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## Mathematics Majors in Medical School Admissions: A Comparative Evaluation of MCAT and GPA Performance

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Mathematics Majors in Medical School Admissions:  
A Comparative Evaluation of MCAT and GPA Performance

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Spring 2024

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## Abstract

Choosing a major as an incoming undergraduate student can be very stressful. This study investigates the differences in success that come with choice of undergraduate major, particularly focusing on the performance of mathematics majors. A large majority of medical school applicants come from a biological sciences background. Despite this preference, there is evidence that students from nontraditional majors produce higher Medical College Admission Test (MCAT) scores and superior grade point averages (GPAs). Utilizing data visualization and analysis through R programming, this research examines public data from the Association of American Medical Colleges (AAMC) to understand the benefits of pursuing a math-focused education. Additionally, qualitative information was gathered through interviews with mathematics faculty at the University of Nebraska at Omaha. This information was used to help understand how mathematical skills might be useful for admissions to medical school and overall preparedness. The findings revealed that students majoring in mathematics consistently show greater MCAT scores and GPA performance than all other majors. Furthermore, interviews with professors gave insight as to why a mathematics background contributes to enhanced critical thinking and problem-solving strategies. They also emphasized the benefits of rigorous mathematical studies for success in medical school or a future in healthcare.

## Introduction

Selecting an undergraduate major is often a stressful decision for incoming students. The latest Association of American Medical Colleges (AAMC) Annual Report reveals that nearly 60% of applicants to American medical schools in the 2023 cycle majored in biological sciences<sup>1</sup>. Biology is a popular choice due to its alignment with many medical school prerequisites. For this reason, biology appears to be a seemingly suitable choice for those pursuing a career in medicine. However, an intriguing trend shows that students from unconventional majors often outperform their peers in terms of admissions success. In the latest cycle, humanities and mathematics majors showed the greatest rate of acceptance into American medical schools at 52%, compared to just 43% for their biological sciences counterparts.<sup>2</sup> Even physical science majors, despite their similarities to biological sciences in fundamental curriculum, reported a much higher acceptance rate of 50%. This suggests that a broad educational background could offer advantages to those applying to medical school.

The Medical College Admission Test (MCAT) and grade point average (GPA) are two of the most crucial metrics for students applying to medical school.<sup>3</sup> Admissions committees value these metrics because they help predict a student's ability to handle the demanding coursework of medical school. In recent years, mathematics majors have held the highest average MCAT scores among all applicants.<sup>1</sup> In the latest cycle, these students had an average score of 511.9.<sup>2</sup> This surpassed the overall average among all applicants by more than 5 points.<sup>2</sup> Existing research has identified the disparity in MCAT performance between mathematics majors and their peers from other disciplines.<sup>7</sup> However, the reason behind this advantage remains unclear. Mathematics

is a field that is unique in the teaching of analytical problem-solving strategies. A high level of statistical reasoning and critical thinking is important for the MCAT exam and many undergraduate courses. The purpose of this research is to investigate the specific advantages that a mathematics education provides in preparing students for this exam, ultimately enhancing their success in the medical school application process.

The success of mathematics majors extends consistently across various standardized admissions exams, and these students exhibit impressive performance in several different disciplines. Mathematics has been recognized as one of the top five majors for cumulative Graduate Record Examination (GRE) scores.<sup>4</sup> Additionally, researchers have found that physics and mathematics majors exhibit the highest scores on the Law School Admission Test (LSAT).<sup>5</sup> Similarly, the Graduate Management Admission Test (GMAT) shows these majors as the top scorers across several years.<sup>6</sup> This suggests that a background in mathematics could lead to greater success for undergraduate students pursuing careers in law, and careers requiring graduate courses, such as business.

Understanding the advantages of a mathematics education, such as increased analytical and problem-solving skills, could change the design of educational programs and cause undergraduate programs to reconsider their existing pre-medical curriculum. To explore these advantages, this study used R programming to visualize MCAT trends over the last decade. Additionally, valuable insights were gathered from current professors that provided more information on the significance of a mathematical education for medical school. Combining these two approaches gave insight on the role

a math-focused education plays in getting students ready for medical school and challenges the idea that biology is their best option.

## Methods

The AAMC releases public data concerning medical school applicants each year. This data was used to accumulate various metrics such as average MCAT scores, GPAs, and majors of applicants to medical school. In 2015, the MCAT was revised and to ensure the relevance of the data, trends spanning only the last eight application cycles were evaluated (2016 to 2023). Data reports for each year were manually merged and converted to a csv file in preparation for further analysis. R programming was the primary tool for statistical analysis and the visualization of time series data in this study. The library “ggplot2” was utilized to create clean and informative graphics. This is a visualization package that is used to make high-quality plots and charts in R. Additionally, “dplyr” was used to facilitate more efficient data manipulation. It is a helpful tool for filtering and arranging datasets. These resources allowed the identification of trends and differences in performance across majors.

Mathematics professors from the University of Nebraska at Omaha were interviewed to obtain qualitative insights. The objective of these conversations was to understand the unique impacts of a mathematics education on both academic and professional outcomes. Each interview lasted between 15 to 20 minutes, either in-person or via Zoom. Furthermore, the questions were designed to gather different viewpoints on how a background in mathematics could contribute to greater problem-

solving skills, critical thinking abilities, and overall preparedness for medical school and the MCAT exam. The following key areas were discussed:

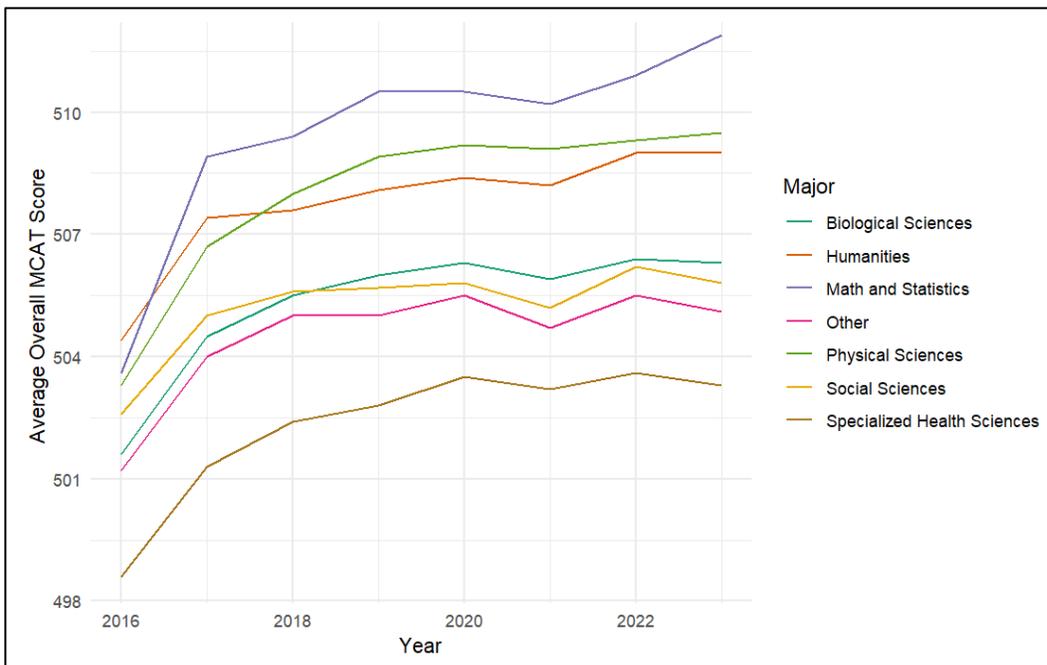
1. **Critical Thinking Across Disciplines:** How does the mathematics curriculum encourage a different approach to critical thinking compared to other science disciplines?
2. **Standardized Testing:** For what reasons do you believe mathematics majors may perform better than their peers on standardized tests?
3. **Student Characteristics:** In your opinion, what characteristics do mathematics majors embody that may contribute to MCAT success?
4. **Study Habits for Science Learning:** How might the study habits of mathematics students be beneficial when approaching the complex study of biological and physical sciences?
5. **Preparation for Medical School:** Beyond the MCAT, in what ways do you believe a foundation in mathematics prepares students for medical school or a future in healthcare?

This research methodology was holistically designed to include both quantitative and qualitative results. Adhering to ethical guidelines, this data was collected from public sources and interviews were conducted with informed consent.

## Quantitative Results

As illustrated in Figure 1, mathematics majors have shown a remarkable upward trend in overall MCAT scores over the last eight years. Since 2017, they have consistently outperformed all other majors (Figure 1). In 2016, mathematics majors

were in line with several other majors with a score slightly above 500 (Figure 1). These initial lower scores could be attributed to the adjustment period following the exam modifications in 2015. After 2017, mathematics students began to separate themselves as the top scorers with a considerable rise in average scores. In more recent years, these students have shown sustained growth in their MCAT scores. Biological sciences majors showed a plateau in average MCAT scores starting in 2020, but mathematics students have continued their improvement. In 2023, mathematics students achieved scores nearly 10 points higher than those recorded in 2016.



**Figure 1. Time Series of Average Overall MCAT Scores by Applicant Major from 2016 to 2023.**

Further trends were analyzed for each section of the MCAT: Biological and Biochemical Foundations of Living Systems (BBLS), Critical Analysis and Reasoning Skills (CARS), Chemical and Physical Foundations of Biological Systems (CPBS), and

Psychological, Social, and Biological Foundations of Behavior (PSBB). This is illustrated in the faceted time series plots of Figure 2.

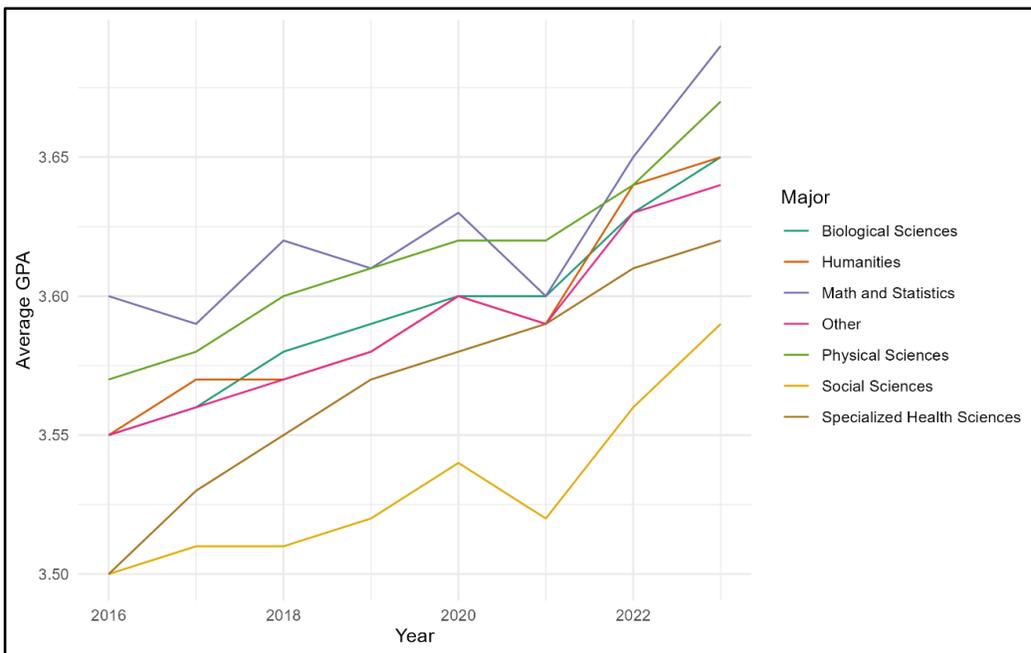


**Figure 2. Time Series of Average MCAT Section Scores by Applicant Major from 2016 to 2023.**

For the BBLS section, there is rapid score improvement with mathematics students consistently outperforming other majors (Figure 2). This improvement can be seen as the scores for mathematics majors increase sharply from 2016 to 2019 and continue to improve steadily through 2023. In the CARS section, the trends show more variability across majors. Humanities majors appear to maintain top scores in this section each year (Figure 2). The CPBS section shows a slight upward trend. There is a small gradual increase in average scores for mathematics majors from 2016 to 2023, but it is much less pronounced than the BBLS section. However, mathematics and

physical sciences majors distinguish themselves with notably greater scores in the CPBS section (Figure 2). Lastly, the PSBB section displays the largest score increases with smaller differences across majors (Figure 2). Despite this, mathematics majors continue to lead with the highest average score in the CPBS section. (Figure 2)

The comparison of average overall student GPA from 2016 to 2023 appears to be less consistent, as shown in Figure 3. Nevertheless, students majoring in mathematics consistently achieve higher GPAs compared to students in other majors each year, except for in 2021 (Figure 3). During the 2021 timeframe, physical sciences were shown to have the highest average GPA, and the other majors showed a sharp decline in scores (Figure 3). This trend could be due to the disruptions caused by the COVID-19 pandemic, which was still ongoing in 2021. The transition to online learning and the stress from the pandemic could have impacted academic performance.



**Figure 3. Time Series of Average Overall GPA by Applicant Major from 2016 to 2023.**

## Qualitative Results

The interviews with mathematics professors offered interesting insights on the impact of a math-focused education. Three professors were individually interviewed regarding five key areas: critical thinking development, standardized testing strategies, student characteristics, study habits, and preparation for medical school or a future in healthcare.

The professors unanimously agreed that a mathematics education encourages more advanced problem-solving beyond simple computation or memorization. During his interview, Dr. Palayangoda emphasized the pivotal role of mathematics in science. He argued that many scientific principles are based off mathematical equations. Analytical thinking is important for understanding the derivation of such scientific concepts, and this can be very important for both clinical and research applications. (L. Palayangoda, personal communication, March 27, 2024). On the other hand, Dr. Roslanowski described the importance of advanced mathematical courses, particularly those involving proof writing. These classes train students to understand the process behind each answer, and through these courses, mathematics students develop a mindset that is not satisfied with superficial answers but seeks to understand the “why” behind them (A. Roslanowski, personal communication, April 3, 2024). Dr. Rech pointed out that this education introduces students to a variety of problem-solving techniques. Unlike rote learning, mathematics requires students to think deeper into the material and justify their reasoning. This skill allows students to be adaptable and apply different concepts to new ideas (J. Rech, personal communication, May 2, 2024).

In regard to standardized testing, the professors shared their perspectives on why mathematics majors tend to outperform their peers. Rather than depending on memorization, Dr. Palayangoda attributes their success to logical thinking patterns. Mathematics students find it easier to recognize the underlying patterns and solutions than those who rely on memorization. On the MCAT exam, students must know how to apply knowledge to new situations rather than simply recalling information (L. Palayangoda, personal communication, March 27, 2024). Furthermore, Dr. Roslanowski reiterated that the mathematics curriculum better prepares students for standardized exams. Their experience with solving challenging math problems trains them to quickly analyze and find solutions (A. Roslanowski, personal communication, April 3, 2024). Dr. Rech pointed out that mathematics students show greater success on a variety of standardized exams, particularly the GRE exam. She suggests that these exams are designed to make students think critically to solve problems. The high level of critical thinking and logical reasoning exhibited by mathematics students allows them to excel in this environment (J. Rech, personal communication, May 2, 2024).

Next, professors identified a few key traits that may help mathematics students succeed. These students, according to Dr. Palayangoda, are quick-minded and can easily adapt their thinking to different situations. When managing the time constraints of standardized exams, this trait can be very useful (L. Palayangoda, personal communication, March 27, 2024). Additionally, Dr. Roslanowski mentioned that his math students typically display a strong work ethic. He noted that this educational path requires a high degree of determination, which could prepare students for the rigorous demands of medical school (A. Roslanowski, personal communication, April 3, 2024).

Similarly, Dr. Rech recognized perseverance as a defining trait developed through challenging mathematical curriculum. She expressed that success in mathematics does not come easy and requires constant effort. This learning process helps build resilience and better equips students for other challenging or competitive environments (J. Rech, personal communication, May 2, 2024).

The next portion of the interview focused on the study habits of mathematics students for the MCAT and beyond. According to Dr. Palayangoda, students with a mathematics background may have an advantage on the MCAT. He suggested that mathematics students could allocate more study time to other sections of the exam and pay less attention to studying the more math-intensive parts (L. Palayangoda, personal communication, March 27, 2024). Dr. Roslanowski suggested that the challenging study of mathematics may prepare students for the complex study of other areas. The study habits developed could still be applied to other fields, such as biological sciences, even if the concepts differ (A. Roslanowski, personal communication, April 3, 2024). Dr. Rech also stressed the importance of time on task. She mentioned that committed practice of mathematical concepts outside of the classroom is typically associated with greater success in the field. This principle can be particularly beneficial for students preparing for the MCAT exam (J. Rech, personal communication, May 2, 2024).

Finally, the professors shared their opinions on how a math-focused education could lead to success in medical school and beyond. Regarding research, Dr. Palayangoda recognized the advantage of having a background in statistics for data interpretation (L. Palayangoda, personal communication, March 27, 2024). Regarding clinical training, Dr. Roslanowski stated that the problem-solving and critical thinking

skills developed in math could be beneficial in various patient care scenarios. For example, each patient presents a unique problem which requires an individualized treatment plan. Rather than applying a memorized concept, students must think critically to design a personalized approach (A. Roslanowski, personal communication, April 3, 2024). Additionally, Dr. Rech focused on the personal attributes that mathematics students develop throughout their education, such as perseverance and resilience. These traits could be beneficial for students facing the rigorous demands of medical school or residency programs (J. Rech, personal communication, May 2, 2024). Overall, the qualitative findings suggest that mathematics can strengthen critical thinking skills and help students develop more advantageous traits for medical school.

## **Discussion**

The quantitative and qualitative results of this study help uncover the advantages that a math-focused education offers those planning to attend medical school. Over the last eight years, mathematics majors have continually scored higher on the MCAT exam compared to other majors. The increasing trend in scores suggests that the skills developed through mathematical training may lead to better scores on standardized tests. This high achievement is noticeable when compared to biology majors, who represent the traditional pathway for pre-medical students. Moreover, mathematics students excel in areas beyond their expertise, such as the Biological and Biochemical Foundations of Living Systems (BFLS) section. This indicates that the skills developed through a mathematics education are versatile and effective across diverse academic areas. Interviews with mathematics professors added depth to these findings and helped uncover the unique skills gained through this specific curriculum.

One recurring topic in every interview was the importance of critical thinking development. The professors described how mathematics extends beyond just manipulating numbers and memorizing them. Advanced mathematical curriculum teaches students how to efficiently tackle, evaluate, and resolve unfamiliar problems. It encourages them to seek a deeper understanding of their answers. These skills make it easier to approach ambiguous situations and adapt to new challenges, which is an important skill to have when approaching standardized tests. Professors attribute these skills to the education received in proof writing courses. These courses focus more on the problem-solving process than on the end result. Students must think deeper into the solution and explain their reasoning behind each step. This method of learning helps develop critical thinking and problem-solving skills that are essential for real-world applications.

The study also touched on the unique traits developed by mathematics students through their education. The challenges encountered when pursuing a degree in mathematics help students develop persistence and resilience. These qualities prepare students for further complex studies, even in areas outside of their expertise. When solving math problems, students must try multiple attempts and approaches before reaching a final solution. Through this trial and error, they learn how to navigate failure and use it as a steppingstone. These challenges encountered by math students teach them how to persevere through difficulties. Advanced mathematical training ensures that students are well-prepared for the demands of the MCAT exam, graduate education, research, and other demanding careers. The critical thinking abilities and resilience gained through a math-focused education better prepares students to thrive in

challenging or competitive environments. By achieving higher MCAT scores and greater GPAs, mathematics students effectively demonstrate the benefits of the skills gained through this educational path. It is reasonable to conclude that many students entering the medical field could benefit from this course of study.

## **Conclusion**

In conclusion, the impressive performance of mathematics majors raises important considerations for the traditional pre-medical curriculum. These results could challenge the assumption that biology and similar science majors are the best options for those pursuing a career in medicine. This study aims to show that incorporating more rigorous mathematical and proof writing coursework could greatly benefit these students, regardless of their major. By broadening the curriculum to include more math courses, students across various disciplines could develop stronger critical thinking and problem-solving skills. Furthermore, it could strengthen applications for medical school by improving valuable metrics for admissions committees. These committees often prefer students with high MCAT scores and strong GPAs, which are believed to be a good indicator of their ability to handle the difficult coursework associated with medical school. Ultimately, the results of this study suggest that the integration of mathematics in undergraduate education could better prepare students for the challenges of medical school and a future in healthcare.

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