DOES MAJOR MATTER? AN EXAMINATION OF UNDERGRADUATE MAJOR AND MEDICAL SCHOOL ADMISSION

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by
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ABSTRACT

The official stance of the Association of American Medical Colleges (AAMC) regarding the undergraduate major of applicants for admission to medical school is that there are no required or preferred majors. While the AAMC is the body that governs admission to allopathic medical schools in the United States, this statement does not provide clarity to prospective medical school applicants as to what undergraduate major to select; it only encourages students from a variety of educational backgrounds to apply. Furthermore, a broad statement about undergraduate major flexibility does not indicate how undergraduate major will eventually impact admission to medical school. While the AAMC encourages applicants to choose any undergraduate major they wish, there is minimal peer-reviewed research or empirical evidence of the relationship between applicants' undergraduate major and their likelihood of admission to medical school.

Through the lens of the student-choice construct, I sought to determine if applicants' undergraduate major is a statistically significant predictor of admission to medical school. The student-choice construct accommodates decisions such as the intent to pursue post-secondary education, which institution to attend, what major to choose, and whether to persist to degree completion. The student-choice construct also contends that these decisions are influenced by the amount of human, financial, social, and cultural capital available to the student throughout the decision-making process.

To study how undergraduate major predicts admission to medical school, I conducted a quantitative study using a hierarchical binary logistic regression. Secondary data were collected using the formal data request procedure outlined by the AAMC. Application-level data were received from the AAMC, and personally identifiable

information including applicants' names, identification numbers, and addresses were removed by the AAMC before the data were delivered. Additionally, given that the study involves the analysis of de-identified extant data, this study received exemption from the Institutional Review Board at Temple University. The dataset included 53,371 applicants to allopathic medical school for the 2019 application cycle. These applicants attended undergraduate institutions primarily located in the United States and Canada.

Findings suggest that undergraduate major does not serve as a statistically significant predictor of admission to medical school over and above applicants' demographic characteristics, MCAT scores, and undergraduate grade point average. Applicants who chose a biology, chemistry, physics, or mathematics (BCPM) major did not have a greater chance of being admitted to medical school than an applicant who chose a non-BCPM major. These findings are consistent with previous studies that sought to predict variables that contribute to medical school admission.

Future research should investigate the predictive validity of admissions variables such as applicant characteristics captured from medical school interviews; letters of recommendation; personal statements and community service, leadership, and healthcare experiences. A combined or comparative study similarly analyzing applicants to different health profession programs might also be useful. In addition, a non-binary categorization of specific undergraduate majors would provide an even more nuanced analysis of how different majors predict admission to medical school.

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I would like to express my sincerest gratitude to the people who have supported me throughout this academic endeavor. The task would have been unimaginable without the support of my family. I am forever grateful for their willingness to understand the intensity of the task while encouraging me throughout this entire process.

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Other members of the Temple University community to whom I wish to give thanks include my supportive coworkers, colleagues, and students. They have patiently allowed me to work toward the completion of this project while fulfilling my responsibilities as an employee.

Lastly, I would like to thank my late grandmother, Mellie Jo Howard. She instilled within me a lifelong love of education and inspired me with her commitment of service to others.

AUTHOR NOTE

This material is based on data provided by the Association of American Medical Colleges ("AAMC"). The views expressed herein are those of the author and do not necessarily reflect the position or policy of the AAMC.

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CHAPTER 1

INTRODUCTION

The official stance of the Association of American Medical Colleges (AAMC) regarding the undergraduate major of applicants for admission to medical school is:

> According to data collected by the AAMC, more than half of all applicants reported undergraduate biological science majors over the past five years, while the rest reported a variety of majors including mathematics, statistics, social sciences, health sciences, and the humanities. Humanities classes can teach students how to develop their communication skills, critical thinking, and cultural competences — all skills that are essential to becoming an effective physician. (AAMC, n.d.)

While the AAMC is the body that governs admission to allopathic medical schools in the United States, this statement does not provide clarity to prospective medical school applicants as to what undergraduate major to select; it only encourages students from a variety of educational backgrounds to apply. Furthermore, a broad statement about undergraduate major flexibility does not indicate how a student's undergraduate major will eventually impact their admission to medical school. While the AAMC encourages applicants to choose any undergraduate major they wish, there is minimal peer-reviewed research or empirical evidence of the relationship between applicants' undergraduate major and their likelihood of admission to medical school.

In a study sponsored by the AAMC, Dunleavy et al. (2011) surveyed 133 medical school admissions officers to determine the importance of various application criteria on admissions decisions. While traditional factors such as undergraduate cumulative science and mathematics grade point average, undergraduate cumulative grade point average, MCAT scores, and medical experience are seen as important in medical school admissions decisions, variables such as letters of recommendations, personal statements, community service, leadership experience, and experience with underserved populations are also considered additional factors impacting admission.

It is also important to consider the volume of prospective physicians entering the medical school application pool each cycle and their odds of acceptance into medical school. For the past 10 years, the acceptance rate to AAMC member institutions has been approximately 41% (see Appendix A). In 2019, according to the AAMC, 53,371 applicants submitted 896,819 total applications to medical schools across the United States. These applicants sought one of 21,869 allopathic medical school seats nationwide (AAMC, 2019).

While prospective applicants can choose any undergraduate major, all applicants must complete the same prerequisite undergraduate courses to be considered for medical school admission (AAMC, 2019). The AAMC's Medical School Admissions Requirement Guide outlines the prerequisite courses needed for admission. Applicants to medical school are expected to take general biology, general chemistry, physics, organic chemistry, biochemistry, and two additional upper-division biology courses (MSAR, 2019). For example, an English major and a Chemistry major would still be expected to take the same core courses in the sciences.

With rigorous coursework, difficult standardized tests, and a limited number of medical school seats sought by a large pool of applicants, it can be fairly hypothesized that prospective physicians seek advantages to differentiate themselves from the masses. Some students are better equipped to identify and implement these advantages than others (Perna & Titus, 2005). Students underrepresented in medicine (URiM) are often disadvantaged in the medical school admissions process and in medical school in general.

URiM students are more likely to be of low-income backgrounds, the first in their family to attend college, and identify as ethnic and racial minorities as compared to those who are more well-represented in the field of medicine. Given these characteristics, URiM students may also have access to fewer resources through their undergraduate social networks. Because of this, it becomes the role of college and university personnel, such as health professions advisors, to boost social and cultural capital amongst the groups of prospective medical students who need it most.

There are also important implications regarding undergraduate major for students who are denied admission to medical school. Because over 50% of all applicants to medical school are not accepted (AAMC, 2019), thousands of applicants must seek ways to leverage their undergraduate degrees to obtain gainful employment or pursue admission to graduate programs in other academic areas. The opportunities available to students regarding the availability and selection of an undergraduate major then become markedly more important for those who do not want to pursue graduate education in specific fields like biology or chemistry.

Through the lens of the student-choice construct, I sought to determine if applicants' undergraduate major is a statistically significant predictor of successful admission to medical school. The student-choice construct (Paulsen & St. John, 2002; Perna, 2006; Salisbury et al., 2009) provides a theoretically and empirically grounded approach for examining a wide array of variables that affect students' decisions about opportunities in higher education, such as choice of major. The student-choice construct accommodates decisions such as the intent to pursue post-secondary education, which institution to attend, what major to choose, and whether to persist to degree completion.

Although the student-choice construct has previously been used to frame admission to medical school (Hadinger, 2017), it has not been used to investigate the role undergraduate major plays in admission to medical school.

The student-choice construct also contends that these decisions are influenced by the amount of human, financial, social, and cultural capital available to the student throughout the decision-making process (Paulsen & St. John, 2002; Perna, 2006; Perna & Titus, 2005). For example, if students, particularly those underrepresented in medicine, were better informed of the breadth of undergraduate major options, might those students choose majors that could lead to stronger undergraduate performance, eventually leading to admission to medical school? Perhaps merely being aware that majors other than biology or chemistry are viable options for successful admission to medical school might give URiM students the knowledge needed to choose from a more diverse array of majors allowing them to stay the course throughout the journey to medical school. Additional analysis is needed to determine if, when coupled with undergraduate major, factors such as applicants' race, sex, socioeconomic status, undergraduate grades, and standardized test scores also predict medical school admission.

Research on undergraduate major among medical school applicants has not previously focused on the relationship between applicants' undergraduate major and their individual characteristics such as race and sex. The representation of women (e.g., Dickson, 2010; Jacobs, 1986; Leslie et al., 1998; Reskin et al., 1996) and people of color (e.g., Barr, 2008; Dickson, 2010; Leslie et al., 1998; Oaxaca, 1998) in science, technology, engineering, and mathematics (STEM) fields remain lower than their representation in the United States population at large. But do these same differences in race and sex exist in majors selected by students who aspire to enroll in medical school, and does this choice in major disadvantage some students over others? Answering these questions could help colleges and universities and their support staff, such as health professions advisors, better inform their students of the potential impact undergraduate major may have on their likelihood of admission to medical school. In turn, these same advisors might be better able to guide those who are underrepresented in medicine toward an academic pathway that best supports their successful entry into medical school.

While there is clear evidence highlighting the low number of women enrolled in undergraduate science and technology majors (Snyder et al., 2019), the number of women graduating from medical school exceeded the number of men for the first time, in the United States, in 2019 (AAMC, 2019). Despite this progress, women are still historically outnumbered by men in obtaining careers in science and technology fields (Snyder et al., 2019).

While the pipeline for women entering medical school has stabilized, the pipeline for URiM applicants to medical school has continued to leak, with little progress over the years (Barr, 2008). Inspired by the U.S. Supreme Court's landmark decision in *Grutter v. Bollinger* (2003), the AAMC Executive Committee adopted a clarification to its definition of populations underrepresented in medicine. The AAMC's current definition of URiM is, "Underrepresented in medicine means those racial and ethnic populations that are underrepresented in the medical profession relative to their numbers in the general population" (AAMC, 2004, para. 2). The AAMC's previous definition was more explicit in defining underrepresented students as Black, Mexican-American, American Indians, Alaska Natives, Native Hawaiians, and Puerto Ricans (AAMC, 2004). For this study, I refer to these formerly defined groups when discussing students who are considered URiM.

According to United States Census data, national trends in population diversity, specifically concerning race and ethnicity, have continued to increase. However, those same gains have not been realized in the medical school enrollment of groups historically underrepresented in medicine. The low number of underrepresented individuals practicing as physicians evidences this deficit. Recent data reflect that only 4.1% of all Medical Doctors (MDs) in the United States are Black or African American, and only 4.4% are Latino or Hispanic (AAMC, 2019). The national medical school applications for 2019 demonstrated a continued deficit in representation from Black and Latino populations. According to the AAMC, the distribution of applicants to medical school by race was 51.5% White, 21.3% Asian, 7.1% Black, and 6.3% Hispanic/Latino (AAMC, 2019). While these data reflect a gradual increase in the number of underrepresented students applying to medical school, when compared to previous application cycles, these numbers do not reflect the steeper rise of these populations in the general population of the United States. With 13% of the current United States population consisting of African Americans and approximately 18% made up of Latinos, the population of American physicians and those applying to medical school does not adequately reflect the racial and ethnic diversity of the nation (Census, 2015).

The AAMC identifies "Cultural Competency" as one of the "Core Competencies" used in the evaluation of physicians (AAMC, 2015). Cultural competency has emerged as an essential issue for several reasons. As the aforementioned racial demographics of the United States become more diverse, physicians will provide care for more patients with a wide range of healthcare needs and perspectives, often influenced by their social or cultural backgrounds. Patients may be unable to speak English, have different thresholds for seeking care, have a limited understanding of what care a physician can provide, or have cultural beliefs that determine whether they adhere to a physician's recommendations (Berger, 1998). Research has shown that communication between physician and patient is associated with better health outcomes, patient satisfaction, and adherence to medical directives. Because of this, adverse health outcomes can occur when cultural differences between physicians and patients are experienced in a clinical setting (Stewart et al., 1999). Cultural competence in medicine also plays a role in improving quality of care and contributes to eliminating racial and ethnic health care disparities (Williams & Rucker, 2000).

Students at liberal arts colleges report more frequent experiences with diversity than their peers at other types of institutions (Kuh & Umbach, 2005). Many liberal arts colleges have policies and practices specifically designed to prepare their students for a diverse world. Liberal arts students encounter perspectives that reflect a range of human experiences, and those students are encouraged and supported to interact with others in ways that help them think and respond in complex ways to a variety of circumstances.

Because of the diversity deficits in medicine, it is vital to explore the lack of representation in medical school as well as identify actionable ways that undergraduate institutions can support and advise students to better prepare for medical school admission. If students were consistently advised that majoring in a natural science was not essential for medical school admission, undergraduate anxieties, academic culling, and competitive pressures might lessen, resulting in a more heterogeneous pool of medical applicants (Bruer, 1981). My study is based on this most basic idea.

Few studies address the choice of undergraduate major and its impact on admission to medical school (Brieger 1999; Bruer, 1981; Simmons, 2005). More specifically, there is no research that has determined how undergraduate major impacts admission to medical school differently across sex and race. This study is designed to answer one primary research question: is undergraduate major a statistically significant predictor of medical school admission over and above an applicant's Fee Assistance Program (FAP) waiver status, sex, URiM status, undergraduate grade point average, and total MCAT score?

Researcher Positionality

To provide important context to my research, I acknowledge how my professional experiences shaped the design of my study and my interpretation of the findings. Further, I share several assumptions that guided my work. I have worked as an undergraduate health professions advisor for over fifteen years at four different institutions. My professional experience prompted my interest in the subject of undergraduate major and medical school admission. Through my observations and experiences, my research was guided by an assumption that students from both science and non-science undergraduate disciplines have a comparable likelihood of admission to medical school.

Organization of the Study

This dissertation is presented in five chapters. Chapter 1 is an introduction to the external pressures impacting admission to medical school and the roles medical school admissions officials and undergraduate health professions advisors play in the admissions process. Chapter 2 is a review of literature that focuses on the following themes: 1) historical perspectives on physician workforce shortages and expansion of medical schools; 2) historical perspectives on medical education and the opportunity to change the profile of new medical school entrants by adjusting long-standing admissions standards and practices; 3) new admissions practices as a result of the holistic review paradigm; and 4) the current role of the health professions advisor community in preparing premedical students. Chapter 3 describes the methods used to answer the research question. Chapter 4 presents the findings of the study. Chapter 5 integrates the findings into a discussion of implications, policy recommendations, and directions for future research.

CHAPTER 2

LITERATURE REVIEW

Prospective medical school students can apply for admission to medical school having completed an undergraduate major in any field or discipline (AAMC, n.d.). Additionally, there is minimal evidence to support the notion that an applicant who majored in science has a greater chance of admission to medical school than an applicant who chose a non-science major. This literature review begins by discussing historical perspectives on the demographic variables of sex and race in relation to students' choice of undergraduate major. It also discusses perspectives on undergraduate major choice in relation to medical school admission as well as the historical shift to the holistic review paradigm. This chapter also briefly addresses how support staff, such as health professions advisors, may better inform students of undergraduate major options and how their major may impact their admission to medical school.

Undergraduate Major

Understanding sex and racial division across undergraduate majors is important when considering how one's major relates to the educational choices they make. Several studies have found that the representation of women and other underrepresented students (Leslie et al., 1998; Pascarella et al., 1996) in science, technology, and engineering fields remain substantially lower than their representation in the overall population. Studying undergraduate major by sex and race is particularly important because some have suggested that the undergraduate major of women and minorities creates significant earning differentials, which can perpetuate class differences (Leslie et al., 1998, Pascarella et al., 1996).

Sex and Undergraduate Major

While gender equity in the sciences has continued to improve, the difference in choice of college majors between male and female students is still noticeable. For example, in 2016, among recipients of bachelor's degrees in the United States, 2.3% of women majored in engineering compared to 14.0% of men, and only 6.4% of women majored in a natural science such as biology or chemistry compared to 9.2% of men. For comparison, 18.7% of women majored in education compared to 6.6% of men (Snyder et al., 2019). These findings suggest women are still underrepresented in STEM fields as compared to men.

Additional research has demonstrated a widening gap between men and women students choosing to major in sciences such as mathematics, economics, physical sciences, and engineering (Turner & Bowen, 1999). While there is abundant research indicating that men historically choose science majors more often than women, the 2017-2018 medical school admissions application cycle marks the first time more women have been admitted into allopathic medical school than men (50.7%). This pattern continued for the 2018-2019 (51.6%) and 2019-2020 (52.4%) application cycles (AAMC, 2019). While it is important to monitor and foster the development of women in science and medicine, these data indicate that a shift to a more gender-diverse medical workforce is underway.

Race and Undergraduate Major

There is an extensive body of research demonstrating the effect of race across a range of undergraduate experiences, including undergraduate major (Rankin & Reason 2005; Saenz et al., 2007; Salisbury et al., 2009; St. John et al., 2005). Research has shown that students from traditionally underrepresented racial minority groups often face obstacles not experienced by those in other groups. Additionally, differences in the social and cultural capital available to students before enrolling in college impacts their ability to enroll and persist in higher education (Engberg & Wolniak, 2010; Museus & Quaye, 2009; Teranishi & Briscoe, 2006; Wells, 2008). Studies have found that racial minority students frequently experience college in ways that their majority counterparts do not (Ancis et al., 2000; Museus & Quaye, 2009; Nora, 2004). These differences in experiences often influence minority students' decisions regarding their interactions with their undergraduate institution or even with other students (Ancis et al., 2000; Museus & Quaye, 2009; Nora, 2004). Considering these aforementioned differences, the number of underrepresented in medicine (URiM) students in science, technology, engineering, and mathematics (STEM) fields remain lower than their representation in the population of the United States at large (Barr, 2008; Dickson, 2010; Leslie et al., 1998; Oaxaca, 1998).

Based on the literature, it is plausible to expect URiM students to approach choosing a major in preparation for medical school differently based on levels of human, financial, social, and cultural capital accumulated before and during the college experience.

Medical School and Undergraduate Major

While narrow in scope, research has been conducted on undergraduate major as it specifically relates to premedical students. Research conducted at medical schools, large state universities, and liberal arts colleges have laid the preliminary groundwork for the study of undergraduate major and medical school admission. Still, there are no peer-reviewed studies that have evaluated the relationship between applicants' undergraduate major and admission to medical school, particularly regarding the race and sex of applicants.

Physicians and graduate medical educators have been contemplating and debating change in undergraduate premedical education for decades. The symptoms of the "Premed Stereotype" (Hackman et al., 1979) have continued over the years. The Premed Stereotype suggests that applicants to medical school tend to overemphasize science coursework, high academic achievement, and competitiveness while discounting the importance of “soft-skills” that can be learned in other disciplines. Because of this, there has been a sustained focus on undergraduate institutions producing more "well rounded" medical school applicants. In the seminal article published in the *New England Journal of Medicine*, Thomas (1978) stated that "more attention should be paid to the success of students in other, non-science disciplines before they are admitted, to assure the scope of intellect needed for a physician's work" (p. 1180).

Decades later, the theme of a "well rounded" medical school student was affirmed as practicing physicians identified communications, natural science, and technology as three subject areas most important for success in medical school (Duffrin et al., 2006). Natural sciences, such as physics, chemistry, and biology, were perceived as less critical for success as a practicing physician. The three subjects deemed essential to the successful practice of medicine are business, communications, and technology. These findings underscore the importance of broadening the academic experiences of undergraduate premedical students. This information could also serve as a reminder to advisors and administration to educate and encourage students to explore all majors available to them.

Liberal arts colleges are uniquely positioned to study the impact of a wide variety of undergraduate majors and admission to medical school. Those associated with liberal arts education have sought to broaden approaches to major selection, emphasizing the importance of critical thinking, and to encourage academic exploration by their premedical students (Brieger 1999; Bruer, 1981; Simmons, 2005). Through the analysis of Association of American Medical Colleges (AAMC) data, Bruer (1981) determined that there is not apparent bias against nonscientists in the medical school admissions process and that there was not a substantial difference in cumulative undergraduate grade point averages or MCAT scores for students who chose majors in the social sciences or humanities. While this supports the notion that undergraduate major is irrelevant for admission to medical school, it is important to note that this study was conducted in 1978. Therefore, an updated analysis is needed. Additionally, the scope of Bruer's research did not include an analysis of how sex, race, or ethnicity may differentially predict medical school admission.

While research addressing medical school admission and undergraduate major is scarce and studies that do address this topic are narrow in scope, there is research that demonstrates the value in encouraging premedical students to explore a broader array of undergraduate majors. A qualitative study conducted at a mid-sized Jesuit university in New England examined student attitudes about liberal arts education and how it prepares them for a career as a future physician (Simmons, 2005). According to the study participants, non-science coursework helped them develop interpersonal communication skills, build empathy for those around them, and gain a greater understanding of cultural diversity. Participants believed that the skills learned from non-science coursework were transferable to their future careers as physicians. Participants also believed that intentional and careful selection of courses could help them better balance their academic workload to maximize their academic performance, thus allowing them to maintain more competitive grades for admission to medical school. Simmons did not examine the associations between undergraduate major, applicants' sex and race, and medical school admission. More specifically, although the study did not explicitly correlate undergraduate major and non-science coursework to admission to medical school, it did emphasize the contributions of non-science coursework to the future practice of medicine.

In a study conducted at the University of Alabama School of Medicine, similar findings were discovered. Sorenson and Jackson (1997) determined that there was not a significant difference in acceptance rates to their medical school between science and non-science majors. Also, Sorenson and Jackson found that MCAT scores, performance in the basic medical science courses, and clinical performance were not significantly different between the science and non-science majors studied. The study also determined that, at the University of Alabama School of Medicine, acceptance rates for non-science majors were higher than acceptance rates for science majors.

Similarly, a study at SUNY Buffalo School of Medicine found that a student's undergraduate major does not significantly contribute to their academic performance, clinical performance, or residency selection (Dickman, 1980). The study concluded that the importance of non-science, liberal arts, and humanities coursework contributes to producing physicians with broad interests and backgrounds. Although the findings of these two medical school studies are consistent, it is important to note that these data only reflect the admissions processes and the applicant pool of two medical schools. Therefore, these discoveries may not be generalizable to medical schools across the country.

While the findings of Sorenson and Jackson (1997), Dickman (1980), and Bruer (1981) support the idea that undergraduate major has no bearing on admission to medical school, findings from a more recent and comprehensive study could be used to inform university advisors, faculty, and administrators about the state of medical school admission and how to best equip students for future success. To address these gaps, my study was designed to analyze undergraduate major in conjunction with other variables such as sex, race, and socioeconomic status to provide a more in-depth analysis of medical school admission. Although the aforementioned studies provide clear evidence that medical school performance is not hindered by whether a student chooses a science or non-science major as an undergraduate, there is still no definitive determination as to whether choosing science or non-science majors significantly predicts admission to medical school, especially in recent years. Furthermore, research has not explored how much of the variance in medical school admission can be explained by undergraduate major over and above an applicant’s sex, race, socioeconomic status, undergraduate grade point average, and total MCAT score.

Without the proper context and social and cultural capital, students may view the relationship between major and career choice as strictly linear. For example, traditional education-career paradigms suggest that nursing majors become nurses, accounting majors become accountants, and education majors become teachers. However, for most students such direct career paths are the exception (Bertram, 1996). For a medical school student, all the skills needed to become a licensed medical professional are learned in medical school, and the burden of clinical training to adequately prepare a physician to practice is the responsibility of the medical school, not undergraduate institutions. Therefore, undergraduate coursework might be the last opportunity for a student to acquire the knowledge and skills that could supplement their practice as a "well rounded" physician.

Student-Choice Construct

Gaining admission to medical school requires a different set of abilities that differ from the skills that are indeed necessary to practice medicine (Duffrin et al., 2006). For example, a student who is adept at chemistry or biology might acquire the necessary skills to perform well on the MCAT. However, this does not guarantee that the student will perform well in medical school. Furthermore, these academic abilities do not mean that an applicant will someday become a highly skilled, caring, and compassionate physician. Many theoretical models fail to consider the diverse set of experiences, backgrounds, and cultures that more closely reflect contemporary society in the United States.

This study investigated undergraduate major and preparation for medical school using the lens of the student-choice construct. This construct was chosen because it provides a theoretically and empirically grounded approach to examine the range of factors that affect how undergraduate students make decisions based on their opportunities (Paulsen & St. John, 2002). The student-choice construct suggests that students operate within a range of postsecondary choices, such as the decision to attend college, which college to attend, what undergraduate major to choose, and whether to re-enroll and persist. From the perspective of this framework, these decisions are influenced by the nature and amount of human, financial, social, and cultural capital available to the student while making these decisions (Paulsen & St. John, 2002; Perna, 2006; Perna & Titus, 2005).

Social and cultural capital are crucial components of this decision-making process, as parents with a higher level of education may be able to provide their students with opportunities to successfully pursue and complete the advanced education and training necessary to become a physician. Students from well-educated families are more likely to seek a career in medicine than students whose parents attained a lower level of education (Antony, 1998).

CHAPTER 3

METHODOLOGY

To study how undergraduate major impacts admission to medical school, I conducted a quantitative study using a hierarchical binary logistic regression. Secondary data were collected using the formal data request procedure outlined by the Association of American Medical Colleges (AAMC). Application-level data were received from the AAMC. The dataset included 53,371 applicants to allopathic medical school for the 2019 application cycle. These applicants attended undergraduate institutions primarily located in the United States and Canada.

Because my study was conducted using the lens of the student-choice construct, and because this theoretical perspective takes into consideration factors such as human, financial, and cultural capital, I examined how applicant-level variables such as Fee Assistance Program (FAP) waiver status, sex, and the underrepresented in medicine (URiM) status of an applicant explain the variance in medical school admission when considered in conjunction with undergraduate grade point average, total MCAT score, and undergraduate major.

I conducted a hierarchical binary logistic regression because this statistical technique can be used to predict a dichotomous outcome variable based on two or more predictor variables. Further, this method was used because it can determine which variables serves as statistically significant predictors of the outcome variable (medical school admission), and which variables do not statistically or meaningfully explain the relationship between the predictor and outcome variables. The most pertinent demographic variables such as gender, socioeconomic status, and race of the applicants were included as predictors in my analysis.

Data Collection

All data were collected by the AAMC via the American Medical College Application Service (AMCAS), the centralized application service for member institutions of the AAMC. In addition to academic records such as grade point averages and MCAT scores, AMCAS also collects extensive student-level demographic and biographic variables such as hometown, sex, age, race/ethnicity, state residency, residency status, family income level, and other variables. For reference, a full list of variables provided via data request from the AAMC is included in Appendix B.

I procured secondary applicant-level data using the formal data request procedure outlined by the AAMC. Personally identifiable information including applicants' names, identification numbers, and addresses were removed by the AAMC before the data were delivered. Additionally, given that the study involves the analysis of de-identified extant data, my study was exempt from review by the Institutional Review Board at Temple University.

Because these data were collected directly by the AAMC, the expert nature, credibility, and trustworthiness of the data were assumed. Choosing to analyze data that already exist provided a pre-established level of validity and reliability given the number and scope of studies that used the same or similar AAMC data. Given the confidence in data reliability and completeness, I chose not to evaluate the efficacy of AAMC's data collection methods (e.g., checking for incomplete and mutually non-exclusive response categories).

Sample

The study consisted of 53,371 medical school admission applicants as included in the AAMC 2019 applicant dataset. The inclusion criteria included any applicant with a completed, submitted, and verified application. These data were chosen because they were readily available using the AAMC formal data request process and were previously vetted and verified by the AMCAS clearinghouse. Among other variables, the sample indicated applicants who were admitted to medical school and those that formally matriculated into medical school. I chose to use the outcome variable of acceptance as opposed to matriculation, as accepted applicants were given the opportunity to attend medical school regardless of whether they took advantage of the opportunity.

It is important to note that my dataset includes applicants to allopathic medical schools in the United States, and not those who applied to osteopathic medical schools. This is consistent with the literature reviewed in this dissertation as most studies addressed allopathic medical school application and acceptance in the United States.

Students from more than 210 undergraduate institutions in the United States, Canada, and Puerto Rico were represented in the AAMC dataset from the AAMC. A list of the schools represented by students in the dataset with 50 or more applicants is included in Appendix C.

Variables

The predictor variables chosen from the AAMC dataset are adapted from the student-choice construct (Paulsen & St. John, 2002; St. John et al., 2001), and are referred to using the specific conventions established by the AAMC (e.g., sex, race/ethnicity). A full list of variables provided by the AAMC can be found in Appendix B.

Demographic Variables

The demographic variables include socioeconomic status (SES), race and ethnicity, and sex. The FAP (Fee Assistance Program) variable provided in the AAMC dataset was selected to measure applicants' socioeconomic status. The Fee Assistance Program provides financial assistance to any qualified applicant to assist in covering the cost of applying to allopathic medical school via the AAMC. While the AAMC Education/Occupation (EO) score has been established as a measure of a medical school applicant's socioeconomic status (Grbic et al., 2015), this information was not included in the dataset provided by the AAMC. Therefore, the FAP indicator was used as an approximate measure of applicants' socioeconomic status. According to the AAMC, among all economic indicators collected through the AAMC application to medical school, the FAP approval indicator had the strongest association with the EO score (Grbic et al., 2015). The FAP indicator served as a dichotomous variable and was coded as 0 = no fee assistance provided, and 1 = fee assistance provided.

Academic Variables

Additionally, I analyzed academic variables of cumulative undergraduate grade point average and total MCAT score. These academic factors were selected because of their prevalence in the literature and because they are some of the most commonly considered applicant data by medical school admissions committees when determining which applicants to admit to medical school (Monroe et al., 2013). The AAMC converted all official transcript grades to a standardized grading system using a 4.0 scale. The MCAT uses a scoring range from the lowest score of 472 to the highest of 528 (AAMC, 2019). These standardized grades and scores are reflected in the AAMC data analyzed in my study.

Undergraduate Major

The final predictor variable is an applicant's undergraduate major. For the purposes of the analysis, undergraduate major was dichotomized and coded as 0 = biology, chemistry, physics, and mathematics (BCPM) and 1 = non-BCPM. Non-BCPM majors include Non-Science, Engineering, Health Professions, Natural Sciences, Computer Science, and Other. These groupings were derived from the categories outlined in the AAMC's course classification guide.

Medical School Admission

In this dissertation the outcome variable (admission to medical school) has one of two possible outcomes which I coded as follows: admitted to medical school = 1, not admitted to medical school = 0. This coding is consistent with the convention followed in this dissertation, according to which any category with a larger number is coded as 0 (Wu et al., 2010).

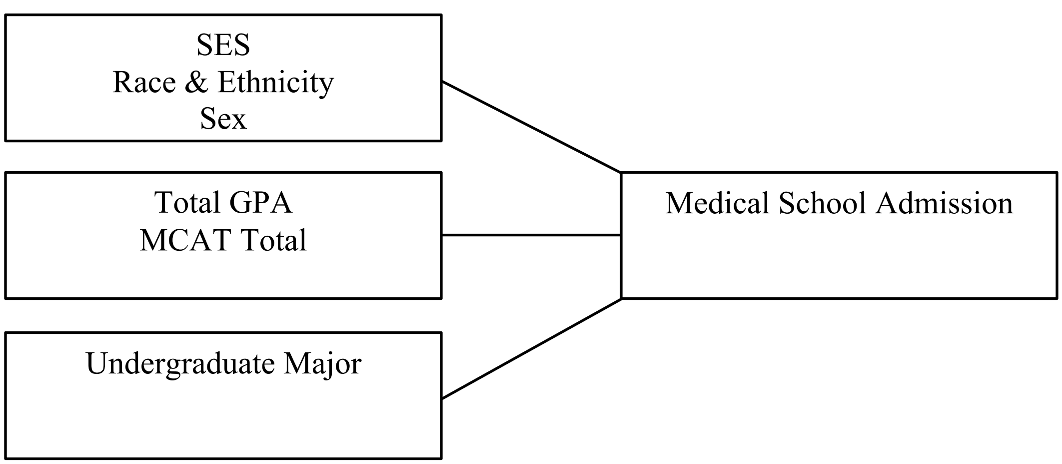

Figure 3.1. A Conceptual Student-Choice Model for Medical School Admission

Data Analysis

A hierarchical binary logistic regression is the appropriate technique to examine the incremental prediction of the outcome after each set of predictor variables are entered into the regression model. The AAMC dataset provided a sufficiently large to support statistical analyses as evidenced by a power analysis (Bohrnstedt & Knoke, 1994; Borman et al., 2002; Heckman, 1979). To begin my data analysis, I tested the relevant assumptions associated with regression analysis. Hierarchical binary logistic regression requires the dependent variable to be dichotomous. In my study, the outcome variable (admission to medical school) has one of two possible outcomes: admitted to medical school or not admitted to medical school. Second, observations are required to be independent of one other. The data meet this assumption, as the observations in the data do not come from repeated measures or matched data such as pre-and post-intervention observations. Multicollinearity was tested by examining tolerance and variance inflation factor (VIF) values. Finally, hierarchical binary logistic regression requires a large sample size. This assumption was met as the AAMC dataset included 53,371 records (Stoltzfus, 2011).

Predictor variables for the hierarchical binary logistic regression were established based on the supporting literature presented in Chapter 2, the student-choice construct, and based on the results of a Pearson correlation analysis. A Pearson correlation analysis was performed for each potential variable that might be selected for inclusion in the regression model.

Once the variables were selected for inclusion in model, demographic variables were added first followed by the academic variables, and finally the variable of undergraduate major. Once a variable was selected for entry in the model, it remained. Forward-selection helped to reduce collinearity since only variables that added uniquely to the significance of predicting the odds of admission to medical school were selected. However, choosing this selection process could potentially eliminate variables from the model that are known to have a strong relationship with the dependent variable if they are unable to maintain their significance in the presence of other variables in the model (Monroe et al., 2013).

Several variables were tested, including number of applications, MCAT section scores, science grade point average, clinical hours, and participation as an NCAA athlete. However, none significantly impacted the later analysis involving the hierarchical binary logistic regression model or were not included due to collinearity issues. The demographic variables (sex, URIM status, and fee waiver status), undergraduate major (BCPM versus Non-BCPM) with the highest number of applicants were treated as the reference categories for comparative purposes and coded accordingly.

I calculated the sensitivity, specificity, negative predictive value, and positive predictive value at each step in the regression model. Sensitivity refers to the ability of a test or statistical model to correctly classify cases with a true positive state. Conversely, specificity refers to the ability of a test to correctly classify cases with a true negative state. Positive predictive value is the proportion of cases with a true positive state. Negative predictive value is the proportion of cases with a true negative state. A separate-samples t-test was also conducted to compare means across BCPM and non-BCPM groups by total MCAT score and undergraduate grade point average.

Limitations

Because the AAMC dataset is large and comprehensive, many of the limitations of using secondary data were eliminated. For example, many of the random biases are averaged in a large sample. However, several systematic biases may exist and confound the results to a considerable extent for large samples (Sink & Mvududu, 2010). While the AAMC application dataset is rather robust and can include dozens of variables (only seven of which were included in the dataset for my study), those variables are dictated by what a person or group of people deem to be important, which may or may not reflect the ideas of the diverse population of students that use the application service. For example, if the governing body is composed entirely of a homogenous group, then the application service and the data it collects might only reflect the experiences and interests of that same narrow population. It is important to note that the AAMC dataset includes information on all 53,371 applicants who applied to one or more allopathic medical schools in the United States in 2019. It does not include information for students applying only to osteopathic medical schools or to allopathic medical schools located in countries other than the United States nor those who applied prior to or after 2019.

CHAPTER 4

RESULTS

This chapter presents the results of several quantitative analyses used to answer the research question. I present descriptive statistics on the applicants to contextualize the findings summarized in this chapter. Next, I detail the results of several tests that I conducted to determine whether the data met the assumptions associated with hierarchical binary logistic regression. I also present the findings of the correlation analysis used to measure the strength of the associations between the predictor and outcome variables. The results of this analysis informed the development of the hierarchical binary logistic regression model. Finally, I present the results of hierarchical binary logistic regression to answer my research question.

Assumption Tests

First, the hierarchical binary logistic regression requires the dependent variable to be binary or dichotomous. Second, the observations are required to be independent of one other. The observations in the data do not come from repeated measures or matched data such as pre-and post-intervention observations. Therefore, this assumption is also met. The results of tests to determine if the data met the assumption of collinearity indicated that multicollinearity were not a concern, as no tolerance values exceeded 1.0 (MCAT Total = .706, Undergraduate Major = .994) and no VIF values exceeded 2.0 (Undergraduate Major = 1.006, MCAT Total = 1.417). Finally, the assumption of large sample size was met as the Association of American Medical College (AAMC) dataset included 53,371 records (Stoltzfus, 2011).

Table 4.1

Descriptive Statistics on Medical School Applicants

	Frequency *n* = 53,371	Percent
Self-Reported Sex		
Female	27,847	52.2
Male	25,495	47.8
Missing	29	.1
URiM Status		
Non-UriM	38,068	71.3
UriM	10,772	20.2
Missing	4,531	8.5
Fee Waiver Status		
No Fee Waiver	46,598	87.3
Fee Waiver	4,774	8.9
Missing	1,999	3.7
Undergraduate Major		
BCPM	33,876	63.5
Non-BCPM	16,944	31.7
Missing	2,551	4.8

Descriptive Statistics

Table 4.1 includes descriptive statistics on applicants' demographic characteristics and undergraduate majors. Applicants were 52.2% female, 47.8% male, while .1% of the applicants declined to specify their sex, resulting in a small amount of missing data for this variable. Students who are not underrepresented in medicine (non-URiM) accounted for 71.3% of applicants, while 20.2% of applicants were classified as URiM. The percentage of applicants who either chose not to report their race and ethnicity or from whom data were missing was 8.5%. Applicants who did not receive an AAMC fee waiver comprised 87.3% of applicants while 8.9% of applicants were granted a fee waiver by the AAMC. The fee waiver status for 3.7% of applicants was missing. As organized by the AAMC course classification guide (see Appendix D), 63.5% of applicants majored in biology, chemistry, physics, or mathematics (BCPM). The remaining applicants studied in one of the following majors: non-Science (14.0.%), Other (10.9%), Engineering (4.3%), Health Professions (3.3%), Natural Sciences (.6%), and Computer Science (.3%). When combined, this non-BCPM group accounted for 31.7% of applicants. Missing or unreported undergraduate majors accounted for 4.8% of applicants.

Table 4.2 displays applicants' academic variables including cumulative undergraduate grade point average and total MCAT score. The mean grade point average of applicants was 3.58 while the mean total MCAT score was 506.1. There were 265 applicants who did not have a reported cumulative undergraduate grade point average (.49%) and 1,045 applicants (1.96%) did not have a MCAT score reported in the dataset. The AAMC converted all official transcript grades to a standardized grading system that uses a 4.0 scale. The MCAT uses a scoring range from the lowest score of 472 to the highest score of 528 (AAMC, 2019).

Table 4.2

Descriptive Statistics of Mean Academic Variables of Applicants

Academic Variable	Frequency	Mean	Standard Deviation
Undergraduate GPA	53,106	3.58	.331
Total MCAT Score	52,326	506.1	9.265

Table 4.3 compares applicants' cumulative undergraduate grade point average and total MCAT score by BCPM and non-BCPM groups. The mean total MCAT score of BCPM applicants was 505.9 while the mean total MCAT score of non-BCPM applicants was 506.6. The mean total undergraduate grade point average was 3.59 for BCPM applicants and was 3.57 for non-BCPM applicants. There was no statistically significant difference in total MCAT score and undergraduate grade point average between the two groups.

Table 4.3

Mean Academic Variables of Applicants by BCPM and Non-BCPM Majors

	Major	Frequency	Mean	Standard Deviation
Total MCAT Total	BCPM	30075	505.9	9.248
	Non-BCPM	14631	506.6	9.284
Undergraduate GPA	BCPM	30075	3.59	.331
	Non-BCPM	14631	3.57	.330

Table 4.4 displays the total number of applicants in the dataset and the corresponding medical school acceptance rates disaggregated by the predictor variables (FAP waiver status, sex, and URiM status). Those who were granted a fee waiver were accepted to medical school at a rate of 37.0% while those who were not granted a fee waiver were accepted to medical school at a rate of 43.4%. Female applicants were admitted to medical school at a rate of 42.7% while 42.3% of male applicants were admitted. Applicants who are not considered URiM were accepted to medical school at a rate of 44.2% while URiM students were accepted at a rate of 41.2%. Finally, those who chose an undergraduate BCPM major were accepted to medical school at a rate of 42.1% while applicants who chose non-BCPM majors were accepted at a rate of 44.9%. Of all applicants in the dataset, 57.5% were not extended an offer to medical school. Aside from sex, the differences in acceptance rates between the groups were significant with small effect.

Table 4.4

Disaggregated Medical School Acceptance Rate by Predictor Variable

		Admission Status			
		Accepted	Not Accepted	Total	Accept Rate
Fee Waiver Status	No Fee Waiver	20,245	26,353	46,598	43.4%
	Fee Waiver	1,770	3,004	4,774	37.0%
Total		22,015	29,357	51,372	42.8%
Sex	Female	11,893	15,954	27,847	42.7%
	Male	10,787	14,708	25,495	42.3%
Total		22,680	30,662	53,342	42.5%
URiM Status	Non-URiM	16,813	21,255	38,068	44.2%
	URiM	4,435	6,337	10,772	41.2%
Total		21,248	27,592	48,840	43.5%
Undergraduate Major	BCPM	14,285	19,591	33,876	42.1%
	Non-BCPM	7,620	9,324	16,944	44.9%
Total		21,905	28,915	50,820	43.1%
Total Applicant Pool		22,687	30,684	53,371	42.5%

Pearson Correlations

Table 4.5 presents Pearson correlation coefficients computed to investigate the significance and strength of the relationships between the predictor and outcome variable. Additional predictor variables, and their corresponding correlations, not included in the model are presented in Appendix E.

Table 4.5

Correlations Between Predictor Variables and Acceptance Outcome

Predictor Variable	Frequency	Pearson Correlation
Fee Waiver Status	51,371	-.037**
Sex	51,343	-.004
URiM Status	47,642	-.028**
Grade Point Average	53,106	.369**
MCAT Total	52,326	.496**

**. Correlation is significant at the 0.01 level (two-tailed)

Despite statistical significance due to the large sample size, findings revealed that the correlation between sex and medical school admission (r = .004, p > .05) is very weak[1] and not statistically significant. In addition, the analysis demonstrated a very weak, significant positive correlation between medical school admission and undergraduate major (r = .027, p < .01), and very weak, significant negative correlations between

[1] Values of r are as follows: 0-0.19 is regarded as very weak, 0.2-0.39 as weak, 0.40-0.59 as moderate, 0.6-0.79 as strong and 0.8-1 as very strong correlation (Godlee, 2020).

medical school admission and URiM status ($r = -.028$, $p < .01$), and fee waiver status ($r = -.037$, $p < .01$). The analysis demonstrated a weak and statistically significant positive relationship between cumulative undergraduate grade point average and medical school admission ($r = .371$, $p < .01$). Finally, the analysis identified a moderate positive correlation between total MCAT score and acceptance to medical school ($r = .496$, $p < .01$). These findings are consistent with information published by the AAMC (Monroe et al., 2013). Although no statistical significance was found between sex and acceptance to medical school, based on the literature (e.g., Dickson, 2010; Jacobs, 1986; Leslie et al., 1998; Reskin et al., 1996), I decided to further test this relationship by including sex as a predictor variable in the hierarchical binary logistic regression model to determine its contribution to the prediction of admission to medical school.

Additionally, larger samples are associated with greater statistical power and reduced sampling error (Sink Mvududu, 2010). Therefore, the statistical significance displayed in Table 4.4 can be attributed to the large sample sizes. Given these findings, a change in the predictor variable does not strongly correlate with a change in the outcome variable.

Hierarchical Binary Logistic Regression

Table 4.6 includes the results of the hierarchical binary logistic regression and the contributions and significance of each of the predictor variables. Table 4.6 provides the results of the hierarchical binary logistic regression and the classifications of predicted and actual outcomes.

Table 4.6

Summary of Binary Logistic Regression Analysis Predicting Acceptance to Medical School

Model	Predictor	*B*	*SE*	Wald	*df*	*p*	*Exp(B)*
1	Constant	-.197	.015	183.248	1	.000	.821
	Fee Waiver Status	-.260	.034	59.520	1	.000	.771
	Sex	-.004	.019	.040	1	.841	.996
	URiM Status	-.087	.024	13.760	1	.000	.916
2	Constant	-99.154	1.056	8809.251	1	.000	.000
	Fee Waiver Status	.127	.043	8.857	1	.003	1.136
	Sex	-.434	.024	314.705	1	.000	.648
	URiM Status	1.603	.035	2133.787	1	.000	4.967
	Total GPA	2.250	.048	2221.488	1	.000	9.491
	MCAT Total	.179	.002	7507.637	1	.000	1.196
3	Constant	-99.076	1.056	8795.197	1	.000	.000
	Fee Waiver Status	.130	.043	9.287	1	.002	1.139
	Sex	-.432	.024	312.219	1	.000	.649
	URiM Status	1.603	.035	2134.455	1	.000	4.968
	Total GPA	2.255	.048	2226.255	1	.000	9.536
	MCAT Total	.178	.002	7483.012	1	.000	1.195
	Major	.033	.011	9.668	1	.002	1.033

Notes. *n* = 53371. Reference categories: No Fee Waiver, Female, Non-URiM, Not Accepted.

Table 4.7

Predicted Outcome of Medical School Acceptance Model

			Predicted		
			Acceptance		
Step 1	Observed (True State)		0	1	Percentage Correct
	Not Accepted	0	25048	0	100.0
	Accepted	1	19659	0	.0
	Overall Percentage				56.0
Step 2			Predicted		
			Acceptance		
	Observed		0	1	Percentage Correct
	Not Accepted	0	20033	5015	80.0
	Accepted	1	5330	14329	72.9
	Overall Percentage				76.9
Step 3			Predicted		
			Acceptance		
	Observed		0	1	Percentage Correct
	Not Accepted	0	20035	5013	80.0
	Accepted	1	5320	14339	72.9
	Overall Percentage				76.9

a. The cut value is .500

Demographic Variables

The first step of the model introduced the demographic variables of FAP Waiver status, sex, and an applicant's URiM status. At this step, the overall model was statistically significant, $X^2(3) = 86.954$, $p = .000$. The overall model explained approximately .3% (Nagelkerke $R^2 = .003$) of the variance in medical school admission. The model correctly predicted the outcome (acceptance to medical school) with an overall accurate prediction rate of 56%. Sensitivity was 56% and specificity was 0%. The positive predictive value was 100% and the negative predictive value was 0%.

FAP Waiver status ($B = -.260$, $SE = .034$, $p = .003$) and the URiM ($B = -.083$, $SE = .024$, $p = .000$) status of an applicant contributes significantly to the predictive value of the model. Consistent with the findings presented in Table 4.3, an applicant's sex did not contribute significantly to the prediction of medical school admission ($p = .841$).

The predictor variables of FAP Waiver status and URiM status have a significant negative relationship with the log odds of admission to medical school, which implies they have an incremental effect on whether an applicant is admitted to medical school. In this case, those who receive the FAP waiver (*Exp (B)* = .771, $p < .01$) have .771 times lower odds of admission to medical school than those who do not receive the FAP waiver. Similarly, URiM applicants (*Exp (B)* = .916, $p < .01$) have a .916 times lower odds of medical school admission compared to non-URiM applicants. FAP waiver status, sex, and URiM status variables together explain approximately .3% of the variance in medical school admission (Nagelkerke $R^2 = .003$) over and above the base model.

Academic Variables

Table 4.5 provides the results of the hierarchical binary logistic regression and the contributions and significance of each of the predictor variables when cumulative undergraduate grade point average and total MCAT score are added to the model. At step 2, the individual predictors of undergraduate grade point average (B = 2.250, SE = .048, p = .000) and total MCAT score (B = .179, SE = .002, p = .000) are statistically significant. In addition, the overall model was statistically significant, $X^2(5) = 18666.149$, p = .000. The overall model explained approximately 45.8% (Nagelkerke R^2 = .458, ΔR^2 = .455) of the variance in medical school admission. The model correctly predicted the outcome of medical school acceptance with an accurate prediction rate of 76.9%. Therefore, there is a 20.9% improvement over the 56.0% prediction as produced in the previous step. Sensitivity was 73% and specificity was 80%. The positive predictive value was 74% and the negative predictive value was 79%.

The addition of the undergraduate grade point average and total MCAT score variables to the model increased the Nagelkerke R^2 value from .003 to .458 adding substantial explanation of the variance in medical school admission. This suggests that this step of the model accounts for approximately 45.5% of the variance in medical school admission.

Both predictor variables have a significant positive relationship with the log odds of admission to medical school, which implies they incrementally predict medical school acceptance over and above applicants' demographic characteristics. In this case, a one-unit increase in the undergraduate grade point average (*Exp (B)* = 9.491, $p < .01$) significantly results in a 9.491 times increase in the odds of admission to medical school.

Similarly, a one unit increase in the total MCAT score (*Exp (B)* = 1.196, $p < .01$) results in a significant 1.196 times increase in the odds of medical school admission. Thus, as consistent with the literature, higher undergraduate grade point averages and total MCAT scores significantly increase the odds of medical school admission over and above the variables added to the model in the prior step.

Undergraduate Major Variable

Table 4.5 includes the results of the hierarchical binary logistic regression and the contributions and significance of each of the predictor variables when undergraduate major is added to the model. At this step, the overall model was statistically significant, $X^2(6) = 18675.818$, $p = .000$. The overall model explained approximately 45.8% (Nagelkerke $R^2 = .458$, $\Delta R^2 = .000$) of the variance in medical school admission. This suggests that the addition of undergraduate major to the model does not contribute to the explanation of the variance in medical school admission over and above the variables added to the model in the prior steps.

As presented in step 3 of Table 4.5, the overall hierarchical binary logistic regression model for the individual predictor undergraduate major is statistically significant ($B = .033$, $SE = .011$, $p = .002$). The model correctly predicted the outcome of medical school acceptance with an overall accurate prediction rate of 76.9%. Therefore, there is no change when compared against the 76.9% prediction as produced in the previous step. Sensitivity was 73% and specificity was 80%. The positive predictive value was 74% and the negative predictive value was 79%.

CHAPTER 5

DISCUSSION

This chapter summarizes the main findings of my study. The discussion is organized by each predictor variable included in the regression model: sex, URiM status, FAP waiver status, MCAT score, and undergraduate grade point average. The discussion also addresses the findings presented in Chapter 4 and contextualizes these findings within the current literature on medical school admissions. It also addresses limitations of the research conducted, provides recommendations for applicants, administrators, advisors, and medical school admissions representatives regarding selection of undergraduate major. Finally, it offers directions for future research.

The Association of American Medical Colleges (AAMC) has stated that an applicant's choice of undergraduate major has no bearing on their ability to be admitted to medical school (AAMC, 2019). Despite earlier research and in response to the continued pervasiveness of the "Premed Stereotype" (Hackman et al., 1979), the notion that prospective medical school students overemphasize science preparation, it is important to empirically examine the role that undergraduate major has in the prediction of admission to medical school.

Using the Student-Choice Construct as a theoretical framework, my findings contribute to scholarly efforts that attempt to account for the variance in admission to medical school as explained by undergraduate major over and above applicants' demographic characteristics and traditional academic achievement variables. Specifically, I investigated medical school admission as predicted by an applicant's sex, Fee Assistance Program (FAP) waiver status, URiM (underrepresented in medicine) status, undergraduate grade point average, total MCAT score, and undergraduate major. Although previous studies have explored the relationship between medical school admission and undergraduate major (Brieger 1999; Bruer, 1981; Dickman, 1980; Simmons, 2005; Sorenson & Jackson, 1997), these studies were conducted at individual undergraduate institutions or for an individual student cohort at a single medical school. No previous study has investigated undergraduate major as a predictor of medical school admission as broadly and with the inclusion of variables that reflect applicants' socioeconomic status, underrepresented status, and sex, in conjunction with the traditional academic variables typically associated with admission to medical school such as MCAT scores and undergraduate grade point average. Therefore, my investigation makes an important contribution to the understanding of how undergraduate major is related to an individual's likelihood of admission to medical school.

Summary of Findings

Data collected from 53,371 medical school admission applicants for 2019 were analyzed. The current study intended to determine whether undergraduate major serves as a statistically significant predictor of admission to medical school when also considering applicants' demographic and academic variables. My findings revealed that undergraduate major does not serve as a statistically significant predictor of admission to medical school over and above applicants' demographic characteristics, MCAT scores, and undergraduate grade point average. Applicants who chose a biology, chemistry, physics, or mathematics (BCPM) major did not have a greater chance of being admitted to medical school than an applicant who chose a non-BCPM major. These findings are consistent with previous studies that sought to predict variables that contribute to medical school admission (Brieger 1999; Bruer, 1981; Dickman, 1980; Simmons, 2005; Sorenson & Jackson, 1997).

Discussion of Findings

Premed Stereotype

Since first identified in 1978, symptoms of the "Premed Stereotype" (Hackman et al., 1979) have continued over the years. The pre-med stereotype suggests that applicants to medical school tend to overemphasize science coursework, high academic achievement, and competitiveness while discounting the importance of “soft-skills” that can be learned in other disciplines. Because of this, there has been a sustained focus on undergraduate institutions producing more "well rounded" medical school applicants. In an article published in the *New England Journal of Medicine*, Thomas (1978) directly addressed the symptoms of this stereotype by stating that "more attention should be paid to the success of students in other, non-science disciplines before they are admitted, to assure the scope of intellect needed for a physician's work" (p. 1180). Consistent with Thomas, I found that undergraduate major does not serve as a statistically significant predictor of admission to medical school when considering demographic and academic factors. Therefore, students who wish to pursue admission to medical school may develop the well-rounded skills needed for success in medicine by pursuing majors in academic disciplines and fields other than the sciences without compromising the likelihood of their admission, *ceteris paribus*. My findings may help pre-health professions advisors, administrators, and applicants gain a new understanding of the relationship between undergraduate major and medical school admission. Importantly, my findings compliment previous research (e.g., Brieger 1999; Bruer, 1981; Dickman, 1980;

Simmons, 2005; Sorenson & Jackson, 1997) that found that medical school applicants chose BCPM majors more frequently but were admitted to medical school at rates similar to those who chose non-BCPM majors.

Applicants' Sex

My findings provide evidence that is consistent with current medical school admission application trends, as more women applied to and were admitted to medical school than men in 2019 (AAMC, 2019). Despite the greater number of women in the 2019 medical school applicant pool, an applicant's sex was not a statistically significant predictor of admission to medical school.

Despite this finding, it is important to frame female persistence in the premedical pipeline in connection with undergraduate major. According to Grace (2019), research suggests that women report more stress from premedical coursework than their male counterparts, less positive course evaluations, less enjoyment of non-BCPM coursework, negative interactions with faculty, and a tendency to interpret low grades in science coursework as a sign that medical school is not the proper track for them. These factors lead to female attrition in the premedical pipeline. Because of this attrition, encouraging women to pursue non-science majors may promote their persistence through the medical school pipeline.

URiM Status

My findings indicate that non-URiM applicants have a higher likelihood of being admitted to medical school. According to Barr (2008) and Lovecchio and Dundes (2002), URiM students in the premedical pipeline report lower levels of satisfaction and drop out of the pre-health pipeline at a greater rate than other students. Specifically, undergraduate premedical URiM students are most discouraged by chemistry coursework. These students identified chemistry courses as discouraging between four and five times more often than the next category, biology. Other STEM courses such as physics and math were also mentioned as “disheartening” (Barr, 2008). If URiM students are discouraged by biology, chemistry, physics, and math coursework, and undergraduate major has no practical bearing on admission to medical school, then guiding undergraduate URiM applicants to choose non-BCPM majors may remove an unnecessary barrier to medical school admission.

FAP Waiver Status

Findings of the current study indicate that students who were granted an application fee waiver by the AAMC were less likely to be admitted to medical school compared to those who did not receive a fee waiver. Niu (2017) indicates that undergraduate students from low-income backgrounds may not possess the cultural and social capital, information, or skills necessary to make well-informed choices of college major, and therefore not maximize their ability to persist through the premedical pipeline. Specifically, Niu (2017) suggests that undergraduate students of lower socioeconomic status are disadvantaged in the pursuit of BCPM majors. Therefore, if the selection of a BCPM major is not a significant predictor of medical admission, then low-income students may achieve a higher undergraduate grade point average in a non-BCPM major and thereby increase their likelihood of medical school admission.

MCAT Score

The current study demonstrates that MCAT scores are statistically significant predictors of admission to medical school. These findings are consistently corroborated in the literature (AAMC, 2019; Anaya, 2001; Bruer, 1981; Dunleavy et al., 2011; Monroe et al., 2013). My findings suggest there is not a statistically significant difference between the mean MCAT scores of BCPM and non-BCPM applicants. Specifically, those applicants who majored in a non-BCPM major scored slightly higher ($M = 506.6$), on average, than those with BCPM majors ($M = 505.9$). This underscores the fact that while total MCAT scores contribute significantly to the prediction of medical school admission, the difference between MCAT score means for BCPM and non-BCPM applicants is not statistically significant. This further highlights the importance of undergraduate major flexibility given that an applicant's undergraduate major does not significantly predict their admission to medical school.

Undergraduate Grade Point Average

Similar to MCAT scores, my findings demonstrate that a higher undergraduate grade point average significantly and positively predicts admission to medical school. This corroborates previous literature (AAMC, 2019; Bruer, 1981; Dunleavy et al., 2011; Monroe et al., 2013). My findings indicate that there is not a statistically significant difference in the mean undergraduate grade point average between BCPM ($M = 3.59$) and non-BCPM ($M = 3.57$) applicants. Therefore, undergraduate major does not appear to have a detrimental impact on an applicant's undergraduate grade point average. Furthermore, this supports the idea that intentional and careful selection of courses could help applicants better balance their academic workload to maximize their academic performance, thus allowing them to maintain more competitive grades to increase the likelihood of gaining admission to medical school (Simmons, 2005). Therefore, the negligible difference in mean undergraduate grade point average between BCPM and non-BCPM majors further supports the finding that choosing a non-BCPM major does not decrease the likelihood of admission to medical school when accounting for applicants' other factors including MCAT scores and demographic characteristics.

Although the completion of BCPM prerequisites courses is unavoidable for most applicants applying to medical school, encouraging students to choose from a wider range of academic majors might better prepare them for a career in medicine and provide students who are predisposed to dropping out of the premedical pipeline a more well-rounded and sustainable academic pathway to the medical profession.

Student-Choice Construct

The student-choice construct (Paulsen & St. John, 2002; Perna, 2006; Salisbury et al., 2009) is useful for examining a wide array of variables that impact a student's decision about the pursuit of opportunities in higher education. The student-choice construct contends that students' decisions are influenced by their human, financial, social, and cultural capital throughout the decision-making process (Paulsen & St. John, 2002; Perna, 2006; Perna & Titus, 2005). This theory can be applied to a student's pathway through the premedical pipeline and accommodates variables included in the AAMC dataset. Through the lens of the student-choice construct, an applicant's FAP waiver status, sex, and URiM status are variables that help to understand a student's choices about pursuing a specific undergraduate major and applying for admission to medical school.

Implications for Policy and Practice

Although my findings indicate that undergraduate major has no practical bearing on the prediction of admission to medical school over and above applicants' demographic characteristics and academic variables, it is important to consider how these findings may inform various stakeholders involved in medical school admissions. In this section, I describe the impact these findings may have on college and university administrators and faculty, health professions advisors, medical school applicants, medical school admissions representatives, and patients.

Implications for Administrators and Faculty

My findings support the notion that college and university administrators and faculty members should develop curricula that allow students to develop the "soft skills" necessary for success in medicine while allowing students to simultaneously take electives or other premedical prerequisite courses in the sciences. This strategy assists premedical students to persist through the undergraduate pre-medical pipeline (Barr, 2008; Lovecchio & Dundes, 2002). Addressing the "Premed Stereotype" could entail developing policies and practices specifically designed to prepare students for a diverse world. Administrators and faculty should be encouraged to create coursework that connects students to a range of human experiences encouraging development of transferrable skills and competencies needed to prepare "well rounded" physicians.

Additionally, colleges and universities should consider alternative methods for teaching science coursework, particularly to students interested in the health professions. For example, it is crucial that colleges and universities understand that while the principles of chemical knowledge are essential for success in medical school, the depth of knowledge required for a career as a chemist might be different (Barr, 2008). Based on my findings, I suggest developing an alternative curriculum and approach to teaching science prerequisites that might provide a more focused and appropriate knowledge of science, designed to meet the needs of future physicians. For example, a redesign of undergraduate premedical curricula might encourage students to choose from a wider range of academic disciplines, especially when they are equipped with the knowledge that choosing a non-BCPM may not decrease the likelihood of their admission to medical school (Brenner, 2013). A redesign of the undergraduate curriculum might also help colleges and universities address diversity initiatives by attracting and retaining prospective URiM medicine students who may otherwise not have persisted through the premedical pathway (Zhang et al., 2021).

Implications for Health Professions Advisors

The role of health professions advisors is crucial in helping health professions students plan for success. In a study conducted by Barr (2008), participants identified problems in a university's undergraduate advising systems as a primary contributor to students' decisions to leave the premedical pathway (Barr, 2008). With these findings in mind, my study serves to inform advisors about how students can select undergraduate majors that best position them for admission to medical school. For example, rather than advising a student who had an early negative experience in a chemistry course by discouraging them from continuing along the premedical pathway, advisors can support these students by sharing with them that negative experiences in chemistry are common (Barr, 2008; Lovecchio & Dundes, 2002) and should not perceived as a disqualifier for entry into medical school. When coupled with my findings, advisors could encourage students to seek alternatives in other undergraduate majors that might foster a more positive experience as they progress through their major and take upper-level coursework in fields they find to be interesting.

Health professions advising offices may need to invest in programs that facilitate more formalized peer support between premedical students in both BCPM and non-BCPM majors. Similarly, advisors can create and foster mentorship opportunities with practicing physicians from educationally and academically diverse backgrounds which might inspire undergraduate premedical students to investigate a greater range of undergraduate majors.

Although the primary focus of my study is admission to medical school, there is an important practical implication for students who are not admitted to medical school or choose to pursue a different career path upon conclusion of their undergraduate academic career. My findings should empower advisors to recommend majors across disciplines to premedical students. By encouraging students to select a major based on their interests rather than perceptions about how a major relates to the likelihood of medical school admission, advisors may better position their students for success regardless of whether students are admitted to medical school.

In summary, advisors should limit placing excessive emphasis on BCPM majors as a critical factor in medical school application planning. As the literature suggests (AAMC, n.d., Paulsen & St. John, 2002; Perna, 2006; Perna & Titus, 2005), the possibility of developing the skills of a successful physician emanates from applicants' development of communication and critical thinking skills, and cultural competence. Advisors should inform students that their choice of undergraduate major is inconsequential when pursuing medical school, *ceteris paribus*.

Implications for Prospective Medical School Applicants

According to Barr (2008), the decline in participation and success of underrepresented students in fields such as the health professions, science, technology, engineering, and math is attributed to and described in the literature as the "leaky pipeline." This pipeline is characterized by a waning interest or performance in medicine throughout a student's undergraduate studies (Barr, 2008; Freeman et al., 2016; Lovecchio & Dundes, 2002; Zhang et al., 2021). Barr (2008) found that health professions students' interest in becoming a physician was most profoundly influenced by their early college experiences in the chemistry classroom. Specifically, women and underrepresented students report the negative impact of chemistry courses more than their counterparts, and these experiences negatively influence their continued interest in medicine. The subject of science coursework was remarkably important to the resiliency of students progressing through the medical school pipeline, as chemistry courses were four to five times more discouraging to students than biology coursework (Barr, 2008). Students cited the demanding rigor of the coursework and poor performance outcomes as primary academic reasons for leaving the premedical pipeline (Loveccio & Dundes, 2002).

The findings of my study may encourage prospective medical applicants to select a major that aligns with their interests and aptitudes and appeases concerns that such a choice will negatively impact MCAT performance, undergraduate grade point average, and ultimately, admission to medical school. This result is of particular value to those student populations that find extensive science coursework an unwelcoming and discouraging experience.

Implications for Patients

There is evidence that suggests a diverse body of medical school students can help improve the quality of care provided to patients, healthcare outcomes, and communication within a healthcare team (Gomez et al., 2019). Further, Lovecchio and Dundes (2002) suggest that skills learned in the humanities may serve to promote qualities in a physician such as compassion and social responsibility. Because of increasing patient dissatisfaction with the relationships with their physicians (Stewart, 1999), courses that address social skills may be more applicable to a premedical curriculum (Lovecchio & Dundes, 2002). Conceptually, training future physicians in disciplines and fields outside of the sciences might produce more caring, understanding, and social physicians thus improving the patient experience while simultaneously improving health outcomes. Research has shown that communication between physician and patient is associated with better health outcomes, patient satisfaction, and adherence to medical directives. Because of this, adverse health outcomes can occur when cultural differences between physicians and patients are experienced in a clinical setting (Stewart et al., 1999). Cultural competence in medicine also plays a role in improving quality of care and contributes to eliminating racial and ethnic health care disparities (Williams & Rucker, 2000). A wider choice of undergraduate majors may promote the development of cultural competencies among prospective physicians.

Given that the number of undergraduate science courses taken by undergraduate premedical students does not impact the performance of medical school students in their preclinical years and do not appear to predict clinical proficiency, coursework in the humanities may serve to promote qualities in physicians such as compassion and social responsibility (Lovecchio & Dundes, 2002). It can be concluded that encouraging undergraduate premedical students to choose majors from a variety of disciplines might attract or even produce more compassionate physicians, thus improving the relationship between doctor and patient.

Implications for Medical Schools Admissions Representatives

The AAMC and medical schools have heralded holistic review as a prominent feature of their processes (AAMC, 2021). My findings suggest that medical school admissions representatives admit students from both BCPM and non-BCPM disciplines without negligible preference of undergraduate major. My findings, when considered in conjunction with the findings of Smith (1998), indicate that once enrolled in medical school, students who majored in BCPM or non-BCPM majors will perform equally well, on average. According to Lovecchio and Dundes (2002), “some evidence exists that premed students with solid backgrounds in humanities, in addition to science, have lower medical school attrition and no greater incidence of academic difficulties in medical school” (p. 723). While science proficiency is a critical skill for medical school preparation, my findings demonstrate that undergraduate major is not a criterion weighted equally or more heavily than MCAT scores or undergraduate grade point average.

Medical schools should develop programs, such as early assurance and linkage programs, that allow premedical students an opportunity to explore various undergraduate majors and develop a wide variety of interests. For example, the early assurance program at the Icahn School of Medicine at Mount Sinai was the first medical school in the country to create such a pathway (Fallar et al., 2020). This program allows college sophomores in any major to apply for early assurance of acceptance to the school.

Once accepted, students are free to pursue their undergraduate premedical career free of the traditional science requirements and the MCAT.

Limitations

Although my findings provide important contributions to the field, my study is not without limitations. Specifically, my study has three analytical limitations. First, the binary nature of the categorical variables presented in this study prevented a more nuanced analysis of the prediction of medical school admission. For example, at the time of this study, the AAMC did not collect applicants' gender identity. Consequently, sex was self-reported as a binary construct (female, male). A more nuanced categorization of race, ethnicity, sex, gender identities, socioeconomic status, and undergraduate major may uncover deeper and more meaningful connections between these variables and admission to medical school.

Second, my study does not capture the differences between accepted students who chose to enroll in medical school and accepted students who did not enroll in medical school. Further, my study does not differentiate between those who enrolled in medical school and persisted until completion and those who did not. For example, a student who was admitted to medical school may not have the financial resources to attend medical school even though they have been admitted. The differences between acceptance, enrollment, and completion are not reflected in this study, yet there may be observable differences in these outcomes across undergraduate majors.

Third, my study has limitations regarding its generalizability. My study was conducted using a single year (2019) of applicant data and included only those applying to allopathic medical schools in the United States and Canada. The specificity of the data analyzed limits the extent to which broad conclusions can be drawn from my findings. To date, no longitudinal study has been conducted over multiple years using applicant data to investigate historical patterns or trends in undergraduate major choice and its impact on admission to medical school.

Fourth, my study focused on applicants to allopathic medical school and does not include applicants in the osteopathic medical school application pool, nor does it examine applicants who were denied entry into an allopathic school but were accepted to an osteopathic program. This is an important distinction as there were an additional 21,584 medical school applications submitted to the national osteopathic medical school application clearinghouse (AACOM, 2019). This is noteworthy because undergraduate major may have a different effect on admission to osteopathic medical schools.

Additionally, given the quantitative research methods utilized in my study, I did not explore the motivations, thought processes, or experiences of medical school applicants to attempt to understand how these factors may have impacted an applicant's choice of undergraduate major and their pursuit of medical school admission. Furthermore, my sample consists only of students who applied to medical school, it does not address students who did not apply. Because of this, my findings do not explore how undergraduate major might shape a student's motivations and decision to even enter the medical school application pool.

Lastly, the data I analyzed did not include information pertaining to an applicant's undergraduate institution. Therefore, I was unable to determine how institution-level variables such as institutional control (public, private), enrollment size, or Carnegie Classification may serve as predictors of medical school admission. Obtaining these data to associate applicants with their undergraduate institutions' location, region, state, or zip code could also better help to understand the impact undergraduate major has on medical school admission for students who completed their undergraduate studies at various types of undergraduate institutions (large state public, small liberal arts, Historically Black Colleges and Universities, Hispanic Serving Institutions, etc.). In addition, the ability to tie undergraduate major data directly to the medical schools to which students are admitted would also help the premedical community understand admissions trends specific to individual medical schools.

Directions for Future Research

My findings have several implications for future investigations involving the prediction of medical school admission. Conducting a more robust longitudinal study of undergraduate major and admission to medical school may provide a deeper understanding about whether my findings are consistent over a longer period of time. Given that AMCAS has been the centralized clearinghouse for allopathic medical schools in the United States since 1970 (AAMC), extending the study to historically examine undergraduate major choice and admission to medical school might reveal long-term patterns and trends in medical school admission. A longitudinal quantitative study to determine if major choice is a predictor of medical specialty would also yield useful results as it could help undergraduate advisors, medical school administrators, and prospective medical students consider potential connections between undergraduate major choice and the medical specialty to which a student aspires.

In addition, conducting a qualitative or mixed-methods study might provide deeper understanding of premedical students' motivations and thought processes about the selection of an undergraduate major. Such studies may also serve to properly situate and clarify undergraduate major choice and the long-term career goals of prospective medical students. By surveying or interviewing applicants, patterns might emerge that could better help medical school officials inform applicants of these choices and their longer-term impact. It would also be beneficial to collect data from premedical students who chose not to enter the medical school application pool. Analyzing these data could reveal connections between variables such as MCAT score, grade point average, undergraduate major and the intent to apply. These connections might help health professions advisors find ways to assist students who might have otherwise dropped out of the premedical pipeline before applying to medical school.

I recommend that future research extend my findings by examining the predictive ability of admissions variables such as applicant characteristics captured from medical school interviews; letters of recommendation; personal statements and community service, leadership, and healthcare experiences. The regression analysis I conducted only accounts for a percentage of the variance in medical school admission. Therefore, it would be useful to determine the contributions of additional variables to the prediction of admission to medical school.

A combined or comparative study similarly analyzing applicants to different health profession programs might also be useful. Replicating this study with applicants to osteopathic medical school would yield more complete results and would more accurately reflect the overall medical school applicant pool. It would be worthwhile to compare the predictive validity of the aforementioned variables for osteopathic applicants as compared to allopathic applicants. It would be equally worthwhile to conduct a similar study to analyze how undergraduate major can be used to predict admission to professional schools such as dentistry, pharmacy, and podiatry.

Finally, a non-binary categorization of specific undergraduate majors would provide a more nuanced analysis of how different majors predict admission to medical school. For example, there would be value in ascertaining the predictive validity of specific undergraduate majors such as chemistry, biology, business, English, and engineering. Although combined groupings of majors do not appear to predict admission to medical school, if disaggregated, more specific patterns might emerge regarding how undergraduate major predicts admission to medical school. These nuances were not captured in the current study.

Conclusion

Based on my observations and experiences, I expected that students from a variety of undergraduate disciplines would have a comparable likelihood of admission to medical school. My findings are consistent with this hypothesis as undergraduate major does not serve as a statistically significant predictor of admission to medical school over and above applicants' demographic characteristics, MCAT scores, and undergraduate grade point average. Applicants who chose a biology, chemistry, physics, or mathematics (BCPM) major did not have a greater chance of being admitted to medical school than applicants who chose a non-BCPM major.

Since 1978, members of the graduate medical education community have called for educating and training more "well-rounded" medical school students (Thomas, 1978). To facilitate this, the AAMC has consistently encouraged students to choose undergraduate majors from a variety of disciplines to prepare for successful entry into medical school (AAMC, n.d.). However, college and university administrators, health professions advisors, and prospective applicants lacked broad evidence that this strategy yields successful medical school admissions outcomes (Brieger 1999; Bruer, 1981; Dickman, 1980; Simmons, 2005; Sorenson & Jackson, 1997). In response, the current study analyzed the predictive ability of undergraduate major on admission to medical school.

The student-choice construct suggests that medical school applicants make a series of choices based on their characteristics, values, beliefs, opportunities, experiences, and constraints. These decisions arise from diverse patterns of choice that might be assessed differently when considering a medical school applicant's race, ethnicity, sex, and socioeconomic status. Grounded in the economic theory of human capital, the student-choice construct can be used to think about how medical school applicants choose an undergraduate major, specifically in ''situated contexts'' that take into consideration the amount and type of human capital, financial capital, social capital, and cultural capital acquired by the applicant. These factors influence the choices applicants to medical school make, including the choice of a BCPM or non-BCPM major.

Based on my findings, a medical school applicant's undergraduate major does not make a statistically significant nor practical contribution to the prediction of medical school admission. Similar to previous studies, applicants with lower socioeconomic status, those from historically underrepresented groups in medicine, and those who are male had lower odds of being admitted to medical school. Total MCAT score and undergraduate grade point average were the strongest predictors of admission to medical school. These findings are important as they suggest that undergraduate premedical students are afforded a wide range of undergraduate major choices, and that a student can equally choose from either BCPM or non-BCPM majors without decreasing the likelihood of their admission to medical school.

Based on my findings, I encourage students, advisors, and administrators to continue to explore ways to incorporate a wide range of undergraduate disciplines in preparing future generations of physicians. It is my hope that a more equal footing is created for students, from all backgrounds and experiences, to pursue and persist along the premedical pathway. While the calls for creating more well-rounded premedical students have existed for decades, my findings indicate that more strategies are needed, and additional studies should be conducted to continue to diversify the practice of medicine in the United States.

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APPENDIX A

Table 1:

Applicants, Matriculants, Enrollment, and Graduates of U.S. Medical Schools, 2010-2011 through 2019-2020

	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Applicants	42,741	43,919	45,266	48,014	49,480	52,549	53,042	51,680	52,777	53,371
Matriculants	18,665	19,230	19,517	20,055	20,343	20,631	21,030	21,338	21,622	21,869
Enrollment	78,740	80,207	81,934	83,356	85,128	86,595	88,191	89,759	91,266	95,758
Graduates	17,360	17,344	18,155	18,072	18,703	18,943	19,260	19,563	19,936	

Note. Source: Association of American Medical Colleges, 2019

https://www.aamc.org/system/files/2019-11/2019_FACTS_Table_1_0.pdf

APPENDIX B

LIST OF VARIABLES INCLUDED IN THE AAMC DATASET

1. Unique Individual Identifier
2. FAP fee Waiver Indicate – (Y/N) If an applicant applied FAP fee waivers to their AMCAS application
3. Permanent Resident State
4. Sex
5. Disadvantaged Indicator
6. Race/Ethnicity – Only for permanent residents and U.S. citizens
7. U.S. Citizen/Permanent Resident Indicator (Y/N)
8. Primary undergraduate degree
9. Primary undergraduate major
10. Graduate degree(s) – This may need to be a separate table as applicants can submit an unlimited number of degrees
11. Graduate major(s) – This may need to be a separate table as applicants can submit an unlimited number of majors
12. Cumulative undergraduate science GPA
13. Cumulative undergraduate non-science GPA
14. Cumulative undergraduate total GPA
15. Graduate science GPA
16. Graduate non-science GPA
17. Graduate total GPA
18. Number of applications submitted

19. Number of acceptances

20. Matriculated indicator (Y/N)

21. Previously applied indicator (Y/N)

22. Federal or state assistance programs indicator (Y/N)

23. Medically underserved area indicator (Y/N)

24. Family income level

25. Contribute to family income indicator (Y/N)

26. Pell grant indicator (Y/N)

27. Community Service/Volunteer –Medical/Clinical –Total Hours

28. Community Service/Volunteer –Not Medical/Clinical –Total Hours

29. Paid Employment –Medical/Clinical –Total Hours

30. Paid Employment –Not Medical/Clinical –Total Hours

31. Physician Shadowing/Clinical Observation –Total Hours

32. Intercollegiate Athletics –Total Hours

1. Total MCAT2015 score (most recent)

2. MCAT2015 CPBS score (most recent)

3. MCAT2015 CARS score (most recent)

4. MCAT2015 BBFL score (most recent)

5. MCAT2015 PSBB score (most recent)

APPENDIX C

UNDERGRADUATE INSTITUTIONS WITH 50 OR MORE APPLICANTS REPRESENTED IN THE AAMC DATASET

Amherst College, Amherst, MA

Arizona State University, Tempe, AZ

Auburn University, Auburn, AL

Augusta State University, Augusta, GA

Austin College, Sherman, TX

Barnard College, New York, NY

Baylor University, Waco, TX

Boston College, Chestnut Hill, MA

Boston University, Boston, MA

Brandeis University, Waltham, MA

Brigham Young University-Idaho, Rexburg, ID

Brigham Young University, Provo, UT

Brown University, Providence, RI

California Polytechnic State University-San Luis Obispo, San Luis Obispo, CA

California State University-Long Beach, Long Beach, CA

California State University-Northridge, Northridge, CA

Carnegie Mellon University, Pittsburgh, PA

Case Western Reserve University, Cleveland, OH

Central Michigan University, Mount Pleasant, MI

City University of New York Brooklyn College, Brooklyn, NY

City University of New York Hunter College, New York, NY

City University of New York The City College, New York, NY

Clemson University, Clemson, SC

Colgate University, Hamilton, NY

College of Charleston, Charleston, SC

College of William & Mary, Williamsburg, VA

Colorado State University, Fort Collins, CO

Cornell University, Ithaca, NY

Creighton University, Omaha, NE

Dartmouth College, Hanover, NH

Davidson College, Davidson, NC

Drexel University, Philadelphia, PA

Duke University, Durham, NC

East Carolina University, Greenville, NC

East Tennessee State University, Johnson City, TN

Emory University, Atlanta, GA

Florida Atlantic University-Boca Raton, Boca Raton, FL

Florida International University, Miami, FL

Florida State University, Tallahassee, FL

Fordham University, Bronx, NY

Furman University, Greenville, SC

George Mason University, Fairfax, VA

George Washington University, Washington, DC

Georgetown University, Washington, DC

Georgia Institute of Technology, Atlanta, GA

Georgia Southern University, Statesboro, GA

Georgia State University, Atlanta, GA

Gonzaga University, Spokane, WA

Grand Valley State University, Allendale, MI

Harvard University, Cambridge, MA

Hofstra University, Hempstead, NY

Howard University, Washington, DC

Indiana University-Bloomington, Bloomington, IN

Indiana University-Purdue University-Indianapolis, Indianapolis, IN

Iowa State University, Ames, IA

James Madison University, Harrisonburg, VA

Johns Hopkins University, Baltimore, MD

Kansas State University, Manhattan, KS

Kent State University Kent Campus, Kent, OH

Liberty University, Lynchburg, VA

Louisiana St University and Agricultural and Mechanical Col, Baton Rouge, LA

Louisiana Tech University, Ruston, LA

Loyola University Chicago, Chicago, IL

Marquette University, Milwaukee, WI

Marshall University, Huntington, WV

Massachusetts Institute of Technology, Cambridge, MA

McGill University, Montreal, QC

McMaster University, Hamilton, ON

Mercer University, Macon, GA

Miami University, Oxford, OH

Michigan State University, East Lansing, MI

Mississippi State University, Mississippi State, MS

Montana State University-Bozeman, Bozeman, MT

New York University, New York, NY

North Carolina State University, Raleigh, NC

Northeastern University, Boston, MA

Northern Arizona University, Flagstaff, AZ

Northwestern University-Evanston, Evanston, IL

Nova Southeastern University, Fort Lauderdale, FL

Oakland University, Rochester, MI

Oklahoma State University, Stillwater, OK

Oregon State University, Corvallis, OR

Penn State University Park, University Park, PA

Pomona College, Claremont, CA

Portland State University, Portland, OR

Princeton University, Princeton, NJ

Purdue University-Main Campus, West Lafayette, IN

Rhodes College, Memphis, TN

Rice University, Houston, TX

Rutgers University - New Brunswick, New Brunswick, NJ

Rutgers University - Newark, Newark, NJ

Saint Louis University, St. Louis, MO

San Diego State University, San Diego, CA

Santa Clara University, Santa Clara, CA

Southern Methodist University, Dallas, TX

Spelman College, Atlanta, GA

St. John's University, Queens, NY

Stanford University, Stanford, CA

State University of New York at Binghamton, Binghamton, NY

State University of New York College at Geneseo, Geneseo, NY

Stony Brook University, Stony Brook, NY

Syracuse University, Syracuse, NY

Temple University, Philadelphia, PA

Texas A & M University, College Station, TX

Texas Christian University, Fort Worth, TX

Texas State University-San Marcos, San Marcos, TX

Texas Tech University-Lubbock, Lubbock, TX

The College Of New Jersey, Ewing, NJ

The Ohio State University Main Campus, Columbus, OH

The University of Akron, Main Campus, Akron, OH

The University of Alabama, Tuscaloosa, AL

The University of Texas at Arlington, Arlington, TX

The University of Texas at Dallas, Richardson, TX

The University of Texas at San Antonio, San Antonio, TX

The University of Texas Rio Grande Valley, Edinburg, TX

The University of Utah, Salt Lake City, UT

Tufts University, Medford, MA

Tulane University, New Orleans, LA

United States Military Academy, West Point, NY

University at Albany, SUNY, Albany, NY

University at Buffalo-SUNY, Buffalo, NY

University of Alabama at Birmingham, Birmingham, AL

University of Arizona, Tucson, AZ

University of Arkansas Main Campus, Fayetteville, AR

University of British Columbia, Vancouver, BC

University of California-Berkeley, Berkeley, CA

University of California-Davis, Davis, CA

University of California-Irvine, Irvine, CA

University of California-Los Angeles, Los Angeles, CA

University of California-Riverside, Riverside, CA

University of California-San Diego, La Jolla, CA

University of California-Santa Barbara, Santa Barbara, CA

University of California-Santa Cruz, Santa Cruz, CA

University of Central Arkansas, Conway, AR

University of Central Florida, Orlando, FL

University of Chicago, Chicago, IL

University of Cincinnati Main Campus, Cincinnati, OH

University of Colorado at Boulder, Boulder, CO

University of Colorado Denver | Anschutz Medical Campus, Denver, CO

University of Connecticut, Storrs, CT

University of Dayton, Dayton, OH

University of Delaware, Newark, DE

University of Florida, Gainesville, FL

University of Georgia, Athens, GA

University of Hawaii at Manoa, Honolulu, HI

University of Houston, Houston, TX

University of Illinois at Chicago, Chicago, IL

University of Illinois at Urbana-Champaign, Champaign, IL

University of Iowa, Iowa City, IA

University of Kansas Main Campus, Lawrence, KS

University of Kentucky, Lexington, KY

University of Louisville, Louisville, KY

University of Maryland-Baltimore County, Baltimore, MD

University of Maryland-College Park, College Park, MD

University of Massachusetts-Amherst, Amherst, MA

University of Miami, Coral Gables, FL

University of Michigan-Ann Arbor, Ann Arbor, MI

University of Michigan-Dearborn, Dearborn, MI

University of Minnesota, Minneapolis, MN

University of Mississippi, University, MS

University of Missouri-Columbia, Columbia, MO

University of Missouri-Kansas City, Kansas City, MO

University of Nebraska - Lincoln, Lincoln, NE

University of Nevada-Las Vegas, Las Vegas, NV

University of Nevada-Reno, Reno, NV

University of New Mexico-Main Campus, Albuquerque, NM

University of North Carolina at Chapel Hill, Chapel Hill, NC

University of North Dakota, Grand Forks, ND

University of North Texas, Denton, TX

University of Notre Dame, Notre Dame, IN

University of Oklahoma Norman Campus, Norman, OK

University of Oregon, Eugene, OR

University of Pennsylvania, Philadelphia, PA

University of Pittsburgh, Pittsburgh, PA

University of Portland, Portland, OR

University of Puerto Rico-Mayaguez Campus, Mayaguez, PR

University of Puerto Rico-Rio Piedras Campus, San Juan, PR

University of Rochester, Rochester, NY

University of San Diego, San Diego, CA

University of South Carolina Columbia, Columbia, SC

University of South Florida, Tampa, FL

University of Southern California, Los Angeles, CA

University of St Thomas, Saint Paul, MN

University of Tennessee-Knoxville, Knoxville, TN

University of Texas at Austin, Austin, TX

University of Texas at El Paso, El Paso, TX

University of Toledo, Toledo, OH

University of Toronto, Toronto, ON

University of Vermont, Burlington, VT

University of Virginia, Charlottesville, VA

University of Washington, Seattle, WA

University of Western Ontario, London, ON

University of Wisconsin-Madison, Madison, WI

Utah State University, Logan, UT

Vanderbilt University, Nashville, TN

Vassar College, Poughkeepsie, NY

Villanova University, Villanova, PA

Virginia Commonwealth University, Richmond, VA

Virginia Polytechnic Institute and State University, Blacksburg, VA

Wake Forest University, Winston-Salem, NC

Washington State University, Pullman, WA

Washington University in St. Louis, St. Louis, MO

Wayne State University, Detroit, MI

Wellesley College, Wellesley, MA

Wesleyan University, Middletown, CT

West Virginia University, Morgantown, WV

Williams College, Williamstown, MA

Xavier University of Louisiana, New Orleans, LA

Yale University, New Haven, CT

Yeshiva University (New York, NY), New York, NY

APPENDIX D

AMCAS® COURSE CLASSIFICATION GUIDE

The following guide provides examples of how courses are often categorized. Please select course classifications based on the primary content of the course. In the case of interdisciplinary courses, where two or more subject matters are combined into one course, refer to the description of the course on your school's website or consult with your Pre-health Advisor to choose the most appropriate course classification.

Biology (BIOL): Anatomy, Biology, Biophysics, Biotechnology, Botany, Cell Biology, Ecology, Entomology, Genetics, Histology, Immunology, Microbiology, Moleular Biology, Neuroscience, Physiology, Zoology

Chemistry (CHEM): Biochemistry, Chemistry, Physical Chemistry, Thermodynamics

Physics (PHYS): Astronomy, Physics

Mathematics (MATH): Applied Mathematics, Biostatistics, Mathematics, Statistics

Behavioral & Social Sciences (BESS): Anthropology, Economics, Family Studies, Psychology, Sociology

Business (BUSI): Accounting, Finance, Human Resources Studies, Management, Marketing, Organizational Studies

Communications (COMM): Journalism, Media Production & Studies, TV, Video & Audio

Computer Science & Technology (COMP): Computer Science, Computer Engineering, Information Systems, Telecommunications

Education (EDUC): Counseling & Personnel Services, Curriculum & Instruction, Educational Administration, Educational Policy, Health Education, Human Development, Physical Education (Except for sports courses.), Special Education

Engineering (ENGI): Aerospace Engineering, Biomedical Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Environmental Engineering, Nuclear Engineering

English Language & Literature (ENGL): Composition & Rhetoric, Creative Writing, Literature

Fine Arts (ARTS): Art, Art History, Dance, Fine Arts, Music, Photography, Theatre

Foreign Languages, Linguistics, & Literature (FLAN): American Sign Language, Comparative Literature, Foreign Language(s) & Literature Linguistics

Government, Political Science, & Law (GOVT): Criminology & Criminal Justice, Government, International Relations & Studies, Law/Legal Studies, Political Science, Public Affairs & Policy, Urban Policy & Planning

Health Sciences (HEAL): Allied Health, Chiropractic, Dentistry, Hearing & Speech Studies, Hospital Administration, Nursing, Nutrition, Occupational Therapy, Optometry, Osteopathy, Physical Therapy, Physician Assistant, Public Health, Pharmacology & Pharmacy, Sports Medicine, Veterinary Medicine

History (HIST): History

Natural & Physical Sciences (NPSC): Agriculture, Animal & Avian Sciences, Environmental Science & Policy, Forestry, Geography, Geology, Horticulture, Landscape Architecture, Meteorology, Natural Resources, Oceanography

Other (OTHR): (All courses that do not fit appropriately in another classification) Architecture, Library Science, Military Science, Sports (tennis, golf, aerobics, etc.)

Philosophy & Religion (PHIL): Ethics, Logic, Philosophy, Religion, Theology

Special Studies (SSTU): Afro-American Studies, American Studies, Gender Studies

APPENDIX E

CORRELATIONS BETWEEN PREDICTOR AND OUTCOME VARIABLE

Additional Variable	Pearson Correlation
GPA Science	.371**
GPA Other	.268**
Number of Applications	.149**
Number of Acceptances	.671**
MCAT CPBS	.430**
MCAT CARS	.379**
MCAT BBLS	.435**
MCAT PSBB	.444**
Family Contribution	-.033**
State-Federal Assistance	.013**
Child Underserved	0.048
Child Income CD	.121**
Pell	.013**
Community Service-Medical	-.010
Community Service Non -Medical	-.021**
Paid Employment Medical	-.065**
Paid Employment Non-Medical	-.065**
Physician Shadowing	-.018**
Intercollegiate Athletics	-.031**

**. Correlation is significant at the 0.01 level (two-tailed)