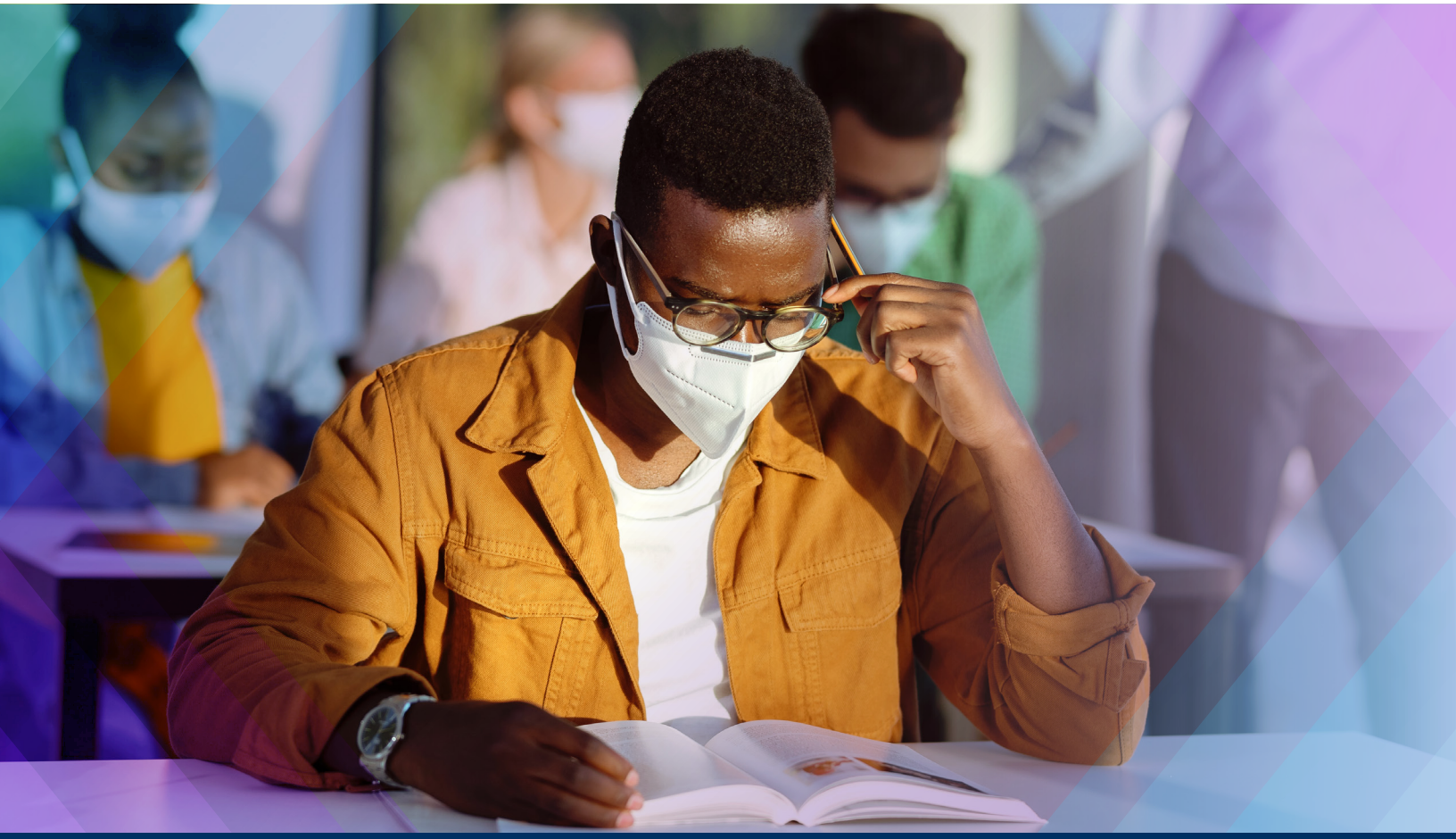
AAMC

Medical College Admission Test®

Using MCAT® Data in 2022 Medical Student Selection



MCAT® is a program of the Association of American Medical Colleges

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Using MCAT® Data in 2022 Medical Student Selection

AAMC
Washington, D.C.

The AAMC (Association of American Medical Colleges) is a not-for-profit association dedicated to transforming health through medical education, health care, medical research, and community collaborations. Its members are all 155 accredited U.S. and 17 accredited Canadian medical schools; more than 400 teaching hospitals and health systems, including Department of Veterans Affairs medical centers; and more than 70 academic societies. Through these institutions and organizations, the AAMC leads and serves America's medical schools and teaching hospitals and their more than 179,000 full-time faculty members, 92,000 medical students, 140,000 resident physicians, and 60,000 graduate students and postdoctoral researchers in the biomedical sciences. Additional information about the AAMC is available at aamc.org.

Suggested citation: AAMC. *Using MCAT® Data in 2022 Medical Student Selection*. Washington, DC: AAMC; 2021.

Contents

Letter to Admissions Officers

As we enter our second year of the global COVID-19 pandemic, we find both hope in the promise of vaccines and grief at the continued loss of life during this global public health crisis. The pandemic continues to affect educational opportunities; pose additional considerations for MCAT® testing; and present uncertainty for personal, financial, and professional health and safety. The 2021 admissions cycle was overwhelming in many ways, particularly under the extraordinary circumstances of the pandemic and with an unprecedented increase in application volume. I know all of you worked diligently to overcome these difficulties, expand your capabilities, and adapt your processes to help your applicants through the last admissions cycle.

In 2020, numerous instances of racially motivated violence and the exacerbation of existing health inequities in disadvantaged communities by the COVID-19 pandemic prompted many in our country to begin reckoning with its history of systemic and individual racism. Academic medicine began to acknowledge the impact of systemic racism on society and in our field, and many institutions pledged to become anti-racist institutions. Medical schools have been engaging in active discussions of how to meet the critical need to diversify the physician workforce. Our admissions community plays a vital role for our schools and for the practice of medicine, by recruiting and supporting applicants who are underrepresented in medicine and who come from disadvantaged and diverse backgrounds.

As we enter the 2022 admissions cycle, we continue to face challenges in the admissions process, but know that we will continue to learn lessons and find solutions as well. The AAMC Committee on Admissions (COA) remains fully committed to supporting applicants and schools and to maintaining the integrity of holistic review as we navigate these uncharted waters together.

The key to navigating the 2022 admissions cycle continues to be flexibility. It is more important than ever to use your existing holistic review practices to consider students' educational opportunities, lived experiences, attributes, and other application components. Many of your 2022 applicants have experienced disrupted learning, finished more than a year of undergraduate education online, faced reduced opportunities for in-person clinical experiences and shadowing, and encountered additional burdens while preparing for the MCAT exam. Applicants continue to be anxious about how these circumstances will affect the competitiveness of their applications and whether we as admissions officers understand the difficulties they are facing. Irregularities in applicants' recent academic metrics may need to be further contextualized against this backdrop of disruption and lost opportunities.

I hope the data presented in this guide will help your admissions committee construct a class that meets the academic, clinical, service, and/or research missions of your medical school. While these data provide the foundation for using MCAT scores in the context of this unusual time, we will likely all need to continue to adapt and iterate throughout this and future admissions cycles. You can find the most up-to-date resources related to admissions during the COVID-19 pandemic on AAMC's website at aamc.org/mcatadmissions.

Please don't hesitate to reach out to MCAT staff at mcatadmissions@aamc.org with questions.

Sincerely,

Lina Mehta, MD
Chair, AAMC Group on Student Affairs Committee on Admissions
Associate Dean for Admissions, Office of Admissions
Professor, Department of Radiology
Case Western Reserve University School of Medicine

Introduction

This guide provides current information and data about the MCAT exam to help admissions officers and their committees make informed decisions about applicants' academic readiness for medical school. It describes the concepts and skills measured by the exam. It shows the characteristics of examinees who took the MCAT exam from 2018 to 2020 and how these examinees prepared for and performed on the exam. It also presents guidance on how to read the MCAT score report and interpret differences in scores and shows data about how admissions committees used MCAT scores and undergraduate grade point averages (GPAs) in the 2018, 2019, and 2020 admissions cycles.

The guide provides the most recent findings about the value of MCAT scores and undergraduate GPAs in predicting students' performance in medical school. New and updated validity findings include data on how well MCAT scores and undergraduate GPAs predict students' performance in their preclerkship and clerkship courses, their scores and pass rates on the United States Medical Licensing Examination (USMLE) Step 1 and Step 2 CK (Clinical Knowledge) exams (first attempt), and their graduation from medical school within four years.

The information in this guide will support schools' holistic review of applicants, which encompasses all the information gathered during the admissions process. Putting MCAT scores in the context of applicants' educational opportunities, experiences, attributes, and other academic data enables admissions officers and their committees to select the students who will contribute to their institutions' unique missions, goals, and diversity interests. Using MCAT scores in the context of applicants' full range of information is a cornerstone of holistic review and a tenet of sound score use according to educational testing standards.[1]

COVID-19 and the MCAT exam

In early 2020, the AAMC partnered with the medical school admissions community to address the challenges posed by the COVID-19 pandemic. Safe and equitable access to MCAT testing and the medical school admissions process was and remains our highest priority during this crisis. In response to canceled test dates from March through May 2020, we made rapid adjustments to the testing plan for the remainder of the year, including a shortened, 5.5-hour exam administered three times daily; waived rescheduling and cancellation fees; an expanded Fee Assistance Program; and strict social distancing and safety measures at testing sites.

Ultimately, more than 88,000 examinees took nearly 100,000 exams in 2020, compared with nearly 87,000 examinees who took more than 97,000 exams in 2019. Data from the complete 2020 testing year confirms that this revised MCAT testing plan provided, in aggregate, the same access to examinees and applicants from races/ethnicities underrepresented in medicine, lower-socioeconomic backgrounds, and different U.S. geographic regions as did the 2019 testing year. Percentages of examinees in 2020 who were repeat testers or who received accommodations or fee assistance were also similar to those from 2019. MCAT score patterns from the 2020 testing year closely resemble those from 2019. While there was a slight increase in overall scores this year, the magnitude is very small and, more importantly, is consistent across demographic groups.

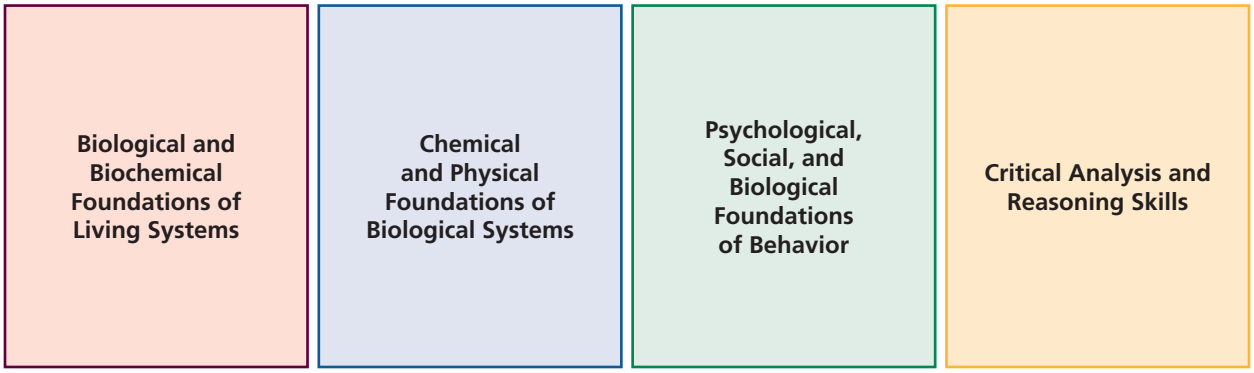
A detailed report on the 2020 testing year and how its data compared with 2019's can be accessed on our website at aamc.org/media/46511/download.

What does the MCAT exam measure?

The MCAT exam is designed to help admissions committees select students who are academically prepared for medical school. MCAT scores are among many sources of application data that admissions committees use in student selection. The scores help admissions officers interpret grades and other academic data coming from undergraduate institutions that have different curricular emphases and grading standards.

The MCAT exam tests the foundational concepts and reasoning skills needed to be ready for medical school.

Figure 1. MCAT sections.



As shown in Figure 1, the MCAT exam has four sections:

1. Biological and Biochemical Foundations of Living Systems
2. Chemical and Physical Foundations of Biological Systems
3. Psychological, Social, and Biological Foundations of Behavior
4. Critical Analysis and Reasoning Skills

Shown in Figure 2, the two natural sciences sections and the behavioral and social sciences section of the MCAT exam test 10 foundational concepts and four scientific inquiry and reasoning skills that are the building blocks for learning in medical school. These sections ask test takers to combine their knowledge of concepts from courses in first-semester biochemistry, psychology, and sociology and year-long courses in biology, chemistry, and physics with their scientific inquiry and reasoning skills to solve problems presented in passages and test questions. The resulting scores provide information about applicants' readiness to learn in medical school.

The Critical Analysis and Reasoning Skills section tests how well test takers comprehend, analyze, and evaluate what they read, draw inferences from text, and apply arguments to new ideas and situations. The passages are drawn from the humanities and social sciences. All the information test takers need to respond to the questions in this section appears in the passages or in the questions themselves (refer to Figure 2). Appendix A provides more detailed descriptions of the concepts and reasoning skills tested by each of the four sections of the exam.

Figure 2. Foundational concepts and scientific inquiry and reasoning skills tested on the MCAT exam.

Biological and Biochemical Foundations of Living Systems	
Foundational Concept 1	Biomolecules have unique properties that determine how they contribute to the structure and function of cells and how they participate in the processes necessary to maintain life.
Foundational Concept 2	Highly organized assemblies of molecules, cells, and organs interact to carry out the functions of living organisms.
Foundational Concept 3	Complex systems of tissues and organs sense the internal and external environments of multicellular organisms and, through integrated functioning, maintain a stable internal environment.
Chemical and Physical Foundations of Biological Systems	
Foundational Concept 4	Complex living organisms transport materials, sense their environment, process signals, and respond to changes using processes that can be understood in terms of physical principles.
Foundational Concept 5	The principles that govern chemical interactions and reactions form the basis for a broader understanding of the molecular dynamics of living systems.
Psychological, Social, and Biological Foundations of Behavior	
Foundational Concept 6	Biological, psychological, and sociocultural factors influence the ways that individuals perceive, think about, and react to the world.
Foundational Concept 7	Biological, psychological, and sociocultural factors influence behavior and behavior change.
Foundational Concept 8	Psychological, sociocultural, and biological factors influence the way we think about ourselves and others, as well as how we interact with others.
Foundational Concept 9	Cultural and social differences influence well-being.
Foundational Concept 10	Social stratification and access to resources influence well-being.

Scientific Inquiry and Reasoning Skills

MCAT questions on these three sections ask test takers to solve problems using the following scientific inquiry and reasoning skills.

Knowledge of Scientific Concepts and Principles
- Demonstrating understanding of scientific concepts and principles.
- Identifying the relationships between closely related concepts.

Scientific Reasoning and Problem Solving
- Reasoning about scientific principles, theories, and models.
- Analyzing and evaluating scientific explanations and predictions.

Reasoning About the Design and Execution of Research
- Demonstrating understanding of important components of scientific research.
- Reasoning about ethical issues in research.

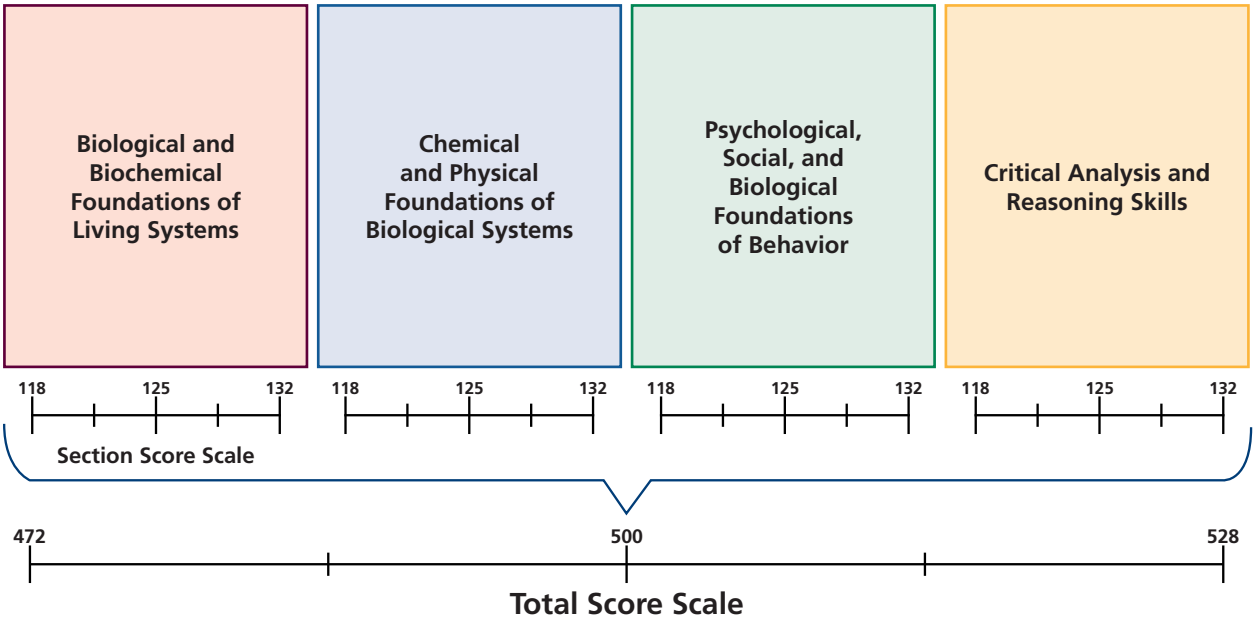
Data-Based and Statistical Reasoning
- Interpreting patterns in data presented in tables, figures, and graphs.
- Reasoning about data and drawing conclusions from them.

Critical Analysis and Reasoning Skills	
Examinees demonstrate their information processing skills in three areas.	
Foundations of Comprehension	• Understanding basic components of the text, such as the main idea and conclusions. • Inferring meaning or intent from immediate sentence context.
Reasoning Within the Text	• Integrating distant components of the text to infer an author's message, intent, purpose, belief, position, bias, or assumptions. • Recognizing and evaluating arguments and their structural elements (claims, evidence, support, relations).
Reasoning Beyond the Text	• Applying or extrapolating ideas from the passage to new contexts, situations, possibilities, alternatives, options, or proposals. • Assessing the impact of incorporating new factors, information, or conditions on ideas from the passage.

How is the MCAT exam scored?

The section and total score scales are centered on memorable numbers that draw attention to the center of the scales.

Figure 3. MCAT section score and total score scales.



As shown in Figure 3, scores on the four sections of the exam are reported on numeric scales centered at 125 and ranging from 118 to 132. Scores from the four sections are summed to produce a total score centered at 500 and ranging from 472 to 528.

The MCAT score scales draw attention to the center of the scales to encourage admissions committees to consider applicants with a wide range of scores.

Research on the current version of the MCAT exam, introduced in 2015, suggests that students who enter medical school with scores at the center of the scale (and above) succeed in medical school. Findings presented later in this guide (pages 27-31) show that entrants with a wide range of MCAT scores passed the Step 1 and Step 2 CK exams on the first attempt and graduated within four years. These findings are consistent with those on the previous version of the exam, which showed that students admitted with a wide range of scores experienced unimpeded progress toward graduation.[2]

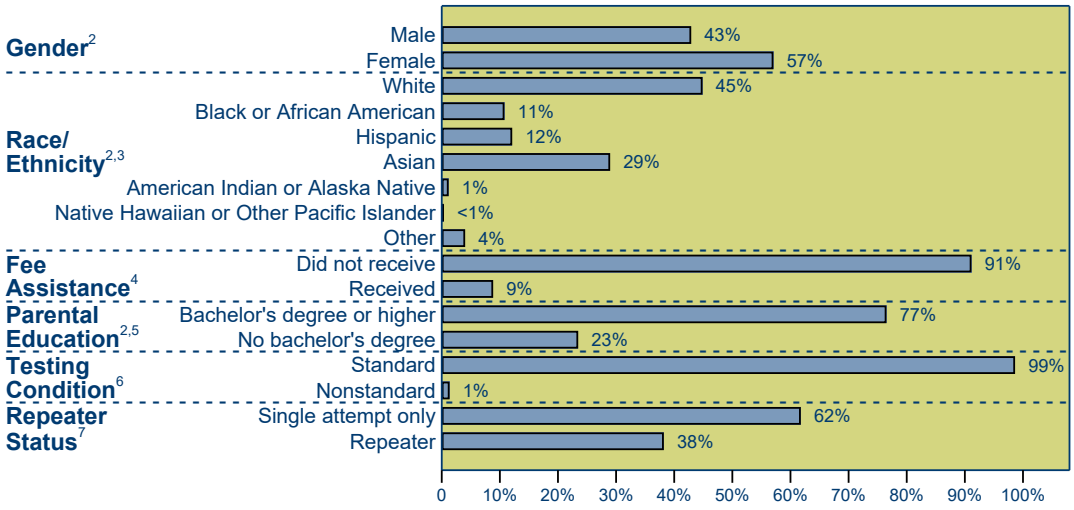
Who takes the MCAT exam?

Examinees with a wide range of backgrounds and experiences took the exam from 2018 to 2020. Figure 4 shows the percentages of the 213,322 examinees by gender, race/ethnicity, and other background characteristics and experiences.

Students from a wide range of backgrounds sit for the MCAT exam.

More than half of examinees were female. When describing their race/ethnicity, 45% of examinees identified as White, 11% as Black or African American, 12% as Hispanic, and 29% as Asian. About 9% were awardees of the AAMC Fee Assistance Program. Twenty-three percent reported that none of their parents received a bachelor's degree, and 1% tested with nonstandard testing conditions. Finally, 38% of the examinees who tested from 2018 to 2020 took this version of the MCAT exam more than once since it was introduced in 2015.

Figure 4. Percentages of MCAT examinees from 2018 to 2020, by gender, race/ethnicity, fee assistance status, parental education, testing condition, and repeater status.[1]



Notes

1. The total number of examinees who took the MCAT exam from 2018 to 2020 was 213,322. For those who took the exam more than once, the information from their most recent administration was used in these analyses.
2. Percentages describe examinees who provided information about their gender, race/ethnicity, and parental education.
3. Percentages add up to more than 100% because racial/ethnic minority results include examinees who may have designated more than one race/ethnicity.
4. The AAMC Fee Assistance Program eligibility is limited to examinees who are U.S. citizens or U.S. permanent residents or students with Deferred Action for Childhood Arrivals (DACA) status. In 2020, AAMC expanded the eligibility criteria to grant benefits to applicant households with a reported total family income of 400% or less (previously 300% or less) than the national poverty level for that family size; 11% of 2020 examinees received this fee assistance.
5. Examinees report the highest level of education for up to four parents. From 2018 to 2020, 206,995 examinees provided information about parental education. These results are for the highest level of parental education.
6. Score reports do not indicate whether scores were obtained under standard or nonstandard testing conditions.
7. For repeater status, "Single attempt only" includes examinees who took the current MCAT exam for the first time in 2018, 2019, or 2020 and did not test again. "Repeater" includes examinees who tested from 2018 to 2020 and who took this version of the MCAT exam more than once in their testing history. Some repeaters tested only once from 2018 to 2020, but are included among repeaters because they also took the exam in a previous year not included in this analysis.

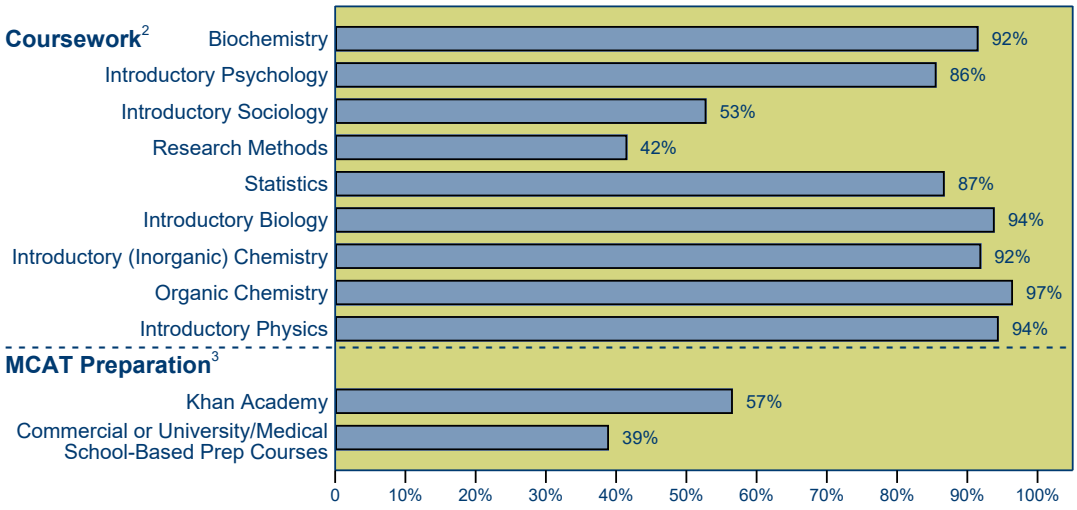
How do examinees prepare for the MCAT exam?

As described previously, the MCAT exam tests concepts from first-semester biochemistry, psychology, and sociology courses and year-long courses in biology, chemistry, and physics. It asks examinees to demonstrate that they can reason about research and data to answer questions about those concepts.

Data about the courses examinees completed before taking the exam show their preparation in these areas. The coursework data in Figure 5 come from 2018-2020 examinees who responded to the AAMC's Post-MCAT Questionnaire (PMQ).[3] Almost all of these examinees took biochemistry, biology, chemistry, and physics courses. Most took courses in psychology and statistics before testing; many took courses in sociology and research methods.

Examinees also studied for the MCAT exam in a variety of ways. Fifty-seven percent reported using the Khan Academy MCAT collection, which includes free, online video lessons and test questions covering concepts and reasoning skills tested on the MCAT exam. Thirty-nine percent took either a commercial preparation course or a course based at a university or medical school before sitting for the exam. (The *Post-MCAT Questionnaire Summary Report* is available at aamc.org/data/pmq.)

Figure 5. Percentages of MCAT examinees who completed college coursework in the natural, behavioral, and social sciences or who prepared for the MCAT exam by using the Khan Academy MCAT collection or completing a test preparation course.[1]



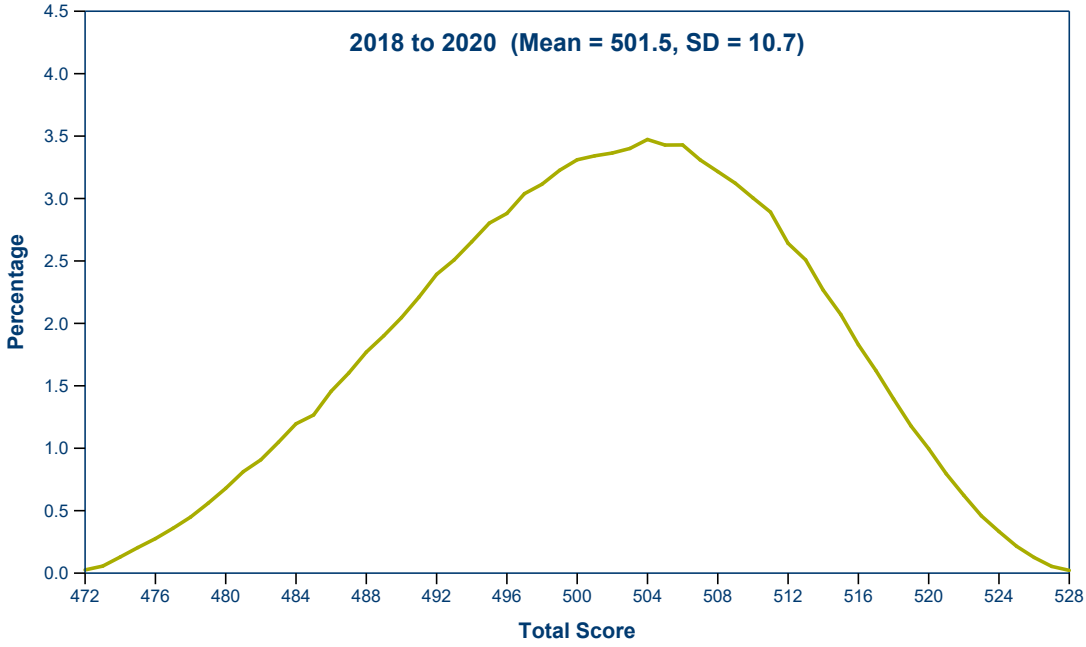
Notes

1. The total number of MCAT examinees from 2018 to 2020 was 213,322.
2. These coursework data are from the AAMC's Post MCAT Questionnaire (PMQ). Each year, between 35% to 40% of examinees complete the PMQ. These respondents are similar to the larger examinee population on most background characteristics but obtain slightly higher MCAT scores on average. For respondents who take the MCAT exam more than once, results are based on the PMQ completed after the examinee's most recent scored exam. The percentages were calculated based on the total number of 2018-to-2020 PMQ respondents who self-reported information about courses for which they had Advanced Placement (AP), International Baccalaureate (IB), College Level Examination Program (CLEP), community college, four-year college, postbaccalaureate, graduate, and professional school credit (N=59,866).
3. Percentages were calculated from examinee responses to questions about their MCAT preparation asked at the end of the testing day. Each year, more than 95% of examinees complete this brief survey at the end of the testing day. In 2020, the end-of-day survey was eliminated from the shortened exam in response to the COVID-19 pandemic. The number of examinees from 2018 to 2019 who provided this information was 143,212. For those who tested more than once, results are based on examinees' most recent responses.

How well do examinees score on the MCAT exam?

Figure 6 summarizes the MCAT total and section scores from all exams administered in 2018, 2019, and 2020. For the examinees who tested more than once from 2018 to 2020, all their scores are included. The mean MCAT total score was 501.5, and the standard deviation was 10.7. Means and standard deviations for the section scores also appear in Figure 6.

Figure 6. Summary of MCAT total and section scores for exams administered from 2018 to 2020.



Section Score Summary for Exams Administered From 2018 to 2020 (N = 281,468)		
	Mean	(SD)
Chemical and Physical Foundations of Biological Systems	125.2	(3.1)
Critical Analysis and Reasoning Skills	124.8	(2.9)
Biological and Biochemical Foundations of Living Systems	125.5	(3.1)
Psychological, Social, and Biological Foundations of Behavior	126.0	(3.1)

Note: The total number of exams administered from 2018 to 2020 was 281,468. These results include multiple scores for the examinees who took the MCAT more than once from 2018 to 2020.

Figure 7 gives additional details about students' total scores in 2018, 2019, and 2020. It summarizes the MCAT scores both overall and for examinees from different backgrounds and experiences, including gender and race/ethnicity, status in the AAMC Fee Assistance Program, and highest level of parental education. It also shows scores from examinees who tested under standard and nonstandard testing conditions and first- and second-attempt scores for examinees who took the exam more than once.

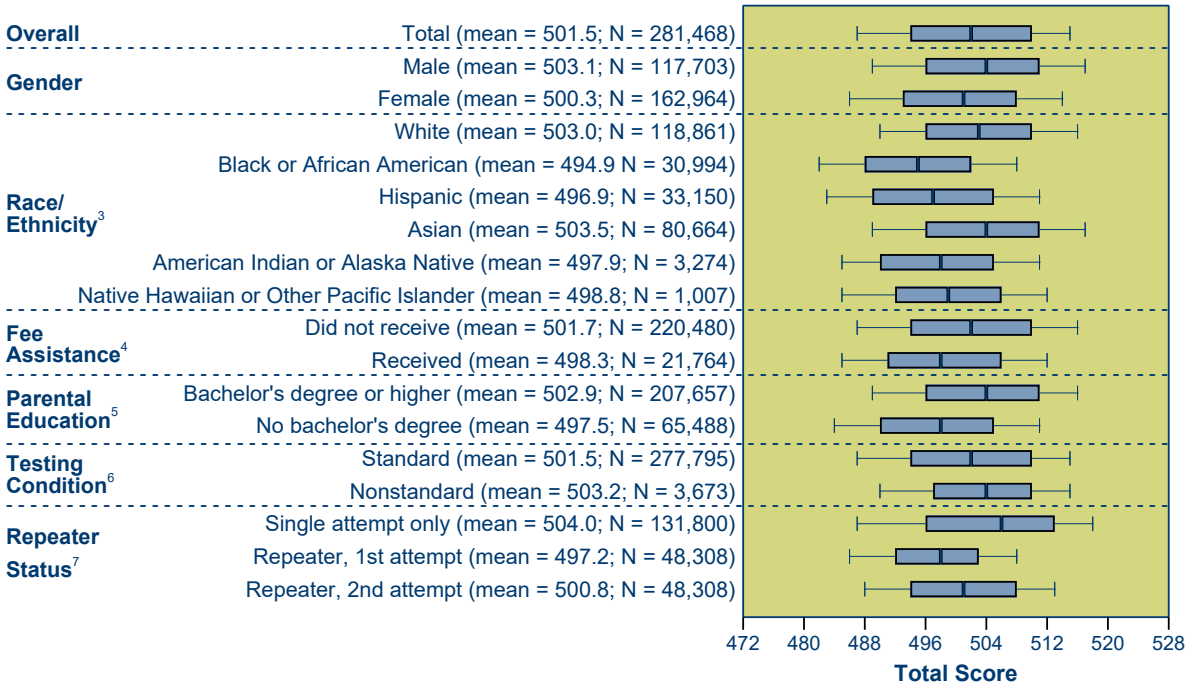
Figure 7 uses box-and-whisker plots to show the median score (the 50th-percentile score), along with the 10th-, 25th-, 75th-, and 90th-percentile scores. The 10th- and 90th-percentile scores are shown by the ends of the "whiskers," the 25th- and 75th-percentile scores are shown by the box (the left edge of each box shows the 25th-percentile score, and the right edge shows the 75th-percentile score), and the median is

shown by the vertical bar inside each box. For example, for female examinees, the 10th-, 25th-, median-, 75th-, and 90th-percentile scores were 486, 493, 501, 508, 514, respectively. The mean MCAT total score for each group appears in parentheses by the group label.

For every group, there are examinees with scores near the bottom, at the middle, and near the top of the MCAT total score scale.

There is variability in the median MCAT total scores for examinees from different backgrounds. However, there is a great deal of overlap in the scores of different groups. The similarities and differences in these data are similar to those reported in the literature for other admissions tests.[4,5] Research suggests the differences in MCAT scores for examinees from groups underrepresented in medicine based on race/ethnicity and other background characteristics reflect societal inequalities in income, education, and other factors rather than test bias.[6]

Figure 7. MCAT total scores for exams administered from 2018 to 2020, overall and by gender, race/ethnicity, fee assistance status, parental education, testing condition, and repeater status.[1,2]



Notes

1. The total number of exams administered from 2018 to 2020 was 281,468.
2. These results include multiple scores from the examinees who tested more than once from 2018 to 2020.
3. Data for examinees who reported their race/ethnicity as "other" are not shown.
4. The AAMC Fee Assistance Program eligibility is limited to examinees who are U.S. citizens or U.S. permanent residents or students with Deferred Action for Childhood Arrivals (DACA) status.
5. Examinees report the highest level of education for up to four parents. These results are for the highest level of parental education for examinees who took the MCAT exam from 2018 to 2020.
6. Score reports do not indicate whether scores were obtained under standard or nonstandard testing conditions.
7. For repeater status, "Single attempt only" includes the scores from the examinees who took the current MCAT exam for the first time in 2018, 2019, or 2020 and did not test again. "Repeater" data include scores from the examinees who took the MCAT exam for the first time in 2018, 2019, or 2020 and then tested at least one more time during this window. They are a subset of those who tested more than once since this version of the MCAT exam was introduced. The "1st attempt" plot shows these repeaters' scores from their very first attempt, and the "2nd attempt" plot shows these same examinees' scores from their second attempt.

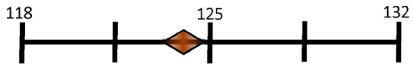
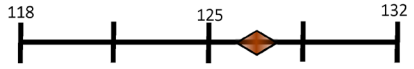
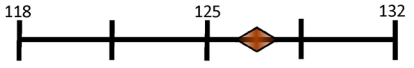
How precise are examinees' MCAT scores, and how should they be interpreted?

Four types of information are essential for interpreting MCAT scores:

- Total and section scores.
- Confidence bands.
- Percentile ranks associated with the scores.
- Score profile.

Figure 8 shows an example of an examinee's score report that includes these four components. Details about the confidence bands, percentile ranks, and the score profile are included below. Other resources—including an interactive version of the score report; videos describing the concepts and reasoning skills tested by the new exam; and downloadable fact sheets describing the scores, confidence bands, percentile ranks, and score profile—can be found at aamc.org/mcatscorereport.

Figure 8. Example score report.

Section	Score	Confidence Band[1]	Percentile Rank of Score[2]	Score Profile[3]
Chemical and Physical Foundations of Biological Systems	124	123–125	42%	
Critical Analysis and Reasoning Skills	123	122–124	35%	
Biological and Biochemical Foundations of Living Systems	127	126–128	72%	
Psychological, Social, and Biological Foundations of Behavior	127	126–128	65%	
MCAT Total	501	499–503	48%	

Notes

1. Test scores, like other measurements, are not perfectly precise. The confidence bands around test scores mark the ranges in which the test taker's true scores probably lie. The diamond shapes and shading show the test taker's true scores are more likely to be their reported scores (in the second column) than the other scores in the confidence bands.

2. The percentile ranks of scores are the percentages of test takers who received the same scores or lower scores. The percentile ranks are updated on May 1 every year to reflect the results from the three most recent previous calendar years.

3. For the four sections, non-overlapping confidence bands show a test taker's likely strengths and weaknesses. Overlapping confidence bands suggest that there are not meaningful differences in performance between sections.

Confidence bands

Like other measurements, MCAT scores are imperfect measures of examinees' true levels of preparation. They are not perfectly precise. Examinees' scores can be dampened by factors such as fatigue, test anxiety, and less-than-optimal test room conditions, or they can be boosted by recent exposure to some of the tested topics.

Confidence bands remind admissions committee members not to overemphasize small differences in scores.

Confidence bands describe the precision of MCAT total and section scores. They show the ranges in which an examinee's true scores probably lie. Reviewing applicants' scores with the confidence bands in mind prevents overinterpretation of small differences in test scores.

Score reports show confidence bands both numerically and graphically. MCAT total scores are reported with a confidence band of plus or minus two points, and MCAT section scores are reported with confidence bands of plus or minus one point. Adding and subtracting two points to an MCAT total score of 500, for example, defines a confidence band that begins at 498 and goes to 502.

Figures 9 and 10 illustrate how confidence bands can be used to interpret MCAT total scores. The reported score for each examinee is shown as a square. The confidence band around each examinee's score is shown by the dashed lines in the figure.

Figure 9 shows that examinee A scored 500, and examinee B scored 502. The confidence bands around these scores overlap. The overlap between the two confidence bands suggests that the two reported scores may not be meaningfully different from each other.

Figure 10 shows that examinee A scored 500, and examinee C scored 506. The confidence bands around their scores do not overlap, suggesting the two scores are more likely to be meaningfully different from each other (compared with the scores for examinees A and B).

Figure 9. Confidence bands for two examinees with similar reported scores.

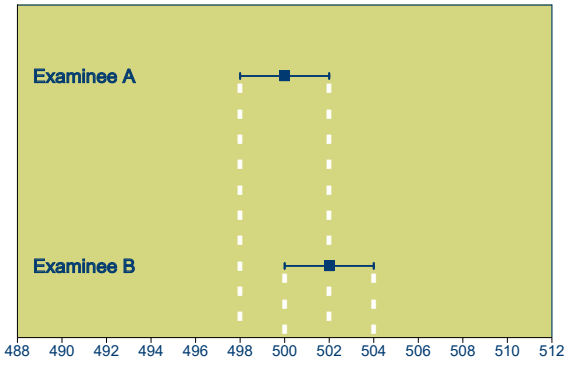
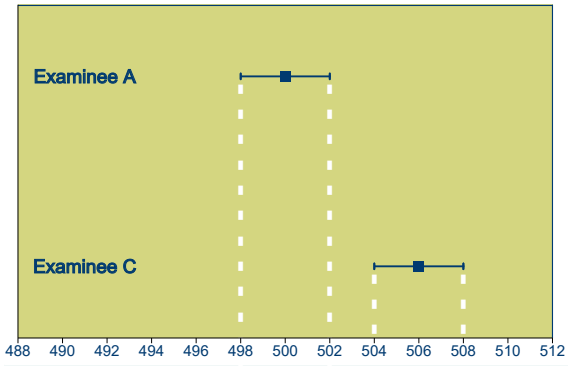


Figure 10. Confidence bands for two examinees with dissimilar reported scores.



Percentile ranks

The percentile ranks for the total and section scores show how the scores of individual applicants compare with the scores of others who took the exam. The percentile ranks show the percentages of test takers who received the same or lower scores on the exam.

Percentile ranks show how an applicant's scores compare with other examinees' scores.

For example, the MCAT total score in Figure 8 on page 9 is 501. It has a percentile rank of 48%. This means that 48% of MCAT scores were equal to or less than 501.

Every year on May 1, the percentile ranks for MCAT scores are updated using data from the previous three administration years. This is a common practice in the standardized test industry and ensures that percentile ranks reflect current information about examinees' scores. Because examinees change from one year to the next, the percentile ranks associated with scale scores may change over time. Basing the percentiles on data from three administration years instead of one year makes the results more stable, but it doesn't prevent year-to-year changes.

That is why MCAT scores have more meaning than percentile ranks. The methods that MCAT developers use to write test questions and build and equate test forms keep the meaning of scores constant over test forms and time. The exam is not graded on a curve. No matter when applicants tested, whom they tested with, or what test forms they took, their scores have common interpretations. MCAT scores describe applicants' academic readiness in relation to the body of knowledge and skills that medical school faculty have described as prerequisite for entering medical students.

The current percentile ranks are based on data from 2018, 2019, and 2020. Appendix B shows the MCAT total and section score percentile ranks in effect from May 1, 2021, to April 30, 2022.

Score profile

The MCAT score profile highlights applicants' strengths and weaknesses across the four sections of the exam through reported scores for each section.

Score profiles highlight applicants' strengths and weaknesses across the four sections of the MCAT exam.

Figure 8 illustrates the score profile associated with an applicant's MCAT section scores. Applicants' strengths and weaknesses on the exam can be considered along with other information about their academic preparation (e.g., coursework and grades) and in relation to institutional missions and goals.

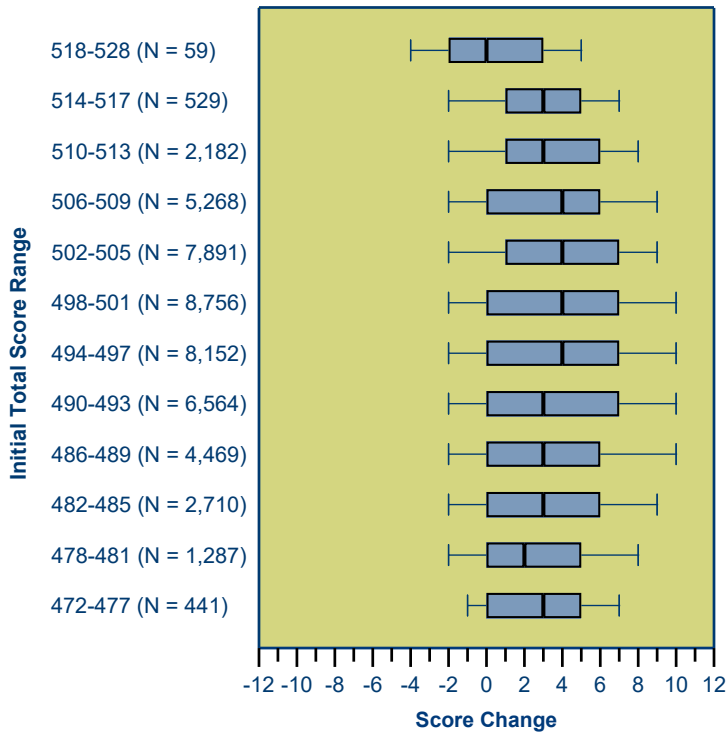
How do examinees' scores change when they retake the MCAT exam, and how do admissions officers use scores for applicants who test more than once?

MCAT examinees can test up to three times in one calendar year and four times across two calendar years. An examinee cannot take the exam more than seven times in their lifetime. As shown in Figure 4 on page 5, about 38% of individuals who took the MCAT exam in 2018, 2019, and 2020 were retesters.

To show the types of score gains obtained upon retesting, analyses were conducted to compare scores from examinees' first attempt with their second attempt. These analyses include scores from examinees who tested for the first time in 2018, 2019, or 2020 and then retook the exam in that window. Figure 11 uses box-and-whisker plots (described earlier for Figure 7) to show the distributions of score gains (and losses) on examinees' second attempts at the exam, relative to their first-attempt scores.

The data show that retesters across a wide range of scores tend to obtain higher scores on their second exams. Figure 11 shows that the median gain was generally three to four score points for examinees who tested a second time and whose first-attempt scores were between 472 and 517. For examinees whose initial scores were between 518 and 528, the median gain was zero points. It is important to note, however, that there was considerable variation in the magnitude and direction of score changes, with some examinees posting increases or decreases greater than four points.

Figure 11. Changes in MCAT total scores between the first and second attempts of MCAT examinees from 2018 to 2020 who retested.



Note: These box-and-whisker plots show changes in MCAT total scores from the first attempt to the second attempt for examinees (N = 48,308) who took this version of the MCAT exam for the first time in 2018, 2019, or 2020 and then tested a second time in this same window.

A 2017 AAMC survey asked admissions officers how they work with retesters' MCAT total scores in the admissions process.[7] The results showed that admissions officers use different strategies for examining retesters' scores. For example, some admissions committees use all exam scores in conjunction with other information about academic preparation that may explain any score changes. Other admissions committees use applicants' most recent exam scores in the admissions process or use the applicants' "best score" as represented by their highest reported total score. Other committees compute the average total score across the multiple attempts.

Applicants' transcripts, experiences, and other information in their applications provide important context for interpreting retesters' scores.

It is important for admissions officers to examine the information in applicants' transcripts and applications in interpreting retesters' scores. Data not shown in Figure 11 suggest that average score gains on the second attempt are greater when the time between the first and second attempts is greater. Information in applicants' files, such as completion of a postbaccalaureate program, graduate degree program, or other coursework, can help explain gains in applicants' scores over time.

How do admissions officers use MCAT scores and other application data in the holistic review of applicants' qualifications?

As already mentioned, MCAT scores are among many sources of application data that admissions committees use to select medical students. The scores help admissions officers interpret grades and other academic data that come from undergraduate institutions with different curricular emphases and grading standards. In addition to applicants' academic data, admissions officers examine applicants' experiences and demographic and personal attributes. Applicants provide a great deal of data about their academic and life experiences, demographics, and personal characteristics through their applications, personal statements, and interviews. Letter writers also provide rich information about applicants' academic, experiential, and personal attributes.

The procedures that admissions officers from different medical schools use to review these data on applicants' qualifications differ in ways that reflect the schools' unique missions, goals, and curricula, as well as the sizes and characteristics of their applicant pools. To learn more about the holistic review of applicants' qualifications, the AAMC periodically surveys admissions officers about the importance of different academic, experiential, demographic, and personal attribute data in making admissions decisions.[7-11]

Reviewing information about the experiences and attributes of applicants helps admissions committees put academic metrics in better balance.

Table 1 summarizes the results of a 2015 AAMC survey of admissions officers.[11] The table highlights the importance of different types of data in admissions decision-making. The results of this and previous AAMC surveys about the use and importance of data for making admissions decisions show that experiences, academic metrics, demographics, and personal attributes all weigh heavily in decisions to offer interview invitations and acceptances.[9,12]

In 2017, admissions officers were surveyed about the relative weight they give to undergraduate GPAs and MCAT scores compared with other information in applicants' files to learn how they place these metrics in context at different stages of the admissions process.[7]

The survey data show that the importance of undergraduate GPAs and MCAT scores, relative to other criteria, decreases as more information about applicants is gathered. Admissions officers are better able to balance data about academic metrics when they are placed in the context of applicants' experiences and attributes. For example, 80% of admissions officers rated other criteria just as or more important in making acceptance offers, compared with 60% who rated other criteria just as or more important in inviting applicants to interview. Placing applicants' MCAT scores in the context of their educational opportunities, lived experiences, academic trajectories, and personal attributes during the admissions process enables medical schools to meet their missions and goals and not overlook students who would make valuable contributions to their programs.

Table 1. Mean Importance Ratings of Academic, Experiential, Demographic, and Interview Data Used by Admissions Committees to Make Decisions About Which Applicants Receive Interview Invitations and Acceptance Offers[1]

Mean Importance Ratings[2]	Academic Metrics	Experiences	Demographics	Other Data
Highest Importance Ratings (≥ 3.0)	• GPA: cumulative biology, chemistry, physics, and math • MCAT total score • GPA: grade trend • GPA: cumulative total • GPA: cumulative total from postbaccalaureate premedical program • MCAT total score trend • Completion of premedical course requirements	• Community service/volunteer: medical/clinical • Community service/volunteer: not medical/clinical • Physician shadowing/ clinical observation • Leadership	• U.S. citizenship/ permanent residency (public)[3] • State residency (public)[3] • Rural/urban, underserved background	• Interview results[4]
Medium Importance Ratings (≥ 2.5 and < 3.0)	• Completion of challenging upper-level science courses • GPA: cumulative "all other" (not biology, chemistry, physics, and math)	• Paid employment: medical/clinical • Research/lab • Other extracurricular activities • Military service	• Race/ethnicity • U.S. citizenship/ permanent residency (private)[3] • Parental education/ occupation/ socioeconomic status (SES)	
Lowest Importance Ratings (< 2.5)	• Degree from graduate or professional program • Completion of challenging nonscience courses • Selectivity of undergraduate institution(s) • Undergraduate major	• Teaching/tutoring/ teaching assistant • Paid employment: not medical/clinical • Intercollegiate athletics • Honors, awards, recognitions • Conferences attended, presentations, posters, publications	• First-generation immigrant status • Fluency in multiple languages • Gender • English language learners • State residency (private)[3] • Legacy status • Community college attendance • Age	

Notes

1. Admissions officers at 130 medical schools completed a 2015 AAMC survey on the use and importance of data in admissions decision-making. The survey asked, "How important were the following data about academic preparation, experiences, attributes/personal competencies, biographic/ demographic characteristics, and interview results in identifying the applicants to [interview, offer an acceptance]?"
2. Importance was rated on a scale ranging from 1 to 4 ("Not Important," "Somewhat Important," "Important," and "Very Important," respectively). For each variable, we computed an overall mean importance rating based on admissions officers' ratings of importance for making decisions about whom to interview and whom to accept (the mean importance rating for the interview variable is the exception to this rule because interview data were not available until applicants were invited to interview). We chose to classify variables using overall mean importance ratings because their mean importance ratings were similar for the interview and the acceptance phases. Variables are ordered by overall mean importance rating.
3. Overall mean importance ratings for public and private institutions were significantly different from one another.
4. Only available at the admissions stage where admissions committees make a decision to offer an acceptance.

National-level data on the academic credentials of applicants whom admissions committees accept reinforce the messages the survey data provide. Table 2 shows the percentages of applicants with different undergraduate GPAs and MCAT total scores who were accepted into one or more medical schools in 2018, 2019, or 2020. These data show that although undergraduate GPAs and MCAT scores are important factors in admissions, they are not the sole determinants of admissions decisions.

Some applicants with high undergraduate GPAs and MCAT scores do not receive any acceptances, while other applicants with modest credentials are accepted by at least one medical school.

Each year, some applicants with high MCAT scores and undergraduate GPAs are rejected by all the medical schools to which they applied. In contrast, other applicants with more modest MCAT scores and undergraduate GPAs are accepted by at least one medical school. In 2018, 2019, and 2020 student selection, 13% of applicants with GPAs of 3.8 or above and MCAT total scores of 518 or above were rejected by all the medical schools to which they applied. In contrast, about 14% of applicants with GPAs of 3.00 to 3.19 and MCAT total scores ranging from 498 to 501 were accepted by at least one medical school.

Table 2. Percentage and Number of 2018, 2019, and 2020 Applicants Accepted Into at Least One Medical School, by MCAT Total Score and Undergraduate GPA Ranges

	MCAT Total										
GPA Total	472-485	486-489	490-493	494-497	498-501	502-505	506-509	510-513	514-517	518-528	All
3.80-4.00	1% 2/151	2% 5/302	7% 47/713	18% 291/1,603	30% 996/3,357	44% 2,484/5,687	59% 5,132/8,663	73% 7,239/9,885	81% 7,144/8,873	87% 7,871/9,087	65% 31,211/48,321
3.60-3.79	1% 4/370	1% 7/583	5% 57/1,229	11% 277/2,446	23% 964/4,196	32% 2,049/6,336	46% 3,702/7,975	62% 4,929/7,932	72% 3,858/5,347	79% 2,556/3,253	46% 18,403/39,667
3.40-3.59	1% 5/592	2% 12/785	3% 48/1,502	10% 259/2,584	18% 727/4,004	26% 1,291/5,045	36% 2,047/5,686	49% 2,427/4,905	61% 1,695/2,776	70% 957/1,374	32% 9,468/29,253
3.20-3.39	<1% 3/709	1% 7/786	2% 32/1,375	7% 145/2,038	14% 404/2,820	22% 683/3,135	29% 883/3,023	40% 932/2,315	49% 590/1,203	57% 287/506	22% 3,966/17,910
3.00-3.19	<1% 4/803	1% 4/705	2% 18/948	6% 82/1,370	14% 220/1,595	21% 340/1,641	26% 397/1,530	33% 363/1,084	43% 197/455	54% 121/223	17% 1,746/10,354
2.80-2.99	1% 4/612	1% 3/515	2% 11/633	4% 26/669	11% 82/745	17% 129/758	22% 126/586	26% 95/361	31% 55/179	45% 33/73	11% 564/5,131
2.60-2.79	0% 0/456	2% 5/307	1% 3/349	5% 16/344	11% 40/378	15% 43/282	21% 43/203	23% 30/128	37% 22/59	19% 3/16	8% 205/2,522
2.40-2.59	0% 0/316	0% 0/159	2% 3/176	3% 5/154	5% 7/129	10% 10/100	23% 15/64	24% 9/38	33% 6/18	--	5% 57/1,162
2.20-2.39	0% 0/197	0% 0/78	0% 0/81	3% 2/61	12% 5/43	11% 4/36	16% 5/31	14% 3/22	--	--	4% 24/557
2.00-2.19	0% 0/95	0% 0/28	3% 1/32	0% 0/13	--	10% 1/10	--	--	--	--	2% 4/202
Less than 2.00	0% 0/48	--	0% 0/10	--		--	--	--			1% 1/82
All	1% 22/4,349	1% 44/4,257	3% 220/7,048	10% 1,103/11,291	20% 3,445/17,274	31% 7,034/23,031	44% 12,350/27,772	60% 16,028/26,676	72% 13,572/18,920	81% 11,831/14,543	42% 65,649/155,161

Notes

1. Dark-green shading = acceptance rates ≥75%; light-green shading = acceptance rates of 50%-74%; gray shading = acceptance rates of 25%-49%.
2. Dashes = cells with fewer than 10 observations; blank cells = cells with zero observations.
3. For students who took the MCAT exam multiple times, the most recent MCAT total score was used in this analysis.
4. Table summarizes data for 2018, 2019, and 2020 applicants who reported MCAT scores from the current exam and undergraduate GPAs (N=155,161).

How well do undergraduate GPAs and MCAT scores predict students' performance in medical school?

This section describes how well undergraduate GPAs and MCAT scores predict medical student performance in preclerkship courses, on the Step 1 exam, in clerkships, on the Step 2 CK (Clinical Knowledge) exam, and their graduation from medical school within four years. Subsequent editions of this guide will present findings related to graduation from medical school in five years for these and future cohorts.

The pages that follow describe the relationships among undergraduate GPAs, MCAT scores, and a variety of medical student performance outcomes from entry through graduation. Some outcomes, such as preclerkship and clerkship grades or test scores, reveal how well academic metrics like MCAT scores and undergraduate GPAs predict the full range of medical student performance. Other outcomes, such as passing the Step 1 and Step 2 CK exams or graduating within four years, home in on how well MCAT scores and undergraduate GPAs predict student success on important milestones but do not distinguish between those that are close to and those that are well above or below the pass/fail standards. Examining the associations of undergraduate GPAs and MCAT scores with these varied outcomes provides different vantage points about the likelihood of success for applicants with different ranges of undergraduate GPAs and MCAT scores.

Examining how undergraduate GPAs and MCAT scores relate to medical students' performance on varied outcomes provides a more complete picture of applicants' likely success in medical school.

Table 3 summarizes the medical student performance outcomes included in this guide. The left column lists each outcome. The middle column describes what each outcome is and how it is measured or calculated. The right column describes the sample of medical students used to examine each outcome, which varies due to data availability.

Table 3. Summary of Medical Students' Performance Outcomes

Performance Outcome	Description	Sample
Preclerkship performance	Preclerkship performance is based on each student's mean performance across preclerkship courses.[1]	2,756 students from 17 validity schools[2] who entered in 2016 or 2017
Step 1 score (first attempt)	The Step 1 score comes from each student's first attempt at the USMLE Step 1 exam.	22,814 students who entered in 2016 or 2017 and took the Step 1 exam by the end of 2020
Passing Step 1 on the first attempt	The Step 1 pass/fail outcome comes from each students' first attempt at the USMLE Step 1 exam.	25,695 students who entered in 2016 or 2017 and took the Step 1 exam by the end of 2020
Clerkship exam score	The clerkship exam score is based on the mean score across the exams administered in clerkship rotations.[3]	2,324 students from 16 validity schools who entered in 2016 or 2017[4]
Clerkship GPA	The clerkship GPA is based on the mean performance across core clerkship courses using each validity school's rating or grading scale.[5]	2,097 students at 14 validity schools who entered in 2016 or 2017[6]
Step 2 CK score (first attempt)	The Step 2 CK score comes from each student's first attempt at the USMLE Step 2 CK exam.	20,794 students who entered in 2016 or 2017 and took the Step 2 CK exam by the end of 2020
Passing Step 2 CK on the first attempt	The Step 2 CK pass/fail outcome comes from each student's first attempt at the USMLE Step 2 CK exam.	22,435 students who entered in 2016 or 2017 and took the Step 2 CK exam by the end of 2020
Graduating in four years	Graduation is defined as graduation within the expected calendar year.	7,502 students who entered in 2016 and are enrolled in regular MD programs

Notes

1. Each school identified the preclerkship courses that have reliable performance measures (e.g., written exams, practical exams, case studies, and other evaluations). Examples of preclerkship courses are: Biochemistry, Cell and Molecular Biology, Cardiovascular and Pulmonary Systems, Behavioral Medicine and Health, Health Care Ethics, Introduction to Clinical Anatomy, and Community Engagement. Although the selected courses vary widely in the extent to which they relate to the knowledge and skills the MCAT exam tests, most teach natural sciences subjects. Because the courses selected by each validity school made up the majority of preclerkship courses at the school, the measure of performance used here, which ranges from 0 to 100, correlated highly with the preclerkship GPAs calculated by the medical schools or with class ranks at each school.
2. Students enrolled at 17 medical schools in the United States and Canada, referred to here as "validity schools," volunteered for validity research about locally defined medical student performance outcomes tied to their school's curriculum, academic support, and learning environment. These students' performance data were analyzed for relevant outcomes.
3. The vast majority of the clerkship exam scores are from National Board of Medical Examiners (NBME) Clinical Science Subject Exams.
4. Sixteen out of 17 validity schools provided available data for this outcome.
5. Each clerkship "grade" reflects a student's overall evaluation based on a combination of clinical performance evaluations, exam scores, and other evaluations required by each clerkship at each school.
6. Fourteen out of 17 validity schools provided available data for this outcome.

In the remainder of this section, we use figures and text to integrate and present findings related to the range of medical student performance outcomes and samples described in Table 3. Some results are summarized at the aggregate school level, and others show what the data look like for individual students. Together, these findings tell the following story:

- MCAT scores strongly predict medical student performance in preclerkship and clerkship courses, as well as on USMLE licensure exams (Step 1 and Step 2 CK).
- Some students perform better in medical school than their MCAT scores predict, and others perform less well.
- MCAT scores predict students' performance better than undergraduate GPAs. Together, they provide better prediction than either academic metric alone.
- Using MCAT scores and undergraduate GPAs together provides a better signal about students' likely success in medical school, including passing Step 1 and Step 2 CK exams and graduating within four years.

Relationships of MCAT scores with students' preclerkship, Step 1, clerkship, and Step 2 CK performance

Figure 12 shows how well MCAT total scores predict students' preclerkship performance, Step 1 scores from the first attempt, clerkship exam scores, clerkship GPAs, and Step 2 CK scores from the first attempt. Correlational analyses were done individually at each school with students who entered medical school in 2016 or 2017, both combined and separately, on each of the five performance outcomes. Then, the correlations for each outcome were grouped together to identify the midpoint of these correlations across all schools for the two entering classes combined, as well as the midpoints for the 2016 and 2017 entering classes separately. Conducting these correlational analyses by school and entering class allows us to see how the correlations of MCAT scores and student performance outcomes vary across schools, each of which has its own approach to teaching, evaluating, and supporting students, which also may change over time.

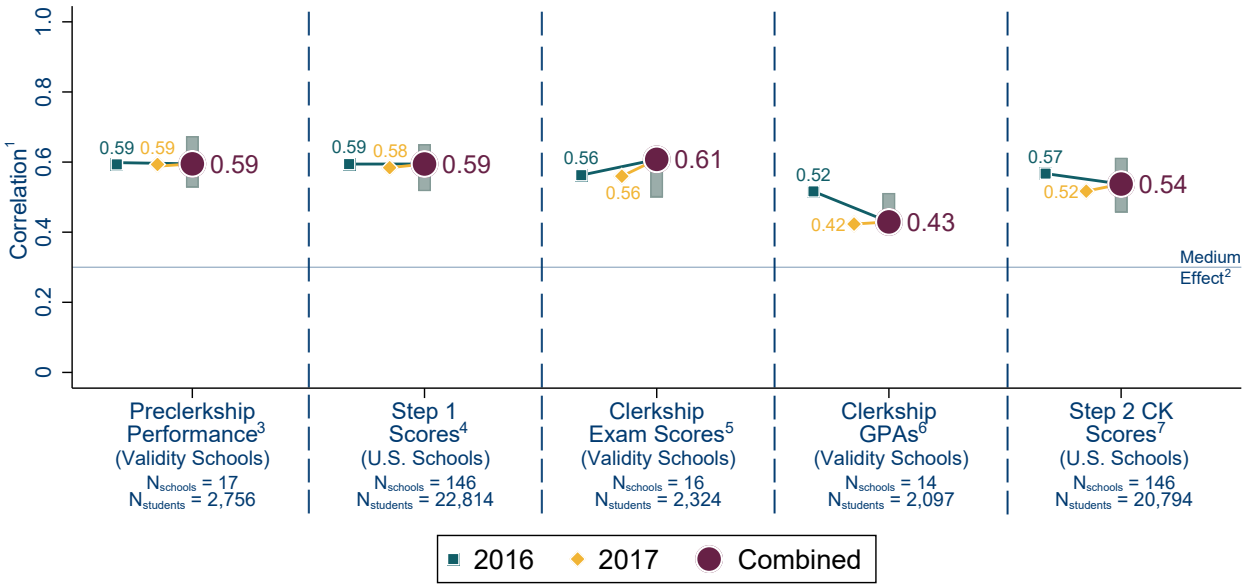
The preclerkship and clerkship findings in Figure 12 are based on local outcomes from validity schools, and the Step 1 and Step 2 CK findings are based on national data from U.S. medical schools. Figure 12 shows the median correlation of MCAT scores with each outcome across schools for the combined cohorts. For each outcome, it also shows the median outcome for 2016 entrants and the median outcome for 2017 entrants. In each panel of Figure 12, the large circle shows the median correlation coefficient (the correlation at the 50th percentile) across all schools, the square shows the median correlation coefficient for 2016 entrants, and the diamond shows the median correlation for 2017. The two ends of the gray bar show the correlations at the 25th and 75th percentiles (the interquartile range) for the two entering classes combined.

The x-axis in Figure 12 shows the medical student performance outcome in each panel. The y-axis shows the strength of the relationship between MCAT scores and each performance outcome, which helps with the comparison of correlation sizes across the preclerkship, Step 1, clerkship, and Step 2 CK outcomes. The horizontal line at a correlation of 0.3 provides a reference point by showing the threshold for a medium effect size in the social sciences.[13]

The "Preclerkship Performance" panel in Figure 12 shows the median and interquartile range of correlations of MCAT total scores with preclerkship performance at the 17 validity schools, as well as the median correlations for the 2016 and 2017 entering classes. The median correlation of MCAT total scores with students' preclerkship performance is 0.59 for the two entering classes combined, which is the same as the median correlation for each entering class. The "Step 1 Scores" panel in Figure 12 shows the correlations of

MCAT total scores with Step 1 scores at the 146 U.S. MD-granting medical schools with at least 30 students who took the Step 1 exam for the first time by the end of 2020. The median correlation of MCAT total scores with Step 1 scores is 0.59 for 2016 and 2017 entrants combined, the median correlation for 2016 entrants is 0.59, and the median correlation for 2017 entrants is 0.58.

Figure 12. Correlations of MCAT total scores with students' preclerkship, Step 1, clerkship, and Step 2 CK performance: medians and interquartile ranges across schools.



Notes

1. Medical students' most recent MCAT total scores at the time of matriculation were correlated with each performance outcome. Analyses were conducted separately for each school with 30 or more students who have data available for each performance outcome. Sample correlations were corrected for range restriction on MCAT total scores and total undergraduate GPAs due to the selective nature of the admissions process[14] but not for unreliability in MCAT total scores or medical student outcomes. Corrections for range restriction were made at the institution level. At each medical school, the applicants from an admissions cycle served as the reference population. Using established statistical methods, the observed correlations were adjusted to reflect what the correlations would be if there had been no selection — that is, if all applicants had been selected for admission.
2. According to Cohen (1992),[13] a correlation coefficient of 0.10 is considered a small association in the social sciences; a correlation coefficient of 0.30 is considered a medium correlation; and a correlation of 0.50 or greater is considered a large correlation.
3. These data are based on 2,756 students who entered medical school in 2016 or 2017 (from 17 validity schools).
4. These data are based on 22,814 students who entered medical school in 2016 or 2017 and took the Step 1 exam for the first time by the end of 2020 (from 146 U.S. medical schools).
5. These data are based on 2,324 students who entered medical school in 2016 or 2017 (from 16 validity schools). For this outcome, analyzing the 2016 and 2017 data together at each school resulted in a higher median correlation than the median correlations resulting from analysis of each cohort separately.
6. These data are based on 2,097 students who entered medical school in 2016 or 2017 (from 14 validity schools).
7. These data are based on the 20,794 students who entered medical school in 2016 or 2017 and took the Step 2 CK exam for the first time by the end of 2020 (from 146 U.S. medical schools).

The next two panels in Figure 12 show initial evidence of how well MCAT total scores predict students' performance in their clerkships. The "Clerkship Exam Scores" panel in Figure 12 shows the correlations of MCAT total scores with the average clerkship exam scores at 16 validity schools. The median correlation of MCAT total scores with clerkship exam scores is 0.61 for both entering classes combined, the median correlation for 2016 entrants is 0.56, and the median correlation for 2017 entrants is 0.56. The "Clerkship GPAs" panel in

Figure 12 shows the correlations of MCAT total scores with clerkship GPAs at 14 validity schools. The median correlation of MCAT total scores with clerkship GPAs is 0.43 for 2016 and 2017 entrants combined, the median correlation for 2016 entrants is 0.52, and the median correlation for 2017 entrants is 0.42.

Finally, the "Step 2 CK Scores" panel in Figure 12 shows the correlations of MCAT total scores with Step 2 CK scores at 146 U.S. MD-granting medical schools with at least 30 students who took the Step 2 CK exam for the first time by the end of 2020. The median correlation of MCAT total scores with Step 2 CK scores is 0.54 for 2016 and 2017 entrants combined, the median correlation for 2016 entrants is 0.57, and the median correlation for 2017 entrants is 0.52.

The median correlations of MCAT scores with preclerkship, Step 1, Step 2 CK, and clerkship performance shown in Figure 12 are medium to large. The difference observed between cohorts for some performance outcomes are small and consistent with prior research.[15] That means MCAT total scores provide an important signal of students' readiness for the heavy knowledge acquisition in the first two years of medical school (i.e., preclerkship and Step 1) and in their application of knowledge in their clinical years (i.e., clerkships and Step 2 CK).

There is a strong relationship between MCAT scores and students' preclerkship, Step 1, clerkship, and Step 2 CK performance.

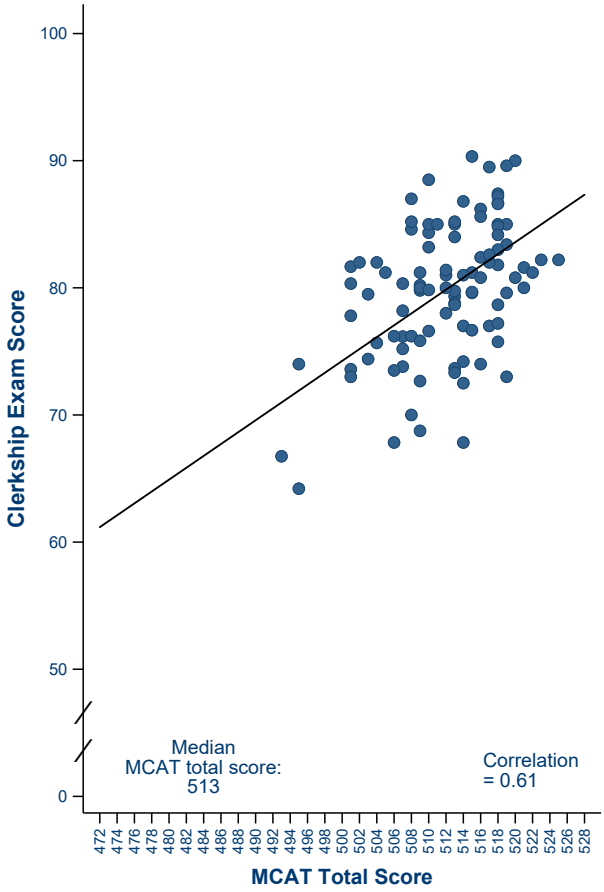
Although MCAT scores are good predictors of students' preclerkship, Step 1, clerkship, and Step 2 CK performance, the strength of prediction varies from one medical school to another. Many factors may contribute to this variability. Medical schools vary in their approaches to teaching and to supporting and evaluating student learning, which may also change over time. The variability across schools in the relationship between MCAT scores and students' performance highlights the importance of studying local validity data so schools can draw conclusions about the ways MCAT scores predict their students' performance in their local environment.

The next two figures highlight data from individual students to show that, although MCAT scores do a good job of predicting medical students' performance, there is variability in medical student performance, only some of which is predicted by MCAT scores. Figure 13 shows how well MCAT scores predict the clerkship performance of students at a single medical school. Figure 14 expands to the national population and shows the variability in medical students' performance on the Step 2 CK exam at different MCAT total scores.

Figure 13 shows how well MCAT total scores predict the clerkship performance of students at a single medical school. It presents a scatter plot that shows the 2016- and 2017-entering students' MCAT scores against their clerkship exam scores at one of the validity schools. Data from the students at this school can be used to study the association of MCAT scores with clerkship exam scores as an example of the patterns that may occur at other schools that use similar performance outcomes.

In Figure 13, the x-axis shows MCAT total scores from low to high (left to right). The y-axis shows students' clerkship exam scores on a scale from 0 to 100 (bottom to top). Each dot represents an individual student's data — the MCAT score they were admitted with and their average clerkship exam score. The diagonal line shows the estimated relationship of MCAT scores with clerkship exam scores. At this validity school, the correlation of the 2016- and 2017-entering validity students' MCAT scores with their performance on clerkship exams is 0.61.

Figure 13. Scatter plot of clerkship exam scores, by MCAT total score for students at one validity school.



Note: The results are for the 98 medical students who entered with scores from this version of the MCAT exam at this validity school in 2016 or 2017 whose clerkship exam scores are available. The median MCAT total score for the students in this analysis is 513 and is based on the most recent score at the time of matriculation. The corrected correlation between MCAT scores and clerkship exam scores is 0.61.

The patterns of dots in Figure 13 show three important findings. First, this validity school accepts students with a wide range of MCAT total scores. Second, on average, participants admitted with higher MCAT total scores show higher clerkship performance. Third, the variability in individual medical student performance is substantial. Some students show higher performance in clerkships than others admitted with the same MCAT score, while others show lower performance. Some students admitted with lower MCAT scores outperformed students with higher scores.

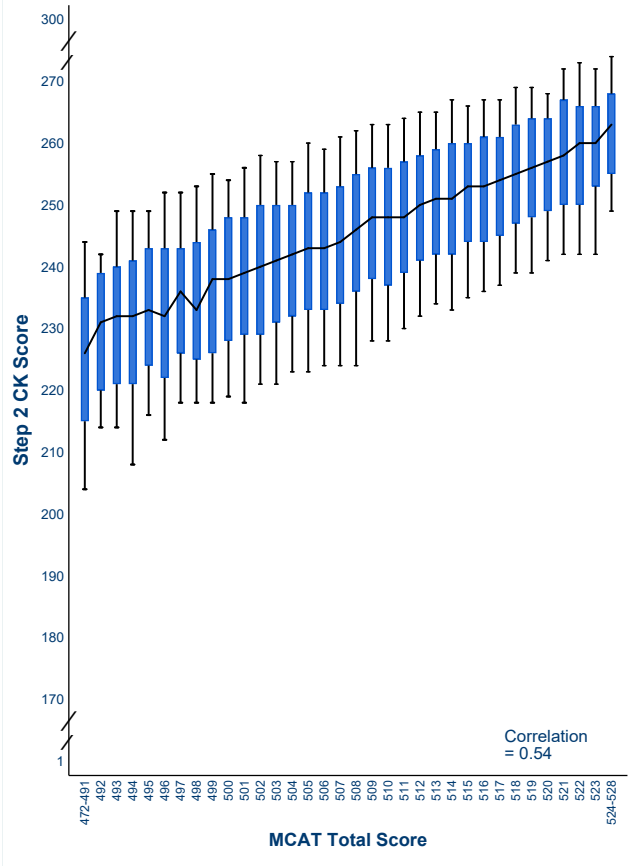
The next figure demonstrates similar patterns with national data. Figure 14 shows the distribution of Step 2 CK scores from the first attempt by MCAT total score for the 22,435 students who entered medical school in 2016 or 2017 and took the Step 2 CK exam by the end of 2020. The x-axis shows the MCAT total scores, and the y-axis shows the Step 2 CK scores. The jagged diagonal line shows the median Step 2 CK score for students admitted with each MCAT total score. The vertical boxes show the Step 2 CK scores at the 25th to the 75th percentiles for students admitted with each MCAT total score, and the vertical lines show the Step 2 CK scores at the 10th to 25th and 75th to 90th percentiles.

Some students perform better in medical school than their MCAT scores predict, and others perform less well.

The data in Figure 14 show that, nationally and on average, 2016 and 2017 entrants with higher MCAT scores obtained higher scores on their first attempt at the Step 2 CK exam. The slope of the jagged diagonal line shows that MCAT scores are closely correlated with Step 2 CK scores. The correlation of MCAT total scores with Step 2 CK scores is 0.54.

Figure 14 also demonstrates student variability by showing the range of Step 2 CK scores for students admitted with each MCAT total score. The bars showing the distribution of Step 2 CK scores at each MCAT total score are tall, which helps explain that — although MCAT scores do a good job of predicting Step 2 CK scores — at every MCAT total score, some students performed better than expected and others performed

Figure 14. Distribution of Step 2 CK scores, by MCAT total score for students at U.S. medical schools.



Note: These data are from the U.S. medical students entering school in 2016 or 2017 who took the Step 2 CK exam for the first time by the end of 2020 (N = 22,435). The jagged diagonal line shows the median Step 2 CK score for these students by their most recent MCAT total score at the time of matriculation. The blue vertical boxes show the Step 2 CK scores from the 25th to the 75th percentiles, and the black vertical lines show the Step 2 CK scores from the 10th to the 25th percentiles and 75th to the 90th percentiles by MCAT total score. The numbers of students admitted with MCAT scores at the bottom and top of the MCAT score scale are too small to compare with those at other points. Therefore, results for students admitted with MCAT total scores from 472 to 491 are reported together, as are the results for those who scored from 524 to 528.

less well than expected. As an example of the variability in Step 2 CK performance, for students admitted with an MCAT total score of 497, the median Step 2 CK score is 236. The Step 2 CK scores at the 25th and 75th percentiles are 226 and 243, respectively.

The data in Figure 14 reveal two important points. First, MCAT scores, which reflect students' premedical preparation in scientific concepts and reasoning skills taught in college, do a good job of predicting performance on a test that measures students' ability to apply medical knowledge, skills, and understanding of clinical science acquired from the first three years of medical school. The data suggest that students' premedical preparation provides important building blocks that support their learning in medical school.

Second, while MCAT scores correlate highly with performance on the Step 2 CK exam, other factors also contribute to performance on the licensure exam. Remember, many students take the MCAT exam when they are juniors in college. They complete their senior year and then three years of medical school before taking the Step 2 CK exam. Significant learning happens during these years, students learn at different rates and respond to curricular and instructional approaches in different ways, and their rank orders change over time. Additionally, these students' undergraduate coursework and GPAs likely explain some of the differences in their readiness for medical school, as we will show in greater detail in the next section.

Relationships of undergraduate GPAs and MCAT scores with students' preclerkship, Step 1, clerkship, and Step 2 CK performance

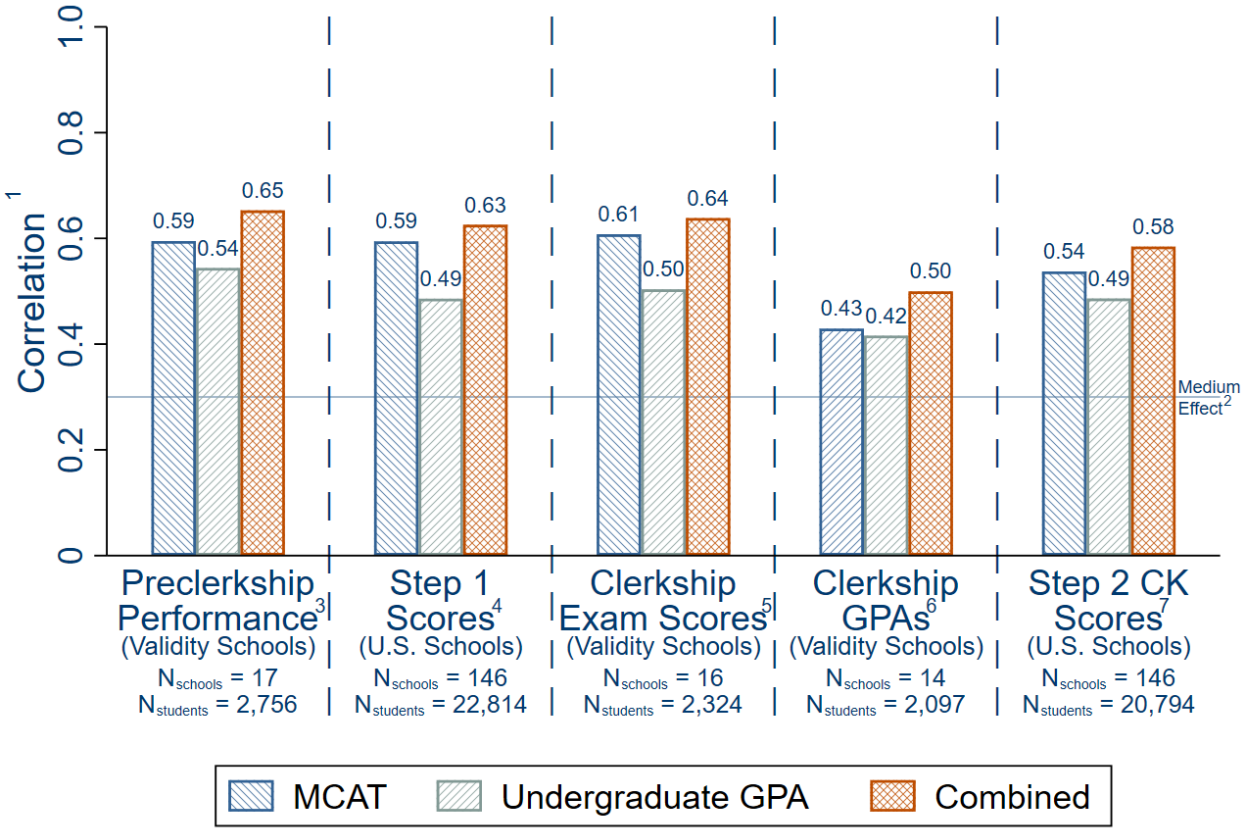
MCAT scores consistently predict students' performance in medical school better than undergraduate GPAs, although both MCAT scores and undergraduate GPAs show strong relationships with medical students' performance. Using MCAT scores and undergraduate GPAs together to assess academic readiness provides a better prediction of future performance in medical school and on licensure exams than using either academic metric alone, as illustrated in Figure 15.

Three correlational analyses were performed at each school to examine the associations of MCAT scores and undergraduate GPAs with medical student outcomes: one for MCAT scores alone as the predictor, one for total undergraduate GPAs alone as the predictor, and one to examine the joint contribution of MCAT total scores and undergraduate GPAs in predicting students' performance. Conducting these correlational analyses by school allows us to see how the correlations between academic metrics and student performance outcomes vary across schools, each of which has its own approach to teaching, evaluating, and supporting students. Information about undergraduate GPAs also helps explain why some students perform better than their MCAT scores predict, and others perform less well.

Using MCAT total scores AND undergraduate GPAs predicts medical student performance better than using either one alone.

Figure 15 shows results for five medical student performance outcomes: preclerkship performance, Step 1 scores, clerkship exam scores, clerkship GPAs, and Step 2 CK scores. The bars on the left with stripes (blue) show the median correlation (the correlation at the 50th percentile) of MCAT scores alone with each outcome, the middle bars with stripes (gray) show the correlation of undergraduate GPAs alone, and the bars on the right with cross-hatching (orange) show the correlations of MCAT scores and undergraduate GPAs combined. The horizontal line at a correlation of 0.3 shows the threshold for a medium effect size in the social sciences.[13]

Figure 15. Correlations of MCAT scores and undergraduate GPAs alone and together with preclerkship, Step 1, clerkship, and Step 2 CK performance: medians across schools.



Notes

1. Medical students' most recent MCAT total scores at the time of matriculation and total undergraduate GPAs were correlated with each performance outcome. Analyses were conducted separately for each school with 30 or more students who have data available for each performance outcome. Sample correlations were corrected for range restriction on MCAT total scores and total undergraduate GPAs due to the selective nature of the admissions process[14] but not for unreliability in MCAT total scores or medical student outcomes. Corrections for range restriction were made at the institution level. At each medical school, the applicants from an admissions cycle served as the reference population. Using established statistical methods, the observed correlations were adjusted to reflect what the correlations would be if there had been no selection; that is, if all applicants had been selected for admission.
2. According to Cohen (1992),[13] in the social sciences, a correlation coefficient of 0.10 is considered a small association; of 0.30, a medium correlation; and of 0.50 or greater, a large correlation.
3. These data are based on 2,756 students who entered medical school in 2016 or 2017 (from 17 validity schools).
4. These data are based on 22,814 students who entered medical school in 2016 or 2017 and took the Step 1 exam for the first time by the end of 2020 (from 146 U.S. medical schools).
5. These data are based on 2,324 students who entered medical school in 2016 or 2017 (from 16 validity schools).
6. These data are based on 2,097 students who entered medical school in 2016 or 2017 (from 14 validity schools)
7. These data are based on 20,794 students who entered medical school in 2016 or 2017 (from 146 validity schools).

Overall, Figure 15 shows that the correlations of MCAT scores and undergraduate GPAs, alone and together, with each medical student performance outcome are medium to large. Figure 15 also shows that for every outcome, the median correlations are larger for MCAT scores than for undergraduate GPAs. Importantly, Figure 15 shows that using MCAT scores and undergraduate GPAs to assess academic readiness predicts future performance in medical school and on the licensing exams better than using either academic metric alone.

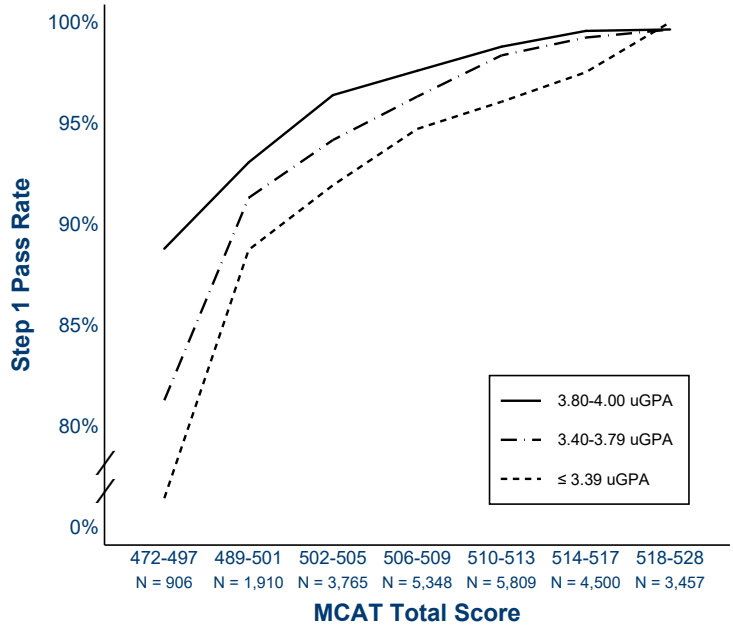
When evaluating students' academic readiness for medical school, MCAT scores should always be used in the context of other important information related to applicants' coursework, GPAs, and other academic experiences. This practice is foundational to holistic review and is a recommended best practice by the AAMC and the *Standards for Educational and Psychological Testing*.[1]

Relationships of undergraduate GPAs and MCAT scores with key milestones: Passing Step 1 and Step 2 CK exams on the first attempt and graduation within four years

Like Figure 15, the remaining figures and tables in this report demonstrate the value of using applicants' MCAT scores and undergraduate GPAs together when evaluating academic readiness for medical school.

Figure 16 shows how the percentages of 2016- and 2017-entering students who passed Step 1 on the first attempt vary by MCAT total scores and undergraduate GPAs. The x-axis shows MCAT total score ranges from low to high, and the y-axis shows the Step 1 pass rate from low to high. The lines show the median Step 1 pass rates for undergraduate GPAs less than 3.40, between 3.40 and 3.79, and at or above 3.80.

Figure 16. Median Step 1 pass rates at U.S. medical schools, by MCAT total score and undergraduate GPA ranges.



Note: These data are from the U.S. medical students entering in 2016 and 2017 who took the Step 1 exam for the first time by the end of 2020 (N = 25,695). The lines show the Step 1 pass rate for these students by their most recent MCAT total score at the time of matriculation, grouped by undergraduate GPAs less than 3.40, from 3.40 to 3.79, and at or above 3.80. The numbers of students admitted with MCAT scores at the bottom and top of the MCAT score scale are too small to be compared with those at other points. Therefore, results for students admitted with MCAT total scores from 472 to 497 are reported together, as are the results for those who scored from 518 to 528.

Table 4 shows percentages and numbers of 2016- and 2017-entering medical school students by undergraduate GPAs and MCAT total scores who passed the Step 1 exam on the first attempt. Blue-shaded cells show the MCAT total score and undergraduate GPA ranges for which 90% or more students succeeded, green-shaded cells show the same for success rates of 80% to 89%, and orange-shaded cells show the same for success rates of 70% to 79%.

Overall, 97% of 2016 and 2017 entrants who took the Step 1 exam by the end of 2020 passed it on the first attempt. The percentages in the cells of Table 4 show the pass rate was high for many combinations of undergraduate GPAs and MCAT scores, although higher undergraduate GPAs and MCAT scores are generally associated with slightly higher pass rates.

Table 4. Percentage and Number of 2016- and 2017-Entering Students Admitted With Scores From the Current MCAT Exam Who Passed the Step 1 Exam on the First Attempt, by MCAT Total Score and Undergraduate GPA Ranges

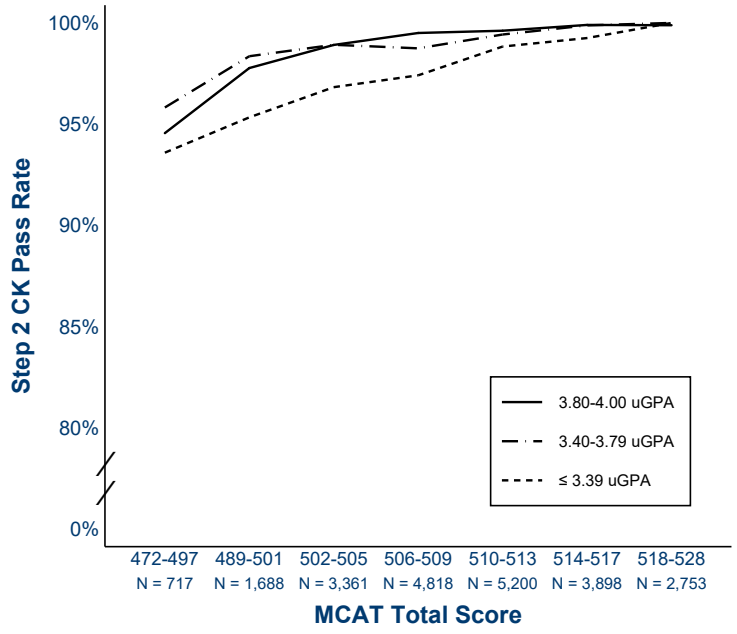
	MCAT Total										
GPA Total	472-485	486-489	490-493	494-497	498-501	502-505	506-509	510-513	514-517	518-528	All
3.80-4.00	--	--	88% 38/43	89% 162/182	93% 550/591	96% 1,336/1,386	98% 2,153/2,206	99% 2,529/2,560	>99% 2,319/2,329	>99% 2,218/2,226	98% 11,311/11,530
3.60-3.79	--	--	83% 39/47	84% 167/200	91% 503/552	95% 1,044/1,097	97% 1,628/1,686	98% 1,802/1,832	>99% 1,294/1,304	>99% 796/799	97% 7,278/7,522
3.40-3.59	--	--	79% 31/39	79% 119/151	92% 369/403	93% 636/687	96% 833/869	98% 894/909	>99% 540/544	>99% 297/298	95% 3,723/3,907
3.20-3.39	--	--	74% 17/23	85% 80/94	90% 194/215	93% 323/348	95% 356/374	95% 317/334	99% 230/233	100% 88/88	94% 1,606/1,716
3.00-3.19		--	--	86% 37/43	86% 86/100	91% 150/165	94% 134/142	>99% 125/126	94% 60/64	100% 29/29	92% 626/679
2.80-2.99	--	--	--	80% 12/15	87% 27/31	96% 50/52	96% 44/46	94% 31/33	94% 15/16	--	92% 195/213
2.60-2.79	--	--	--	--	92% 11/12	79% 15/19	81% 13/16	--	--	--	84% 70/83
2.40-2.59		--	--	--	--	--	--	--	--		84% 27/32
2.20-2.39					--	--	--	--		--	82% 9/11
2.00-2.19										--	--
Less than 2.00			--								--
All	42% 5/12	57% 16/28	82% 137/168	84% 585/698	91% 1,745/1,910	95% 3,563/3,765	97% 5,170/5,348	98% 5,713/5,809	>99% 4,468/4,500	>99% 3,445/3,457	97% 24,847/25,695

Notes

1. Blue shading = pass rates of 90%-100%; green shading = pass rates of 80%-89%; orange shading = pass rates of 70%-79%.
2. Dashes = cells with fewer than 10 observations; blank cells = cells with zero observations.
3. For students who took the MCAT exam multiple times, the most recent MCAT total score was used in this analysis.

Figure 17 shows how the percentages of 2016- and 2017-entering students passing the Step 2 CK exam on the first attempt vary by MCAT total scores and undergraduate GPAs. The x-axis shows MCAT total score ranges from low to high, and the y-axis shows the Step 2 CK pass rate from low to high. The lines show the median Step 2 CK pass rates for three undergraduate GPA ranges.

Figure 17. Median Step 2 CK pass rates at U.S. medical schools, by MCAT total score and undergraduate GPA ranges.



Note: These data are from the U.S. medical students entering in 2016 and 2017 who took the Step 2 CK exam for the first time by the end of 2020 (N = 22,435). The lines show the Step 2 CK pass rate for these students by their most recent MCAT total score at the time of matriculation, grouped by undergraduate GPAs less than 3.40, from 3.40 to 3.79, and at or above 3.80. The numbers of students admitted with MCAT scores at the bottom and top of the MCAT score scale are too small to be compared with those at other points. Therefore, results for students admitted with MCAT total scores from 472 to 497 are reported together, as are the results for those who scored from 518 to 528.

Table 5 shows percentages and numbers of 2016 and 2017 medical school entrants by undergraduate GPAs and MCAT total scores who passed the Step 2 CK exam on the first attempt. Blue-shaded cells show the MCAT total score and undergraduate GPA ranges for which 90% or more students succeeded. Green-shaded cells show the same for success rates of 80% to 89%, and orange-shaded cells show the same for success rates of 70% to 79%.

Overall, 99% of 2016 entrants who took the Step 2 CK exam by the end of 2020 passed it on the first attempt. The percentages in the Table 5 cells show the pass rate was high for many combinations of undergraduate GPAs and MCAT scores, although higher undergraduate GPAs and MCAT scores are generally associated with slightly higher pass rates.

Table 5. Percentage and Number of 2016- and 2017-Entering Students Admitted With Scores From the Current MCAT Exam Who Passed the Step 2 CK Exam on the First Attempt, by MCAT Total Score and Undergraduate GPA Ranges

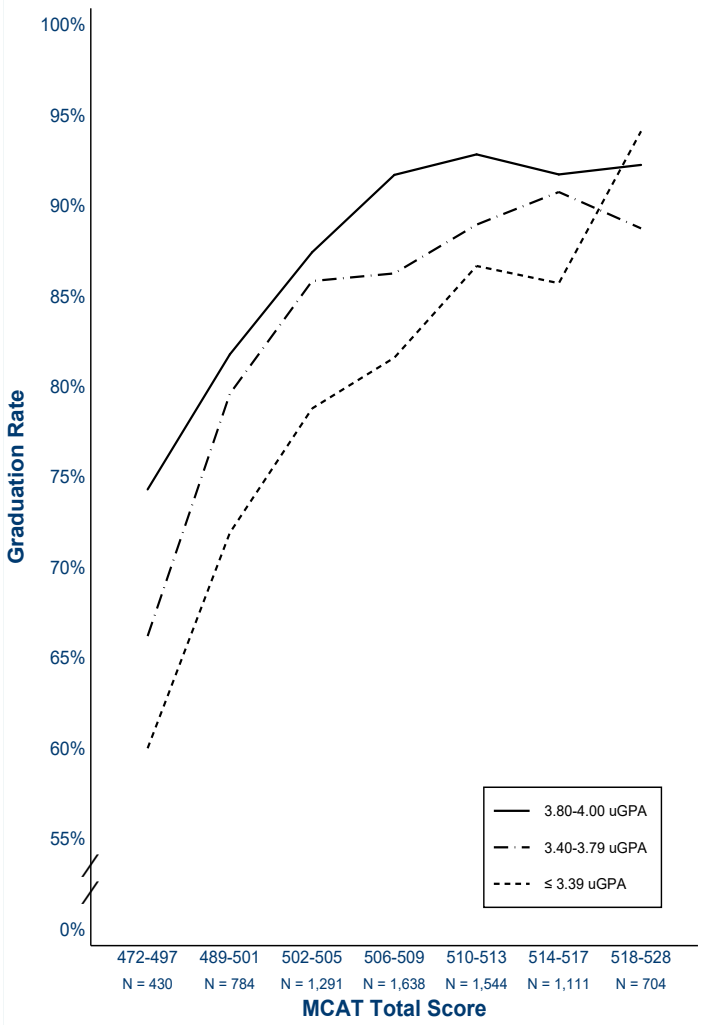
	MCAT Total										
GPA Total	472-485	486-489	490-493	494-497	498-501	502-505	506-509	510-513	514-517	518-528	All
3.80-4.00	--	--	97% 37/38	94% 148/158	98% 526/538	99% 1,271/1,285	>99% 1,998/2,008	>99% 2,323/2,332	>99% 2,000/2,002	>99% 1,726/1,728	>99% 10,035/10,095
3.60-3.79	--	--	90% 35/39	97% 163/168	98% 487/496	>99% 970/979	>99% 1,513/1,528	>99% 1,619/1,627	>99% 1,157/1,159	100% 651/651	>99% 6,599/6,652
3.40-3.59	--	--	97% 29/30	97% 109/112	99% 349/354	99% 585/593	98% 766/780	>99% 807/813	100% 470/470	100% 254/254	99% 3,373/3,411
3.20-3.39	--	--	94% 16/17	99% 68/69	97% 174/180	98% 285/292	98% 314/319	99% 284/287	>99% 193/194	100% 82/82	98% 1,417/1,442
3.00-3.19		--	--	91% 29/32	93% 76/82	95% 136/143	97% 121/125	>99% 102/103	98% 52/53	100% 24/24	96% 547/570
2.80-2.99	--	--	--	--	96% 24/25	96% 43/45	94% 34/36	96% 25/26	100% 11/11	--	96% 159/165
2.60-2.79			--	--	--	100% 15/15	93% 14/15	--	--	--	94% 61/65
2.40-2.59		--		--	--	--	--	--	--		93% 25/27
2.20-2.39						--		--		--	--
2.00-2.19										--	--
Less than 2.00			--								--
All	--	89% 16/18	95% 128/135	96% 533/558	98% 1,648/1,688	99% 3,314/3,361	99% 4,766/4,818	>99% 5,172/5,200	>99% 3,892/3,898	>99% 2,751/2,753	99% 22,224/22,435

Notes

1. Blue shading = pass rates of 90%-100%; green shading = pass rates of 80%-89%; orange shading = pass rates of 70%-79%.
2. Dashes = cells with fewer than 10 observations; blank cells = cells with zero observations.
3. For students who took the MCAT exam multiple times, the most recent MCAT total score was used in this analysis.

Figure 18 shows how the percentages of 2016-entering students graduating medical school within four years vary by MCAT total scores and undergraduate GPAs. The x-axis shows MCAT total score ranges from low to high, and the y-axis shows medical school four-year graduation rate from low to high. The lines show the median graduation rates for three undergraduate GPA ranges.

Figure 18. Median four-year graduation rates at U.S. medical schools, by MCAT total score and undergraduate GPA ranges.



Note: These data are from the U.S. medical students entering in 2016 who graduated within four years (N = 7,502). The lines show the median graduation rates for these students by their most recent MCAT total score at the time of matriculation, grouped by undergraduate GPAs less than 3.40, from 3.40 to 3.79, and at or above 3.80. The numbers of students admitted with MCAT scores at the bottom and top of the MCAT score scale are too small to compare with those at other points. Therefore, results for students admitted with MCAT total scores from 472 to 497 are reported together, as are the results for those who scored from 518 to 528.

Table 6 shows the percentages and numbers of 2016 entrants by undergraduate GPAs and MCAT total scores who graduated within four years. Overall, most (87%) of the 2016 entrants with scores from this exam graduated within four years. The last row of Table 6 shows the positive relationship between MCAT scores and graduation within four years. The last column shows the same relationship for undergraduate GPAs and on-time graduation.

Compared with medical students' performance on passing the licensure exams, there is more variability in their success on four-year graduation by MCAT score and undergraduate GPA ranges. As shown in the last row of Table 6, four-year graduation rates fall below 72% for students in the lowest MCAT score ranges (i.e., 497 and below). However, as reported in a recent AAMC *Data Snapshot*,[16] five-year graduation rates have consistently remained at 95% for more than two decades. If this trend continues, most of these 2016 entrants are expected to graduate within five years.

Table 6. Percentage and Number of 2016-Entering Students Admitted With Scores From the Current MCAT Exam Who Graduated within Four Years, by MCAT Total Score and Undergraduate GPA Ranges

	MCAT Total										
GPA Total	472-485	486-489	490-493	494-497	498-501	502-505	506-509	510-513	514-517	518-528	All
3.80-4.00		--	64% 18/28	78% 62/80	82% 193/236	87% 431/493	92% 652/711	93% 661/712	92% 499/544	92% 405/439	90% 2,922/3,244
3.60-3.79		--	59% 19/32	73% 63/86	81% 183/227	87% 323/371	88% 454/513	88% 409/463	91% 307/336	89% 147/165	87% 1,906/2,197
3.40-3.59	--	--	68% 15/22	64% 44/69	78% 137/175	84% 192/229	82% 205/251	90% 211/234	89% 125/140	88% 58/66	83% 988/1,189
3.20-3.39	--	--	43% 6/14	69% 29/42	74% 59/80	78% 87/111	84% 92/109	91% 81/89	87% 53/61	95% 19/20	80% 427/533
3.00-3.19	--		--	79% 11/14	63% 24/38	82% 45/55	82% 33/40	76% 26/34	82% 18/22	--	78% 170/219
2.80-2.99	--	--	--	--	80% 16/20	78% 18/23	--	--	--	--	75% 55/73
2.60-2.79	--		--	--	--	--	--	--	--	--	67% 20/30
2.40-2.59		--		--	--	--	--		--		71% 10/14
2.20-2.39						--		--			--
2.00-2.19										--	--
Less than 2.00											
All	20% 2/10	38% 5/13	61% 63/104	72% 217/303	79% 618/784	85% 1,102/1,291	88% 1,444/1,638	91% 1,398/1,544	91% 1,009/1,111	91% 642/704	87% 6,500/7,502

Notes

1. Blue shading = progression rates of 90%-100%; green shading = progression rates of 80%-89%; orange shading = progression rates of 70%-79%.
2. Dashes = cells with fewer than 10 observations; blank cells = cells with zero observations.
3. For students who took the MCAT exam multiple times, the most recent MCAT total score was used in this analysis.
4. Students entering medical school who have advanced standing from medical, graduate, or other programs; are enrolled in joint programs (e.g., MD-PhD) at the time of matriculation or graduation; participate in special research or nonresearch studies; or are deceased are not included in this table.

The patterns in these data show that higher undergraduate GPAs can compensate for more modest MCAT total scores when predicting applicants' future performance in medical school. For example, an applicant with an undergraduate GPA between 3.80 and 4.00 and an MCAT total score of 502 may perform about the same or better than those with higher MCAT scores and lower GPAs. The same is true for MCAT total scores: Higher MCAT scores can sometimes compensate for more modest undergraduate GPAs.

An applicant's transcripts, experiences, and other information in their application provide important context for interpreting discrepant MCAT scores and undergraduate GPAs.

A careful review of an applicant's transcripts, experiences, and other information in their application will likely add insight and clues for judging discrepant MCAT scores and undergraduate GPAs. Both undergraduate GPAs and MCAT scores provide important information about applicants' academic strengths and weaknesses. Omitting either one in evaluating applicants' academic preparedness for medical school can result in capable applicants being overlooked or challenges to schools' abilities to provide students with academic support.

Bringing it all together

To summarize, the MCAT exam is doing its job of assessing applicants' academic readiness for medical school. MCAT total scores — alone and together with undergraduate GPAs — demonstrate value in predicting applicants' likely preclerkship, Step 1, clerkship, and Step 2 CK performance (refer to Figure 15). Medical students with a wide range of MCAT scores and undergraduate GPAs succeed in medical school, passing the Step 1 and Step 2 CK exams on the first attempt and graduating within four years (refer to Tables 4, 5, and 6).

MCAT scores and undergraduate GPAs do a good job of predicting students' preclerkship, Step 1, clerkship, and Step 2 CK performance, ***and yet*** *students with a wide range of metrics pass the Step 1 and Step 2 CK exams on the first attempt and graduate from medical school on time.*

This raises the question: How can it be true that, on average, students with higher MCAT scores and undergraduate GPAs do better on preclerkship and clerkship courses and the Step 1 and Step 2 CK exams, and yet most students graduate within four years? Many factors might contribute to the answer to this question. An important one involves the granularity of the outcome measures. Outcome measures such as preclerkship and clerkship grades and test scores allow for finer distinctions in students' performance as students make their way through the curriculum, whereas the milestone outcomes, such as graduating within four years, show whether or not students progress but not how far above or below the progression criteria they are.

Other factors may play an important role. When admissions officers and their committees admit students with more modest MCAT scores and undergraduate GPAs, they do so because these applicants stand out to them as capable of succeeding and contributing to teaching and learning at their schools. Information from these applicants' experiences, attributes, and academic preparation lead admissions committees to believe these applicants can succeed at their schools.

These data also reinforce that medical schools support the students they admit. Some students who may have faced academic or other challenges were still able to succeed because of their efforts and their school's support. Nationally, 87% of 2016 entrants admitted with scores from the current version of the MCAT exam graduated within four years. As reported in a recent AAMC *Data Snapshot*, five-year graduation rates have consistently remained at 95% for more than two decades.[16] If this trend continues, most students admitted in 2016 will graduate in four or five years.

Each medical school admits classes of students that will help meet its educational, research, community service, and health care missions and goals by carefully considering the full range of rich data applicants provide about their experiences, attributes, and academic preparation. Faculty work with their students by using their curricula, academic support, and learning environments, which are tailored to their school's educational goals and their students' needs. In place at each medical school are also different levels of social and wellness support services (see, for example, the 2018 innovation report in *Academic Medicine* by Elks et al.[17]). Results from this validity research show that MCAT scores are only one signal of students' likely success and that other factors also shape performance.

Conclusions and next steps

This is the first large-scale evaluation of the predictive validity of scores from the current version of the MCAT exam. In March 2020, *Academic Medicine* published a collection of articles summarizing the initial findings.[18-22] Included in these findings are data about how well MCAT scores predict students' performance in the first year of medical school,[18] how examinees prepare for and perform on the exam,[19] how admissions committees can admit more diverse classes by considering applicants with a wider range of MCAT scores,[20] and how to help students strategically prepare for the exam.[21] To read the articles, visit aamc.org/mvc2020articles.

This guide extends the findings previously reported to include additional results pertaining to the predictive validity of MCAT scores against medical students' performance from entry through graduation. Initial findings presented in last year's guide were based on students who entered medical school in 2016 as the first cohort with scores from the current MCAT exam. Those validity findings are now available for both the 2016 and 2017 cohorts combined. The aggregated findings based on the larger sample confirm the initial results reported last year.

Collectively, the predictive validity findings on the current MCAT exam so far are consistent with those from the previous version of the MCAT exam, which show the value of scores from the old MCAT exam in predicting students' performance in medical school and on licensure exams.[2,22] Studies show that undergraduate grades and scores from the old MCAT exam predicted students' grades in medical school, academic difficulty or distinction, scores on USMLE Step exams, time to graduation, and unimpeded progress toward graduation.[2,22-25]

Future research will include findings about the associations of MCAT scores and undergraduate GPAs with graduation within five years.

Future research will examine how well scores from this version of the MCAT exam predict graduation within five years. They will include findings based on data from these and additional cohorts of medical students. Findings about the value of MCAT scores and undergraduate GPAs in predicting graduation within five years for this and future cohorts will be released in this guide each year on the AAMC website (aamc.org/mcatadmissions), in peer-reviewed publications, and at regional and national meetings.

Appendix C provides context about the plan to evaluate the fairness, impact, use, and predictive validity of this version of the MCAT exam.

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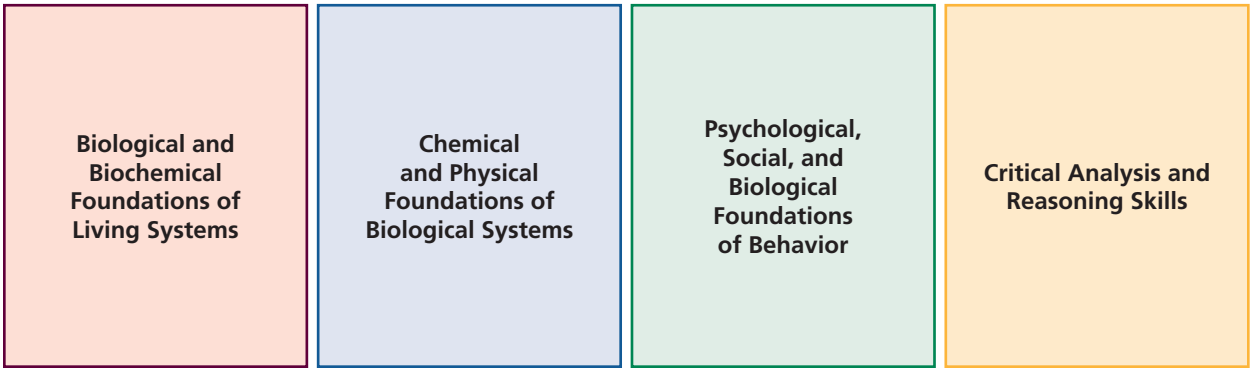
Appendix A. Description of the Foundational Concepts, Scientific Inquiry and Reasoning Skills, and Information-Processing Skills Tested on the Four Sections of the MCAT Exam

Appendix A provides descriptions of the foundational concepts, content categories, and ways that examinees demonstrate their scientific inquiry and reasoning skills on the three sections of the MCAT exam that assess academic preparation in the natural, behavioral, and social sciences. It also describes the ways examinees demonstrate their information-processing skills in the Critical Analysis and Reasoning Skills section.

The concepts tested in each section align with concepts medical school faculty, residents, and medical students rated as important to the success of entering students. These concepts are organized around the academic competencies described by seminal reports such as the *Scientific Foundations for Future Physicians* (2009) and the *Behavioral and Social Science Foundations for Future Physicians* (2011).[26,27] To read more about the quantitative and qualitative research that supports the design and development of the MCAT exam, visit aamc.org/mr5mcatcollection and refer to Schwartzstein et al. (2013).[28]



Biological and Biochemical Foundations of Living Systems

Medical school applicants must be prepared to learn about the biological and biochemical concepts that contribute to health and disease. When they enter medical school, they must be ready to learn how:

- The major biochemical, genetic, and molecular functions of the cell support health and lead to disease.
- Cells grow and integrate to form tissues and organs that carry out essential biochemical and physiological functions.
- The body responds to internal and external stimuli to support homeostasis and the ability to reproduce.

The Biological and Biochemical Foundations of Living Systems section tests three foundational concepts and several reasoning skills that are building blocks for learning in medical school. This section asks examinees to solve problems by combining their knowledge of foundational concepts from biology, biochemistry, general chemistry, and organic chemistry with their scientific inquiry and reasoning skills.

Figure A.1 lists the foundational concepts and the more specific content categories tested within each foundational concept. It also provides examples of the ways examinees are asked to combine their knowledge of foundational concepts with their scientific reasoning skills to answer test questions in this section.

Figure A.1. Foundational concepts, content categories, and scientific inquiry and reasoning skills tested in the Biological and Biochemical Foundations of Living Systems section.

Biological and Biochemical Foundations of Living Systems		
Foundational Concept 1 Biomolecules have unique properties that determine how they contribute to the structure and function of cells and how they participate in the processes necessary to maintain life.	**Foundational Concept 2** Highly organized assemblies of molecules, cells, and organs interact to carry out the functions of living organisms.	**Foundational Concept 3** Complex systems of tissues and organs sense the internal and external environments of multicellular organisms and, through integrated functioning, maintain a stable internal environment.
Content Categories • Structure and functions of protein and their constituent amino acids. • Transmission of genetic information from the gene to the protein. • Transmission of heritable information from generation to generation and the processes that increase genetic diversity. • Principles of bioenergetics and fuel molecule metabolism.	**Content Categories** • Assemblies of molecules, cells, and groups of cells within singular cellular and multicellular organisms. • The structure, growth, physiology, and genetics of prokaryotes and viruses. • Processes of cell division, differentiation, and specialization.	**Content Categories** • Structure and functions of the nervous and endocrine systems and ways in which the systems coordinate the organ systems. • Structure and integrative functions of the main organ systems.
Questions in this section of the test ask examinees to combine their knowledge of the foundational concepts listed above with their scientific inquiry and reasoning skills. Questions in this section might ask examinees to: • Recall the structural characteristics of two tissues and relate them to one another. • Apply their understanding of Le Châtelier's Principle to explain differences in deprotonation of organic acids when added to blood vs. pure water. • Use knowledge of adaptive immune response to evaluate the acceptability of a treatment for use in a clinical context. • Form a hypothesis about the effect of the pineal gland on thermogenesis based on the data from an experiment investigating the interaction of temperature and pineal gland activity on body and organ weights for hamsters under different experimental conditions. • Use data about wavelength and light absorption to determine the color perception of an individual with a given phenotype.		

Chemical and Physical Foundations of Biological Systems

Medical school applicants must be prepared to learn about the mechanical, physical, and biochemical functions of human tissues, organs, and organ systems and how these contribute to health and disease. When they enter medical school, they must be ready to learn about:

- The physiological functions of the respiratory, cardiovascular, and neurological systems in health and disease.
- Molecular and cellular functions in health and disease.

The Chemical and Physical Foundations of Biological Systems section tests two foundational concepts and several reasoning skills that are building blocks for learning in medical school. This section asks test takers to solve problems by combining their knowledge of foundational concepts from biology, biochemistry, physics, and general and organic chemistry with their scientific inquiry and reasoning skills.

Figure A.2 lists the foundational concepts and content categories tested in this section. It also provides examples of the ways examinees are asked to combine their knowledge of foundational concepts with their scientific inquiry and reasoning skills to answer test questions in this section.

Figure A.2. Foundational concepts, content categories, and scientific inquiry and reasoning skills tested in the Chemical and Physical Foundations of Biological Systems section.

Chemical and Physical Foundations of Biological Systems	
Foundational Concept 4 Complex living organisms transport materials, sense their environment, process signals, and respond to changes using processes that can be understood in terms of physical principles.	**Foundational Concept 5** The principles that govern chemical interactions and reactions form the basis for a broader understanding of the molecular dynamics of living systems.
Content Categories • Translational motion, forces, work, energy, and equilibrium in living systems. • Importance of fluids for the circulation of blood, gas movement, and gas exchange. • Electrochemistry and electrical circuits and their elements. • How light and sound interact with matter. • Atoms, nuclear decay, electronic structure, and atomic chemical behavior.	**Content Categories** • Unique nature of water and its solutions. • Nature of molecules and intermolecular interactions. • Separation and purification methods. • Structure, function, and reactivity of biologically relevant molecules. • Principles of chemical thermodynamics and kinetics.
Questions in this section of the test ask examinees to combine their knowledge of the foundational concepts listed above with their scientific inquiry and reasoning skills. Questions in this section might ask examinees to: • Identify the relationship between the distribution of electric charges in the axon and the electric field lines they produce. • Recognize the principles of flow characteristics of blood in the human body and apply the appropriate mathematical model to an unfamiliar scenario. • Change the experimental conditions of a test for proteins in a solution to prevent the formation of precipitates. • Select between the standard and Doppler ultrasound techniques for a given context, considering the appropriateness, precision, and accuracy of each technique. • Use, analyze, and interpret data in a graph to determine the half-life of a radioactive substance used to measure cardiac function.	

Psychological, Social, and Biological Foundations of Behavior

Medical school applicants must be prepared to learn about the impact of behavioral and sociocultural factors on illness and health outcomes. When they enter medical school, they must be ready to learn how:

- Cognitive and perceptual processes influence the understanding of health and illness.
- Behavior can either support health or increase risk for disease.
- Perception, attitudes, and beliefs influence interactions with patients and other members of the health care team.
- Patients' social and demographic backgrounds influence their perceptions of health and disease, the health care team, and therapeutic interventions.
- Social and economic factors can affect access to care and the probability of maintaining health and recovering from disease.

The Psychological, Social, and Biological Foundations of Behavior section tests five foundational concepts and several reasoning skills in the behavioral and social sciences that are building blocks for learning in medical school. This section tests the foundational concepts in psychology, sociology, and biology that tomorrow's doctors need to serve an increasingly diverse population and have a clear understanding of the impact of behavior and sociocultural differences on health. Like the natural sciences sections, this section asks test takers to solve problems by combining their knowledge of foundational concepts with their scientific inquiry and reasoning skills. It does not measure applicants' interpersonal skills, the way they will behave, or their attitudes and beliefs about social issues.

Figure A.3 lists the foundational concepts tested in this section. It also provides examples of the ways examinees are asked to combine their knowledge of foundational concepts with their scientific inquiry and reasoning skills to answer test questions in this section.

Figure A.3. Foundational concepts, content categories, and scientific inquiry and reasoning skills tested in the Psychological, Social, and Biological Foundations of Behavior section.

Psychological, Social, and Biological Foundations of Behavior				
Foundational Concept 6 Biological, psychological, and sociocultural factors influence the ways that individuals perceive, think about, and react to the world.	**Foundational Concept 7** Biological, psychological, and sociocultural factors influence behavior and behavior change.	**Foundational Concept 8** Psychological, sociocultural, and biological factors influence the way we think about ourselves and others, as well as how we interact with others.	**Foundational Concept 9** Cultural and social differences influence well-being.	**Foundational Concept 10** Social stratification and access to resources influence well-being.
Content Categories • Sensing the environment. • Making sense of the environment. • Responding to the world.	**Content Categories** • Individual influences on behavior. • Social processes that influence human behavior. • Attitude and behavior change.	**Content Categories** • Self-identity. • Social thinking. • Social interactions.	**Content Categories** • Understanding social structure. • Demographic characteristics and processes.	**Content Categories** • Social inequity.
Questions in this section of the test ask examinees to combine their knowledge of foundational concepts listed above with their scientific inquiry and reasoning skills. Questions in this section might ask examinees to: • Draw conclusions about the type of memory affected by an experimental manipulation when shown a graph of findings from a memory experiment. • Reason about whether a causal explanation is possible when given an example of how personality predicts individual behavior. • Distinguish the kinds of claims that can be made when using longitudinal data, cross-sectional data, or experimental data in studies of social interaction. • Identify the relationship between demographic variables and health variables reported in a table or figure. • Identify the relationship between social institutions that is suggested by an illustration used in a public health campaign.				

Critical Analysis and Reasoning Skills

The structure of the Critical Analysis and Reasoning Skills section is different from the structure of the other sections of the exam. It asks applicants to process information, solve problems, and draw conclusions from information presented in passages. Medical students are required to comprehend and analyze a great deal of information in different contexts, and this section has been developed specifically to assess the information-processing skills an applicant will need to be successful in medical school.

The Critical Analysis and Reasoning Skills section tests how well applicants comprehend, analyze, and evaluate what they read; draw inferences from text; and apply arguments to new ideas and situations. It tests examinees' ability to process information by having them read passages from a diverse set of disciplines in the humanities and social sciences. These passages are excerpted from the kinds of books, journals, and magazines college students are likely to read.

All passages in this section of the MCAT exam consist of multiple paragraphs and require thoughtful reading. Students must grasp the meaning of each paragraph and also identify the relationships across paragraphs. Additionally, students need to attend to the authors' stated and unstated assumptions and the rhetorical choices they have made to develop stance, voice, and style. Some passages require an understanding of the authors' interpretations, implications, or applications of historical accounts, theories, observations, or societal trends.

The questions that follow the passages require their own focused kinds of reading, analyzing, and reasoning because many ask students to think about the passages from different perspectives or to question the authors' statements, judge the relevance of the authors' examples, or consider crucial facts that might challenge the authors' assertions or analysis. It is important to keep in mind that the questions in this section do not rely on specific background knowledge in the humanities and social sciences. Students get all the information they need to answer the questions from the accompanying passages and the questions themselves.

The Critical Analysis and Reasoning Skills section assesses three broad critical analysis and reasoning skills: Foundations of Comprehension, Reasoning Within the Text, and Reasoning Beyond the Text. The major elements of each skill are described in Figure A.4.

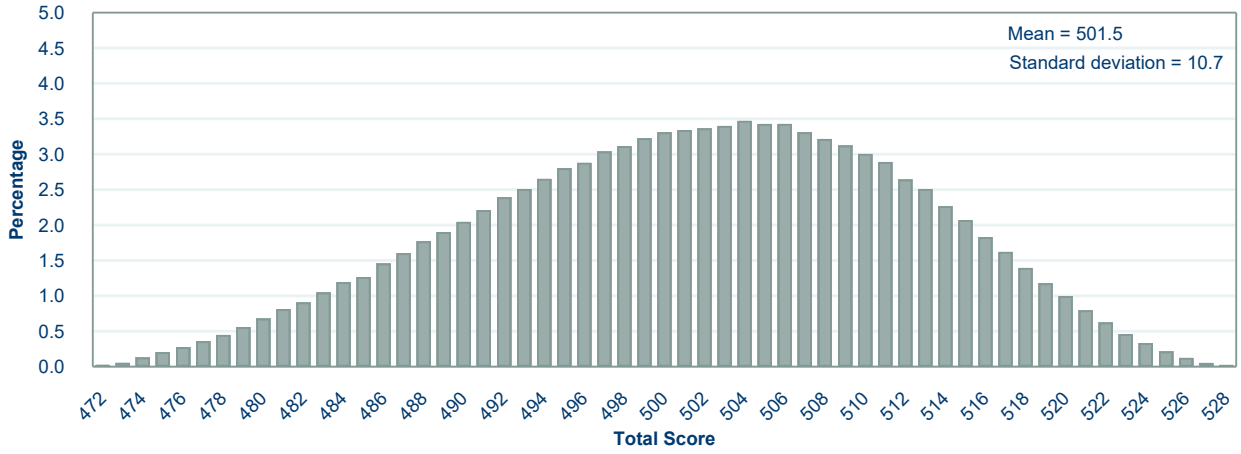
Figure A.4. Analysis and reasoning skills tested in the Critical Analysis and Reasoning Skills section.

Critical Analysis and Reasoning Skills
Foundations of Comprehension Questions measuring Foundations of Comprehension ask examinees to demonstrate their information-processing skills by: • Understanding the basic components of the text, such as the author's thesis, the main point or theme of the passage, and the meanings of words or phrases as they are used in a specific context. Recognizing the purpose or function of such rhetorical labels as "for example," "therefore," or "consequently." • Interpreting the author's intent using the sentences in the text or question. Attending to the ways an author's language and tone can shape an argument or to points that the author merely hints at through connotative language or figures of speech.
Reasoning Within the Text Questions measuring Reasoning Within the Text ask examinees to demonstrate their information-processing skills by: • Integrating distant components of the text to infer meaning or intent. Determining an author's purpose, position, or point of view. Inferring their beliefs, identifying their assumptions, and detecting bias. Identifying paradoxes, tensions, or contradictions within an argument. • Evaluating the degree and nature of support for an argument or for particular claims, distinguishing fact from opinion, assessing the credibility of sources. Considering the relevance of information and the legitimacy of generalizations and examining the relationships between different parts of the passage.
Reasoning Beyond the Text Questions measuring Reasoning Beyond the Text ask examinees to demonstrate their information-processing skills by: • Applying or extrapolating ideas from the passage to new contexts, situations, possibilities, alternatives, options, or proposals, such as identifying a new scenario that is consistent with an author's point of view or a relationship described in the passage. • Assessing the impact of introducing new factors, information, or conditions on ideas from the passage to evaluate students' understanding that inferences and conclusions may change in the face of new information.

Appendix B. Summary of MCAT Total and Section Scores

MCAT Total Scores and Percentile Ranks in Effect May 1, 2021–April 30, 2022

MCAT Total (N = 281,468)



Total Score	Percentile Rank
472	<1
473	<1
474	<1
475	<1
476	1
477	1
478	1
479	2
480	3
481	4
482	4
483	6
484	7
485	8
486	9
487	11
488	13
489	15
490	17

Total Score	Percentile Rank
491	19
492	21
493	24
494	27
495	29
496	32
497	35
498	38
499	42
500	45
501	48
502	52
503	55
504	58
505	62
506	65
507	69
508	72
509	75

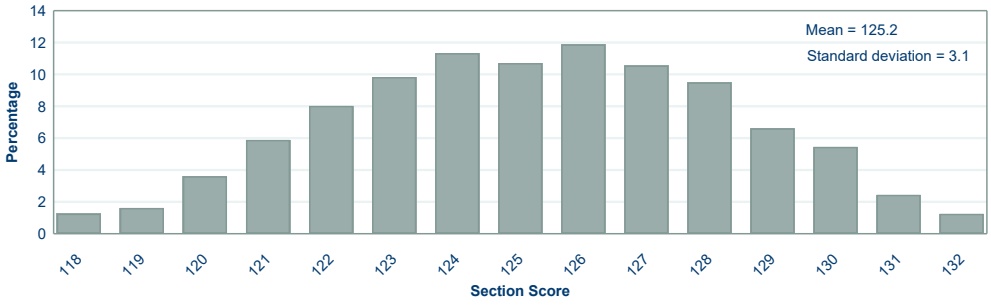
Total Score	Percentile Rank
510	78
511	81
512	84
513	86
514	88
515	90
516	92
517	94
518	95
519	96
520	97
521	98
522	99
523	99
524	100
525	100
526	100
527	100
528	100

Notes

- The column labeled "Percentile Rank" provides the percentage of scores equal to or less than each score point. These percentile ranks are based on all MCAT results from the 2018-2020 testing years combined. For example, 72% of MCAT total scores were equal to or less than 508 across all exams administered in 2018-2020 combined.
- Updates to the percentile ranks will be made on May 1 each year and be based on exams administered in the three most recent test administration years.

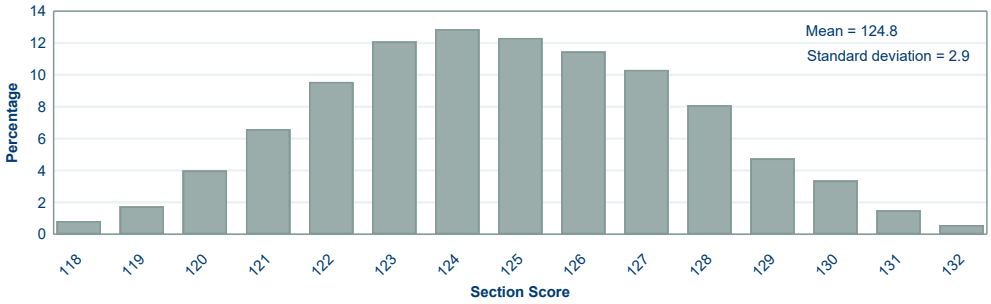
MCAT Section Scores and Percentile Ranks in Effect May 1, 2021–April 30, 2022

Chemical and Physical Foundations of Biological Systems



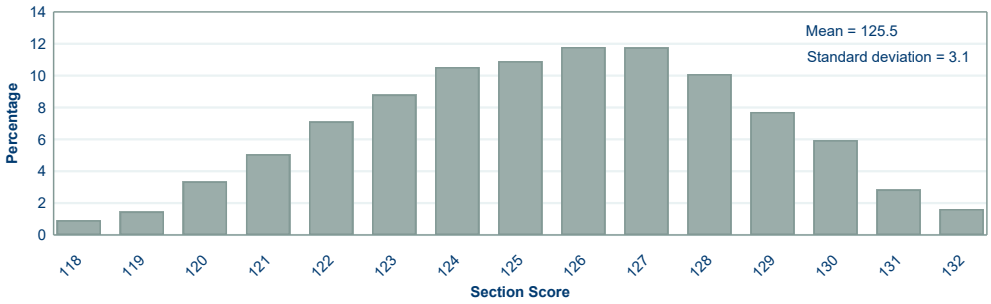
Total Score	Percentile Rank
118	1
119	3
120	6
121	12
122	20
123	30
124	42
125	52
126	64
127	75
128	84
129	91
130	96
131	99
132	100

Critical Analysis and Reasoning Skills



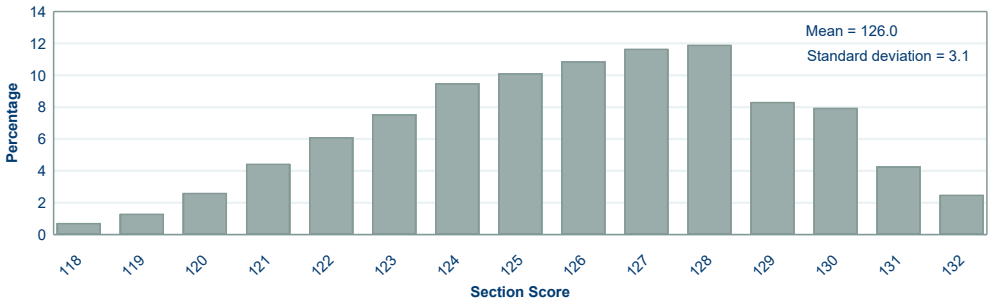
Total Score	Percentile Rank
118	1
119	3
120	7
121	13
122	23
123	35
124	48
125	60
126	71
127	82
128	90
129	95
130	98
131	99
132	100

Biological and Biochemical Foundations of Living Systems



Total Score	Percentile Rank
118	1
119	2
120	6
121	11
122	18
123	27
124	37
125	48
126	60
127	72
128	82
129	90
130	96
131	98
132	100

Psychological, Social, and Biological Foundations of Behavior



Total Score	Percentile Rank
118	1
119	2
120	5
121	9
122	15
123	23
124	32
125	42
126	53
127	65
128	77
129	85
130	93
131	97
132	100

Appendix C. MCAT Validity Research

The research findings presented in this guide come from a research collaborative evaluating the validity, fairness, impact, and use of scores from the MCAT exam introduced in 2015. Beginning in 2012, representatives from medical schools in the United States and Canada studied the meaning and value of scores from the Psychological, Social, and Biological Foundations of Behavior section of the MCAT exam. Their early work laid the foundation for the present research, led by representatives from medical schools and prehealth advisors from undergraduate institutions serving on the MCAT Validity Committee (MVC).

The MVC members are admissions and student affairs officers, education deans, and researchers from medical schools, as well as prehealth advisors in current and previous leadership positions of the National Association of Advisors for the Health Professions. The participating schools, as shown in Table C.1, were selected from 65 institutions across North America that volunteered to participate in the MCAT validity research. The validity schools represent a wide range of institutional missions, geographic regions, and institution types (public or private). They are also diverse with respect to their applicant pool sizes and characteristics, curricula, instruction, and grading systems.

Table C.1. Schools Participating in MCAT Validity Research

Participating Validity Schools	
Boston University School of Medicine	Tulane University School of Medicine
Columbia University Vagelos College of Physicians and Surgeons	University of Arizona College of Medicine - Tucson
East Tennessee State University James H. Quillen College of Medicine	University of Calgary Cumming School of Medicine
Meharry Medical College School of Medicine	University of California, San Francisco, School of Medicine
Memorial University of Newfoundland Faculty of Medicine	University of Central Florida College of Medicine
Morehouse School of Medicine	University of Illinois College of Medicine at Chicago
Philadelphia College of Osteopathic Medicine	University of Mississippi Medical Center School of Medicine
Rutgers Robert Wood Johnson Medical School	University of North Carolina at Chapel Hill School of Medicine
Saint Louis University School of Medicine	Uniformed Services University of the Health Sciences F. Edward Hébert School of Medicine
Stanford University School of Medicine	Note: Prehealth advisors from Colgate University, the University of Hawaii, and Meredith College are also members of the MCAT Validity Committee.
The Ohio State University School of Medicine	
University of Texas Health Science Center at San Antonio Joe R. and Teresa Lozano Long School of Medicine	

The MVC is leading the evaluation of the validity, fairness, impact, and use of scores from the MCAT exam. The MCAT validity research addresses multiple goals:

- Provides evidence about the value of MCAT scores in admissions decisions and the comparability of scores for medical students from different backgrounds.
- Answers questions about the preparation, performance, and challenges faced by examinees from different backgrounds.
- Presents data to admissions officers that support their efforts to admit diverse classes of capable, caring students with the capacity to succeed and to contribute to the teaching and learning at their schools and to the practice of medicine.
- Uses findings about the needs of aspiring physicians from underrepresented backgrounds to improve test preparation resources and outreach efforts.

Below are examples of the research being conducted to achieve these goals.

The MVC is exploring how well medical students' MCAT scores predict their academic performance at different stages of their undergraduate medical education. Data on how well MCAT scores predict students' performance across preclerkship and clerkship courses, on the USMLE Step 2 CK exam, and graduation within four years are reported in this guide. In the future, the MVC will conduct research on the validity of MCAT total and section scores and undergraduate GPAs in predicting graduation within five years.

Research on the use of MCAT scores in medical student selection will examine the types of validity data that are most useful to medical schools with different missions, curricula and student support, and applicant pool characteristics. This research will help admissions officers identify applicants with the preparation needed to do well at their medical schools. It will also inform the AAMC's development of resources, tools, and data to help admissions officers and their committees use MCAT scores in sound ways.

Finally, the research draws on quantitative and qualitative data from examinees and prehealth advisors to deepen the current understanding about the needs and challenges of examinees when they prepare for the MCAT exam. The MVC is closely studying differences in the preparation and performance of examinees from educationally or economically disadvantaged backgrounds when compared with their more advantaged peers. The Post-MCAT Questionnaire was revised to include new survey questions about premedical students' test preparation strategies and barriers. The responses may reveal differences in the ways examinees from different backgrounds prepare that could inform the types of resources and outreach they need from the AAMC and the guidance they need from the prehealth advising and undergraduate faculty communities.

This research may reveal better ways to increase access to affordable resources that will support all examinees, but especially those from lower socioeconomic backgrounds and who attend less-resourced undergraduate institutions.

In March 2020, *Academic Medicine* published a collection of articles summarizing the MVC's research so far. These articles describe how well MCAT scores predict students' performance in the first year of medical school,[18] how examinees prepare for and perform on the exam,[19] how admissions committees can admit more diverse classes by considering applicants with a wider range of MCAT scores,[20] how to help students strategically prepare for the exam,[21] and how structural racism and inequality affect educational opportunity and academic achievement.[29] To read the articles, visit aamc.org/mvc2020articles. New findings from the MCAT validity research will be made available each year in this guide, at national and regional meetings, and at aamc.org/admissions. Questions about the research may be sent to mcatadmissions@aamc.org.

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