MCAT
Medical College Admission Test

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MCAT and Medical School Admissions

Research to Support the Design of the MCAT2015 Exam (as published in the May 2013 issue of *Academic Medicine*)

For more information about the MCAT2015 exam, please see the MCAT2015 website: www.aamc.org/mcat2015

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Foreword

Today's conversations about health care reform make clear that tomorrow's physicians won't be reimbursed for the numbers of patients they see or the numbers of procedures they do. Rather, they'll be paid for the outcomes of their patients' care. Physicians will be accountable for the disparate needs of their patients, for the impact of the social determinants of their patients' health, and for the results of their partnerships with patients. These important conversations provide some of the foundation for the work that we and our colleagues did in developing blueprints for the new Medical College Admission Test® (MCAT®) that will be launched in 2015.

This publication, *MCAT and Medical School Admissions: Research to Support the Design of the MCAT2015 Exam*, includes articles that describe the research that informed the development of these blueprints and the changes they will bring to the MCAT exam. This collection of articles, originally published in *Academic Medicine* in May 2013, discuss critical issues we considered when deciding how to preserve what works best about the current exam, eliminate what doesn't work, and further enrich the exam by incorporating the concepts that tomorrow's doctors will need.

Updating the MCAT Exam

As Schwartzstein and his coauthors explain in the first article,[1] we began our work by reviewing an enormous amount of data about the current MCAT exam and the ways in which admissions committees use MCAT scores. We learned that admissions committees want MCAT scores that describe how well their applicants can use what they've learned; they're less interested in scores that describe what applicants were taught. Consequently, we designed a format for the new MCAT exam that focuses on the outcomes of applicants' learning in the natural, social, and behavioral sciences, and we developed blueprints that ask applicants to bring together concepts from different disciplines to solve challenging problems, just as they will be required to do when they become practicing physicians.

Our ideas weren't new. They mirrored the recommendations of other expert panels, such as the AAMC (Association of American Medical Colleges), the Howard Hughes Medical Institute's Scientific Foundation for Future Physicians Committee,[2] the Institute of Medicine's (IOM) BIO2010 Committee,[3] and the IOM's panel on Improving Medical Education.[4] These panels challenge baccalaureate faculty to create courses that promote competency-based learning and focus on big ideas in the sciences. They also encourage faculty to develop multidisciplinary curricula that ask students to demonstrate that they understand the overarching principles of biological complexity, genetic diversity, body systems interactions, human development, human interaction, environmental influence, and research methods that physicians and other scientists use to do their work.[5] The blueprints for the new exam reflect these recommendations and balance attention on a broad range of competencies in the natural sciences, social and behavioral sciences, and critical analysis and reasoning.

The Current MCAT Exam

This collection of articles also document our committee's evaluation of the current MCAT exam so that in designing the new test, we could preserve the things that worked well and eliminate the things that didn't. In the second article, Dunleavy and her coauthors describe the extent to which scores from the current MCAT exam provide valuable information about the academic characteristics of medical school applicants.[6] They show that MCAT scores are good predictors of which students will complete medical school in five years without difficulty in their courses or when taking the United States Medical Licensing Exams. In the third article, Davis and his coauthors look at the extent to which the MCAT exam fairly tests examinees from groups who are underrepresented in medicine.[7] They conclude that the MCAT exam does not unfairly disadvantage applicants from racial and ethnic minority groups.

Medical Student Selection

Articles in this collection also document our efforts to understand admissions officers' practices and needs. In the fourth article, Monroe and her coauthors review the ways in which admissions committees screen their applications, decide which applicants to interview, and select the students they will admit.[8] They describe the wide variety of academic, personal, and experiential data that admissions committees value.

The fifth article focuses on the personal attributes that admissions officers seek in their applicants.[9] Koenig and his coauthors say that today's admissions officers want better measures of intrapersonal competencies like integrity and ethics, reliability and dependability, and resilience. They also want better measures of interpersonal competencies like service orientation, cultural competence, and social skills.

Support for Medical School Applicants

Similar to medical school admissions officers, we and the other members of the MCAT review committee are committed to ensuring that all applicants have equal access to information about medical school application and the new MCAT exam. Medical school applicants and the faculty who work with them will need a great deal of support to prepare for the new exam. Already available and under development are a wide range of low- and no-cost preparation materials for the new MCAT exam, including electronic repositories of tutorials and other materials that teach concepts the new exam will test, a guidebook, a curriculum-mapping tool, webinars, videos, and practice questions and tests.[10-13]

MCAT Review Committee

In closing, we want to thank our wonderful colleagues on the MCAT review committee. We truly appreciate their dedication and their spirit of collaboration. Many of them authored the articles in this collection and everyone contributed in vital ways to the ideas that these articles describe. We thank them for their work on this collection and, more importantly, for their hard work in shaping the MCAT^{2015} exam that will play a part in process of selecting tomorrow's physicians.

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Redesigning the MCAT Exam: Balancing Multiple Perspectives

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Abstract

The authors of this commentary discuss the recently completed review of the current Medical College Admission Test (MCAT), which has been used since 1991, and describe the blueprint for the new test that will be introduced in 2015. The design of the MCAT2015 exam reflects changes in medical education, medical science, health care delivery, and the needs of the populations served by graduates of U.S. and Canadian medical schools.

The authors describe how balancing the ambitious goals for the new exam and the varying priorities of the testing program's many stakeholders made blueprint design complex. They discuss the tensions and trade-offs that characterized the design process as well as the deliberations and data that shaped the blueprint.

The blueprint for the MCAT2015 exam balances the assessment of a broad range of competencies in the natural, social, and behavioral sciences and critical analysis and reasoning skills that are essential to entering students' success in medical school. The exam will include four sections: Biological and Biochemical Foundations of Living Systems; Chemical and Physical Foundations of Biological Systems; Psychological, Social, and Biological Foundations of Behavior; and Critical Analysis and Reasoning Skills.

The authors also offer recommendations for admission committees, advising them to review applicants' test scores, course work, and other academic, personal, and experiential credentials as part of a holistic admission process and in relation to their institutions' educational, scientific, clinical, and service-oriented goals.

Much has changed in both academic medicine and health care since the current version of the Medical College Admission Test (MCAT) was introduced in 1991. Scientific knowledge has exploded. Patients live longer and have more complicated medical problems. The ways in which physicians interact with their patients have altered radically.

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The populations of the United States and Canada are more diverse, with better health outcomes in the aggregate; however, health outcomes are more disparate when examined by population group.

These changes have important implications for medical education and the future physician workforce. They affect medical school curricula and teaching methods as well as criteria for admission. Medical school admission committees today are seeking applicants who have strong natural science backgrounds, solid foundations for learning about the social and behavioral determinants of health, strong critical thinking and problem-solving skills, and appreciation for the cultural differences that patients bring with them into the examining room.

In standardized testing, periodic reviews of examinations are considered a best practice, especially in fields with rapidly changing knowledge and practice patterns, like medicine.[1] In this commentary, we discuss the development of the blueprint for the new MCAT exam that will be launched in 2015. We describe the deliberations that drove the redesign during the fifth comprehensive review of the MCAT exam (MR5). We focus more on the tensions and trade-offs that characterized the review and shaped the new exam rather than on the supporting data. Nonetheless, it is important to note that the blueprint for the MCAT2015 exam rests on a broad evidence base. It reflects advice from expert panels and recommendations from national reports about the competencies[2] that entering medical students need to be prepared to learn and to succeed in medical school. It takes into account feedback on the current and proposed tests by participants at more than 90 outreach events and data from more than 2,700 surveys completed by faculty and administrators from U.S. and Canadian undergraduate institutions and medical schools. It was also informed by analyses of test takers' work on the current exam and by course-taking data from medical school applicants. The qualitative and quantitative data that we and our colleagues on the MR5 Committee gathered, and the ways in which we used these data in developing the new exam's blueprint, are described in Appendixes 1 and 2.

These datasets and our conversations as a committee reflected the many objectives and varying priorities of the MCAT testing program's different stakeholder groups, including prospective examinees, medical school administrators and faculty, prehealth advisors and baccalaureate faculty, and members of disciplinary societies and higher education organizations. Many of these groups view the MCAT exam as a powerful lever for change in medical and prehealth education. Our work made it clear, however, that these groups' numerous and differing goals could not be met without constructing an exam to test many more things than is reasonable.

For example, whereas some stakeholders called for the addition of biochemistry, cellular/molecular biology, and genetics concepts,[2] others worried about the increased undergraduate course-taking burden that testing these concepts would imply. Some called for assessing foundational knowledge in the social and behavioral sciences,[3] whereas others were concerned about undergraduate institutions' capacity to increase enrollments in social and behavioral sciences courses to accommodate prehealth students. Many stakeholders recognized the difficulty of using a standardized test to increase diversity in medical school admissions, but, even so, they hoped that the new exam would support efforts to increase racial, ethnic, socioeconomic, and other types of diversity.

The tensions created by these and other competing interests made the MCAT[2015] design process complex. We had to make compromises in order to balance the limitations of a single exam with the need to address the goals and concerns of a diverse student population and collegiate system. Throughout the process, we had to address the trade-off between content coverage and exam duration as each concept included had to be subject to a minimum number of questions to assess applicants' capabilities reliably. Our goal was to design an exam that

- responds to the recommendations of the Scientific Foundation for Future Physicians (SFFP) Committee[2] regarding the natural sciences competencies that are needed by entering medical students;
- tests competencies that provide a solid foundation for learning in medical school about the human and social aspects of medicine[3];
- asks examinees to demonstrate that they can use their knowledge of the natural sciences and the social and behavioral sciences to solve problems that call for scientific reasoning and research skills;
- communicates the expectation that students who are preparing for medical school should read broadly in the humanities and social sciences; and
- balances the assessment of a broad range of competencies in the natural sciences, competencies in the social and behavioral sciences, and critical analysis and reasoning skills.

Below, we discuss the compromises we made and the decision rules we followed as the MR5 Committee worked to design the MCAT[2015] exam to meet each of these five goals.

Goal 1: Test Natural Sciences Competencies

In 2009, the SFFP Committee[2] released a report describing the natural sciences competencies with which students should enter medical school and those with which they should graduate. The committee highlighted the increasingly rapid rate at which new knowledge revises our understanding of the natural sciences fundamental to medicine and argued that future physicians must be scientifically inquisitive and possess the knowledge, skills, and habits of mind that will enable them to integrate new scientific discoveries into their work. The committee suggested that focusing on competencies, rather than traditional course requirements, would allow baccalaureate faculty to develop innovative interdisciplinary and integrative courses to help students build strong foundations in the natural sciences. Many of the SFFP Committee's recommendations mirrored the recommendations of other recent seminal reports in natural sciences education.[4–6]

The SFFP recommendations, together with other recommendations from the literature and feedback from MCAT stakeholders at outreach events, helped shape our surveys of medical school and baccalaureate faculty concerning content to include on the new exam. We collected more than 2,700 completed surveys.[7] Medical school faculty rated the importance of candidate natural sciences concepts to entering students' success in medical school. Baccalaureate faculty described the levels at which these concepts are taught in their institutions' introductory core course sequences in biology, organic and general chemistry, physics, biochemistry, and cellular/molecular biology. In addition, we analyzed course-taking data for applicants to U.S. medical schools, which we drew from the Association of American Medical College's medical school applicant database.[8] (Data were not centrally available for applicants to Canadian medical schools.)

When we examined the concepts to which medical school faculty members gave high importance ratings, our results suggested a larger testing domain in the natural sciences than could reasonably be covered on the new exam. We determined that incorporating all of the highly rated concepts would stretch the new exam's limits and duration.

In addition, expanding the testing domain to include all of the highly rated concepts in biochemistry and cellular/molecular biology would increase the number of premedical courses needed to prepare for the exam. Although the SFFP Committee[2] encouraged the development of integrative college-level courses that would include many of these competencies, baccalaureate faculty participating in MCAT outreach events highlighted the difficulty of teaching in this integrated model, particularly at smaller or relatively underresourced schools. They also pointed to the need for textbooks written explicitly to support an integrated approach.

Because 80% of MD-granting medical schools in the United States and Canada require or recommend a biochemistry course for admission,[9] and two-thirds of applicants to U.S. medical schools already take biochemistry,[8] we decided to include biochemistry concepts as they are taught in first-semester biochemistry courses. In contrast, few medical schools require or recommend cellular/molecular biology courses,[9] and few applicants take them,[8] so we decided to limit the testing of such concepts to those taught in introductory biology courses. (Many introductory biology courses now devote a significant amount of time to concepts in cellular/molecular biology.)

The MCAT[2015] exam will include two natural sciences sections: the Biological and Biochemical Foundations of Living

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Systems and the Chemical and Physical Foundations of Biological Systems. Together, these sections will test five foundational concepts[10]:

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.
2. Highly organized assemblies of molecules, cells, and organs interact to carry out the functions of living organisms.
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 within an ever-changing external environment.
4. Complex living organisms transport materials, sense their environment, process signals, and respond to changes using processes understood in terms of physical principles.
5. The principles that govern chemical interactions and reactions form the basis for a broader understanding of the molecular dynamics of living systems.

Goal 2: Test Foundations for Learning About the Human and Social Aspects of Medicine

In 2011, the Behavioral and Social Science Foundations for Future Physicians (BSSFFP) Committee released a report on preparing medical students and doctors to deal with the human and social issues of medicine.[11] Building on the recommendations of the Institute of Medicine's (IOM's) *Improving Medical Education* report,[12] the BSSFFP Committee described the critical roles that behavioral and sociocultural factors play in health and illness and the ways in which they interact with biological factors to influence health outcomes. The committee emphasized the importance of behavioral- and social-science-derived competencies to the effective practice of medicine. It recommended that students enter medical school with the foundational knowledge necessary to learn about the behavioral and sociocultural determinants of health, concepts that are receiving increasing attention in medical school curricula.

Input from stakeholders at MCAT outreach events reinforced these recommendations, as did data from our surveys of admission and academic affairs officers, who rated disciplinary knowledge in psychology, sociology, cultural studies, and public health as important or somewhat important to entering medical students' success.[13,14]

Just as in the natural sciences, a larger testing domain was suggested than was manageable. Including concepts from psychology, sociology, population health, anthropology, cultural studies, economics, geography, cognitive science, and other disciplines[3] would have resulted in an unacceptably long test. In addition, it would have been difficult to build test forms for the MCAT[2015] exam that are equivalent to each other in content coverage and difficulty. Importantly, applicants would have had difficulty preparing for an exam that covered such a wide range of competencies.

We ultimately decided to add a section focused on the concepts taught in introductory psychology and sociology courses. These concepts are linked to several of the IOM's "high priority" areas in the behavioral and social sciences,[12] as well as areas discussed in the BSSFFP report.[11] This decision was bolstered by admission requirements and applicant course-taking data: Half of the MD-granting medical schools in the United States and Canada require or recommend a course in the social or behavioral sciences for admission,[9] whereas about two-thirds of applicants to U.S. medical schools take introductory psychology and one-third take introductory sociology.[8] Many undergraduate institutions require or make available introductory psychology and sociology courses as part of their core curricula, which might ease some of the burden of preparing for the new test section.

The new Psychological, Social, and Biological Foundations of Behavior section of the MCAT[2015] exam will be organized around five foundational concepts[10]:

1. Biological, psychological, and sociocultural factors influence the ways that individuals perceive, think about, and react to the world.
2. Biological, psychological, and sociocultural factors influence behavior and behavior change.
3. Biological, psychological, and sociocultural factors influence how we think about ourselves and others.
4. Social and cultural differences influence well-being.
5. Social stratification affects access to resources and well-being.

Goal 3: Test Scientific Inquiry and Research Skills

Like the SFFP and BSSFFP Committees, the MR5 Committee recognized the importance of scientific inquiry and research skills to medical students' and physicians' success. Medical school faculty want to be assured that students can use their knowledge about the natural sciences and the social and behavioral sciences to solve problems that call for scientific reasoning. Using data from our survey of medical school faculty and the recommendations of the SFFP and BSSFFP Committees and others,[2,4–7,11–14] we identified the scientific inquiry, research, and statistics concepts and skills that are important to test for prospective medical students.

We designed a conceptual framework for testing these in the two natural sciences sections and in the Psychological, Social, and Biological Foundations of Behavior section. The MCAT[2015] exam will ask examinees to demonstrate[10]

- *knowledge of scientific concepts and principles* by showing their understanding of scientific principles and by identifying the relationships between closely related concepts;
- *scientific reasoning and problem solving* by reasoning with scientific principles, theories, and models and by analyzing and evaluating scientific explanations and predictions;
- *reasoning about the design and execution of research* by demonstrating their understanding of important components of scientific research and by reasoning about ethical issues in research; and
- *data-based and statistical reasoning* by interpreting patterns in data presented in tables, figures, and graphs and by reasoning about data and drawing conclusions from them.

The research methods and statistics concepts that medical school faculty rated as important to success in medical school included basic probability, measures of central tendency, measures of variability, confidence intervals, statistical significance levels, graphical presentation of data, research ethics, hypothesis formulation, independent and dependent variables, hypothesis testing, and reporting research results.[7] To demonstrate the third and fourth skills in the conceptual framework above, examinees will need a basic understanding of these concepts, which are discussed in many introductory psychology and sociology courses. Further, baccalaureate faculty survey data confirmed their importance to undergraduate students' work in introductory biology, chemistry, physics, and biochemistry courses.[7] Therefore, examinees should not need additional targeted course work in research methods or statistics to prepare for the new exam.

Goal 4: Communicate the Need to Read Broadly in the Humanities and Social Sciences

At the beginning of our deliberations, we reviewed data on the predictive validity of the Verbal Reasoning (VR) section of the current MCAT exam. These data showed that VR scores predict a range of academic outcomes in medical school, including grades, performance on licensure examinations, and the numbers of years required to complete undergraduate medical education.[15–18] Data from the admission and academic affairs officer surveys,[13,14] input from colleagues on the Holistic Review Project Advisory Committee,[19] and feedback from stakeholders at outreach events also suggested that testing analysis and reasoning skills on the MCAT exam was of continuing importance.

In addition, we reviewed predictive validity data for the Writing Sample (WS) section of the current exam as well as survey data about admission officers' use of WS scores.[13,20,21] Validity data showed that WS scores add little to the prediction of medical student outcomes once applicants' VR scores and undergraduate grades are considered. Survey data showed that many admission officers only use WS scores in making decisions about a small percentage of their applicants (primarily those applicants whose application essays and interviews suggest communication difficulties and those with modest VR scores). Given these data, we decided not to include the WS section on the new exam.

Our outreach and survey data highlighted ethics, philosophy, cultural studies, and population health as important new disciplines to include. With the addition of biochemistry, psychology, and sociology concepts, however, we were concerned about the impact that testing more subjects would have on examinees. For example, the time and tuition that might be needed to prepare for the exam could disadvantage, in particular, examinees from lower socioeconomic backgrounds. Similarly, examinees from "alternative backgrounds" (e.g., individuals who decide later in life to pursue a medical career or begin their undergraduate work in community colleges) might have difficulty completing the course work necessary to perform well.

We therefore decided to test examinees' critical analysis and reasoning skills using passages from a wide range of humanities and social science disciplines but without requiring specific knowledge of particular disciplines. The new Critical Analysis and Reasoning Skills section will replace the VR section. It will test examinees' skill at comprehending and analyzing what they read, drawing inferences from text, and applying the arguments and ideas that the passages describe to new situations. It will address stakeholders' priorities by including passages from the fields of ethics, philosophy, cultural studies, and population health. We expect that our drawing attention to these disciplines will encourage examinees to familiarize themselves with the issues and arguments these disciplines raise and to read broadly in preparation for medical school.

Additional details about this and each of the other sections described in this commentary are available in the *Preview Guide for the MCAT^2015 Exam*.[10] That resource also provides sample questions.

Goal 5: Balance Testing in the Natural, Social, and Behavioral Sciences and Critical Analysis and Reasoning

We believe that the MR5 Committee's recommendations for the MCAT^2015 exam preserve what works about the current exam, eliminate what does not, and enrich the exam by adding concepts that will help ensure that future medical students are adequately prepared in key competencies in the natural sciences and the social and behavioral sciences. They also recognize the importance of critical analysis and reasoning skills. At the same time, our recommendations are mindful of the need for a diverse physician workforce and of the practical challenges of adapting baccalaureate curricula and applicants' course taking to meet these new expectations.

Recommendations for Admission Committees

In the MR5 Committee's deliberations, we and our colleagues recognized many paths to achieving the competencies that the MCAT^2015 exam will test. We are heartened by the baccalaureate faculty who are developing multidisciplinary, competency-based courses that will make it possible for prospective medical students to efficiently prepare for the new MCAT exam and medical school. Examples of such courses include Integrated Introduction to the Life Sciences: Chemistry, Molecular Biology, and Cell Biology at Harvard University[22]; the Transformation in Medical Education Initiative at the University of Texas[23]; and the Howard Hughes Medical Institute's National Experiment in Undergraduate Science Education at Purdue University, the University of Maryland at Baltimore County, the University of Maryland at College Park, and the University of Miami.[24]

It is important, however, to recognize that some colleges and universities are not as well positioned to examine their curricula and refine them. It would be unrealistic to expect that faculty everywhere have the resources needed to rethink what and how they teach. Indeed, more than 300 undergraduate institutions in the United States do not have prehealth advisors on staff. Further, some state schools and minority-serving institutions have been hard hit by the downturn in the U.S. economy.

Better communication between undergraduate colleges and medical schools about the content and focus of existing courses and their alignment with the competencies is important. In addition, we encourage medical school admission committees to continue to be flexible as they review applicants' portfolios. They should carefully review the transcripts of applicants who have not completed all of the standard prerequisite courses or have taken integrated courses that have unusual titles. They should consider applicants who have taken alternate paths to touchstone courses such as biochemistry and/or have credits from community colleges, online courses, and other learning alternatives. We acknowledge that such flexibility in reviewing the credentials of applicants who have followed different academic paths will be difficult. This flexibility is, however, an additional, critical aspect of the holistic processes that admission committees already use to review applicants' academic, personal, and experiential credentials in ways that reflect their institutions' educational, scientific, clinical, and service-oriented goals.

In Sum

The production of doctors is a complex process that incorporates experiences and course work in college and medical school, as well as training in residency programs. To the degree that the MCAT exam influences the college experiences of applicants and is predictive of their success in medical school, the exam may play a positive role in shaping the future physician workforce.

In the 21st century, physicians have to be "Renaissance" people with expertise in areas as different as psychology, biology, statistics, sociology, economics, culture, and communication skills. With the explosion of medical knowledge and the technologies that make information easily available, physicians must be able to find and evaluate information and to think critically when applying that information to solve their patients' problems. We believe that the MCAT^{2015} exam's broader focus, emphasis on analytical reasoning, and adoption of scientific competencies will help foster the development of such physicians.

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Appendix 1

The Qualitative Evidence Base for the MCAT2015 Exam*

	Recommendations from expert panels	Findings from national reports and the broader literature	Input from MCAT stakeholders
Data collected	The following expert panels provided important input to the MR5 Committee: • Scientific Foundations for Future Physicians Committee • Behavioral and Social Science Foundations for Future Physicians Committee • Holistic Review Project Advisory Committee	National reports in natural and social sciences education informed the MR5 Committee's work, including • *Scientific Foundations for Future Physicians*[2] • *Behavioral and Social Science Foundations for Future Physicians*[11] • *Vision and Change in Undergraduate Biology Education—A Call to Action*[4] • *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*[5] • *Science, College Board Standards for College Success*[6] • *Improving Medical Education: Enhancing the Behavioral and Social Science Content of Medical School Curricula*[12] The committee's work was additionally informed by the broader literatures on • Medical school admissions • Racial and ethnic group differences in academic achievement • Bias in testing • Stereotype threat • Test speededness • Predictive value of MCAT scores	MR5 Committee members solicited input on the current and future MCAT exams at 90 events attended by baccalaureate and medical school stakeholders. Participants included • Preheath advisors and baccalaureate faculty • Medical school administrators and faculty • Medical students • Members of disciplinary societies and higher education associations Participants described what they liked and did not like about the current exam, what they wanted the future exam to do, and what they thought about the MR5 Committee's (then) current thinking.
How data were gathered	The MR5 Committee and the three expert panels reported progress at panel and committee meetings from 2008 to 2011. The expert panels' reports also informed the MCAT review.	Between 2008 and 2011, MR5 Committee members studied national reports and selected literature reviews.	MR5 Committee members and AAMC staff tracked themes in stakeholders' input between 2008 and 2011 and reported and discussed them at the 10 committee meetings.
How samples were selected	The MR5 Committee included two members each from the three expert panels.	MR5 Committee members, expert panel members, outside experts, and interested stakeholders identified the national reports and literatures of greatest significance.	MR5 Committee members, expert panel members, outside experts, and interested stakeholders identified meetings and conferences of greatest interest. Committee members and AAMC staff organized sessions at these events. They also responded to invitations from organizers of additional events.
How data were used	The data informed decisions about the quantitative data to collect, the extant data to analyze, and the disciplines to test.		

*The MCAT2015 exam is the version of the Medical College Admission Test that will be introduced in 2015. The MR5 Committee is the committee charged by the Association of American Medical Colleges with conducting the fifth comprehensive review of the MCAT exam (MR5). The committee reviewed the 1991 version of the exam and designed the blueprint for the new exam.

Appendix 2

The Quantitative Evidence Base for the MCAT^{2015} Exam*

	Surveys of medical school administrators	Surveys of medical school faculty, residents, and students	Surveys of baccalaureate faculty	Analyses of extant data
Data collected	• Medical school admission officers and academic affairs officers described the disciplinary knowledge and academic skills they wanted entering students to have. • Admission officers described the ways that they and their committees review applications and select students.	Medical school faculty, residents, and medical students completed surveys that described the natural science concepts that entering students need to know in order to succeed in medical school now and in the curriculum likely to be in place five years in the future. Surveys asked respondents to rate baccalaureate-level concepts in • Introductory biology (including genetics) • General chemistry • Organic chemistry • Physics • Biochemistry • Cellular/molecular biology • Research methods • Statistics Respondents rated concepts on a scale from 1 (not important) to 5 (extremely important); a "cannot rate" option also was available.	Baccalaureate faculty completed surveys about the natural science concepts that they cover in their current courses and expect to teach in the curriculum likely to be in place five years in the future. Surveys asked respondents to rate concepts in • Introductory biology (including genetics) • General chemistry • Organic chemistry • Physics • Biochemistry • Cellular/molecular biology • Research methods • Statistics Respondents rated the extent to which they cover concepts in their current curricula and likely future curricula on a scale from 1 (not covered) to 4 (covered in greater depth); a "cannot rate" option also was available.	MR5 Committee analyses of extant data examined • Medical student selection rates by MCAT scores and GPAs • Medical school course prerequisites • College and university course offerings • Applicants' course taking • The predictive validity of MCAT scores • Differences by racial and ethnic group on MCAT, in testing time, and in the predictive validity of MCAT scores • Possible advantages of different score-reporting options
How data were gathered	Online surveys were administered in 2008 and 2009. Response data were summarized with descriptive statistics.[13,14]	Online surveys were administered in fall 2009, and response data were summarized with descriptive statistics.[7] Inferential statistics were used to examine differences in importance ratings across the different respondent groups.	Online surveys were administered in winter 2009, and response data were summarized with descriptive statistics.[7] Inferential statistics were used to examine differences in coverage ratings across minority-serving and majority-serving institutions.	Between 2008 and 2011, committee members studied descriptive data and inferential statistics derived from a number of data sources, including AAMC's Data Warehouse, AAMC's Medical School Admissions Requirements 2009–2010, college and university Web sites, and the scientific literature.
How samples were selected	Admission and academic affairs officers from all MD-granting medical schools in the United States and Canada that use MCAT were invited to participate, and 226 completed surveys. Respondents represented 141 medical schools. Response rates: 90% for admission officers, 70% for academic affairs officers.	2,001 basic and clinical sciences faculty, medical students, and residents from all MD-granting medical schools in the United States and Canada that use MCAT were invited to complete surveys, and 1,300 (65%) responded, representing 114 medical schools and providing data about the importance of natural science concepts to success in the current curricula. In another survey, 1,008 basic and clinical science faculty were invited to provide importance ratings for success in the curriculum likely to be in place five years in the future. Of the 841 (83%) who responded, the final analytic samples had response rates ranging from 80% to 88% across the disciplines. (Response data for faculty who reported a lack of confidence in their future ratings were omitted from the final samples.)	1,599 biology, cellular/molecular biology, chemistry, biochemistry, and physics faculty from 121 minority-serving and 169 majority-serving institutions in the United States and Canada were invited to complete surveys. Minority-serving institutions were oversampled to ensure that there would be sufficient data on their curricula. 1,023 (64%) of invitees responded, representing 188 institutions. For ratings of concept coverage in the future curriculum, 846 (83%) respondents were included in the final analytic sample. (Data for respondents who reported a lack of confidence in their future ratings were omitted from the final sample.) Across disciplines and institution types, the final sample represented between 12% and 53% of institutions. The median percentage of minority-serving institutions was 22%, and the median percentage of majority-serving institutions was 45%. Across disciplines, the response rates ranged from 43% to 61%, with the median at 53%.	Examinee, applicant, and medical student datasets included records from 2000 to 2009. Sample sizes ranged from 12,374 to 114,856. Course prerequisite data were examined for all MD-granting medical schools in the United States and Canada that use the MCAT exam. Course-offering data were examined for 121 minority-serving institutions and for 169 majority-serving institutions.

(*Appendix Continues*)

Appendix 2, Continued

<table>
<tr><th></th><th>Surveys of medical school administrators</th><th>Surveys of medical school faculty, residents, and students</th><th>Surveys of baccalaureate faculty</th><th>Analyses of extant data</th></tr>
<tr><td rowspan="2">How data were used</td><td rowspan="2">Data were used to decide which disciplines and concepts to test on the new exam and which to use as stimuli for testing examinees' critical analysis and reasoning skills.</td><td colspan="2">Together, the medical school and baccalaureate data were used to identify concepts eligible for testing on the new MCAT exam. To be eligible, concepts had to meet eligibility criteria in both the medical school and baccalaureate datasets.</td><td rowspan="2">Analyses informed decisions about the disciplines and concepts to test, the length of the exam, score-reporting scales, and other issues.</td></tr>
<tr><td>To meet the medical school eligibility criterion, concepts had to have average importance ratings of 3.0 or higher for entering medical students' success in the future curriculum.</td><td>To meet the baccalaureate data criterion, concepts had to be covered at a minimal level (at a scale value of 2 or higher) at 50% or more of baccalaureate institutions in introductory sequences in biology, chemistry, physics, or first-semester biochemistry. For the vast majority of concepts, data about concept coverage at minority-serving institutions were statistically indistinguishable from data from other institutions.</td></tr>
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* The MCAT[2015] exam is the version of the Medical College Admission Test that will be introduced in 2015. The MR5 Committee is the committee charged by the Association of American Medical Colleges with conducting the fifth comprehensive review of the MCAT exam (MR5). The committee reviewed the 1991 version of the exam and designed the blueprint for the new exam.

The Predictive Validity of the MCAT Exam in Relation to Academic Performance Through Medical School: A National Cohort Study of 2001–2004 Matriculants

Dana M. Dunleavy, PhD, Marc H. Kroopnick, MEng, PhD, Keith W. Dowd, MA, Cynthia A. Searcy, PhD, and Xiaohui Zhao, PhD

Abstract

Purpose
Most research examining the predictive validity of the Medical College Admission Test (MCAT) has focused on the relationship between MCAT scores and scores on the United States Medical Licensing Examination Step exams. This study examined whether MCAT scores predict students' unimpeded progress toward graduation (UP), which the authors defined as not withdrawing or being dismissed for academic reasons, graduating within five years of matriculation, and passing the Step 1, Step 2 Clinical Knowledge, and Step 2 Clinical Skills exams on the first attempt.

Method
Students who matriculated during 2001–2004 at 119 U.S. medical schools were included in the analyses. Logistic regression analyses were used to estimate the relationships between UP and MCAT total scores alone, undergraduate grade point averages (UGPAs) alone, and UGPAs and MCAT total scores together. All analyses were conducted at the school level and were considered together to evaluate relationships across schools.

Results
The majority of matriculants experienced UP. Together, UGPAs and MCAT total scores predicted UP well. MCAT total scores alone were a better predictor than UGPAs alone. Relationships were similar across schools; however, there was more variability across schools in the relationship between UP and UGPAs than between UP and MCAT total scores.

Conclusions
The combination of UGPAs and MCAT total scores performs well as a predictor of UP. Both UGPAs and MCAT total scores are strong predictors of academic performance in medical school through graduation, not just the first two years. Further, these relationships generalize across medical schools.

Research evaluating the predictive validity of the Medical College Admission Test (MCAT) has focused primarily on the relationship between MCAT scores and scores on the United States Medical Licensing Examination (USMLE) Step exams. Overall, studies have shown that MCAT scores predict medical school matriculants' subsequent scores on licensure exams up to six years after matriculation.[1–5] Critics suggest that these studies overstate the predictive value of MCAT scores because the analyses relate scores from a standardized admission test to scores from standardized licensing tests, ignoring important measures of medical student performance like course grades and clerkship ratings, the need for academic remediation, measures of academic distinction, and time to graduation.[6,7]

Although the majority of students who start medical school graduate within five years of matriculation, 6% do not.[8] Some students leave medical school for academic reasons, and others leave for personal or financial reasons. Some students take longer than planned to graduate because they encounter academic difficulties in courses or clerkships, have trouble passing the USMLE Step exams, or are slowed by nonacademic complications. This study expands the criterion domain for predictive validity research on the MCAT exam by focusing on students' progress through medical school. We examined relationships between MCAT total scores, undergraduate grade point averages (UGPAs), and a new variable: unimpeded progress toward graduation (UP). We considered matriculants who did not withdraw and were not dismissed for academic reasons, graduated within five years, and did not repeat any of the Step 1 or 2 exams before passing them to have experienced UP. We considered students who had difficulty in any of these areas not to have experienced UP; in other words, such students experienced impeded progress in medical school (IP).

Implications of IP and UP

UP is an important outcome because students' progress through medical school has individual, institutional, and societal implications. Arguably, the most important implications of UP and IP are for individual matriculants. In 2012, the median one-year cost of attendance at U.S. medical schools was $53,685 for public schools and $72,344 for private

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The authors have informed the journal that the research team for this report agrees that both Dr. Dunleavy and Dr. Kroopnick completed the intellectual and other work typical of the work of the first author.

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schools; the median student education debt for the class of 2012 was $170,000.[9] Matriculants who experience IP therefore have a higher cost of attendance and are likely to have higher educational debt on graduation than those who experience UP. (It should be noted, though, that not all schools charge students additional tuition for taking more than four years to graduate.) Additionally, students who withdraw or are dismissed because of academic difficulty may be saddled with sizable educational debt and lack the medical degree that would help them pay it off.

In addition, students who experience IP may have fewer options after graduation than those who experience UP. Not passing the Step exams on the first attempt, for example, has implications for GME opportunities. More than 80% of residency program directors responding to the 2010 National Resident Matching Program (NRMP) Director Survey indicated that they would seldom or never interview an applicant who had failed Step 1 or Step 2 Clinical Knowledge (Step 2 CK) on the first attempt.[10] Applicants with first-attempt failures on the Step exams are less likely than those who pass to match in the NRMP's Main Residency Match.[11] They also may have a higher risk of being dismissed from GME programs that require residents to complete the USMLE sequence within a specific time frame[12] and of failing to achieve licensure due to state licensing board restrictions on the number of attempts permitted and the time line for completing the USMLE sequence.[13]

The implications of IP also extend to medical schools. The most recent comprehensive study[14] of the cost of educating medical students in the United States estimated that total educational resource costs (i.e., both direct instructional costs and additional costs required to support faculty) were $72,000 to $93,000 per student per year (in 1996 dollars). The costs likely have increased since that 1997 study was published, because of curricular reforms that emphasize low student–faculty ratios, problem-based and small-group learning, and increased clinical course work in the first year of medical school.[15] In addition, there are opportunity costs associated with matriculants who withdraw or are dismissed for academic reasons because their slots could have been filled by others. Thus, medical schools bear an increase in total educational costs when students experience IP.

Finally, there are also societal implications related to IP. The Association of American Medical Colleges (AAMC) projects that there will be a shortage of about 125,000 physicians in the U.S. workforce by 2025.[16] To the extent that matriculants withdraw, are dismissed for academic reasons, or experience delayed graduation, fewer residents and, ultimately, fewer physicians will be available to manage the nation's growing health care needs.

For these reasons, we believe that UP is an important outcome and that information about it is of practical value to medical school faculty and administrators. To the extent that medical schools understand predictors of UP, they will be able to provide better support services for matriculants who are at risk for experiencing academic-related delays. They also may be better positioned to plan for the financial implications of accepting matriculants with risk of experiencing IP.

Previous research has examined the relationship between prematriculation variables and outcome variables similar to those described above. Using data on the 1977 version of the MCAT exam, Jones and Vanyur[17] found that MCAT section scores were negatively related to delayed graduation and withdrawal/dismissal for academic reasons. More recent studies using data from the 1991 version of the MCAT exam have also shown links between MCAT scores and withdrawal/dismissal for academic reasons.[1,18,19]

Using data from a national sample of medical students who matriculated in 1992, Huff and Fang[18] conducted a survival analysis to determine whether MCAT scores predicted if and when matriculants experienced academic difficulty in medical school. After controlling for other variables, they found that as MCAT scores increased, risk of experiencing academic difficulty decreased. Similarly, in a study of 11 medical schools, Julian[1] showed that the percentage of students who experienced academic difficulty decreased as MCAT scores increased. Both studies' authors noted that the majority of matriculants with lower MCAT scores completed medical school without experiencing academic difficulty.

Andriole and Jeffe[19] examined the relationship between various prematriculation variables and a four-category variable in which matriculants were grouped into one of the following categories: (1) withdrawn or dismissed for academic reasons, (2) withdrawn or dismissed for nonacademic reasons, (3) graduated within 10 years and did not pass Step 1 and/or Step 2 CK on the first attempt, and (4) graduated within 10 years and passed Step 1 and/or Step 2 CK on the first attempt. The first three categories were considered "suboptimal" outcomes; the fourth was considered the optimal outcome. Andriole and Jeffe[19] found that matriculants were more likely to have suboptimal outcomes if they were Asian/Pacific Islanders, belonged to underrepresented racial/ethnic groups, were 24 years of age or older, had obtained an undergraduate degree from an institution that was not classified as having very high research activity, had an MCAT total score less than 29, had premedical education debt of $10,000 or greater, and/or had participated in a summer academic enrichment program as an undergraduate.

In this study, we extend the published research by investigating the relationships between MCAT total scores, UGPAs, and UP, a new indicator that incorporates medical student academic outcomes beyond standardized test scores and occurs about six years after application to medical school. We examine these relationships at the school level, allowing for the investigation of potential differences in the MCAT's predictive validity by school.

Method

We drew all matriculant data used in this study from deidentified research tables in the AAMC's Data Warehouse. We linked data for individual matriculants using the AAMC research identification variable. This study was approved by the institutional review board of the American Institutes for Research as part of the MCAT program's psychometric research protocol.

Study sample

Individuals who matriculated at 128 MD-granting U.S. medical schools between 2001 and 2004 and took the paper-and-pencil 1991 version of the MCAT exam were eligible for inclusion in this study. We selected these cohorts because, in February 2012 when we conducted this study, the majority of these matriculants had completed the Step 1, Step 2 CK, Step 2 Clinical Skills (Step 2 CS), and Step 3 exams and had graduated from medical school. We excluded matriculants enrolled in MD/PhD or other special programs because of planned delays in graduation. We also excluded matriculants from medical schools that were missing UGPA data for 30% or more of the matriculants (n = 6) and those with special or joint programs that have unique educational missions or atypical time lines for graduation (n = 3). The final subset of 119 medical schools (71 public and 48 private) mirrored the distribution of U.S. public and private schools and was geographically diverse. Across the four years, the number of students in each school ranged from 118 to 1,084, with a median of 426 students per school.

Description of variables

Predictor: UGPA. Cumulative UGPA is the average of the matriculant's grades from all undergraduate courses; it excludes grades from any graduate courses. We chose UGPA rather than the biology, chemistry, physics, and math (BCPM) GPA because UGPA is a more complete representation of the undergraduate academic experience. Differences in baccalaureate course content and grading standards make the meaning of UGPAs variable across undergraduate institutions, however.

Predictor: MCAT total score. The MCAT total score is the sum of the matriculant's scores on the three multiple-choice sections of the 1991 version of the exam: Verbal Reasoning (VR), Biological Sciences (BS), and Physical Sciences (PS). The VR section assesses the examinee's ability to understand, evaluate, and apply information and arguments presented in text. The BS and PS sections assess the examinee's ability to apply his or her introductory-level knowledge of biology, chemistry, and physics to solve scientific problems. Scores for each multiple-choice section are reported on a 15-point scale, resulting in an MCAT total score ranging from 3 to 45. In our analyses, we included each matriculant's most recent MCAT total score at the time of application to medical school.

Criterion: UP. We created a dichotomous composite variable, UP, that represents academic progress in medical school. UP was operationalized as *not* being dismissed or withdrawing for academic reasons, graduating within five years of matriculation, and passing Step 1, Step 2 CK, and Step 2 CS on the first attempt. Using this variable, we identified two categories of matriculants: those who experienced UP and those who did not (i.e., experienced IP).

Data analyses

Many admission committees use MCAT total scores and UGPAs together to predict applicants' academic readiness for medical school, but the ways they use these data differ according to institutions' educational missions, goals, and applicant pools.[20,21] As such, we examined the predictive validity of UGPAs and MCAT total scores separately and together. This allowed the comparison of the predictive validity for the following models:

- Model 1: UGPAs alone
- Model 2: MCAT total scores alone
- Model 3: UGPAs and MCAT total scores together

We examined the predictive validity of UGPAs and MCAT total scores at the school level. That is, we conducted separate analyses for each medical school. We used this approach for several reasons: (1) Medical schools use UGPAs and MCAT total scores differently, (2) the meaning of some medical student outcomes, such as standards for withdrawal/dismissal due to academic reasons and for graduation, differ across schools, (3) schools offer different levels and types of academic support, and (4) schools have their own educational missions and goals. These differences might alter the relationships between UGPAs, MCAT total scores, and UP. Adopting a school-level approach allowed us to investigate whether the direction and strength of relationships between these variables differed by school, as well as to estimate the validity of UGPAs and MCAT total scores across all 119 schools.

We used logistic regression analyses to estimate the relationships between UGPAs, MCAT total scores, and UP. We did not correct logistic regression analyses for range restriction. We summarized results across schools by computing the median and interquartile range (IQR) of predicted UP rates.

We also evaluated the extent to which each model differentiated between matriculants who experienced UP and those who did not, using the area under the receiver operator characteristic curve (AUC).[22] We considered a model to be discerning when the confidence interval (CI) around the AUC was greater than 0.50.[23] For each model, we examined the 95% CI for the AUC by school. Then, we computed the percentage of schools in which the 95% CI was greater than 0.50 for each model.

Results

Across the distribution of 119 medical schools included in this study, we observed that the majority of matriculants experienced UP: For schools at the 10th percentile, 83% of matriculants experienced UP; for schools at the 25th percentile, 87% of matriculants experienced UP; for schools at the 50th percentile, 90% of matriculants experienced UP; for schools at the 75th percentile, 92% of matriculants experienced UP; and for schools at the 90th percentile, 95% of matriculants experienced UP. Therefore, in the majority of schools in the sample, at least 83% of matriculants experienced UP.

Figure 1 shows the positive relationship between UGPAs and the percentage of matriculants predicted to experience UP: The likelihood of a matriculant experiencing UP increases as his or her UGPA increases until UGPA exceeds 3.50, and then it tends to level off. As illustrated by the size of the IQRs, the relationship between UGPAs and UP varies across medical schools. When UGPAs are low, there is more variability in the likelihood of UP than when UGPAs are high.

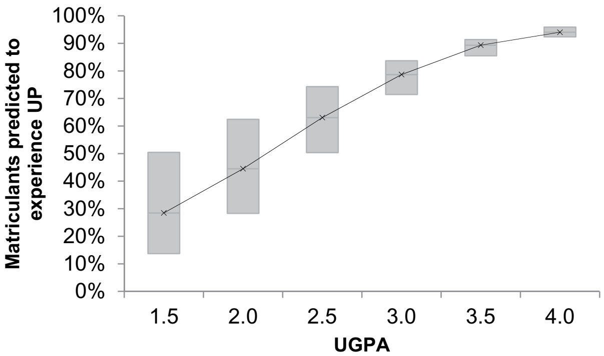

Figure 1 Median and interquartile range (IQR) of the percentage of 2001–2004 matriculants at 119 U.S. medical schools predicted to experience unimpeded progress toward graduation (UP) based on undergraduate grade point average (UGPA). UP was operationalized as *not* being dismissed or withdrawing for academic reasons, graduating within five years of matriculation, and passing the United States Medical Licensing Examination Step 1, Step 2 Clinical Knowledge, and Step 2 Clinical Skills exams on the first attempt. Shaded boxes represent the IQRs. The lower bound represents the 25th percentile, and the upper bound represents the 75th percentile of the percentage of matriculants predicted to experience UP across schools; the *X*s in these boxes represent the median.

Figure 2 shows the positive relationship between MCAT total scores and the percentage of matriculants predicted to experience UP: The likelihood of a matriculant experiencing UP increases consistently as his or her MCAT score increases until MCAT total score exceeds 30, at which point it tends to level off. As observed with UGPAs, the relationship between MCAT total scores and UP varies across medical schools. When MCAT scores are low, there is more variance in the likelihood of UP than when MCAT scores are high. However, the IQRs for MCAT total scores are smaller than those for UGPAs, indicating that the relationship between MCAT scores and UP is more similar across schools than is the relationship between UGPAs and UP.

Figure 3 shows that the relationship between MCAT total scores and the percentage of matriculants predicted to experience UP depends on UGPAs. That is, at all points along the MCAT total score scale, medical students are more likely to experience UP if they have higher UGPAs. This effect is stronger for lower MCAT total scores than for higher MCAT total scores.

Our analyses to determine which model is the best predictor of UP provided the following results:

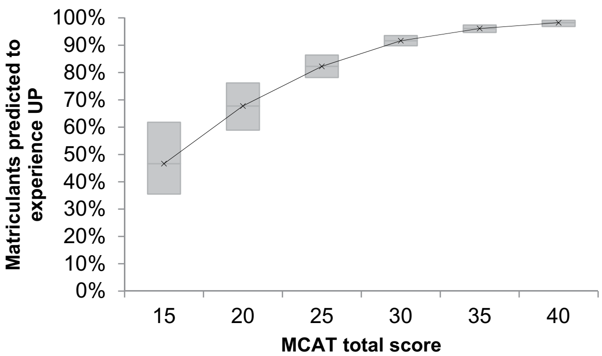

Figure 2 Median and interquartile range (IQR) of the percentage of 2001–2004 matriculants at 119 U.S. medical schools predicted to experience unimpeded progress toward graduation (UP) based on Medical College Admission Test (MCAT) total score. UP was operationalized as *not* being dismissed or withdrawing for academic reasons, graduating within five years, and passing the United States Medical Licensing Examination Step 1, Step 2 Clinical Knowledge, and Step 2 Clinical Skills exams on the first attempt. MCAT total score represents the sum of the matriculant's most recent scores on the three multiple-choice sections of the 1991 version of the exam (possible range, 3–45). Shaded boxes represent the IQR. The lower bound represents the 25th percentile, and the upper bound represents the 75th percentile of the percentage of matriculants predicted to experience UP across schools; the *X*s in these boxes represent the median.

- UGPAs alone (Model 1) differentiated among matriculants who were and were not likely to experience UP in 76 (64%) schools.
- MCAT total scores alone (Model 2) differentiated among matriculants who were and were not likely to experience UP in 89 (75%) schools.
- UGPAs and MCAT total scores together (Model 3) differentiated among matriculants who were and were not likely to experience UP in 107 (90%) schools.

Thus, the combination of UGPAs and MCAT total scores offers better prediction of UP than either UGPAs or MCAT total scores alone.

Discussion

In this study, we found that the combination of UGPAs and MCAT total scores predicts UP, an academic outcome that relies on data beyond standardized test scores and occurs about six years after application to medical school. MCAT total scores, however, contribute more to the prediction of UP than do UGPAs. By using data for matriculants at 119 U.S. medical schools, we demonstrated that the relationships among UGPA, MCAT total scores, and UP generalize across medical schools, although there is some variance in predictive value at lower UGPAs and lower MCAT total scores.

We extended previous research on the predictive validity of the MCAT exam by examining the relationships between UGPAs, MCAT total scores, and our UP indicator, which incorporates data about *not* experiencing academic difficulty resulting in withdrawal or dismissal from medical school, graduating within five years of matriculation, and passing Step 1, Step 2 CK, and Step 2 CS on the first attempt. Our findings indicate that UGPAs and MCAT total scores are both strong predictors of the extent to which matriculants will experience UP; this is important because it shows that UGPAs and MCAT total scores predict academic performance in medical school well beyond the first two years. Our findings are also consistent with research showing that MCAT scores predict IP in medical school[17–19] as well as academic outcomes beyond test scores, such as grades in basic sciences courses, clerkship performance, and academic difficulty or distinction.[1,5]

HOME

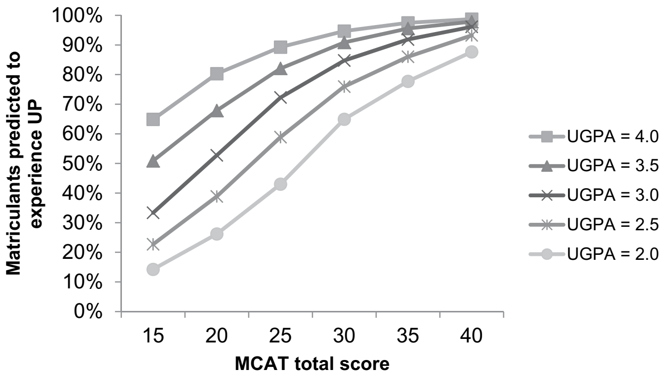

Figure 3 Median percentage of 2001–2004 matriculants at 119 U.S. medical schools predicted to experience unimpeded progress toward graduation (UP) based on undergraduate grade point average (UGPA) and Medical College Admission Test (MCAT) total score. UP was operationalized as *not* being dismissed or withdrawing for academic reasons, graduating within five years, and passing the United States Medical Licensing Examination Step 1, Step 2 Clinical Knowledge, and Step 2 Clinical Skills exams on the first attempt. MCAT total score represents the sum of the matriculant's most recent scores on the three multiple-choice sections of the 1991 version of the exam (possible range, 3–45).

Second, consistent with Julian's study,[1] our findings indicate that MCAT total scores are better predictors of UP than are UGPAs alone. This is likely because the content of the MCAT exam is more closely aligned with the USMLE Step exams (which are a component of UP) than are UGPAs. UGPAs reflect several areas of study and are likely influenced by factors beyond academic knowledge and skill (e.g., study habits). In addition, UGPAs are not standardized across undergraduate institutions.

Third, we found that UGPAs and MCAT total scores together predict UP better than either UGPAs or MCAT total scores do alone. This finding is consistent with previously published research indicating that the combination of UGPAs and MCAT total scores yields the best prediction of scores on the Step exams.[1] It also suggests that medical school admission committees should consider UGPA and MCAT total scores together when evaluating applicants.

Finally, we examined the extent to which the relationships between UGPAs, MCAT total scores, and academic outcomes (i.e., UP) varied across 119 U.S. medical schools. Our results indicated that there was consistency across schools; however, there was more variability between schools in the percentage of matriculants predicted to experience UP at lower UGPAs and lower MCAT total scores. One reason for variability in these relationships is likely sampling error due to differences in sample sizes, applicant pools, and admission criteria. Other reasons include medical schools' different goals and missions, their different standards for academic performance and graduation,[24] and the different levels of academic support they offer throughout medical school and in preparation for the Step exams. These differences, particularly in the level of academic support provided, may have more impact on students with lower UGPAs and lower MCAT scores.

Limitations

This study was limited to the variables about academic performance in medical school available in AAMC databases. Our data did not allow us to examine the relationships between UGPAs, MCAT total scores, medical school grades, clerkship ratings, and other local indicators of students' academic performance in medical school. In addition, results of this study may not generalize to the new versions of the MCAT and Step 1 exams.

There are also some deficiencies of the UP variable which may influence the generalizability of our results and the magnitude of the relationships between UP, UGPAs, and MCAT total scores. As noted above, we employed UP as a composite variable that included *not* withdrawing or being dismissed for academic reasons, graduating within five years, and passing Step 1, Step 2 CK, and Step 2 CS on the first attempt. UP could be defined in different ways, and its components could differ by medical school. For example, it is possible that failing Step 2 CK may not delay graduation at all schools. In addition, UP was limited by the quality of data available about matriculants with planned delays in graduation. We tried to minimize this limitation by excluding matriculants who were enrolled in joint degree programs or other special programs that may delay graduation; however, we were not able to identity all such matriculants.

Additionally, we did not correct for range restriction in the logistic regression analyses because there is not an agreed-on approach for doing so.[25] Further, the majority of matriculants proceed through medical school without major academic setbacks and pass Step 1, Step 2 CK, and Step 2 CS on the first attempt.[24] As a result, there was relatively little variance in UP within or across schools, limiting our ability to detect an effect. Additionally, there were small sample sizes for some extreme UGPAs and MCAT total scores, which may have limited the accuracy and generalizability of our predictions for those UGPAs and MCAT total scores.

Finally, this study did not examine the relationships between UGPAs, MCAT total scores, and physician performance because relevant outcome data were not available. Recent models suggest that physician performance is complex and multidimensional, consisting of several meta-dimensions: academic knowledge and skills (e.g., clinical knowledge and expertise, clinical problem solving), interpersonal skills (e.g., communicating and building relationships), and intrapersonal skills (e.g., professional integrity, personal organization).[26–28] It is important to note that the MCAT exam is *not* designed to predict the entire domain of medical student or physician performance. Rather, it is designed to predict academic knowledge and skills alone. Other admission tools, such as the interview, are intended to predict interpersonal and intrapersonal aspects of medical student and physician performance.

Future directions

As admission tools are designed to predict different aspects of performance, we suggest that future research on predictive validity clearly specify which aspects of performance the tool is designed to predict and provide a conceptual rationale for specific predictor–outcome relationships. Future research on the MCAT exam should examine whether MCAT total scores predict long-term academic knowledge and skills in clinical settings. For example, outcomes like diagnostic accuracy, recertification, career distinction, and promotion in military settings would be conceptually appropriate outcomes given the purpose of the MCAT exam. Additionally, as performance is multidimensional in nature, it is important to evaluate the incremental contribution of nonacademic factors (e.g., interpersonal skills) above UGPAs and MCAT total scores in predicting academic knowledge and skills. Likewise, future research should assess whether UGPAs and MCAT total scores contribute to the prediction of other aspects of performance, such as communication skills or demonstrating cultural competence, which may rely on specific technical knowledge.

We also suggest that this study be replicated with data from the future versions of the MCAT exam and Step exams and with BCPM GPA. Researchers should also examine school-level variables (e.g., provision of academic support, mission, class size) that may moderate the relationships between UGPAs, MCAT total scores, and various medical student outcomes. For example, does smaller class size or the provision of academic support reduce the relationships between UGPAs, MCAT scores, and UP? To these ends, the AAMC plans to establish a validity studies service with a pilot group of medical schools to validate the 2015 version of the MCAT exam. This service will be used to expand the evidence base for the validity of the MCAT exam, and it will act as a springboard for ongoing and collaborative validity research between the AAMC and member schools.

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Do Racial and Ethnic Group Differences in Performance on the MCAT Exam Reflect Test Bias?

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Abstract

The Medical College Admission Test (MCAT) is a standardized examination that assesses fundamental knowledge of scientific concepts, critical reasoning ability, and written communication skills. Medical school admission officers use MCAT scores, along with other measures of academic preparation and personal attributes, to select the applicants they consider the most likely to succeed in medical school. In 2008–2011, the committee charged with conducting a comprehensive review of the MCAT exam examined four issues: (1) whether racial and ethnic groups differ in mean MCAT scores, (2) whether any score differences are due to test bias, (3) how group differences may be explained, and (4) whether the MCAT exam is a barrier to medical school admission for black or Latino applicants.

This analysis showed that black and Latino examinees' mean MCAT scores are lower than white examinees', mirroring differences on other standardized admission tests and in the average undergraduate grades of medical school applicants. However, there was no evidence that the MCAT exam is biased against black and Latino applicants as determined by their subsequent performance on selected medical school performance indicators. Among other factors which could contribute to mean differences in MCAT performance, whites, blacks, and Latinos interested in medicine differ with respect to parents' education and income. Admission data indicate that admission committees accept majority and minority applicants at similar rates, which suggests that medical students are selected on the basis of a combination of attributes and competencies rather than on MCAT scores alone.

The medical school admission process involves recruiting, evaluating, and accepting applicants to medical school. During the evaluation process, admission officers review a wide variety of applicant data related to academic preparation, personal attributes, and extracurricular experiences to assess applicants' strengths and determine their likelihood of success in medical school. In determining whom to accept, admission officers must weigh these data in relation to the institution's mission, goals, and diversity interests.

One important source of academic preparation data is the Medical College Admission Test (MCAT), a standardized examination that assesses fundamental knowledge of scientific concepts, critical reasoning ability, and written communication skills. MCAT scores are the only common metric of academic preparedness on which medical school applicants can be compared because the meaning of undergraduate grade point averages (UGPAs) can vary by field, course, and undergraduate institution.[1,2]

It is vital, therefore, that tests used in high-stakes decisions, such as medical school admissions, be subjected to the highest levels of scrutiny. Professional testing standards call for an ongoing program of validation to collect evidence about such tests' validity, reliability, and fairness, among other things.[3]

Medical college admission officers, as primary users of MCAT scores, recognize the criticality of ensuring that the MCAT exam produces valid and reliable information about applicants' academic preparedness and that scores are used appropriately in the admission process. They have a stake in ensuring that MCAT content is relevant, that the exam predicts important medical school outcomes, and that the test does not unfairly disadvantage any applicant group.

The importance of these considerations is heightened in the context of selecting a diverse student body. Diversity, including but not limited to racial and ethnic diversity, is widely viewed as an important goal by admission committees. Admitting a heterogeneous student body may help the medical school achieve its distinct missions and goals, such as serving underserved communities or populations. A diverse student body has been linked to important benefits in medical school and beyond, including improved teaching[4] and learning[5] and strong attitudes about the importance of equitable access to care.[6] Further, increasing the diversity of medical students increases the likelihood that future physicians will be prepared to care for a diverse and global patient population, as well as to serve communities with disparate health care needs.[6]

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In this article, we examine evidence culled from extant data and primary research findings about the use of the MCAT scores of white, black, and Latino medical school applicants. This research was conducted as part of the fifth comprehensive review (MR5) of the MCAT exam, the current version of which was introduced in 1991. The Association of American Medical Colleges (AAMC) convened the MR5 Committee to evaluate the current exam and make recommendations for a new version. This reviewed research related to medical school admissions, racial and ethnic group differences in academic achievement, bias in testing, stereotype threat, test speededness, and the predictive value of MCAT scores. Primary analyses were also conducted, using data from the total population of MCAT examinees, from the subset of examinees who applied to medical school, and from the more restricted groups of examinees who received offers of acceptance from one or more medical schools and of examinees who ultimately matriculated.

Here, we present our analysis of primary and extant data sources, organized around four issues central to the question of whether racial and ethnic group differences in MCAT performance reflect test bias. First, we evaluate how mean scores on the MCAT differ for racial and ethnic groups, and how these differences compare to differences on other widely used admission exams. Second, we examine whether MCAT scores exhibit bias in their prediction of subsequent outcomes—specifically, graduation from medical school and United States Medical Licensing Examination (USMLE) Step 1 performance. Third, we explore possible explanations for mean differences on MCAT scores, such as family, neighborhood, and school conditions that may limit an applicant's opportunities to achieve his or her potential. Finally, we consider whether the MCAT exam acts as a barrier to medical school admission for underrepresented minorities (URMs).

To examine these issues, we extracted data from the data warehouse maintained by the AAMC, which contains records of MCAT examinees, applicants to U.S. medical schools, and students who have matriculated at U.S. medical schools.

The AAMC assigns a unique personal identifier to each person's data, which allows researchers to link deidentified records for analysis. We limited our study to data for individuals who self-reported their race/ethnicity as white, black, or Latino because data for other URM groups were based on small sample sizes insufficient for the analyses. Preliminary analyses were conducted during 2008–2011, and we finalized our results in May 2012. This study was approved by the institutional review board of the American Institutes for Research as part of the MCAT program's psychometric research protocol.

Question 1: Do White, Black, and Latino Applicants Differ in Mean MCAT Scores?

The MCAT exam has been shown to be a useful predictor of selected benchmarks of success in medical school, both when considered alone and in combination with other academic credentials.[7–9] Evidence from a wide variety of sources has demonstrated that well-developed standardized tests of knowledge, skill, and achievement, including the MCAT exam, are valid predictors of performance in a variety of employment and academic settings.[10,11]

Although the MCAT exam has been shown to be an effective predictor of performance in medical school, differences have been observed between the mean MCAT scores of examinees in different racial and ethnic groups. Prior research has reported, for example, that mean MCAT scores are lower for black and Latino students than for white students.[8] Using data for white, black, and Latino examinees who tested during 2009, we calculated mean MCAT total and section scores, as well as standardized mean differences (*d*s) to facilitate interpretation of between-group differences. A *d* of 0 reflects no difference in mean scores between groups, whereas a positive *d* reflects a majority mean that is higher than the minority mean, and a negative *d* reflects a minority mean that is higher than the majority mean. In terms of magnitude of differences, a *d* of 0.2 is small, 0.5 is medium, and 0.8 is large.[12] As reported in Table 1, we found large standardized mean differences in MCAT total scores (white–Latino = 0.8, white–black = 1.0) and medium to large differences in MCAT section scores that

Table 1

MCAT Scores for 2009 Examinees and Undergraduate GPAs for Medical School Applicants to the 2010 Matriculating Class, Means and Standardized Mean Differences (*d*s) by Racial and Ethnic Group*

Data type	White, mean (SD)	Black, mean (SD)	Latino, mean (SD)	*d*†,‡ White–black	White–Latino
MCAT score§,¶					
Total score	26.3 (5.9)	20.0 (6.3)	21.6 (6.9)	*1.0*	*0.8*
Biological sciences	9.1 (2.4)	6.9 (2.6)	7.5 (2.8)	*0.9*	0.6
Physical sciences	8.5 (2.4)	6.6 (2.2)	7.1 (2.4)	*0.8*	0.6
Verbal reasoning	8.7 (2.2)	6.5 (2.5)	7.0 (2.7)	*0.9*	*0.8*
Undergraduate GPA**	3.6 (0.3)	3.3 (0.4)	3.4 (0.4)	*0.9*	0.5

* Individuals who self-identified as white alone were classified as white, individuals who self-identified as black alone or in combination with other races (including white) were classified as black, and individuals who self-identified as Latino alone or in combination with other races (including white) were classified as Latino.

† $d = \frac{(\text{mean}_{\text{white}} - \text{mean}_{\text{black or Latino}})}{\text{SD}_{\text{pooled}}}$, where $\text{SD}_{\text{pooled}} = \sqrt{\frac{(N_{\text{white}} - 1)\text{var}_{\text{white}} + (N_{\text{black or Latino}} - 1)\text{var}_{\text{black or Latino}}}{(N_{\text{white}} - 1) + (N_{\text{black or Latino}} - 1)}}$

‡ Italicized values reflect large *d*s; other values reflect medium *d*s.

§ MCAT indicates Medical College Admission Test. Sample sizes for white, black, and Latino examinees were 33,807, 6,183, and 5,810, respectively. The most recent score in 2009 was used for repeat examinees. Source: AAMC Data Warehouse: Examinee File, accessed January 27, 2012.

¶ The MCAT exam has three multiple-choice sections, scored 1–15, for which data are reported here. The total score reflects the sum of these three section scores and ranges from 3 to 45. The MCAT exam also includes a Writing Sample section, whose results are not reported here.

** Sample sizes for white, black, and Latino applicants to MD-granting U.S. medical schools were 23,472, 3,642, and 3,262, respectively. Source: AAMC Data Warehouse: Applicant Matriculant File accessed January 27, 2012.

are consistent with differences in MCAT scores from other years.[8]

We also compared the mean UGPAs of white, black, and Latino medical school applicants who applied for admission to the 2010 matriculating class. The large white–black difference ($d = 0.9$) is similar in magnitude to that in mean MCAT total scores, whereas the medium white–Latino difference ($d = 0.5$) is somewhat smaller than that in MCAT total scores.

The mean differences we found in 2009 MCAT scores mirror differences on other standardized tests used for a variety of educational purposes.[10,13–20] Table 2 presents *d*s for several graduate admission exams including the Graduate Record Examination (GRE), the Graduate Management Admission Test (GMAT), and the Law School Admission Test (LSAT), all of which have been shown to have racial/ethnic differences in test performance comparable to (or greater than) those on the MCAT exam.[13,15,19] As this table illustrates, the performance differences on graduate admission exams are also similar to those seen on undergraduate admission tests[14,15,19] and on measures of earlier achievement in kindergarten through high school.[19]

It is critical, however, to recognize that mean differences in MCAT scores do not provide a complete picture of black and Latino examinees' performance on the MCAT exam compared with that of white examinees. Specifically, substantial overlap exists in the distribution of MCAT scores for these three groups of examinees (Figure 1).

Question 2: Are the Mean Differences in MCAT Scores Due to Test Bias?

Numerous authors in the popular and academic press have expressed concern that the mean differences in majority and URM examinees' performance on admission and other standardized tests could be due to test bias.[10,21–24] Test bias is a fundamental concern when life-altering decisions rely in part on test scores, because it could unfairly limit access to opportunities—in the case of the MCAT exam, test bias could affect admission to medical school. Although some individuals may conclude that any test showing average differences in performance between majority and URM examinees is biased, such differences, in the absence of corroborating evidence, are insufficient to conclude that there is bias.[3,25] Instead, professional testing standards compel testing experts to gather logical and empirical evidence about potential sources of these group differences using well-established (and generally agreed-on) procedures to determine whether test bias exists.[3]

Test bias arises "when deficiencies in a test itself or the manner in which it is used result in different meanings for scores earned by members of different identifiable subgroups."[3] Deficiencies in the test could be caused by construct-irrelevant variance, which occurs when test performance is influenced by factors, such as test content and administration conditions, that are unrelated to the knowledge and skills, or the "construct," measured by a test. Item content is also construct-irrelevant if it draws on experiences more common to one group of examinees than another and is unrelated to the knowledge or skills being measured. Researchers evaluate whether these types of construct-irrelevant factors cause people with the same underlying skill level to earn different test scores.[3,26]

Two broad strategies are employed to examine the possibility of bias in the MCAT exam. First, extensive resources are devoted to preventing irrelevant test content from influencing performance and to making sure that the test administration is standardized and relies on procedures suited to the tasks being performed by the examinee. MCAT item writers, reviewers, and editors follow detailed guidelines to ensure that the content of passages and items meets test specifications. All items undergo bias and sensitivity review by experts with diverse backgrounds to identify and eliminate any features of the items that are construct-irrelevant. Items that survive the bias and sensitivity review are tried out on the MCAT exam but are not counted in examinees' scores. Instead, examinees' responses to these items are analyzed to determine whether the items are of appropriate difficulty and adequate reliability. Only items that survive these sensitivity and empirical reviews are used as scored items on the MCAT exam. The MCAT administration process is also standardized to ensure

Table 2

White–Black and White–Latino Standardized Mean Differences (*d*s) on Different Types of Admission and School Exams

	*d**	
Exams by type	White–Black	White–Latino
Graduate admission exams		
Medical College Admission Test (MCAT)	1.0†	0.8†
Graduate Record Examination (GRE)	1.3‡	0.7‡
Graduate Management Admission Test (GMAT)	1.0§	0.4§
Law School Admission Test (LSAT)	1.1§	0.9§
Undergraduate admission exams		
SAT Composite	1.1¶	0.8**
ACT Composite	1.0††	0.7††
K–12 measures		
Elementary school math samples	0.9‡‡	0.7‡‡
Elementary school verbal/reading samples	0.8‡‡	0.7‡‡
High school math samples	0.9‡‡	0.8‡‡
High school reading samples	0.8‡‡	0.7‡‡

* The *d*s in this table were drawn from other sources; they were originally reported to two or more places after the decimal point.
† Based on scores of examinees who took the MCAT exam in 2009. Source: AAMC Data Warehouse: Examinee File, accessed January 27, 2012.
‡ Test scores from 1988 to 1997. Source: Roth et al, 2001.[13]
§ Test scores from 1996 to 1997. Source: Camara and Schmidt, 1999.[15]
¶ Test scores from 1987 to 2006. Source: Sackett and Shen, 2010.[19]
** Test scores from 1992 to 2006. Source: Sackett and Shen, 2010.[19]
†† Test scores from 1997 to 2005 and 2007. Source: Sackett and Shen, 2010.[19]
‡‡ Test scores ranging from pre-1970 to 2004. Source: Sackett and Shen, 2010.[19]

that scores have comparable meaning. Examinees receive the same instructions, the same amount of testing time, and the same types of computer equipment to eliminate the possibility that differences in test scores are caused by differences in administration conditions. (Examinees with appropriately documented disabilities are granted nonstandard accommodations to minimize aspects of a disability that are not related to the construct being measured.)[3]

Second, "differential prediction"[3] analysis is used to examine whether a given MCAT score forecasts the same level of future performance regardless of the examinee's race or ethnicity. If the MCAT exam predicts success in medical school in a comparable fashion for different racial and ethnic groups, medical students with the same MCAT score will, on average, achieve the same outcomes regardless of racial or ethnic background.[25] On the other hand, if their outcomes differ significantly, test bias in the form of differential prediction exists because the prediction will be more accurate for some groups than for others. Determining whether the MCAT exam is biased in identifying who will be successful in medical school is of utmost importance because of the role that MCAT scores play in the process of selecting qualified applicants.[27,28]

Consider, for example, using MCAT scores to predict the likelihood of medical students' graduating within four years of matriculation. We would look for bias in prediction by comparing the predicted and observed graduation rates for each group. If 90% of students with a given MCAT score were predicted to graduate in four years, we would expect the observed graduation rates for white and black students earning that MCAT score to be highly similar and around 90%. If the observed graduation rates were 90% for white students but 95% for black students with the same MCAT score, this would be evidence of predictive bias against black students because their four-year graduation rate was higher than predicted and also higher than that of white students earning the same score. This is an example of underprediction.

In general, if a test were to *underpredict* the performance of a group, the observed performance of students in that group would be *higher* than their predicted performance. Underprediction of URM students' performance is important in the context of medical school admissions because if URMs perform better in medical school than their MCAT scores would suggest, they may be admitted at lower rates than they should be.

We therefore examined the differential prediction of the MCAT exam for white, black, and Latino students who matriculated at U.S. medical schools in 2000–2004 for two types of medical school outcomes: (1) passing USMLE Step 1 and (2) graduating from medical school. We used MCAT total scores to predict pass/fail status on the Step 1 exam, both at first attempt and eventually (after additional attempts until 2010), and to predict graduation status four and five years after matriculation. All outcome measures were dichotomous, coded as "1" if a student succeeded (e.g., graduated within four years) and "0" if a student did not succeed (e.g., did not graduate within four years).

We conducted logistic regression analyses to estimate the probability of success on the basis of students' MCAT total scores (e.g., the probability that someone earning an MCAT total score of 27 will graduate in four years). We compared the predicted success rates with the observed success rates—separately for white, black, and Latino students—to examine whether the MCAT exam is biased against URM (i.e., black and Latino) students in its predictions of their performance in medical school. For each outcome measure, we conducted two identical sets of logistic regression analyses: one for black and white students and one for Latino and white students.* We conducted the analyses separately by school and then pooled the results.†

We defined prediction error as observed minus predicted success rates, so positive differences indicate that more students succeeded than predicted, whereas negative differences indicate that fewer students succeeded than predicted. For example, on the outcome of graduation within four years of matriculation, positive differences would indicate that MCAT scores underestimated black (or Latino) students' performance in medical school because more black (or Latino) students graduated in four years than were predicted to graduate in four years on the basis of their MCAT total scores. On the other hand, zero or negative differences would indicate, respectively, that the same number of

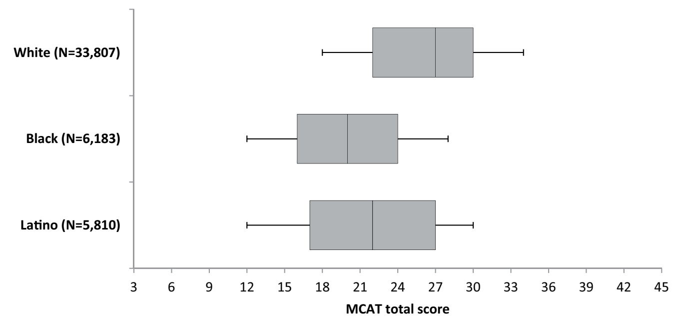

Figure 1 The distribution of Medical College Admission Test (MCAT) total scores* for white, black, and Latino examinees who tested in 2009. The box-and-whisker plots show the scores associated with the 10th, 25th, 50th (median), 75th, and 90th percentiles for each group. The most recent score in 2009 was used for repeat examinees. Source: AAMC Data Warehouse: Examinee File, accessed January 27, 2012.
*The MCAT exam has three multiple-choice sections, each of which is scored 1 to 15. The total score reflects the sum of these three section scores and ranges from 3 to 45. The MCAT exam also includes a writing sample section, whose results are not reported here.

*By conducting analyses separately for the set of black and white students and for the set of Latino and white students, we explicitly established white students as the benchmark against which differential prediction of each minority group was compared. Results based on an overall model that included all three groups in the same analysis did not differ appreciably in magnitude or direction of differences.

†For each school, we summed the predicted probabilities of success separately for white and black students, computing four indices: (1) predicted number of white students succeeding, (2) observed number of white students succeeding, (3) predicted number of black students succeeding, and (4) observed number of black students succeeding. We then summed these four indices over all schools. We performed the same set of steps to estimate the predicted and observed numbers of students succeeding for Latino and white students.

Table 3

Comparison of Observed and Predicted Success Rates on Four Measures of Medical School Performance for White, Black, and Latino Medical Students Who Matriculated at MD-Granting U.S. Medical Schools From 2000 to 2004*,†

	White students						Black students					
Outcomes‡	N	Mean MCAT score	Observed success, %	Predicted§ success, %	Difference¶ Freq	Difference¶ %	N	Mean MCAT score	Observed success, %	Predicted§ success, %	Difference¶ Freq	Difference¶ %
Pass Step 1 on first attempt	49,072	30.3	96.0	95.8	133	0.3	5,955	24.7	80.9	83.1	−133	−2.2
Pass Step 1 eventually	49,072	30.3	99.6	99.6	17	0.0	5,955	24.7	98.0	98.3	−17	−0.3
Graduate in 4 years	46,590	30.1	88.9	88.1	371	0.8	5,653	24.4	71.0	77.5	−371	−6.6
Graduate in 5 years	46,590	30.1	95.6	95.2	193	0.4	5,653	24.4	86.1	89.5	−193	−3.4

	White students						Latino students					
Outcomes‡	N	Mean MCAT score	Observed success, %	Predicted§ success, %	Difference¶ Freq	Difference¶ %	N	Mean MCAT score	Observed success, %	Predicted§ success, %	Difference¶ Freq	Difference¶ %
Pass Step 1 on first attempt	49,072	30.3	96.0	95.8	84	0.2	5,228	26.2	86.0	87.6	−84	−1.6
Pass Step 1 eventually	49,072	30.3	99.6	99.6	12	0.0	5,228	26.2	98.4	98.6	−12	−0.2
Graduate in 4 years	46,590	30.1	88.9	88.4	245	0.5	5,073	26.0	76.8	81.6	−245	−4.8
Graduate in 5 years	46,590	30.1	95.6	95.4	111	0.2	5,073	26.0	89.3	91.5	−111	−2.2

* Source: AAMC Data Warehouse: Medical College Admission Test (MCAT) Examinee, Medical Student, and United States Medical Licensing Examination (USMLE) data from the National Board of Medical Examiners, accessed January 27, 2012.

† Students who self-identified as white alone were classified as white, students who self-identified as black alone or in combination with other races (including white) were classified as black, and students who self-identified as Latino alone or in combination with other races (including white) were classified as Latino.

‡ Step 1 indicates the USMLE Step 1 exam; "eventually" reflects additional attempts through 2010. The graduation analyses excluded students enrolled in joint-degree programs (e.g., MD-PhD), participating in special research/nonresearch studies, or who were deceased. If a student took the MCAT exam more than once, his or her most recent score at the time of matriculation was used in these analyses.

§ Separate logistic regression models were estimated for the black–white and Latino–white comparisons. The use of different regression models resulted in slightly different predicted success rates for white medical students. Basing analyses on a single, combined model would not have substantially changed the overall direction or magnitude of the differences. Analyses were conducted within schools and then pooled.

¶ *Difference* is computed as the observed number of medical students who succeeded on a criterion (e.g., graduate in 4 years) minus the number who were predicted to succeed. *Freq* is the difference between observed and predicted numbers succeeding, rounded to the nearest whole number. Positive values indicate that more medical students in a group succeeded than predicted. Negative values indicate that fewer medical students in a group succeeded than predicted.

or fewer black (or Latino) students succeeded on the criterion than were predicted to succeed on the basis of their MCAT total scores, suggesting that the MCAT exam is not biased against black (or Latino) students.

The results of our analysis are summarized in Table 3. For the outcome of passing Step 1 on the first attempt, 83.1% of black students were predicted to pass compared with 80.9% who actually passed. In other words, 2.2% fewer black students passed Step 1 than were predicted to pass. Similarly, 1.6% fewer Latino students passed than were predicted to pass. The differences between observed and predicted success rates were smaller for the outcome of passing Step 1 eventually, but these analyses similarly did not show underprediction that would suggest the MCAT exam is biased against black or Latino students (–0.3% and –0.2%, respectively).

The results for predicting graduation rates were similar. Specifically, fewer black and Latino medical students graduated in four years than were predicted to graduate (–6.6% and –4.8%, respectively). The differences between the observed and predicted percentages of students graduating in five years were smaller (–3.4% and –2.2% for black and Latino students, respectively). These results indicate that the graduation rates of black and Latino medical students were not underpredicted by the MCAT exam.

Two important trends are reflected in Table 3. First, the differences between the observed and predicted success rates are greater for passing Step 1 on the first attempt and graduation within four years of matriculation than they are for the outcome measures reflecting eventual (or later) success. As the success rates approach 100%, the differences decrease. The second, and arguably more important finding, is that these results provide no evidence that the MCAT exam is biased against either black or Latino medical students—that is, none of the four outcomes showed these minority groups succeeding at rates greater than those predicted by their MCAT scores.

Our findings are consistent with past studies on the differential prediction of the MCAT exam and other standardized tests used for college and graduate school admissions, which have shown no statistically significant predictive bias against minority students.[8,26,29–31] Confirming that the current MCAT exam is *not* biased against black and Latino applicants was important as the MR5 Committee sought to identify changes that would improve the exam's value in identifying the applicants who are the most likely to succeed in medical school.

Question 3: What Might Explain Mean Differences in MCAT Scores Across Groups?

If the MCAT exam is not biased, what other factors could be contributing to differences in MCAT scores? The environments and experiences of youth raised in the United States vary in innumerable ways, as reflected in social class and economic status; rural, suburban, or urban environments; variations in racial and ethnic diversity in communities, neighborhoods, and schools; and access to resources and educational opportunities, to name a few. Some of these environments have been shown to contribute—positively or negatively—to academic achievement, meaning that exposure to some conditions may maximize one's potential for achievement, whereas exposure to other conditions may limit one's potential.[32–35] None of these factors works in isolation; rather, it is likely that both positive and negative conditions accumulate, taking shape in different ways for different people.

Family and neighborhood characteristics, educational factors, and geographic conditions all have been shown to correlate with academic achievement gaps spanning kindergarten through high school and college; these gaps, in turn, have been shown to vary systematically by racial and ethnic group status.[32–35] Table 4 presents a small sample of the various factors that correlate with the academic achievement gaps among racial and ethnic groups. The risk factors analyzed in these prior studies suggest that, compared with white students, black and Latino students generally are more likely to be exposed to school, family, and environmental conditions that may reduce their potential for academic achievement and are less likely to be exposed to positive factors. For example, black and Latino third-graders are more likely than white third-graders to report having changed schools three or more times since the first grade[32] and to live in food-insecure households.[34] Conversely, the parents of white students in grades K to 12 are more likely to volunteer or serve on a committee at their child's school than are the parents of black and Latino students.[34] Black and Latino students are more likely to experience living in poverty and attending low-quality day care,[35] whereas white students are more likely to be read to every day by a family member.[34]

The prevalence of the environmental conditions reported in Table 4 for the general U.S. population may not reflect the conditions experienced by medical school examinees, applicants, or

Table 4

Factors Affecting the General Population Related to Academic Achievement Gaps Between Racial and Ethnic Groups*

Factors by type	% of individuals of same racial/ethnic group to whom factors apply: White	Black	Latino
Early environmental factors			
Children aged 0–17 living in poverty†	11	36	29
Children aged 0–17 living in food-insecure households (in which children are at risk of getting inadequate nutrition)‡	12	29	24
Children aged 0–17 in families where no parent has full-time, year-round employment†	27	50	39
Children aged 0–17 living in single-parent household‡	23	56	29
Children (at about age 2) attending low-quality day care†	27	75	63
Children aged 3–5 who are not read to every day by a family member‡,§	32	50	55
Children aged 1–5 with "elevated" blood lead levels (elevated defined by CDC)‡	1	4	**
K–12 educational factors			
Third-grade students who changed schools three times or more since first grade¶	13	27	25
Eighth-grade students whose teachers have four years or less of experience as elementary or secondary school teachers‡	20	28	30
Eighth-grade math students whose teachers left before the end of the school year‡	28	52	44
Eighth-grade math students whose teachers have neither an undergraduate major nor minor in math‡	40	45	44
Students in grades K–12 whose parents did not report volunteering or serving on a committee at their child's school‡,§	52	68	72
Students aged 12–18 who reported that street gangs were present at school‡	17	37	38

* The percentages in this table were drawn from other sources; they were originally reported to one or more places after the decimal point. CDC indicates Centers for Disease Control and Prevention.
† Data from 2003 to 2005. Source: Barton and Coley, 2007.[35]
‡ Data from 2000s. Source: Barton and Coley, 2009.[34]
§ This factor was reframed in the opposite direction to be consistent with the framing of the other factors presented in this table; the percentages for each group were recomputed for inclusion here.
¶ Data from 1990 to 1991. Source: Barton, 2003.[32]
** Data not available.

Table 5

Profiles of White, Black, and Latino MCAT Examinees, Medical School Applicants, and Matriculants at U.S. Medical Schools, 2010*

Factors by type	% of individuals of the same racial/ethnic group to whom factors apply		
	White	Black	Latino
Parental education			
No parent has a college degree[†]	13	31	30
At least one parent has a college degree, but none have graduate degrees[†]	31	27	28
At least one parent has a graduate degree[†]	56	42	42
Parental income			
Single-parent household[†]	7	26	17
Qualified for fee assistance program[‡]	3	17	10
Family income by quintile of U.S. household incomes[§]			
Family income in the lowest quintile	4	18	12
Family income in the second lowest quintile	4	15	11
Family income in the middle quintile	10	15	20
Family income in the second highest quintile	26	23	23
Family income in the highest quintile	56	29	34
Undergraduate education			
Applicants who attended more than three colleges[†]	3	6	4
Examinees who did not attend a college with access to a pre-health advisor[‡,¶]	3	5	3
MCAT preparation			
Examinees who did not participate in any MCAT prep course[¶,**]	48	49	46
Examinees who did not participate in a private MCAT prep course[¶,**]	54	58	52

*Students who self-identified as white alone were classified as white, students who self-identified as black alone or in combination with other races (including white) were classified as black, and students who self-identified as Latino alone or in combination with other races (including white) were classified as Latino. MCAT indicates Medical College Admission Test.

† Data for white (n = 23,861), black (n = 3,737), and Latino (n = 3,335) applicants to MD-granting U.S. medical schools who applied to enter the 2010 matriculating class. Source: AAMC Data Warehouse: Applicant Matriculant File, accessed May 18, 2012.

‡ Data for white (n = 34,495), black (n = 6,461), and Latino (n = 5,975) examinees who took the MCAT exam in 2010. Source: AAMC Data Warehouse: Examinee and Applicant Matriculant Files, accessed May 18, 2012.

§ Data for white (n = 7,381), black (n = 833), and Latino (n = 751) students who matriculated to 130 MD-granting U.S. medical schools in 2010 and answered the question "Regardless of your dependency status, please indicate your parents' combined gross income for last year (a rough estimate is sufficient)" in the 2010 Matriculating Student Questionnaire. Sources: AAMC Data Warehouse: Matriculant Student Questionnaire File, accessed May 18, 2012, and U.S. Census data, Table H-1.[38]

¶ This factor was reframed in the opposite direction to be consistent with the framing of the other factors; the percentage for each group was recomputed.

**Data for white (n = 32,417), black (n = 6,142), and Latino (n = 5,600) examinees who took the MCAT exam in 2010 and who answered a survey question about test preparation activities at the completion of the exam. Source: Postexam survey results obtained from Prometric, October 27, 2010.

matriculants, however. Recent research suggests that medical students are more likely to come from families earning incomes that are higher than those of families in the general population[36] and that white medical students' parental education levels are likely to be higher than those of URM medical students.[37] For example, in each year from 1987 to 2005, less than 6% of medical students had parental incomes in the bottom fifth of U.S. household incomes, whereas 48% of medical students had parental incomes in the highest fifth.[36,38] We therefore explored whether, within the select group of persons interested in medical school, whites, blacks, and Latinos varied in their exposure to certain conditions that could influence their achievement on the MCAT exam.

Table 5 presents selected indicators pertaining to parental education and income, along with undergraduate education indicators and MCAT preparation activities for whites, blacks, and Latinos who, in 2010, took the MCAT exam, applied to medical school, or matriculated. These data suggest that although medical schools disproportionately attract individuals from better economic circumstances than those of the general population, differences exist in the conditions experienced by whites, blacks, and Latinos who are interested in pursuing a medical degree. We found that, compared with white applicants, black and Latino applicants were less likely to have at least one parent who earned a college or graduate degree and more likely to have no parent with a college degree. Black and Latino applicants were also more likely than white applicants to have been raised in families with lower household incomes or in single-parent households and to qualify for the fee assistance programs provided by the AAMC.

The data in Table 5 suggest only a small sample of the potential explanations for average differences in performance on the MCAT exam. Beyond the influence of socioeconomic status, achievement may be influenced (positively or negatively) by differential access to the educational or occupational opportunities that can occur through social and cultural capital—whereby individuals with certain social networks gain access to opportunities that promote academic achievement[39,40]—or by institutional racism, where differential access to opportunities is incorporated into institutional policies or practices.[41] Similarly, achievement may be influenced by repeated exposure to subtle slights or microaggressions[42] that permeate the educational process and cause the individual to question his or her own competence on the basis of his or her race or ethnicity.[43] These various influences are complex and were not addressed by this study.

Although the data in Table 5 provide context for understanding group differences in MCAT performance, they cannot provide direction for deciding which applicants will be successful in medical school. No two applicants will have the same school, home, and life experiences. Indeed, the same life

HOME

experiences could have different effects on achievement for any two applicants. It is also true that these factors are correlates rather than determinants of performance. Students of varying backgrounds have succeeded in medical school and, more importantly, as practicing physicians. Finally, as discussed previously, whereas white, black, and Latino applicants' exposure to risk factors and mean MCAT scores vary, there is a wide range of overlap in the MCAT scores (Figure 1). Between-group differences in exposure to risk factors in the general or the medical school applicant population do not readily apply to any individual in a particular group.

Question 4: Does the MCAT Exam Act as a Barrier to Admission for Black and Latino Applicants?

In this section, we examine admission decisions as a means of understanding how medical school admission committees weigh white, black, and Latino applicants' MCAT scores in relation to other personal characteristics and life experiences, as well as other indicators of academic preparedness. The admission process is complex and involves multiple stages[44]; in addition, each medical school establishes its own criteria and weights for different types of applicant data to select students who will succeed given the educational program, resources, and mission of the institution. At the end of the process, however, each committee makes decisions about whom to accept, and this admission decision is therefore our focus. Specifically, the mean differences in MCAT performance and in UGPAs reported in Table 1 suggest that if these academic credentials were highly emphasized in the admission process, the acceptance rates of black and Latino applicants would be considerably lower than those of white applicants.

Figure 2 compares white, black, and Latino individuals' academic qualifications, as measured by MCAT scores and reported in applications for admission to the 2010 matriculating class, with the percentages of applicants in each group who were ultimately offered acceptance by one or more medical schools. As the figure illustrates, the percentage of white applicants with MCAT scores ≥ 25 is much greater than the percentage of black or Latino applicants reporting similar scores (84% for whites versus 37% for blacks and 56% for Latinos). This profile of MCAT scores stands in sharp contrast to the overall acceptance rates shown in Figure 2 (47% for whites versus 40% for blacks and 49% for Latinos), reflecting differences of 7 percentage points for white versus black applicants and –2 percentage points for white versus Latino applicants.

The similar overall acceptance rates for the three groups suggest that admission committees do not limit themselves to the consideration of MCAT scores in their efforts to identify the applicants who are the most likely to succeed in medical school. If they did, differences in acceptance rates across racial and ethnic groups would more closely parallel differences in their mean MCAT scores. That is, greater emphasis on the MCAT exam would decrease the percentages of minority applicants selected for entry into medical school.[11] In sum, although group differences on the MCAT exam have the potential to reduce the percentage of URM students selected into medical school, these results show that this is not occurring in practice.

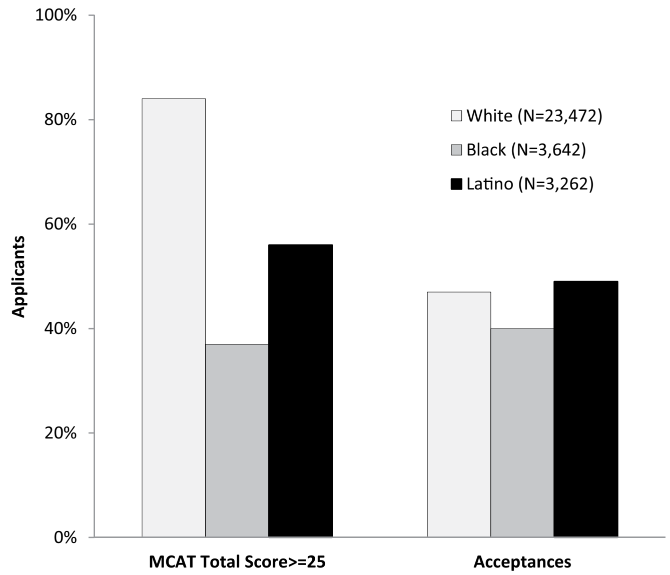

Figure 2 The percentages of white, black, and Latino individuals applying for admission to the 2010 matriculating medical school class with Medical College Admission Test (MCAT) total scores ≥ 25,* and the percentages of those same applicants who were accepted into at least one MD-granting U.S. medical school. If an applicant took the MCAT more than once, his or her most recent score at the completion of the application cycle was used in this analysis. Source: AAMC Data Warehouse: Applicant Matriculant File, accessed January 27, 2012.
*An MCAT total score of 25 was selected as the cut score because more than 75% of applicants report MCAT total scores ≥ 25, and the profile of percentages of white, black, and Latino applicants reporting scores at or above a given threshold remained very similar when the threshold was set at higher and lower values. Only when the threshold was set at MCAT total scores between 15 and 20 were the differences reduced in the profile of percentages of white, black, and Latino applicants reporting scores at or above the cut. MCAT total scores reflect the sum of the exam's three multiple-choice sections and range from 3 to 45.

In Conclusion

Black and Latino examinees had lower average 2009 MCAT scores than did white examinees. The between-group differences we found are similar to those reported for the GRE, LSAT, SAT, and other admission tests. They also are similar to differences in the average UGPAs of URM and majority medical school applicants. Our findings do not, however, point to bias in the design, use, or predictive value of the MCAT exam. Rather, data that predict medical students' performance on the basis of their MCAT scores show that the MCAT exam is not biased against black and Latino applicants. Factors other than bias in the exam might explain differences in performance, such as family, neighborhood, and school conditions, which relate to academic achievement and differ by group. Admission committees accept majority and URM applicants at similar rates, looking beyond MCAT data to select students with a wide range of experiences and characteristics. Indeed, the high success rates for all students on the outcomes we examined likely reflect multiple influences, including admission committees' use of MCAT scores in conjunction with other data in determining applicants' likelihood for success in medical school, the resources provided by institutions to assist students who need support, and the efforts of the medical students themselves.

Although this study provides evidence that the current MCAT exam is not biased against URMs in predicting performance in medical school, additional research is needed. Arguably, passing Step 1 and graduating are not the only measures of success in medical school. It is important to understand how the MCAT exam predicts other important measures of medical student performance that it might reasonably be expected to predict and, conversely, which outcomes it does not predict well.[45] Upcoming changes to the MCAT exam will necessitate the collection of new evidence on the predictive validity of the revised test, particularly with respect to aspects of medical school performance that rely on foundations of scientific reasoning, reasoning with data, biochemistry knowledge, and knowledge of the behavioral and social sciences.[46]

Medical schools with different missions likely look for different qualities in applicants and also value and reward performance differently. Therefore, an important related focus of future research is potential variations in the predictive validity of the MCAT exam at medical schools whose priorities lie in research, education, and clinical performance, among other areas. It also is important to consider the value of the MCAT exam together with other applicant data, such as personal characteristics and experiences.[47]

Finally, in this article, we presented a small sample of socioeconomic indicators on which white, black, and Latino examinees, applicants, and matriculants varied. Not all factors that might influence achievement are socioeconomic, however. Stereotype threat, for example, is often cited as a factor that may influence performance.[43] According to this theory, the negative stereotypes about a group to which an examinee belongs can be internalized and thereby hinder the examinee's performance, particularly if the examinee affiliates strongly with the group and if the stereotype is made salient on the test. Stereotype threat has been shown to reduce working memory capacity,[48] interfere with the learning process,[49] and impair performance on tests in laboratory settings.[43] However, there is a lot we do not yet know about how stereotype threat works in applied educational settings, although the evidence for its effects in these settings has been mixed.[50,51] Future research should look at the differences between minority-serving and other institutions and whether these different types of medical schools show different patterns of performance for white, black, and Latino students. Stereotype threat involves a complex interplay of conditions and individual reactions, and attempts should also be made to design research that will improve our understanding of whether and how it plays a role in mean MCAT score differences among white, black, and Latino examinees.

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An Overview of the Medical School Admission Process and Use of Applicant Data in Decision Making: What Has Changed Since the 1980s?

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Abstract

Purpose

To investigate current medical school admission processes and whether they differ from those in 1986 when they were last reviewed by the Association of American Medical Colleges (AAMC).

Method

In spring 2008, admission deans from all MD-granting U.S. and Canadian medical schools using the Medical College Admission Test (MCAT) were invited to complete an online survey that asked participants to describe their institution's admission process and to report the use and rate the importance of applicant data in making decisions at each stage.

Results

The 120 responding admission officers reported using a variety of data to make decisions. Most indicated using interviews to assess applicants' personal characteristics. Compared with 1986, there was an increase in the emphasis placed on academic data during pre-interview screening. While GPA data were among the most important data in decision making at all stages in 1986, data use and importance varied by the stage of the process in 2008: MCAT scores and undergraduate GPAs were rated as the most important data for deciding whom to invite to submit secondary applications and interview, whereas interview recommendations and letters of recommendation were rated as the most important data in deciding whom to accept.

Conclusions

This study underscores the complexity of the medical school admission process and suggests increased use of a holistic approach that considers the whole applicant when making admission decisions. Findings will inform AAMC initiatives focused on transforming admission processes.

In recent years, academic medicine has been shifting from a hierarchical, autonomous, and expert-centered model to one that is increasingly team-based, collaborative, and patient-centered. Rapid scientific and technological advances are also leading to changes in academic medicine, as are changes in the demographic composition of the United States and Canada.[1,2] Additionally, health care reform efforts are under way in the United States, and there have been calls for increases in the number and diversity of health care practitioners in the workforce.

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These changes signal that it is necessary to review the medical school admission process. We suggest that they have a cyclical relationship with the admission process: Changes in academic medicine affect the admission process through their influence on the applicant pool, the legal and social contexts in which admission decisions are made, and the medical school curriculum. At the same time, the future physician workforce is shaped by the admission process and medical training.

Although researchers have spent considerable time investigating the emergent culture in academic medicine, relatively little is known about the medical school admission process of the early 21st century. In fact, a description of the typical admission process has not been published in more than 20 years.[3,4] To better understand the current process and how it differs from that described over two decades ago, in 2008 we surveyed admission deans about their medical schools' admission policies and practices.

In this article, we begin by contrasting the applicant pool, legal and social contexts, and medical school curriculum at the time of our survey with those in 1986, when the Association of American Medical Colleges (AAMC) conducted a previous survey of admission deans that also focused on medical school admission practices. We then describe current admission processes and compare our findings, when possible, with those of the 1986 survey as reported by Mitchell.[4]

Changes in the Applicant Pool

Since the mid-1980s, the number and composition of medical school applicants have changed dramatically. At that time, there were concerns about a declining applicant pool and a potential decline in the academic quality of applicants.[5] Additionally, the percentages of minority and female applicants were relatively low.[6] By 2008, the applicant pool had grown and become more diverse with respect to Asian and female applicants.*

In 1986, among the 32,886 individuals who applied to at least one U.S. medical school, there were 2,303 (7%) black or African American, 1,972 (6%) Hispanic or Latino, 2,581 (8%) Asian or Pacific Islander, 125 (<1%) Native American, and 25,250 (77%) white applicants.[7] In 2008, the number of applicants increased to 42,231 and included 3,342 (8%) black or African American, 3,086 (7%) Hispanic or Latino, 9,317 (22%) Asian or Pacific Islander, 400 (<1%) American Indian or Alaska Native, and 26,601 (63%) white individuals.[8]

The number and percentage of women in the applicant pool increased from 11,558 (35%) in 1986 to 20,360 (48%) in 2008.[9,10] The majority of the growth among female applicants was from an increase in the percentage of female Asian or Pacific Islander applicants, which nearly tripled from 8% (n = 981) to 22% (n = 4,469); conversely, the percentage of white female applicants decreased, and the percentages of black and Hispanic or Latino female applicants remained stable.[7–10]

We suggest that these changes in the size and composition of the applicant pool may have affected the admission process in several ways when compared with that of the mid-1980s. Given the increase in applicants, admission committees—especially those with large applicant pools—may add stages to the process to reduce the number of applicants remaining at each stage. Second, with more applicants in the pool, admission officers may rely more heavily on data that are quantifiable and easily incorporated into pre-interview screening tools. Third, in light of the changes in composition of the applicant pool, admission committees may use a combination of quantitative and qualitative (academic and nonacademic) data in order to achieve broad diversity in the student body.

Changes in the Legal and Social Contexts

Increasing the diversity of the workforce and the numbers of minorities and women in medicine have been long-standing concerns in medical education.[11] Even so, the legal and social contexts of the mid-1980s limited the consideration of age, race/ethnicity, and gender in admission decisions[12] and thus limited admission committees' options.

The legal context in which admission committees operate has changed substantially, however. For example, the Supreme Court's 2003 decision in *Grutter v. Bollinger*[13] affirmed the importance of mission-driven, evidence-based admission decisions and introduced the concept of educational benefits of diversity.† It also established that all applicants must be considered through the same admission process, which allowed schools to change their diversity and admission policies. In 1986, only 28% of U.S. medical schools included diversity as a primary goal of their admission process,‡ whereas 57% did in 2008.[14,15]

In addition, changes in the social context enabled the AAMC to introduce several projects aimed, in part, at improving diversity. For example, Project 3000 by 2000 and the Aspiring Docs program—introduced in 1991 and 2006, respectively—were designed to increase the number of historically underrepresented minority (URM) students enrolled in medical school. The Holistic Review Project was introduced in 2002 with the aim of improving diversity by encouraging admission committees to evaluate applicants' nonacademic characteristics in addition to their academic achievements. In recent years, the admission community has expanded its definition of *diversity* to include "personal attributes, experiential factors, demographics, or other considerations"[16] such as socioeconomic status (SES) and rural background.

We suggest that, together, these legal and social context changes may have affected the admission process in at least two ways. First, admission committees may now consider more and varied information about applicants in making admission decisions than they did in the mid-1980s. Second, with a slightly more diverse applicant pool and a more permissive legal environment, admission committees may now be more likely to consider information about applicants' race/ethnicity, gender, and/or SES background in the admission process.

Changes in the Medical School Curriculum

Medical educators have long expressed concern that the medical school curriculum places too much emphasis on the natural sciences at the expense of the psychosocial, humanistic, and professional aspects of medicine.[17] In the mid-1980s, most medical schools' curricula were organized into distinct basic and clinical science years. In general, the first two years were lecture-based and focused on the natural sciences, whereas the third and fourth years focused on the clinical sciences and patient interactions.

In the 1990s and 2000s, a series of structural modifications to the medical school and residency accreditation processes, as well as new curricular resources, paved the way for fundamental changes in medical education. For example, the Liaison Committee on Medical Education[18] (LCME) and the Accreditation Council for Graduate Medical Education[19] revised their accreditation standards to require medical schools and residency programs to teach and assess professional attributes. LCME standard MS-31-A states, "A medical education program must ensure that its learning environment promotes the development of explicit and appropriate professional attributes in its

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* Per U.S. federal guidelines, in 2002 the American Medical College Application Service (AMCAS) started to ask applicants who are U.S. citizens or permanent residents to self-identify using two separate questions. The first question ("ethnicity") asks applicants to indicate whether they are "Spanish/Hispanic/Latino/Latina" or "Not Spanish/Hispanic/Latino/Latina." The second question ("race") asks applicants to self-identify using non-Hispanic or Latino race categories, and applicants are asked to "check all that apply." The ethnicity category and several of the race categories include subcategories to permit further self-identification. Prior to 2002, AMCAS applicants were not able to select more than one race; thus, racial/ethnic data collected prior to 2002 are not directly comparable to data collected later.

† At the time of writing, the Supreme Court had heard oral arguments in *Fisher v. Texas*, a case challenging the use of race in admissions, and was expected to rule on the case in early 2013.

‡ We examined descriptions of schools' selection processes in the 1985–1986 and 2007–2008 Medical School Admission Requirements[14,15] to identify the percentage of all MD-granting U.S. and Canadian medical schools with diversity as a primary goal of their admission process. We classified schools as having diversity as one of their primary goals if they listed at least one of the following goals: diversity as an institutional goal, creating a diverse matriculating class, and/or increasing the diversity of the medical profession.

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medical students (attitudes, behaviors, and identity)."[18] In addition, the AAMC Medical School Objectives Project series[20] and the Institute of Medicine (IOM) report on behavioral and social sciences in medical school curricula[21] identified—and, importantly, provided curriculum materials to help medical schools modify their curricula to teach—the broad knowledge, skills, and attitudes that graduating medical students should possess.

These formal accreditation requirements and the availability of the aforementioned AAMC and IOM resources may have enabled medical schools to revise their curricula in fundamental ways. For example, many schools now include both natural and clinical sciences instruction in the first two years and/or offer problem-based rather than lecture-based courses. A growing number also offer behavioral and social sciences, humanities, and professionalism courses.

We suggest that, given these changes in the structure and focus of the medical school curriculum, today's applicants may be required to demonstrate some new knowledge, skills, and attitudes compared with applicants in the mid-1980s. As such, admission committees may now place more emphasis on different types of information about applicants—such as personal attributes like teamwork, communication skills, compassion, empathy, and integrity—than they did in the past.

Method

In 2008, the committee charged with the fifth comprehensive review of the Medical College Admission Test (MR5 Committee) conducted a two-part study to explore current medical school admission policies and practices. The first part of the study consisted of site visits to medical schools in the United States and Canada; the second part was a survey of admission officials in all MD-granting U.S. medical schools and the Canadian schools that use the MCAT exam.

Medical school site visits

To gather information about current admission policies and practices, in spring 2008 MCAT staff visited eight MD-granting medical schools in the United States and Canada that were selected to be representative of AAMC's member schools with respect to geographic location and mission/educational philosophy. The site visits were made by seven MCAT staff, who conducted eight interviews with individuals and/or small groups at each site. The interview participants were staff and faculty involved in the admission process (including the dean or associate dean of admissions, chair or co-chair of the admission committee, admission committee members, admission staff, student affairs and academic affairs officials, diversity and cultural affairs officials, the vice dean for education, and office of academic enhancement/counseling/academic coordinator officials) and medical students.

MCAT staff transcribed and reviewed the 30- to 90-minute interviews. The resulting qualitative data (not reported here) were used to inform the development of the survey (i.e., wording of questions and response options).

Survey of medical school admission officials

In spring 2008, admission deans from all MD-granting U.S. medical schools and the Canadian medical schools that use the MCAT exam (n = 142) were invited via e-mail to participate in an online survey regarding admission processes. Three reminder e-mails were sent to nonrespondents at one-week intervals after the survey opened. The survey took approximately 60 minutes to complete and included 69 questions, which were divided into three sections: description of the admission process; use of undergraduate grade point average (UGPA), MCAT score, and other applicant data at each stage of the process; and the importance of such data to admission decisions. Ratings of importance were made using a five-point scale, ranging from 1 = not important to 5 = extremely important. The survey items relevant to this study, with response data, are provided in Supplemental Digital Appendix 1, available at http://links.lww.com/ACADMED/A124.

Demographic and institutional data were not collected on the survey. We drew data on participating schools' institutional characteristics (e.g., public or private, location) from the AAMC's Data Warehouse in March 2012 and linked these data to survey responses. Responses were confidential; all identifying information was removed after survey and institutional data were matched, prior to data analysis.

In addition, we drew MCAT score and UGPA data from the AAMC's Data Warehouse for 2008–2010 applicants who were offered acceptance by one or more MD-granting U.S. medical schools. We computed the percentages of accepted applicants in various MCAT total score and UGPA categories (e.g., MCAT total score = 27–29 and UGPA = 3.20–3.39). We drew data for 2008–2010 to correspond with the period in which the survey was conducted.

Data were analyzed with IBM SPSS Statistics.[22] We computed means, standard deviations, and frequencies.

This study was reviewed by the AAMC Human Subjects Research Protection Program and determined to be exempt. It also underwent AAMC Data Collection and Instrument Clearance review to ensure that the survey instrument and methodology complied with AAMC policies and procedures.

Results

Of the 142 admission deans invited to participate in the survey, 129 deans or their designees responded (response rate = 90%). For these analyses, we excluded 9 responses because of incomplete data (i.e., missing data for more than 80% of the questions). The final sample for these analyses was 120 medical school admission officers representing 77 (64%) public and 43 (36%) private institutions, a distribution mirroring that of AAMC member schools. With regard to location, 6 (5%) of the responses were from Canadian schools that use the MCAT exam, whereas the rest were from schools in the United States: 42 (35%) from the southern region, 30 (25%) from the northern region, 27 (23%) from the central region, and 15 (13%) from the western region. There were no differences between responding and nonresponding schools with respect to public/private status or region of the United States or Canada.

The admission process in 2008

Slightly more than half (57%, 68/120) of the respondents reported that their medical school's admission decisions are made using a two-stage process that includes an initial application and an interview. Admission staff and/or a subset of admission committee members first review application data to select the interview pool. This review is often formulaic, but some schools conduct a holistic review of every application to determine who will be interviewed. After the interviews are completed, the admission committee meets to decide which applicants will be offered acceptance. In general, these meetings consist of a formal presentation of each applicant's background and qualifications, a discussion of ratings and/or content from the interview, and a formal vote to accept, reject, hold, or refer to a special program.

Slightly less than half (43%, 52/120) of the respondents reported that their schools use a three-stage process to make admission decisions, the same as reported by Mitchell[4] in 1986 (43%, 49/113). The three-stage approach includes an initial review of application data by admission staff to select applicants to invite to submit secondary applications. Then, admission staff and/or committee members review data from both the initial and secondary applications to select interviewees. Finally, the admission committee meets to review and discuss all applicant information (i.e., data from both of the applications and the interview) and decides which applicants will be offered acceptance. Of the 52 schools structuring their admission process in this manner, 42 (81%) were public and 10 (19%) were private.

Overall, admission officers rated a wide range of data as important to admission committees' decisions about which applicants to invite to submit secondary applications, interview, and accept into medical school (Table 1). However, the uses and importance of these data differed by the stage of the process. For example, respondents rated MCAT scores and UGPAs as the most important types of data for deciding which applicants to invite to submit secondary applications and to interview, but these data were less important in deciding whom to admit. Admission officers rated two types of nonacademic data—interview recommendations and letters of recommendation—as the most important in deciding which applicants to accept. There was substantial variation across schools, though, suggesting that admission committees tailor their processes to match their schools' educational missions and goals.

Table 2 compares the relative importance of 15 types of data in making acceptance decisions in 1986 and 2008. Among the most important types of data, 64% (7/11) were nonacademic in 2008 compared with 50% (5/10) in 1986,[4] suggesting that nonacademic data are more important to admission decisions today than in the past. In 2008, admission officers rated interview recommendations and letters of recommendation as the most important, whereas they rated cumulative GPA and science and math GPA as the most important in 1986. Furthermore, personal statements and community service in medical/clinical settings gained in importance in 2008 compared with 1986. The rated importance of MCAT scores was about the same in 1986 and 2008. Demographic characteristics were among the top 15 types of data as rated in 1986, whereas race and gender were among the least important variables as rated in 2008.

The admission interview in 2008

All responding admission officers reported that their medical schools conduct admission interviews. Almost two-thirds (64%, 77/120) reported that admission committee members screen application materials to decide whom to interview; more than half (56%, 67/120) indicated that admission staff are also involved in the screening process. Only 12% (14/120) reported that their schools use computer-based algorithms to make this decision. The majority (69%, 78/113) indicated that two or more people screen each applicant's information, and 53% (60/114) reported that this review takes 15 minutes or longer.

Interviews were described as one-on-one by 83% (99/119) of the responding admission officers. Most respondents (87%, 104/120) reported that interviews are conducted by admission committee members, whereas 17% (20/120) reported that they are conducted by staff and 68% (81/120) indicated that, in some cases, they are conducted by medical students. (Percentages may exceed 100% because respondents could select multiple types of interviewers.) Many respondents (59%, 71/120) indicated that their schools conduct two interviews with each interviewee. Over 50% of respondents (more than 65 of 119) reported that interviewers are allowed to review personal statements, letters of evaluation/recommendation, MCAT scores, or UGPAs before or during interviews; however, 13% (16/119) indicated that interviewers are not allowed to do so before the interview. Admission interviews were described as typically lasting 30 to 44 minutes each.

Results showed that the admission interview is somewhat structured. The majority of respondents (65%, 77/119) indicated that interviewers are given general guidance about the content of the questions they should ask. Many medical schools use a standard rating process to evaluate applicants during the interview: For example, over 50% of respondents (more than 60 of 119) reported that interviewers use a numeric rating scale to assess applicants on multiple dimensions or on overall interview performance. The interview process and format are nearly identical for faculty-, staff-, and student-led interviews, but fewer data about applicants are made available to student interviewers than to faculty and staff interviewers.

Admission officials indicated that interviews are most often used to assess nonacademic characteristics and skills: Over 85% (more than 100 of 119) reported that interviews include questions about applicants' motivation for pursuing a medical career, compassion and empathy, personal maturity, oral communication skills, service orientation, and professionalism. Less than 20% (fewer than 22 of 113) reported including questions about applicants' academic content knowledge (e.g., biology, chemistry, psychology) in interviews.

The role of UGPAs and MCAT scores in 2008

Medical school admission processes typically use MCAT scores and UGPAs to identify the most and least capable applicants and to provide interpretive context for one another. As Figure 1 shows, less than half of respondents indicated that their schools use these data to identify applicants who may need additional academic support or

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Table 1

Mean Importance of Various Types of Applicant Data in Selecting Applicants at Each Stage of the Medical School Admission Process, as Rated by Admission Officials in the United States and Canada, 2008 Survey

Type of applicant data	Data category‡	Mean (SD) importance of data in deciding whom to ...*,†		
		Invite to submit a secondary application§ (n = 52)	Invite to interview (n = 120)	Offer acceptance (n = 120)
Interview recommendation	C	—	—	*4.5 (0.9)*
Letters of evaluation or recommendation	C	1.6 (1.3)	*3.3 (1.5)*	*3.7 (1.1)*
GPA: Cumulative undergraduate	A	*3.0 (1.6)*	*3.7 (1.2)*	*3.6 (1.2)*
GPA: Cumulative science/math	A	*2.8 (1.7)*	*3.6 (1.3)*	*3.6 (1.3)*
Community service/volunteer—medical/clinical	E	2.2 (1.5)	*3.3 (1.3)*	*3.5 (1.1)*
MCAT total score (excludes Writing Sample)	A	*2.7 (1.6)*	*3.5 (1.4)*	*3.4 (1.3)*
Personal statements	C	2.0 (1.4)	*3.2 (1.3)*	*3.3 (1.2)*
Medical/clinical work experience	E	2.0 (1.5)	3.1 (1.4)	*3.3 (1.3)*
MCAT Biological Sciences section score	A	*2.6 (1.6)*	*3.3 (1.4)*	*3.3 (1.4)*
Community service/volunteer—not medical/clinical	E	2.0 (1.4)	3.1 (1.3)	3.2 (1.2)
MCAT Verbal Reasoning section score	A	*2.5 (1.6)*	*3.2 (1.3)*	3.2 (1.3)
Leadership experience	E	1.9 (1.3)	3.0 (1.3)	3.1 (1.2)
MCAT Physical Sciences section score	A	*2.5 (1.5)*	3.1 (1.4)	3.1 (1.4)
Completion of premedical course requirements§	A	*2.4 (1.8)*	3.1 (1.7)	3.1 (1.6)
Experience with underserved populations	E	1.9 (1.3)	2.6 (1.4)	2.9 (1.3)
Medical/clinical research experience	E	1.6 (1.1)	2.5 (1.3)	2.7 (1.2)
State residency	D	*2.9 (1.8)*	2.7 (1.7)	2.7 (1.7)
GPA: Cumulative nonscience/math	A	1.9 (1.2)	2.5 (1.4)	2.6 (1.3)
U.S. citizenship/permanent residency	D	*2.9 (1.9)*	2.6 (1.8)	2.6 (1.8)
MCAT Writing Sample score	A	1.7 (1.1)	2.1 (1.3)	2.1 (1.2)
Socioeconomic status	D	1.5 (1.0)	2.0 (1.3)	2.1 (1.2)
Race/ethnicity	D	1.4 (1.0)	1.9 (1.2)	2.1 (1.3)
Rural background	D	1.6 (1.1)	1.9 (1.3)	2.1 (1.3)
Completion of challenging nonscience courses	A	1.3 (0.7)	1.9 (1.2)	2.0 (1.2)
Selectivity of undergraduate institution	A	1.3 (0.8)	1.7 (1.1)	1.9 (1.2)
Urban background	D	1.3 (0.8)	1.5 (1.0)	1.5 (0.9)
Gender	D	1.0 (0.3)	1.2 (0.8)	1.3 (0.8)

*Mean (standard deviation) importance ratings are based on responses to the question "How important were the following data in selecting the applicants who (received secondary application/were invited to interview/were accepted)?" Respondents rated the importance of each type of data in each stage of the process using the following rating scale: 1 = not important, 2 = somewhat important, 3 = important, 4 = very important, or 5 = extremely important. If a respondent did not rate a given data point, it was coded as 1 = not important.

†Italicized type indicates the highest ratings for each stage in the admissions process. Data are displayed in descending order based on their rating of importance to offers of acceptance.

‡*A* indicates academic data; *C*, a combination of multiple types of data; *E*, experiential data.

§Results are based only on the 52 responses from admission deans (or their designees) at medical schools that review initial application materials to invite secondary applications.

nonnative English speakers who have adequate reading comprehension skills.

As Figure 2 shows, most respondents indicated that their schools use MCAT scores to predict performance in the basic sciences (68%, 82/120) or on the United States Medical Licensing Examination (USMLE) Step 1 exam (77%, 92/120). The majority of respondents also reported use of UGPAs to predict performance in the basic sciences. Less than 33% (fewer than 35 of 120) indicated that their schools use MCAT scores and UGPAs to predict USMLE Step 2 and Step 3 exam performance, clinical clerkship performance, academic distinction, and time to graduation.

Chart 1 shows that although UGPAs and MCAT scores are important factors in admission processes, they are not the sole determinants of acceptance decisions. For example, 105 (9%) of the 1,233 applicants with UGPAs of 3.80 to 4.00 and MCAT total scores of 39 to 45 were not accepted by any of the medical schools to which they applied in 2008–2010. In contrast, 597 (18%) of the 3,324 applicants with UGPAs of 3.20 to 3.39 and MCAT scores of 24 to 26 were accepted by at least one medical school. These findings buttress the importance ratings data presented

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Table 2

Importance of Applicant Data in Deciding Whom to Admit to Medical School, 1986 Versus 2008*

Importance	1986	2008
High	• GPA: Cumulative • GPA: Cumulative science and math • Quality of undergraduate institution • Letters of recommendation • Interview recommendation • Extracurricular activities: Non-health-related • MCAT scores • Health-related work experience • State residency • Completion of difficult undergraduate courses	• Interview recommendation • Letters of evaluation or recommendation • GPA: Cumulative undergraduate • GPA: Cumulative science/math • Community service/volunteer—medical/clinical • MCAT total score† • Personal statements • Medical/clinical work experience • Community service/volunteer—not medical/clinical • Leadership experience (tie) • Completion of premedical requirements (tie)
Medium	• GPA: Cumulative nonscience • Quality of graduate or postgraduate program‡ • Personal statements • Demographic factors (race/ethnicity, age, sex) • Research experience	• Experience with underserved populations • Medical/clinical research experience • State residency • GPA: Cumulative nonscience/math (tie) • U.S. citizenship (tie)

* Relative importance of applicant data in 2008 is based on the ratings of 120 admission deans (or their designees) in response to the following survey question: "How important were the following data in selecting the interviewees who were accepted?" For details about the ratings and data categories (i.e., academic, experiential, combination), see Table 1. Data from 1986 were reported by Mitchell.[4]

† MCAT Biological Sciences, Physical Sciences, Verbal Reasoning, and Writing Sample scores were excluded from this comparison because MCAT section and total scores were combined into one variable in the 1986 survey.

‡ Quality of graduate or postgraduate program was not included on the 2008 survey.

earlier, suggesting that a wide variety of data are important to admission decisions.

Discussion

Our findings suggest that several aspects of the medical school admission process remain unchanged since the mid-1980s, whereas others have changed in fundamental ways. Some of the changes may be explained by differences in the applicant pool, legal and social contexts, and medical school curricula. Many admission committees now seem to use a holistic admission process to identify applicants who best fit their schools' educational missions and goals. Below, we contrast our findings with the 1986 findings reported by Mitchell.[4]

Aspects of the admission process that have not changed

Certain aspects of the admission process are largely unchanged since the mid-1980s. First, as in 1986,[4] admission officers today use a variety of data in making decisions, which suggests that they remain committed to evaluating both academic and nonacademic information. Second, our data suggest that, as in 1986, schools' admission processes are structured into two or three stages. Third, in both 1986 and 2008, admission officers rated MCAT scores as important to each stage in the process and indicated that they use MCAT scores and UGPAs to provide an interpretive context for each another. Fourth, the number, length, and format of admission interviews are the same as those described by Johnson and Edwards[3] in 1991. Similarly, the admission interview continues to be the primary source of information about applicants' personal characteristics.

Finally, as in the 1986 survey,[4] admission officers in our survey rated the importance of demographic characteristics in the admission process as relatively low. We found this to be somewhat surprising given changes in the legal and social contexts that now allow admission committees to consider diversity in the context of their schools' educational missions and goals. We suggest, on the basis of the data presented in this article and comments made by focus group participants during site visits, that some medical school admission committees may feel that conducting holistic reviews allows URM and rural applicants to show their full potential and precludes the need to consider demographic variables explicitly.

Aspects of the admission process that have changed

As was the case in the mid-1980s, most admission committees use a multistage process to make decisions. However, our data suggest that admission committees now place different emphasis on applicant data at each stage of the process. For example, in summarizing the results of the 1986 survey, Mitchell[4] noted that although test scores decreased in importance as decision making proceeded, importance ratings did not differ appreciably across the stages of the admission process. In contrast, our data suggest that admission committees now consider slightly different data when deciding whom to invite to submit secondary applications, interview, and accept. Academic data seem to be slightly more important in deciding which

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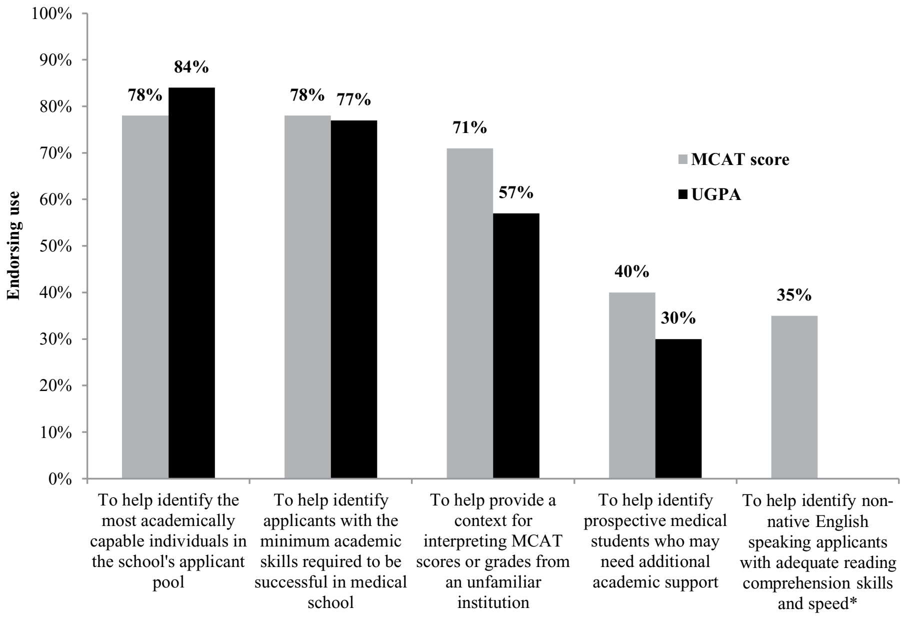

Figure 1 Ways in which U.S. and Canadian medical schools use undergraduate grade point average (UGPA) and Medical College Admission Test (MCAT) scores during the admission process, as endorsed by the 120 admission deans (or their designees) who responded to a 2008 survey.
* Responses were not collected for use of UGPA data.

applicants to invite to submit secondary applications and to interview than in deciding whom to accept.

This difference is likely due to the increasing size of applicant pools and the ease of incorporating academic data into automated screening processes. As applicant pools become larger, schools may elect to reduce the number of applications for review at each stage in the process by screening applicants on a subset of admission data. Incorporating computers into the screening process

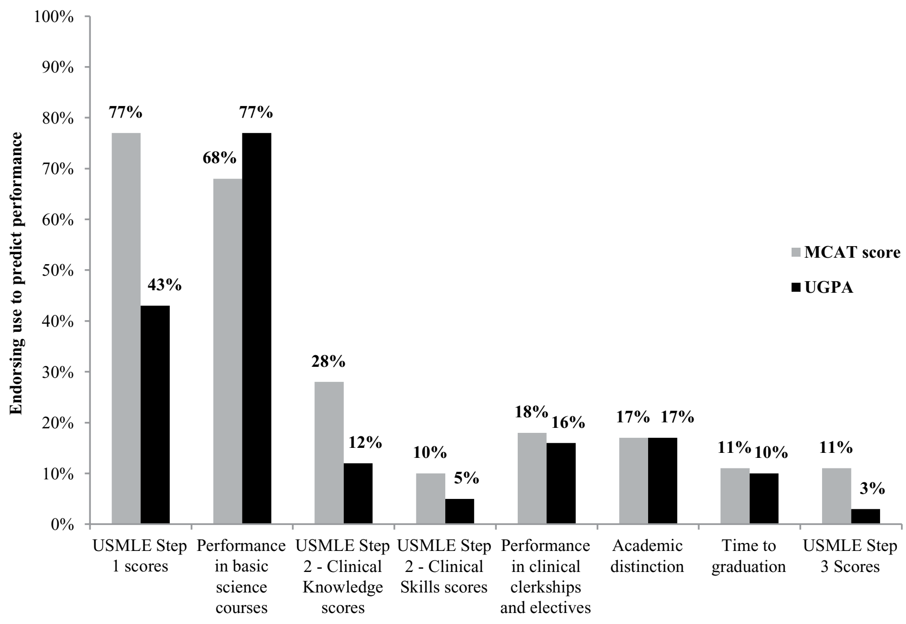

Figure 2 U.S. and Canadian medical schools' use of Medical College Admission Test (MCAT) score and undergraduate grade point average (UGPA) data to predict various outcomes, as endorsed by the 120 admission deans (or their designees) who responded to a 2008 survey. USMLE indicates United States Medical Licensing Examination.

may exacerbate the emphasis placed on quantifiable data because applicants' data can be entered, sorted, and compared easily. In addition, the emphasis that many medical schools place on their *U.S. News and World Report* rankings[23,24] may also explain why admission officials rated MCAT scores and UGPAs as highly important. However, we interpret the 2008 survey data reported in this article—and the qualitative data from the 2008 medical school site visits—as indicating that the inclusion of multiple stages does not preclude the use of a holistic admission process.

Arguably, the most notable change in the admission process is the increased importance placed on nonacademic data in making acceptance decisions. In 2008, admissions officers rated more nonacademic data as "of high importance" than did admission officers in 1986. Further, all types of academic data dropped in ratings of relative importance in the 2008 survey compared with the 1986 survey (except MCAT scores), whereas nonacademic data such as interview recommendations, letters of recommendation, and personal statements gained in importance.

Acceptance rate data provide additional support for this change, showing that applicants with different levels of academic preparedness (i.e., the combination of cumulative UGPA and MCAT total score) are accepted into medical school. Together, these data and the high importance ratings given to both academic and nonacademic data in the 2008 survey suggest that many medical schools are conducting a more holistic admissions process than they have in the past. This may be due to changes in the legal and social contexts that allow schools to consider demographic information as part of their admissions process; formal training programs such as the AAMC's Holistic Review Training, which helps schools tailor their admission process to their educational missions and goals[16]; and changes in the medical school curriculum, health care systems, and the practice of medicine that may require matriculants to possess different knowledge, skills, and attitudes to be successful in medical school today.[25] Additionally, grade inflation occurs at many undergraduate institutions.[26] It

Chart 1

Percentage and Number of 2008, 2009, and 2010 Applicants Who Were Offered Acceptance By One or More Medical Schools, by Medical College Admission Test (MCAT) Total Score and Undergraduate Grade Point Average (UGPA) Categories*

	MCAT total score										
UGPA	5–14	15–17	18–20	21–23	24–26	27–29	30–32	33–35	36–38	39–45	All MCAT total scores
3.80–4.00	4% 3/69	6% 11/181	18% 88/485	*25%* *330/1,301*	*42%* *1,370/3,282*	67% 3,915/5,818	**82%** **5,975/7,258**	**86%** **4,884/5,678**	**90%** **2,894/3,225**	**91%** **1,128/1,233**	72% 20,598/28,530
3.60–3.79	1% 1/180	4% 14/351	12% 122/989	18% 409/2,217	*29%* *1,313/4,490*	52% 3,753/7,283	72% 5,485/7,610	**80%** **3,702/4,625**	**85%** **1,636/1,925**	**85%** **359/420**	56% 16,794/30,090
3.40–3.59	2% 6/298	3% 13/488	10% 120/1,184	17% 440/2,534	23% 1,060/4,522	*36%* *2,417/6,657*	56% 3,540/6,376	67% 2,127/3,176	73% 852/1,172	**79%** **174/219**	40% 10,749/26,626
3.20–3.39	1% 2/391	2% 11/534	8% 87/1,120	13% 280/2,084	18% 597/3,324	*26%* *1,109/4,282*	*39%* *1,490/3,850*	51% 904/1,762	61% 324/530	62% 58/93	27% 4,862/17,970
3.00–3.19	1% 3/440	3% 18/546	6% 58/921	11% 168/1,479	16% 326/2,026	23% 566/2,417	*30%* *522/1,758*	*41%* *339/817*	*42%* *100/236*	*44%* *19/43*	20% 2,119/10,683
2.80–2.99	0% 0/383	1% 4/389	5% 31/616	11% 94/838	15% 156/1,049	16% 166/1,038	24% 177/744	*33%* *93/281*	*28%* *25/90*	57% 8/14	14% 754/5,442
2.60–2.79	0% 0/329	1% 2/225	5% 20/386	7% 35/475	11% 56/520	15% 67/450	18% 53/294	21% 29/141	17% 6/36	8% 1/12	9% 269/2,868
2.40–2.59	0% 0/217	0% 0/140	2% 3/178	3% 7/222	8% 18/216	10% 18/175	15% 19/124	*26%* *15/57*	18% 3/17		6% 83/1,347
2.20–2.39	0% 0/147	0% 0/79	2% 2/99	5% 4/85	7% 6/82	5% 3/58	6% 2/33	11% 2/18	—		3% 20/605
2.00–2.19	0% 0/77	2% 1/43	0% 0/32	4% 1/27	4% 1/24	0% 0/23	8% 1/12	—			2% 6/241
1.47–1.99	0% 0/35	0% 0/20	0% 0/14	0% 0/11	—	—	—	—			0% 0/80
All UGPAs	1% 15/2,566	2% 74/2,996	9% 531/6,024	16% 1,768/11,273	25% 4,904/19,543	43% 12,014/28,063	62% 17,264/28,063	73% 12,097/16,559	81% 5,841/7,235	86% 1,747/2,036	45% 56,255/124,503

* These data include all MD-granting U.S. medical schools accredited by the Liaison Committee on Medical Education. Canadian and Caribbean medical schools were excluded from this analysis. Bold type and dark shading denote acceptance rates ≥75%, light gray shading denotes acceptance rates of 50% to 74%, and italicized type denotes acceptance rates of 25% to 49%. Dashes indicate fewer than 10 observations; blank cells indicate 0 observations.

is unclear whether knowledge of such inflation affects admission officers' use of UGPAs in their decision making; however, we suggest that it may contribute to the emphasis placed on nonacademic factors, where there is more variance among applicants.

Limitations and future directions

Our findings underscore the complexity of the medical school admission process as well as the admission community's desire to consider the whole applicant when making admission decisions.

This study is not without limitations, however. Despite the high survey response rate, data were not collected from all MD-granting U.S. medical schools and all Canadian schools that use the MCAT exam. Similarly, findings are limited to the questions included in the survey, and admission deans (or their designees) were selected as the only type of respondents. Therefore, the study may not have captured all aspects of the medical school admission process. Gathering data from a larger number of medical schools and expanding the response base to include other admission staff would increase the generalizability of these findings. In addition, the results reported here were informed only by quantitative data, so it is difficult to infer meaning absent from the context from which the data were derived. Finally, this study was conducted in 2008 and may not precisely reflect the medical school admission process in 2013.

Findings from this study will be used to inform AAMC initiatives focused on transforming medical school admissions. Future research should investigate how admission committees learn about applicants' nonacademic characteristics and whether the emphasis that committees place on such information varies by institutional characteristics (e.g., public versus private status, educational mission, size of the applicant pool). Future research should also explore whether positive and negative data about applicants are "weighted" differently. For example, do unfavorable letters of recommendation carry more "weight" in admission decisions than do favorable ones?

Future research should also explore the relationship between admission variables and the changing demographics of the applicant pool and matriculating classes. During a time when diversity has become an important social value, why have the percentages of Asian and female applicants increased, whereas the percentages of black and Latino applicants have remained relatively stable since the mid-1980s? Future research should explore the factors affecting who applies to medical school, how those factors affect what admission officers consider when making admission decisions, and what effects those factors have on the demographic composition of matriculating classes.

It would be interesting to replicate this study on a regular basis (perhaps every 5 or 10 years) to identify trends and changes in the admission process. For example, if more schools adopt a holistic admission process, will nonacademic factors become more important than academic factors in pre-interview screening decisions? In addition, replication would provide comparison data for schools interested in self-study of their admission processes. Another direction for future research would be to explore the context in which medical school admission decisions are conducted, with a focus on identifying links between admission policies, practices, and specific institutional educational missions and goals. Collecting qualitative in addition to quantitative data would provide additional context for interpreting results.

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Core Personal Competencies Important to Entering Students' Success in Medical School: What Are They and How Could They Be Assessed Early in the Admission Process?

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Abstract

Assessing applicants' personal competencies in the admission process has proven difficult because there is not an agreed-on set of personal competencies for entering medical students. In addition, there are questions about the measurement properties and costs of currently available assessment tools. The Association of American Medical College's Innovation Lab Working Group (ILWG) and Admissions Initiative therefore engaged in a multistep, multiyear process to identify personal competencies important to entering students' success in medical school as well as ways to measure them early in the admission process.

To identify core personal competencies, they conducted literature reviews, surveyed U.S and Canadian medical school admission officers, and solicited input from the admission community. To identify tools with the potential to provide data in time for pre-interview screening, they reviewed the higher education and employment literature and evaluated tools' psychometric properties, group differences, risk of coaching/faking, likely applicant and admission officer reactions, costs, and scalability.

This process resulted in a list of nine core personal competencies rated by stakeholders as very or extremely important for entering medical students: ethical responsibility to self and others; reliability and dependability; service orientation; social skills; capacity for improvement; resilience and adaptability; cultural competence; oral communication; and teamwork.

The ILWG's research suggests that some tools hold promise for assessing personal competencies, but the authors caution that none are perfect for all situations. They recommend that multiple tools be used to evaluate information about applicants' personal competencies in deciding whom to interview.

There is general agreement in the medical education community about the *academic* competencies that medical students should demonstrate when they matriculate. Widely accepted measures, such as undergraduate grade point averages (UGPAs) and Medical College Admission Test (MCAT) scores, provide information about these competencies early in the medical school admission process. Although the community has agreed on the personal competencies that medical students should demonstrate at graduation,[1] it has not reached consensus on those that are important at entry or how to incorporate them into the admission process.

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Albanese and colleagues[2] estimated that more than 87 different personal qualities are assessed during the admission process. This lack of consensus among schools is surprising given that research has linked certain personal competencies to positive admission and medical school outcomes. For example, Carrothers and colleagues[3] found that having good interpersonal skills, knowing one's emotions, recognizing emotions in others, possessing the ability to manage one's emotions in difficult situations, and being able to motivate oneself were frequently cited by medical school admission committee members as desirable attributes for prospective medical students. Similarly, Adams and colleagues[4] found that demonstrating motivation, a desire to learn, integrity and ethics, self-management, and strong interpersonal and teamwork skills were reported by medical school faculty members, residents, and students as being important to success in medical school.

Researchers have related some of these personal characteristics and skills to improved patient care outcomes and to patients' ratings of their physicians.[5,6] For example, good teamwork and collaboration are correlated with improved patient outcomes, patient satisfaction, and greater job satisfaction among physicians.[7] Patients who report being treated with dignity by their physicians are more likely to adhere to treatment plans and to be satisfied with their care.[8] Similarly, physicians who "adopt a warm, friendly, and reassuring manner" with their patients are more effective than those who keep consultations formal and do not offer reassurances.[9] Recently, Hojat and colleagues[10] found that patients of physicians with high levels of empathy have better health outcomes than patients of physicians with moderate and low levels of empathy. Moreover, when physicians' personal skills are lacking, negative professional outcomes are likely. For instance, Papadakis and colleagues[11] showed that unprofessional behavior in medical school (e.g., irresponsibility, lack of capacity for self-improvement) predicts later disciplinary action by state medical boards.

The Role of Personal Competencies in Medical School Admissions

Leaders of the Association of American Medical Colleges (AAMC)[12] and others in the medical education community have called for more emphasis to be placed on applicants' personal competencies in the admission process. Many applicants who have the potential to become excellent doctors may not be invited to interview because admission committees lack information about their personal competencies. Data show that a significant part of admission screening takes place before interviews: In 2011, the average applicant submitted 14 applications but received less than 2 interview invitations.[13]

This challenge—identifying and accepting applicants who have the knowledge, skills, attitudes, and/or diversity that could make a positive contribution to medical schools and the physician workforce—highlights the need to develop tools that present readily usable, standardized data about applicants' personal competencies for inclusion in pre-interview screening. To meet this challenge, the medical education community must first agree on a universal set of personal competencies to measure as well as a set of tools that balances the needs and goals of the admission community with practical (e.g., cost, accessibility) and psychometric issues. Many of the tools currently available to provide data about applicants' personal competencies do not have sufficient reliability and predictive validity[14,15]; moreover, they do not present data in an easily consumable format or in time for pre-interview screening.

In this article, we describe the results of research designed to address these two needs. First, we identify a set of core personal competencies that students should demonstrate when they enter medical school. Then, we evaluate existing tools that could be used to assess these competencies. Finally, we make recommendations for future research.

Defining Core Personal Competencies for Entering Medical Students

Although there have been attempts to systematically define the personal competencies that medical school matriculants should demonstrate on entry (e.g., the AAMC explored this in the 1970s and 1990s),[16] there has been little effort to build consensus about these competencies in the wider medical education community. Therefore, the AAMC undertook a rigorous, multi-year process to research and identify core personal competencies for students entering medical school in the 21st century. This process (Table 1) relied on the work of individuals involved in three large-scale projects—the committee conducting the fifth comprehensive review of the MCAT exam (MR5 Committee), the Innovation Lab Working Group (ILWG),* and the AAMC Admissions Initiative†—as well as input from stakeholders representing admissions, academic affairs, student affairs, and multicultural/diversity affairs.

Identifying personal characteristics important to success in medical school

The MR5 Committee began the process by conducting two surveys designed to identify the knowledge, skills, and personal characteristics that are important for entering students to be successful in medical school. In 2008, U.S. and Canadian admission officers were asked to describe their school's admission process and to rate the importance of 41 personal characteristics to success in medical school. In 2009, U.S. and Canadian academic affairs officers were asked to rate the importance of 72 characteristics to success in medical school. Data from these two surveys[17,18] served as a starting point to prioritize personal characteristics for future study.

Developing the set of core personal competencies

Next, the ILWG conducted a multistep job analysis to identify the core set of personal competencies that entering students require to be successful in medical school. A job analysis is a systematic process used to determine the tasks required by a position and the competencies required to perform them successfully. In employment settings, conducting a job analysis before designing a selection system is considered a best practice.[19] We first reviewed the literature, published through summer 2012, on the importance of various personal characteristics and behaviors in medical education, and then linked the behaviors deemed important for medical student performance with the personal characteristics previously identified as important in the MR5 Committee's admission[17] and academic affairs[18] officer surveys. (This linking activity is a critical component of the job analysis.) We then asked the following questions about each personal characteristic:

1. Is this characteristic related to medical student performance, particularly the behaviors associated with success in medical school?
2. Do students need to display this characteristic at entry into medical school?
3. Is it reasonable to assume that medical school applicants can demonstrate this characteristic? (Is it developmentally appropriate?)
4. Is this characteristic fixed, or is it malleable? Is it something that medical education can build on as the student matures and is exposed to new experiences?

On the basis of the answers to these questions, we selected a subset of personal characteristics to develop into core personal competencies. We adopted this approach to be consistent with calls for an integrated and competency-based approach to medical education, the competency-based approaches used by others in the medical community (e.g., the Accreditation Council for Graduate Medical Education [ACGME] Outcomes and Milestones Projects,[1] the Scottish Doctor Project[20]), and research conducted in the United Kingdom on a competency model for general practitioners.[21] This approach also allowed us to group related characteristics, knowledge, skills, and attitudes into larger behavioral categories that are important for success in medical school and to reduce the number of characteristics identified as "top priorities."

* The authors of this article were members of the ILWG, which was composed of four medical school representatives (T.W.K., S.K.P., C.T., J.P.W.), one consultant with expertise in developing assessments of personal characteristics (Nick Vasilopoulos), and three AAMC staff members (D.M.D., Karen Mitchell, Karla Whittaker).

† The AAMC Admissions Initiative (https://www.aamc.org/initiatives/admissions/) is a multiyear project designed to help medical schools transform their admission processes. Its purpose is to develop new tools and improve existing tools to provide information to medical schools about applicants' personal and academic competencies.

Table 1

Summary of the Multi-Year Process Used to Develop the Core Personal Competencies for Entering Medical Students, Association of American Medical Colleges (AAMC)

Group	Time frame	Actions taken
MR5 Committee*	Spring 2008	• Conducted site visits at 8 U.S. and Canadian medical schools that use the Medical College Admission Test (MCAT) to learn about the personal characteristics required for success at those medical schools and their admission practices.
	Summer to fall 2008	• Surveyed admission officers at U.S. MD-granting medical schools and Canadian medical schools that use the MCAT exam about their admission practices and the knowledge, skills, and personal characteristics required for success in medical school. • Collected input about personal characteristics from constituents at the AAMC's annual meeting.
	Spring 2009	• Collected input about personal characteristics from constituents at the AAMC's spring meetings.
	Summer 2009	• Surveyed academic affairs officers at U.S. MD-granting medical schools and Canadian medical schools that use the MCAT exam about the knowledge, skills, and personal characteristics required for success in medical school.
	Fall 2009	• Collected input about personal characteristics from constituents at the AAMC's annual meeting.
Innovation Lab Working Group	December 2009 to May 2010	• Convened by the AAMC to identify core personal competencies for entering medical students and evaluate tools for assessing them. • Reviewed the following materials: ○ Data from the 2008 admission officers' survey[17] ○ Data from the 2009 academic affairs officers' survey[18] ○ Higher education and employment literatures about personal characteristics and common assessment tools • Collected feedback from constituents at the AAMC annual meeting, AAMC regional meetings, MR5 meetings, and Holistic Review Project Advisory Committee meetings. • Drafted a list and definitions of core personal competencies for entering medical students based on results of the admission officers and academic affairs officers' surveys, constituent feedback, and the literature.
	April to May 2010	• Conducted a survey of admission officers at U.S. MD-granting medical schools and Canadian medical schools that use the MCAT exam to validate the importance of the draft personal competencies required at entry to be successful in medical school. • Shared survey results and collected input about draft personal competencies from constituents at AAMC regional meetings.
	Fall 2010	• Collected input on draft personal competencies from constituents at outreach events.
Admissions Initiative	Summer 2011	• Convened by the AAMC to review and finalize the list of personal competencies and to investigate tools to assess personal competencies.
	Fall 2011	• Collected input on draft personal competencies from constituents at the AAMC's annual meeting.
	February 2013	• Received endorsement of final list of 9 core competencies from the AAMC Committee on Admissions.

*MR5 Committee indicates the committee that conducted the fifth comprehensive review of the MCAT exam.

We initially identified and drafted definitions for seven personal competencies for prospective medical students. In spring 2010, we invited the associate/senior associate dean for admissions (or his or her designee) at each U.S. MD-granting medical school and the Canadian medical schools that use the MCAT to participate in an ILWG survey designed to validate the importance of the draft competencies. The 41-item, online survey provided a definition for each competency. Respondents were asked to rate each competency's importance to entering students' success in medical school and their satisfaction with tools currently available to assess it. They were also asked to indicate when in the admission process they would prefer to receive information about each competency. Nonresponders received three reminder e-mails. Ninety-eight (69%) of 143 admission officials responded, representing 65 (66%) public and 33 (34%) private institutions. Eight (8%) of the schools represented were in Canada, and the rest were in the United States (31 [32%] in southern states, 23 [23%] in northern states, 21 [21%] in central states, and 14 [14%] in western states).

As shown in Table 2, on average, all of the draft personal competencies were rated by admission officials as "very important" to "extremely important." Respondents were not, however, satisfied with the quality of information available about these competencies during the admission process. Most reported that they would like to receive information about each competency at the pre-interview screening stage, when the data could be used to help select the interview pool (Table 3). Results did not differ by respondent institution type (public versus private) or location.

On the basis of these findings, we initially recommended that the AAMC engage in further study of six of the seven proposed core personal competencies for entering students.

Table 2

Admission Officers' Ratings of Core Personal Competencies' Mean Importance to Entering Students' Success in Medical School and Their Mean Satisfaction With the Tools Currently Available to Assess These Competencies, 2010*

Core personal competency	Importance to entering students' success in medical school†	Satisfaction with tools currently available to assess‡
Ethical responsibility to self and others	4.8	2.8
Social skills	4.6	3.3
Reliability and dependability	4.5	2.9
Capacity for improvement	4.4	2.9
Resilience and adaptability	4.3	2.8
Service orientation	4.3	3.6
Teamwork§	4.3	—
Oral communication§	4.2	—
Cultural competence§	3.7	—

*Ratings reflect the responses of 98 admission officers at U.S. MD-granting medical schools and Canadian medical schools that use the Medical College Admission Test on the Innovation Lab Working Group's 2010 personal competencies survey (response rate = 69%). On that survey, "ethical responsibility to self and others" was called "integrity and ethics," "social skills" was called "social and interpersonal skills," and "capacity for improvement" was called "desire to learn."

† Respondents rated the importance of each personal competency using a five-point scale (1 = not important, 2 = somewhat important, 3 = important, 4 = very important, 5 = extremely important).

‡ Respondents rated overall satisfaction with tools available to assess each competency using a five-point scale (1 = not satisfied, 2 = somewhat satisfied, 3 = satisfied, 4 = very satisfied, 5 = extremely satisfied).

§ Separate importance and satisfaction ratings for this competency were not collected on the 2010 survey because it was added to the list after the data collection was complete. The mean reported is the average of the importance ratings from the 2008 admission officers' survey[17] and the 2009 academic affairs officers' survey.[18] The response rate to the 2008 admission officers' survey was 90% (n = 129), and ratings were made on the same five-point scale as in the 2010 survey.

Collecting feedback on the core personal competencies

The ILWG's recommendation served as the foundation for the AAMC Admissions Initiative. One of that group's first projects was to review the ILWG's draft definitions of the recommended core personal competencies. Admissions Initiative members collected input from the AAMC's Group on Student Affairs (GSA), Committee on Admissions (COA), and Holistic Review Project Advisory Committee, as well as from AAMC staff representing different constituencies and from constituents at AAMC regional and annual meetings. Revisions to the competency definitions were generally minor and related to form and organization. Many constituents stated that cultural competence, oral communication, and teamwork (which were subsumed in the definitions of the ILWG's six recommended competencies) should be stand-alone competencies to signal their importance to medical schools and to ensure that they receive adequate attention during the admission process. Before adding these three as core personal competencies, Admissions Initiative members reviewed data from the MR5 Committee's admission and academic affairs officers' surveys[17,18] about their importance to success in medical school. As shown in Table 2, on average, each of these three was rated as "important" or "very important" in those surveys. As such, they were added, resulting in a final list of nine core personal competencies for entering medical students.

Table 3

Admission Officers' Preferences Regarding the Receipt of Information About Applicants' Personal Characteristics at the Pre-interview Screening Stage, 2010*

Core personal competency	% Who would prefer information at pre-interview screening stage
Reliability and dependability	81
Resilience and adaptability	81
Capacity for improvement	76
Ethical responsibility to self and others	74
Service orientation	71
Social skills	68
Cultural competence†	—
Oral communication†	—
Teamwork†	—

*Ninety-eight admission officers at U.S. MD-granting medical schools and Canadian medical schools that use the Medical College Admission Test responded to the Innovation Lab Working Group's 2010 personal competencies survey (response rate = 69%). Survey question: If information from *reliable and valid* measures of [insert competency name] were available to you, how would you use it in selecting your applicants? (1) In selecting applicants who receive secondary applications; (2) In selecting applicants who are invited to interview; (3) Not at all; we have local tools to assess this competency. On that survey, "ethical responsibility to self and others" was called "integrity and ethics," "social skills" was called "social and interpersonal skills," and "capacity for improvement" was called "desire to learn."

† Data are not available for this competency because it was added to the list after the data collection was complete.

Approving the nine core personal competencies for entering medical students

In February 2013, the AAMC's COA endorsed the final list of nine core personal competencies for entering medical students (defined in Table 4): ethical responsibility to self and others; reliability and dependability; service orientation; social skills; capacity for improvement; resilience and adaptability; cultural competence; oral communication; and teamwork.

These personal competencies are linked to behaviors associated with success in medical school, are linked to the ACGME competencies, and build on the personal characteristics rated by admission and academic affairs officers as the most important for students to demonstrate at entry in order to be successful in medical school.

Exploring Tools to Assess the Core Personal Competencies Early in the Admission Process

Although the ILWG survey suggested a desire among admission officers for

Table 4

Core Personal Competencies for Entering Medical Students*

Competency	Definition
Ethical responsibility to self and others	Behaves in an honest manner; cultivates personal and academic integrity; adheres to principles; follows rules and procedures; resists peer pressure to engage in unethical behavior and encourages others to behave in honest and ethical ways; develops and demonstrates ethical and moral reasoning.
Reliability and dependability	Consistently fulfills obligations in a timely and satisfactory manner; takes responsibility for personal actions and performance.
Service orientation	Demonstrates a desire to help others and sensitivity to others' needs and feelings; demonstrates a desire to alleviate others' distress; recognizes and acts on his/her responsibilities to society, locally, nationally, and globally.
Social skills	Demonstrates an awareness of others' needs, goals, feelings, and the ways that social and behavioral cues affect people's interactions and behaviors; adjusts behaviors appropriately in response to these cues; treats others with respect.
Capacity for improvement	Sets goals for continuous improvement and for learning new concepts and skills; engages in reflective practice for improvement; solicits and responds appropriately to feedback.
Resilience and adaptability	Demonstrates tolerance of stressful or changing environments or situations and adapts effectively to them; is persistent, even under difficult situations; recovers from setbacks.
Cultural competence	Demonstrates knowledge of social and cultural factors that affect interactions and behaviors; shows an appreciation and respect for multiple dimensions of diversity; recognizes and acts on the obligation to inform one's own judgment; engages diverse and competing perspectives as a resource for learning, citizenship, and work; recognizes and appropriately addresses bias in self and others; interacts effectively with people from diverse backgrounds.
Oral communication	Effectively conveys information to others using spoken words and sentences; listens effectively; recognizes potential communication barriers and adjusts approach or clarifies information as needed.
Teamwork	Works collaboratively with others to achieve shared goals; shares information and knowledge with others and provides feedback; puts team goals ahead of individual goals.

*This list represents a core set of entry-level personal competencies required for success at most medical schools. It is not intended to be exhaustive of all the entry-level competencies required for students to be successful in medical school.

tools that assess applicants' personal competencies early in the admission process, there are many unanswered questions about the use and value of such measures in medical school admissions.[22] To begin to answer these questions, the ILWG reviewed the medical, higher education, and employment literatures published through summer 2012. We identified more than 50 seminal articles (including several meta-analyses) and six nonpublished technical reports about tools currently used to measure personal competencies in higher education and employment settings. We made subjective, holistic judgments about tools' potential to provide information on applicants' core personal competencies for use in the pre-interview screening stage of the admission process. We judged six types of tools according to the following eight criteria: validity, reliability, group differences, susceptibility to faking and coaching, applicant reactions, user reactions, cost/resource utilization, and scalability for use in pre-interview screening (Appendix 1).

Situational judgment tests

In situational judgment tests (SJTs), examinees are asked to indicate how they would (or should) respond to dilemmas presented in text-based, video, or animated scenarios. Response formats vary: Examinees may be asked to select from multiple-choice options, identify the most and least effective responses, and/or answer open-ended questions. SJTs have been used in medical school admission processes in Canada (the CASPer assessment[23]), Belgium,[24–26] and Israel.[27]

The employment literature[28] provides strong evidence for the reliability and validity of SJTs, as does research conducted in Belgium,[26] where an SJT has been used in the medical school admission process since 1997. Additionally, research from the United Kingdom shows that SJT scores predict competency-based ratings of physician performance and provide incremental validity above and beyond a clinical problem-solving test.[29] Further, applicants hold generally positive attitudes about SJTs.[30]

There is some evidence suggesting that there may be small racial/ethnic group differences in performance on SJTs that emphasize decision making.[31] However, research conducted by the College Board and the Law School Admission Council indicates that including these tests in the admission process may increase the percentage of African American and Latino matriculants compared with using academic data alone, and that performance on SJTs is the best predictor of "lawyering effectiveness."[32,33] These studies were conducted in a research (rather than operational) environment, though.

SJTs are somewhat expensive to develop because of the technical expertise needed to create and score scenarios. However, they are scalable for use in pre-interview screening because they can be administered to a large number of applicants before the interview. Further, when SJTs are scored, data are presented in a format that is easy to consume.

Standardized evaluations of performance

In standardized evaluations of performance (SEPs), raters use a graphic, comparative, or behaviorally anchored rating scale to evaluate applicants on a set of competencies.

Although most medical school admission processes use nonstandardized letters of recommendation—which have poor interrater reliability for nonacademic variables,[34] have poor predictive validity, and lack comparative data—other graduate and professional program (e.g., veterinary medicine, optometry, physical therapy) admission processes use SEPs. In 2009, the Educational Testing Service introduced the Personal Potential Index,[35] an SEP for use in graduate admissions, but there is no published literature to date on its psychometric properties.

Research on the Medical Student Performance Evaluation shows small but significant observed positive correlations between standardized evaluations and performance on comprehensive clinical performance exams.[36] Admission officers are likely to have positive attitudes about SEPs because raters must include specific examples of behaviors illustrating applicants' personal competencies.[37] Although the employment literature includes some evidence of small racial/ethnic group differences,[38] there is no evidence of group differences in the educational literature.

There is potential for rater leniency and consequent lack of variance in ratings, though. Given that applicants select their SEP raters, those raters may feel obligated to act as advocates rather than as objective evaluators. SEPs are also somewhat expensive because of the expertise needed to develop them and the infrastructure required to support their use. However, they are scalable for use with large applicant pools. SEP ratings would make data about applicants' personal competencies available in an easy-to-use format in time for pre-interview screening.

Accomplishment records

Accomplishment records, also known as autobiographical questionnaires, are standardized descriptions of achievements and experiences. Applicants are asked to describe behaviors related to a set of important personal competencies. Typically, applicants write about a situation in which they demonstrated a certain competency, describing the specific actions taken and the outcome. The resulting narratives can be scored by raters or left unscored. Variations of this tool are already used in medical school admission processes, such as in the descriptions of experiences in the Work/Activities section of the American Medical College Application Service (AMCAS) application, in secondary applications developed at individual medical schools, and as part of the MOR[27] center assessment.

Reliability is best when accomplishment records are collected in proctored settings and are scored by multiple raters.[39] Validity data are not available with respect to their use in admissions. Applicants and users may have lukewarm reactions to them because of the added workload. There is little published research on unscored accomplishment records, but they are inexpensive to develop and can be administered to large numbers of applicants. It should be noted that unscored accomplishment records cannot be easily incorporated into pre-interview screening because a substantial amount of time and experience is needed to read and interpret them.

Personality and biographical data inventories

Personality inventories and biographical data inventories ask applicants to indicate the extent to which a series of statements accurately describe them, typically using a Likert-type response scale. These tools are relatively inexpensive to develop and can be administered to large numbers of applicants.

Both types of inventories have good psychometric properties and are commonly used in employee selection. However, there are concerns about their use in a high-stakes admission context. A primary concern is the potential for coaching and faking responses. Research demonstrates that applicants can respond to these types of inventories in ways that may make them appear more attractive and may compromise the validity of these assessments.[40] Bardes and colleagues[22] suggest that this phenomenon could be exacerbated in the medical school admission context because test preparation companies and others routinely help applicants prepare to apply to medical school. Applicants from low socioeconomic backgrounds who do not have access to such coaching may be at a disadvantage. There could also be negative reactions from applicants regarding privacy issues[30] and from admission officers concerning the validity of these assessments.

Local interviews

The majority of medical schools use local (on-campus) interviews to assess applicants' personal competencies. Interview types range from unstructured to structured, but most medical school interviews are semistructured. The typical medical school interview process includes a standard set of dimensions or questions, uses rating scales to evaluate applicant responses, and involves multiple interviews and/or interviewers.[41] Local interviews have a number of limitations, however. Reliability for unstructured interviews is poor, and the practice of providing interviewers with access to applicants' application data introduces bias.[42,43] In addition, local interviews are subject to rater error, and ratings may have more to do with the interviewer than the interviewee.[43]

Although the unstructured personal interview has not been shown to predict clinical performance in medical school,[44] semistructured interview scores have been shown to predict clerkship performance.[45,46] In recent years, the Multiple-Mini Interview (MMI)[‡] pioneered by McMaster University,[14,15] structured interviews conducted at the University of Iowa Carver College of Medicine,[47] and "behavioral event interviews" used by the Scholarly Excellence, Leadership Experiences, Collaborative Training program at the Morsani College of Medicine[48] have paved the way for improved measurement of personal characteristics via interviews.

The employment[49] and medical school admission[45,46,50,51] literatures provide strong evidence for the reliability and validity of semistructured and structured interviews. Applicants and interviewers generally have positive attitudes about semistructured interviews,[30] and applicants perceive the MMI process as being fair.[52] There is no evidence of racial/

‡ It should be noted that the MMI could be categorized as an assessment center because it includes multiple exercises (i.e., situational interview questions, role-play activities, and group activities). We categorized it as an interview because of its heavy emphasis on situational interview stations. In addition, in our experience, most admission officers view the MMI as a variant of an interview.

ethnic group differences on interviews in the educational literature.

One concern about interviews is the potential for coaching and faking. Research suggests that applicants actively try to present themselves in a more favorable light during interviews and that those who do so successfully are likely to obtain higher interview scores.[53–55] Unstructured local interviews may provide important information about medical school applicants' personal competencies, but they lack reliability and have not been shown to predict future performance. Semistructured and structured interviews may also provide information about personal competencies and have better psychometric properties. However, local interviews are resource intensive.

Assessment centers

Assessment centers can employ several standardized exercises (e.g., interviews, role-plays, in-baskets, group discussions) to provide multiple opportunities for multiple raters to evaluate applicant behaviors. Assessment centers have been used in medical school admission processes in Belgium[24–26] and Israel.[27] In the United States, assessment centers' role-playing component has been used in the United States Medical Licensing Examination Step 2 Clinical Skills exam and in various medical schools' objective structured clinical exams. The employment,[56,57] medical school admission,[24–26] and medical practice[58] literatures all provide evidence for the reliability and validity of assessment centers. In Israel, applicants and admission officers who participated in the MOR perceived it to be fair for screening purposes.[27] Data from assessment centers provide important information about applicants' personal competencies, but such centers are resource intensive. Thus, it is not feasible to conduct them on a national level to provide data in time for pre-interview screening.

Tools recommended for future study

After reviewing the literature and evaluating potential tools on the eight criteria, we suggested that the AAMC further investigate three tools for possible use in assessing applicants' core personal competencies during the admission process: SJTs, SEPs, and accomplishment records. We recommended these tools because each of them

- provides data about personal competencies in a format that is easy to use and would be available in time for pre-interview screening,
- allows for multiple sources of assessment,
- has acceptable validity and is likely to provide predictive value beyond UGPAs and MCAT scores in predicting nonacademic outcomes,
- demonstrates less potential risk of coaching and faking effects compared with other tools,
- is likely to be accepted by applicants and admission officers, and
- avoids exorbitant costs that would likely be passed on to applicants.

Given the many unanswered questions about assessment of personal competencies, we believe that the AAMC should conduct additional research before developing these tools for use in medical school admissions. No tool is perfect for all situations, so we recommend that multiple tools be employed to assess personal competencies to enable admission officers to evaluate the information collected (just as they currently consider both UGPAs and MCAT scores in context). SJTs, SEPs, and accomplishment records should be used together—as part of an "admissions toolbox"—along with data on applicants' academic competencies, in deciding which applicants to interview.

Moving Forward

Lack of consensus about the personal competencies[2] needed at entry for success in medical school and concerns[22] about the tools available to assess them have long hampered changes in medical school admission processes. Yet if medical schools do not incorporate data about applicants' personal competencies into their admission processes, the composition of future matriculating classes is unlikely to change.

In this article, we report the nine core personal competencies for entering medical students that have been endorsed by the AAMC COA: ethical responsibility to self and others; reliability and dependability; service orientation; social skills; capacity for improvement; resilience and adaptability; cultural competence; oral communication; and teamwork. This is the first list of personal competencies that is likely to generalize to all U.S. MD-granting medical schools and Canadian medical schools that use the MCAT exam, and it provides a common taxonomy for admission researchers. Individual medical schools may require additional personal competencies, but our data suggest that these nine are important for—and can be linked to behaviors critical to—success at the majority of medical schools. Each of these competencies can also be linked to ACGME competencies and competency models for physician performance. Future research should examine the relationships among these personal competencies and performance outcomes at the national level, and whether these personal competencies differ in importance on the basis of medical schools' characteristics (e.g., mission, values).

Our evaluation and comparison of tools currently used to measure personal competencies incorporates research from the employment literature and provides admission officers with new information that may be useful as they evaluate their local admission practices. From a practical perspective, the data and literature reviewed in this article will serve as the foundation for the AAMC Admissions Initiative, which over the next several years will investigate options for developing tools to assess these core personal competencies in the medical school admission process and make recommendations about which tools, if any, should be implemented by medical schools.

Future research on the use of SJTs in medical school admissions should explore different formats for presenting scenarios (e.g., actors, avatars), alternative response formats (e.g., rank order, narrative responses), validity, and the impact of coaching/faking on validity and user acceptance. In addition, research should investigate admission officers' interest in SEPs and in incorporating an accomplishment record in the AMCAS application, as well as the likely value to the admission process. Research should also identify strategies to minimize the negatives and to capitalize on the strengths of the individual tools. In determining which tool (or set of tools) is a viable option for assessing applicants' core personal competencies during the medical school admission process, the AAMC Admissions Initiative

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should weigh each tool's advantages and drawbacks and balance them both with the admission community's needs and goals and patients' needs.

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Appendix 1

Strengths and Weaknesses of Tools Currently Available to Assess Core Personal Competencies for Entering Medical Students*

Assessment tool	Description	Validity†,‡	Reliability†	Racial/ ethnic group differences†	Potential for faking/ coaching†	Likely applicant reaction†	Likely admission officer reaction†	Cost and resources†	Scalability for use in pre-interview screening†
Situational judgment test	• Examinees indicate how they would (or should) respond to the dilemma presented in a text-based, video, or animated scenario. • Response formats include multiple-choice, identifying the most/least effective responses, and open responses.	+	+	=	=	+	+	=	+
Standardized evaluation of performance	• Raters evaluate applicants on a set of competencies using a rating scale. • Rating formats include graphic, comparative, and behaviorally anchored rating scales.	=	=	=	−	Unknown	=	+	+
Accomplishment record (unscored)	• Applicants describe behaviors related to the competencies being assessed, typically by writing about a situation, the specific actions taken, and the outcome. • Narratives can be scored by raters or left unscored.	Not applicable	Not applicable	=	=	=	=	+	+
Personality and biographical data inventories									
Personality inventory	• Applicants indicate the extent to which a series of statements accurately describe them. • Responses typically use a Likert-type scale.	=	+	+	−	=	=	+	+
Biographical data inventory	• Applicants indicate the extent to which a series of statements about past experiences accurately describe them. • Responses are typically multiple-choice or use a Likert-type scale.	+	+	=	−	=	=	+	+

(*Appendix continues*)

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Appendix 1, *Continued*

Assessment tool	Description	Validity†,‡	Reliability†	Racial/ ethnic group differences†	Potential for faking/ coaching†	Likely applicant reaction†	Likely admission officer reaction†	Cost and resources†	Scalability for use in pre-interview screening†
Local interview									
Unstructured interview	• Questions vary in this formal interaction between an applicant and one or more interviewers. • Scoring is unspecified.	–	–	=	=	+	+	–	Not applicable
Semistructured interview	• The number and content of questions are predetermined in this formal interaction between an applicant and one or more interviewers. • Scoring may be structured.	+	+	+	=	+	+	–	Not applicable
Assessment center	• Applicants participate in several standardized exercises (e.g., interviews, role-plays, in-baskets, group discussions). • Multiple opportunities are provided for behavioral evaluations by multiple raters.	=	=	=	=	+	+	–	–

*The summary of empirical evidence summarized in this appendix is subjective and reflects consensus among the Innovation Lab Working Group members after reviewing and discussing data from the higher education and employment literatures published through summer 2012.

† Plus sign indicates that data are favorable and suggest use; equals sign, data are mixed but still positive overall; minus sign, data suggest caution before implementation; unknown, limited or no empirical research available.

‡ Decision rule for assigning a value to validity data: Plus sign indicates average validity ≥ 0.20; equals sign, average validity between 0.11 and 0.19; minus sign, average validity ≤ 0.10.

AM Last Page: The MCAT Exam: Comparing the 1991 and 2015 Exams

Marc Kroopnick, MEng, PhD, Manager, MCAT2015 Development and Psychometrics, Association of American Medical Colleges (AAMC)

In the spring of 2015, potential physicians will take the MCAT2015 exam, the newest version of the MCAT exam. The MR5 Committee (the advisory committee for the MCAT2015 exam) redesigned the exam to test the academic competencies* that tomorrow's physicians will need to know to succeed in medical school. The design is based on survey responses from over 2,700 medical school and baccalaureate faculty members and feedback from expert panelists and participants in over 90 outreach events. The MCAT2015 exam will, like the current exam (the MCAT1991 exam, introduced in 1991), test concepts in the natural sciences, as well as skills in critical analysis and reasoning. Unlike the MCAT1991 exam, the MCAT2015 exam will also cover concepts from the behavioral and social sciences. The table below highlights the features the MCAT2015 exam shares with the MCAT1991 exam, as well as its new features.

How Are the MCAT1991 and MCAT2015 Exams the Same?		What's Different on the MCAT2015 Exam?
	Content	
• Concepts from biology, general chemistry, organic chemistry, and physics that are rated as important for success in medical school are tested; in fact, approximately 75% of questions on the MCAT2015 exam test concepts that also appear on the MCAT1991 exam. • Questions require examinees to demonstrate their scientific reasoning and problem-solving skills. • Two test sections focus on natural sciences concepts.	**Natural Sciences**	• Biochemistry concepts that are rated as important for success in medical school are tested. • Questions test scientific competencies* by asking examinees to solve problems about biological and living systems and to integrate concepts from multiple disciplines. • Questions require examinees to use research methods and statistical skills to solve problems in the same ways that natural scientists do.
• This is a brand new test section.	**Behavioral and Social Sciences**	• Concepts from psychology and sociology (along with related biology concepts) that provide the foundation for learning about the behavioral and sociocultural determinants of health and health outcomes are tested. • Questions test scientific competencies* by asking examinees to integrate knowledge from different disciplines (just like in the natural sciences sections). • Questions require examinees to demonstrate scientific reasoning and problem-solving skills and to use research methods and statistical skills in the same ways that social and behavioral scientists do.
• No specific content knowledge is needed to do well on this section. • Passages include content from the social sciences and humanities. • Questions require examinees to demonstrate a variety of analytical and reasoning skills (i.e., cognitive-processing skills).	**Critical Analysis and Reasoning Skills**	• Passages from the social sciences and humanities that emphasize cultural studies, population health, ethics, and philosophy are included. • No natural sciences and technology passages are included. • Questions test examinees' analysis and reasoning skills using the most current science on cognitive processing.
• This section has been eliminated.	**Writing Skills**	
	Test Administration and Score Reporting	
• Multiple-choice questions are predominantly prompted by passages and, in some cases, graphs, tables, or charts. • Section scores and an aggregate total score are reported to examinees and medical schools. • A computer-based testing format that has proven effective is used.		• Individual test sections include more questions than on the MCAT1991 exam; accordingly, the test day is longer by approximately two hours. • Reliable comparisons of section scores for different examinees are made possible by the greater number of test questions.

*The natural sciences competencies tested on the MCAT2015 exam align with the competencies described by the AAMC-sponsored Scientific Foundations for Future Physicians Committee. The behavioral and social sciences competencies tested on the MCAT2015 exam build on the competencies that are described in the Institute of Medicine's report, *Improving Medical Education: Enhancing the Behavioral and Social Content of Medical School Curricula* (National Academies Press; 2004; edited by Patricia A. Cuff and Neal Vanselow), and promulgated by the AAMC-sponsored Behavioral and Social Science Foundations for Future Physicians Committee.

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