates among underrepresented racial minorities and low income students have decreased in the last decade but are still higher than Whites or students from college educated parents respectively (NCES 2013). Undergraduate enrollment among racial minorities has also increased, but remains disparate for Latinos, Blacks and Native Americans compared to Asians and Whites (NCES, 2011). Medical schools should consider investing more heavily in partnerships at the high school level through more district-wide and top-down mechanisms to provide enrichment and awareness about careers in medicine and promote greater persistence from high school to college. This strategy is consistent with SCCT and provides for more career exposure that allows students to explore their interests and develop strong aspirations earlier in the education process.

The quality and rigor of high school instruction in science and math may also be an area that medical schools could employ partnerships to address. If the nation's medical schools committed to providing resources on the macro level to assist high schools in need there may be more positive long term effects for the future applicant pool nationwide. The logic-model approach to visualizing the process of medical education makes it clear that at every educational transition medicine loses potential physicians who are not graduating high school, not finishing bachelor's degrees, and therefore absent from the pool.

Perhaps one solution is to expand BA/MD programs that more tightly track students into careers in medicine and the health professions. Some states (New Mexico and Missouri) have expanded their programs guaranteeing admissions to medical school for undergraduate students accepted out of high school as long as they maintain academic standards. For low income students and racial minorities, tighter academic tracks at the high school level have been shown to increase achievement (Bryk, Lee & Smith, 1990). Whether these programs are an ideal option for increasing the number of underrepresented students in medicine remains unexamined. What is needed is greater attention to retaining and supporting underrepresented students at the post-secondary level.

Stop participating in ranking systems. The ranking of medical schools by *USNWR* hurts the medical profession in several ways. Ranking ultimately encourages competition that does not serve higher education or society (Ehrenberg, 2003). Rankings in medicine work against diversity in the profession and diversity of leadership. The pressure to raise *USNWR* ranking puts unjustified emphasis on test scores and grades, which do not necessarily correlate to better academic outcomes (Monks & Ehrenberg, 1999). This strong emphasis on matriculating students with high scores is often in direct opposition to need based aid, as larger aid packages are often awarded to students with higher scores. As previously discussed these are likely to be students already possessing advantages for higher education. The emphasis on research dollars and space can take away from the teaching enterprise and ultimately hurt the educational mission of a medical school.

Both Webster (2001) and McGaghie and Thompson (2001) have outlined significant methodological flaws in the *USNWR* formulas for ranking institutions. The continued justification for acknowledging the relevance of USNWR and actively participating in its typology is that applicants use the information to make decisions (McDonough, Lising, Walpole, & Perez, 1998; Eric Neilson, Northwestern Feinberg School of Medicine Alumni Weekend Dean's update, April 11, 2014). Rankings ultimately matter because students use them, and students use them because they matter. Executive leaders in academic medicine need to interrupt this cycle and publicly declare abandonment of this external ranking system. Presidents of some liberal arts colleges did this in 2007 and vowed to create a more robust and useful classification system (Finder, 2007). If the goal of ranking is better decision making and ultimately better fit for applicants and matriculants, surely academic medicine can propose a better tool.

The nation's allopathic medical schools are vastly different from each other. Schools have different missions and foci, and using one type of ranking system that weighs endowment, for example, does not accurately sum up a school. Since the starting of this dissertation more than 10 new schools have received accreditation or provisional accreditation. Based on many of the metrics in *USNWR* these schools will never be able to compete simply because they are new. Students should not be discouraged from attending a school that suits them well because they worry it will not be perceived favorably throughout their career. All accredited schools should have equal stature, with unique strengths and missions emphasized instead.

The ranking systems in medicine are a strong manifestation of EMI. Since most deans at the helm of schools have trained or spent professional time at an institution in the top 25 of *USNWR*, they have benefitted from the perceived prestige generated by the ranking system (Gibson, 2011). The benefits have situated them at the top of schools where they have high levels of power and influence to keep the system in place. Even when evidence is presented that these systems are flawed, leaders continue to endorse ranking because they have personally benefitted from it and their institutions continue to benefit as well. It will take tremendous courage and passion for equality in medicine to interrupt the rankings game.

Future Questions/Issues

This study examined the backgrounds of applicants to allopathic medicine and the potential effects of their college choice via selectivity on admission to medicine. There are many salient issues that remain to be studied that could explore additional implications of selectivity and applicant background. This study would have been bolstered by knowing the institutional choice sets to which students applied in the first place. Perhaps students from highly selective undergraduate institutions only applied to highly selective medical schools? Knowing where students from various types of schools apply would be helpful in creating a medical school choice model taking into account many individual and institutional factors. The results of this study also imply that undergraduate choice models may not fully take into consideration the early graduate studies plans of students when they are choosing an undergraduate institution. Perhaps SES is a salient factor in college choice for influencing considerations for advantages in graduate study. Most college choice models have the bachelor's degree and undergraduate study program as the outcome. Perhaps revisiting the models would provide insight into new points of departure and intervention for increasing access and equity in higher education beyond the bachelor's level. It would also provide more insight into potential gaps in advising or strategic knowledge for applicants.

There are gaps in evidence in this study for more elements of social cognitive career theory among the applicants. Experiences and exposure to medicine were not quantified or evaluated. This study did not examine what aspects of preparation were most salient for developing an interest in medicine and persisting during the undergraduate years. Admissions decisions are not solely made on the academic index variables; there is also an interview and additional application components. This study did not attempt to quantify the other variables influencing admission to medicine. What types of experiences were in the applications? Were there trends in their activities or other aspects of the successful versus unsuccessful applicants (like hours of research, number of research experiences reported)? How much exposure and experience to medicine is enough? How much did letters of recommendation influence outcomes? What other factors gleaned from the applications could explain these differences?

Another aspect that remains to be studied is the influence of advisers on the admissions process. Is there at typology for pre-health advising that would be helpful for students in choosing an undergraduate institution in the first place? What role do advisers play in students gaining admission? More information about the prevalence of advisers, their roles, and their effect on admissions outcomes would be helpful in creating policies and interventions moving forward. Inclusive institutions contribute the fewest number of applicants to medicine each year, so they presumably have fewer (if any) advisers helping students with the process. Are students from these schools less likely to apply because there are no advisers, or are there no advisers because so few students are interested? Letters of recommendation also have an influence on admission outcome, but their influence has yet to be formally studied or quantified.

Among remaining issues to be examined in the context of stratification and inequality in medical education are the effects of the MCAT on the applicant pool. Which types of students leave the potential pool before applying through AMCAS? Do most students making it to the test phase simply incur additional delay if they struggle with the exam, or do they abandon their dreams for medicine altogether? Examining potential delays in the pipeline via the MCAT is relevant because of the workforce shortages constantly touted and the tide of expanding enrollment at medical schools across the country.

How do undergraduate institutional characteristics and experiences affect career trajectory in medicine? What types of specialties do students from specific types of institutions pursue? What types of extracurricular experiences are prevalent among applicants by institutional type? Are they the same or different? Presumably a student gains access to social and cultural networks by virtue of the institutions they have attended in their career. Does attending an elite school make it more likely that a student will choose a more competitive specialty in medicine? Does selectivity have anything to do with residency matching and the behaviors of medical students when applying to medicine? If the nation needs primary care doctors, does the educational background of a student tell us anything about how to achieve more students interested in primary care? Is there an undergraduate institutional type or medical school type that students interested in primary care are more likely to attend?

Conclusion

The diversity of allopathic medicine is impacted by a relatively small number of decision makers and professionals that function as gate keepers and resource purveyors for the profession. Medicine remains a difficult profession to attain with a very narrow preparation pathway, unyielding academic standards, and unforgiving emphasis on many factors rewarding the most resourced applicants. The system, by design, has vast disparities based on individual and institutional factors and yields these same inequalities among practicing physicians in the U.S.. The time to train remains a cost burden disproportionately affecting low income students who lack cultural, social and economic capital from their families of origin. This study has outlined the current state of diversity within the applicant pool and how individual and institutional characteristics affect the outcome of applying to medicine. The boost for applicants applying from selective schools appears to benefit those already occupying advantageous positions by virtue of their parents' educations.

To diversify medicine aspects of preparation, recruitment, admission, and training must change. Institutional leaders must be willing to create new partnerships and innovate programs that better address the needs of underrepresented groups including low income students. Preparation resources need to rigorously mitigate educational disparities that so drastically compound for many low SES and racial minority populations so they can have access to tools that will facilitate admission as efficiently and effectively as their peers with more resources.

Cognitive career development must extend earlier in the process so students can learn about medicine sooner and understand what is required in order to achieve it. The deficits compounded through disparities in parental education must be addressed through career exposure, mentorship, and greater access to venues where students can learn about careers in medicine. By the time students enter college for the undergraduate degree, the pipeline to medicine has already been narrowed. For the underrepresented students that remain, several characteristics about their candidacy are already forged. They cannot change the selectivity of the school they are attending, nor can they change their parents' educations.

Decision makers at the gates of MD programs should be mindful of the benefits and outcomes of diversity within the profession and leverage resources in order to ensure participation from the groups currently underrepresented by race or SES. The history of medicine affirms that the physician workforce of today is a consequence of purposeful design. The changes needed to increase access and equity in medicine for the future also necessitate purposeful design. Achieving greater diversity will benefit practitioners, patients and ultimately the health of the nation. The more inclusive medicine becomes as a profession, the better medicine will be for all.

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