Meeting the Need for Emergency Medicine Physicians:

A National Study of Factors Influencing Medical Specialty Career Choice

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Higher Education)
at the University of Michigan
2019

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Dedication

To my family, friends, and colleagues who have helped me to reach the end of this journey. I wish to specifically recognize the loving support of my wife, Dr. Kathryn Thirolf, who challenges me to think critically every day. To my children, Emily and John (Jack) Burkhardt, who gave me indefatigable love even when I needed to work instead of play. Finally, to my parents, John and Janis, for instilling in me a lifelong love of learning, an intense desire to make a positive impact on the world, and the powerful drive to achieve.

Acknowledgements

First, I wish to thank all the members of my dissertation committee, Drs. DesJardins, Gruppen, Bowman, and Rodriguez, many of whom have acted as my mentors and collaborators for the better part of the last decade. I also wish to credit my faculty and resident colleagues in the University of Michigan Department of Emergency Medicine for inspiring me to find my own particular space in academia. I especially need to thank Drs. William Barsan and Robert Neumar, my faculty chairs in Emergency Medicine for the past ten years, for their tireless and consistent support in achieving this degree. Additionally, I wish to recognize the contribution, in the form of the Education Fellowship Grant, made by the Society of Academic Emergency Medicine toward the completion of my research. Finally, this dissertation would not be possible without the support of Drs. Marie Caulfied and John Prescott, at the Association of American Medical Colleges, and Dr. Mark Raymond, at the National Board of Medical Examiners, who provided both invaluable data and advice as well as the freedom to follow my results wherever they led.

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Abstract

Objective: The process by which medical students choose a specialization is incompletely understood, especially as related to factors that influence changes in specific career interest during medical school. Women and Underrepresented in Medicine (URiM) students are less likely than their peer to apply for residency in emergency medicine (EM). Identifying whether medical students from these groups have baseline differences in their career interests or if the lower likelihood in planning a career in certain medical specialties develops during medical school. However, comparison to other major medical specialty patterns will provide the first steps toward a general understanding of the mechanisms at play.

Hypothesis: First, female and URiM students have lower interest in EM even after controlling for other factors. Second, career interest in EM for both groups would be like other students at medical school onset and that a "cooling out" of interest would occur. Third, that women and URiM physicians would exhibit no difference in EM career persistence. Fourth, female and male students enter medical school with similar interest in fields like internal medicine and surgery and women will have higher odds of an interest in fields with typically more female physicians such as pediatrics and OB/GYN. Fifth, URiM students will have equivalent interests not non-URiM students. Sixth, women will both be "cooled out" and under-recruited. Fourth, URiM medical specialty interest will remain relatively stable from entry of medical school to graduation.

Methods: Secondary data analyses was conducted on a cross-section of all residency applicants from 2005-2010. Data sources included: AAMC, NBME, AMA. Binary logistic regression

models (BLM) were fitted with the outcomes: a planned career in EM at medical school entry, planned career in EM at graduation, and continued practice in EM. BLMs were also fitted with the outcomes: a planned career in one of four medical specialties (Internal Medicine, Pediatrics, OB/GYN, and General Surgery/Surgical Specialties) at medical school entry and again at graduation. Regression models included demographics, student attitudes, debt, undergraduate GPA and standardized test scores, and, medical school experiences.

Results: URiM students expressed less interest in a career in EM when entering medical school and at graduation. No gender differences in interest existed at medical school onset. Women were less likely to enter EM by the time of medical school graduation. After residency, both female and URiM students had similar persistence in EM as all other graduates. Women were less likely to be interested in a career in Internal Medicine and Surgery and more interested in Pediatrics and OB/GYN at the start of medical school while URiM students expressed more interest in OB/GYN and Surgery. At graduation, women were still less likely to enter Internal Medicine and Surgery and more interested in OB/GYN and Surgery. URiM students were more likely to enter in Internal Medicine and less likely Pediatrics.

Conclusions: Female and URiM medical students were less likely to enter EM. Women were less likely to develop a career interest in EM. While URiM students were less interested in EM generally, those initially interested in EM had a "cooling out" effect. Women have stable preferences regarding planned medical specialties in other specialties. In contrast, URiM students enter medical school more likely to enter OB/GYN and Surgical careers but at graduation were more likely to plan on Internal Medicine and less likely Pediatrics.

Chapter One: Introduction

Access to health care may be among the most politically contentious issues to this point in the 21st century. The current debates focus on who among us should be eligible for care and how care should be financed. The ways in which these questions are ultimately resolved will have profound effects on the organization and delivery of health care in the United States; will affect decisions related to infrastructure, general terms of global employment, and the size and reach of federal and state governments; and even reshape an important part of the nation's economy. It is not an exaggeration to suggest that the choices made in this debate, largely through a political process, may result in life or death for some individuals. The stakes are very high.

While it has not received as much general attention, there is yet another policy problem that results from the larger political debate about health care delivery. Emergency Medicine (EM) trained physicians are responsible for providing care for millions of patient visits each year nationwide[1] and are often the only option for patients who cannot receive care elsewhere.[2] While the specialization makes up less than 5% of all physicians, EM physicians provide care in almost 30% of acute care patient encounters.[3] If the policies of the Patient Protection and Affordable Care Act of 2010 (ACA) are significantly altered, more patients may be seeking care in the emergency department (ED). Even without a major change to the ACA, the number of patients seeking the care of emergency physicians is certain to continue to rise.[3] Every health

care policy alternative under consideration is likely to have some increasing effect on acute care interactions. The key point to observe is that the specialty is already stretched and while physical infrastructure can be added (at considerable cost), staffing emergency departments with competent, well-trained physicians will be a challenge for years to come.

The practice of medicine is personally challenging and intellectually demanding.[4] Even though it is accorded a high status in our society, those who choose this field are asked to make contributions in ways that often exceed the personal, financial, and psychic benefits they receive.[5-8] Perhaps at one time the primary connection that shaped medicine could be captured in the relationship between a doctor and a patient. At the point of practice, that connection still matters most.[9,10] But as medical care becomes the symbolic and tangible expression of a social compact, the private practice of medicine becomes increasingly a public practice.

Because of the growing attention paid to the ways in which the health care system functions, the contexts in which medicine is practiced (who does it, how, where, and on whose behalf) will be scrutinized with increasing interest by stakeholders beyond members of the medical profession. Traditionally the public has maintained an unusually high degree of faith in physicians and given them wide latitude to establish and monitor their profession. Even as there has been a decreasing level of trust afforded to other professional groups,[11] physicians generally maintain considerable leverage to shape their own work, to control and evaluate the practice of their arts, and (most important to this study) to decide who is allowed to enter the medical profession. As pressures toward increased accountability to patients, government agencies, students, and taxpayers continue to grow,[12] medicine and those involved in medical education may no longer be afforded the same level of unfettered autonomy enjoyed in the past.

One area of increasing public scrutiny is the pipeline and various related selection processes through which individuals are accepted into the medical profession. Admissions policies in other professional contexts have been challenged in Supreme Court cases[13,14] and state constitutional referenda.[14] Among the many consequences of this heightened attention and judicial oversight has been a pattern of adaptations by higher education institutions to maintain systems of inclusion that are perceived as fair, without abandoning commitments to increased diversity in undergraduate, graduate, and professional education.[14] This increased scrutiny makes it even more important that researchers and policy makers clearly understand the manner in which future physicians are recruited, selected, educated, and eventually enter practice. To approach this level of transparency, with an ultimate goal of ensuring greater fairness, will require a fuller understanding of this process. This process includes areas that are within the purview of medical education as well as those that are beyond the control of medical educators. Some of these events and influences occur well before an aspiring professional even makes the choice of a profession at all. The basic steps of the process of physician education are represented in Figure 1 and explained fully in Chapter 2.

Dissertation Research Questions

The process by which medical students choose a specialization is incompletely understood, especially as related to factors that influence changes in specific career interest during medical school. The reasons why medical students choose to enter a medical specialty have important ramifications on the physician workforce, patient care, and issues of representation in the field.[15] Studies focused on medical career choice, including those related to emergency medicine, have generally relied on surveys of candidates, asking subjects to retroactively consider the factors in their decisions, and are only roughly correlated with one's career interest.[16-18] The most commonly reported findings of such approaches in emergency

medicine suggest that differences in career choices may be based on income preferences and lifestyle choices made by medical school students as they approach decisions to apply for a residency in a specialization.[15,19,20]

Preferences in specialty choice are not static, however, and can change both on the individual level[21] and across groups of students over time.[22] Unfortunately, the prior research fails to account for several important explanations. The current literature does not use statistical evidence to describe which among these factors are the most important, nor how these factors interact with each other. Further research is also needed to describe which students do not persist in their career choices, and specifically how a range of factors influences decisions to enter practice in emergency medicine. The answers to these questions are important because without them it is possible that the medical profession is not recognizing important considerations, including what has been described as a "cooling out."[23] "Cooling out" is a loss of interest by students due to educational experiences that make continued study undesirable, often as the result of implicit biases against certain learners. In emergency medicine, the question becomes whether learners from historically underrepresented backgrounds in the specialty, including minority students[24] and women, lose interest as a result of unintended discouragement experienced during their education regarding their ability to succeed in emergency medicine?[25]

Medical students are trained to make logical and rationally considered decisions.[26] When medical students make career decisions, it may be reasonable to assume they are making considered decisions about their futures. This presumption suggests that framing this study based on theories of rationality may be fruitful. Specifically, a bounded rationality decision-making framework could provide a good theoretical basis from which to start an investigation into this process.[27,28] The use of a decision-making frame has the advantage of bringing the temporal

component of specialty selection into focus. The current literature has not answered whether students change their interests based on their training experiences, academic ability, personality, or specialty cultural issues that may "cool out" medical students----each explanation occurring at different times in the decision process. Similarly, career decision-making has been studied in other disciplines, and theories of self-efficacy[29,30] and social learning[31] have been developed that should be used to guide variable selection and model generation in medical education.

Significance of This Area of Study

Emergency physicians provide care for millions of Americans. Physicians trained in EM are responsible for providing care for millions of patient visits a year nationwide.[1] Emergency physicians make up less than 5% of all physicians but provide care in almost 30% of acute care patient encounters.[3] If the policies of the Affordable Care Act are maintained and/or adopted nationwide, the number of patients seeking the care of emergency physicians is likely to rise even more.[3] Alternatively, if a new form of national health care is implemented, the implications for changes in emergency care are less clear, but cases are also likely to increase as once uninsured patients seek care in emergency departments.

Diversity among emergency medicine physicians has implications for patient care. Despite the enormous resources devoted to graduate medical education, the manner in which we recruit and select residents is not well studied and is not optimized to meet the demand in numbers or achieve the level of diversity needed for practicing emergency physicians.[32] While the causes of limited access are likely multifaceted, there are undeniably persistent systemic issues of underrepresentation in medicine for some minority groups.[13,33] URiM representation in the physician population has been recognized as a continuing issue in Emergency Medicine.[34]

"Leaks in the pipeline" exist at other levels of the educational system[35] but have been less well studied in medical specialty selection.

Furthermore, evidence suggests that the lack of minority representation may exacerbate persistent challenges faced by medically underserved groups receiving health care. Medically underserved populations have reported increased trust in the provider and improved clinical outcomes when treated by physicians from historically underrepresented groups.[36,37] Medical students from white and other "nonminority" backgrounds choose to practice in medically underserved populations at a higher rate after training with URiM students.[38] These majority students report feeling more capable of caring for minority patients, more likely to endorse ideas of equitable access to health, and more likely to work in underserved communities.[38] This problem is one that will likely become even more challenging as more individuals enter the health care system. It is predictable that available resources will become increasingly strained as the numbers of previously underserved groups seeking care grows.

The federal government directly pays for resident physician training programs. The public has a direct stake in decisions that determine who is admitted to medical schools and residency programs. Federal funding via Medicare has supported these programs directly for many decades, and reimbursement programs play a critical role in sustaining them.[39] Should this interest be translated into pressure to change the composition of the field or drive candidates to specific specialties, the parameters within which medical education operates could be dramatically changed.

Emergency medicine wants to select the best possible doctors out of an increasingly competitive process. The number of U.S. medical school graduates has been increasing steadily while the number of residency slots has remained largely unchanged, increasing the competition

to match in a residency program across all fields.[40] Within emergency medicine, this trend toward higher competition is even more pronounced.[40] It is in the best interest of EM as a field, and in the best interest of patients, that EM recruits academically gifted and highly interested physicians from all racial, gender, and geographic backgrounds to the specialty. Given limitations in available residency slots, a larger number of applicants will be denied entry into the specialty of EM based on the current selection processes at a time when more, better trained, and diversely experienced emergency physicians are needed.[41] Careful, intentional, evidence-based recruitment and selection will be increasingly critical to achieve the goals of the specialty.

Given the above, this research described in this dissertation moves the literature forward by utilization of a theoretically driven, national-scale educational research project designed to improve the evidentiary basis and overall knowledge of specialty selection in medicine, using the specific case of emergency medicine as a reasonable initial level of analysis. This dissertation describes three the results of specific research studies:

Research Study 1

Question 1: As a student in medical school approaches the time of application to residency, what factors correlate with an interest in emergency medicine?

Hypothesis 1: The importance of a balanced work-life lifestyle and desire for a higher future income will be correlated with increased likelihood of choosing emergency medicine. As described in the introduction, this is in keeping what has been shown to be principal factors influencing medical student career choice to date.

Subhypothesis (a): Additional factors including academic ability, gender, and underrepresented minority status (URiM) will be related to persistent interest toward specialization in emergency medicine.

Subhypothesis (b): Controlling for academic qualifications, female and URiM applicants will each have a lower probability of applying to emergency medicine.

Research Study 2

Question 2: How does emergency medicine career interest change from the time of entry into medical school until the time of application to residency?

Hypothesis 2: Women and URiM students will have higher probabilities of changing their career interest than men and non-URiM students, when other academic metrics of competitiveness are controlled for in the model.

Research Study 3

Question 3: Through the course of medical school training, do common patterns in student career selection behavior exist across different medical specialties (i.e., are there similar issues of cooling out of some groups as we hypothesize exist in emergency medicine)?

Hypothesis 3: Specialties with issues of continued underrepresentation will have similar patterns of student selection behavior as those observed in emergency medicine. Controlling for preferences based on content interest, considerations of academic competitiveness, and financial need will also have significant correlations for how well many specialties are able to recruit from underrepresented groups.

Chapter Two: Conceptual Framework

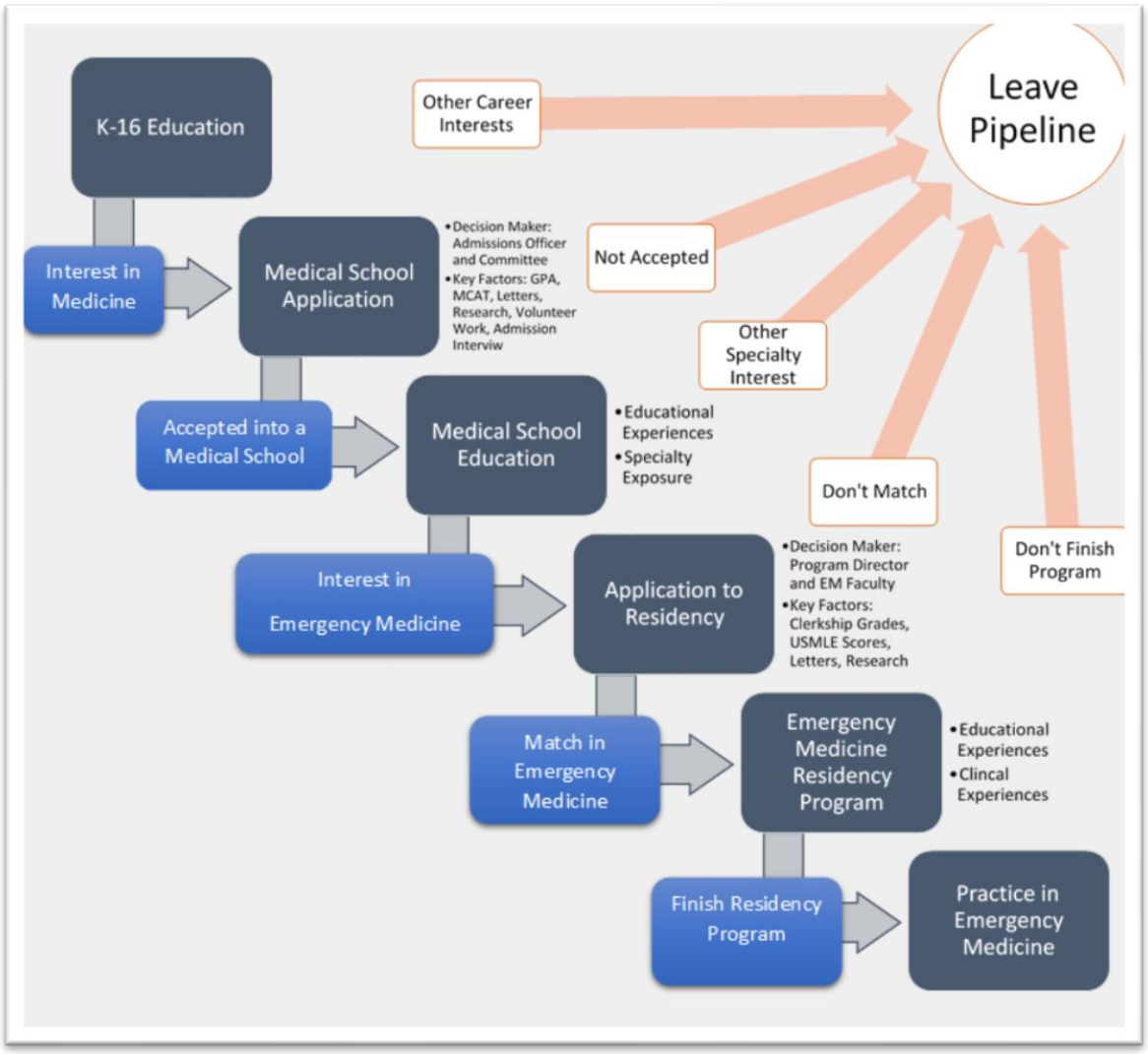
The Medical Education Pipeline: From Interest to Practice

Given the complexity of the pipeline into the medical profession, studying the entire process in its aggregate form (from elementary and high school, adolescent influences, and pre-college choices through certification and licensure) is impossible and would not result in many useful generalizations.

An obvious stage of the process that is both deserving of consideration and has received some scholarly attention is the point at which students are admitted to medical school. Those charged with determining medical school admissions have the difficult role of acting as the "gatekeepers" to the profession. Less than half of all applicants are admitted to a single medical school. Getting in is the key: Once matriculated, academic attrition is exceedingly rare (<2%).[42] The medical school selection process is therefore terribly "high stakes," expensive, and is characterized by a significant power imbalance between most students and schools. Medical school admissions are the point where the idea of a "pipeline" becomes most germane. While the idea of a pipeline in higher education has increasingly become under attack as inadequate given the multiple opportunities for entry and exit into the process,[43] medical education has very little external entry outside of the medical school educational process (international medical school graduates largely in primary care residencies)[44] and very little exit (as reported above). Also, while individual medical schools exhibit some variability in the characteristics and

qualifications that are most important to their admissions officers in making decisions about offering acceptance to an applicant, they are much more uniform than at other stages of the K-16 educational process. The applicant's chance of admission at almost every medical school relies heavily on his or her academic quantitative metrics.[45] Quantitative data, such as undergraduate

Figure 1 The Emergency Medicine Physician Pipeline



GPA and Medical College Admission Test (MCAT) scores are the most common factors considered in offering applicants an opportunity to complete a secondary application and in offering an admissions interview.[45]

In short, while the selection factors considered by admission officers in medical school are under their control, the educational experiences and opportunities for applicants are not, a point made clearly in the research and which is represented in Figure 1. Physician-educators have the responsibility to promote greater understanding of the factors that are within the control of their profession. With that in mind, I have adopted a specific segment of the pipeline on which to focus my analysis, the time between medical school matriculation and residency training onset. This time period offers opportunities to examine both independent and dependent variables that, compared to others, are under the purview of physicians and contains a largely stable population of learners.

Residency programs consist of post-doctoral training in an individual medical specialty. This training consists of practical instruction while the learner provides supervised care in academic training hospitals as well as a didactic program consisting of lectures, small groups, and simulation courses. While only a single year of post-graduate training is required (intern year) to apply for a medical license, most U.S. medical students complete an entire residency program in a specialty area.[46] Residency length varies by specialty and program type but usually last between three and seven years, with additional subspecialty training in the form of fellowships extending training time to ten years after the completion of medical school in some cases.[46] Given the extensive personal and financial costs involved in the process, reliability and validity in the selection of residency applicants is a key issue in the medical education process.

The selection of residency candidates replicates many of the same considerations described above in medical school admissions but has the benefit of both immediately preceding and following stages in the pipeline being taught by physician-educators (Figure 1). Like medical school admissions, resident selection also strongly influences the physician workforce,

health care outcomes, and more general societal outcomes.[41,47] Resident selection also involves a high-stress process which has the effect of dramatic effects on both the training program and applicants. In the short-term residency match determines the training and living location of the new resident in addition to the faculty and specific program they will train in.[48] In the long-term, residency match will determine the specialty of practice, the likely regional practice location, and the competitiveness for job opportunities following training.[49,50] Unlike medical school admissions, residency selection involves institutions and potential residents creating a rank list of desirable programs/applicants and does not follow the traditional admissions timeline or power dynamics. This process is administered by the National Residency Match Program,[51] and is commonly referred to as the "match" in the medical community. Within the match, each applicant creates a rank order of programs they would like to train at with the program listed as most desirable being ranked first. A similar list of applicants (rank list) is created by each residency program director, with the input of other residency faculty. Following submission of both lists, a computer program matches applicants with programs through a process of matching and then replacing based on the two priority lists. While this process takes place across the whole spectrum of medical specializations, my position as an emergency medicine faculty member makes this an obvious point of interest. Also considering the importance of emergency physicians to the overall delivery of health care[3] factors affecting residency selection and the match process which brings candidates into emergency medicine is of special importance generally. Therefore, that is the focus of the following studies.

The factors that are most important to both residency applicants and program decision makers are largely understudied. The current literature for emergency medicine, and Graduate Medical Education in general, is limited but strongly suggests the current process is not based in

a clear theoretical foundation, lacks rigor, and adds little in predictive value to those factors carried over from admission to medical school. Improvements in the medical education selection process, especially in emergency medicine, will allow for the possibility of both a more equitable approach and examination of possible interventions to improve inclusion.

Understanding How Selection Processes Impact the Physician Pipeline

Research into the medical education selection processes in general, and residency selection in particular, has generally been conducted without a theoretical framing to guide the study design.[52] I propose three interrelated conceptual lenses to address this critical gap in the literature. The first of these focuses on the individual decision-making process potential residents utilize in choosing a medical specialty. The second framework focuses on the resident selection-making process made by faculty. The final framework examines how the selection factors utilized by faculty are shaped by the larger educational process and other important societal influences and how in turn these influence career selection behavior by students. Understanding the selection process at the individual program decision maker level, at the institutional level, and at the learner level requires consideration of all three frameworks.

Career specialty interest formation and maintenance

Medical education scholars have been concerned with understanding medical student specialty selection for at least a half century.[53] Recurrent survey-based studies have demonstrated entering medical students often begin their studies with clear attitudes and preference with regard to where they plan to practice,[54,55] although these studies have reported conflicting evidence on how stable these preferences remain through the time of graduation from

medical school. Factors empirically demonstrated to have a role in career interest at the start of medical school include lifestyle interests, income, prestige, procedural orientation, as well as societal prestige and respect of peer physicians.[56,57]

Work-life balance, or having a controllable lifestyle, has been increasingly cited as a key factor in medical student specialty selection.[58,59] The importance of a having a controllable lifestyle is especially important for those choosing emergency medicine.[60-62] Some researchers have even argued it accounts for most of the change in the distribution of resident trainees by specialty.[63,64] The broadest definition of specialties with a more controlled lifestyle includes anesthesiology, dermatology, emergency medicine, neurology, ophthalmology, otolaryngology, pathology, psychiatry, and radiology.[63] It is perhaps not surprising that many of these same specialties are either considered "consistently competitive" or "newly competitive" for successful residency matching compared to other choices.[65,66]

While work-life balance is directly related to the medical practice in a specialty, two other key considerations are primarily external validators of success: specialty prestige and average income. Prestige can be an especially powerful factor for some medical students' selection behavior[67] and as such has been studied frequently over the past half century.[58,59,68] Medical specialty prestige can be generated in several ways. First is the perception of the specialty by peers. Surgical subspecialties, especially neurosurgery, have long benefited from higher prestige from peer physicians.[58] Primary care specialties have repeatedly cited a lack of professional prestige as a cause of student's choosing other medical specialties.[69-71] Conversely more procedurally-driven or specialties focused on more complex organ systems have had higher reported prestigiousness as measured by medical students.[72] Negative comments, or "bashing of

a specialty" by other physicians has also been shown to negatively impact recruitment of students to primary care specialties,[73,74] psychiatry,[74] as well as emergency medicine.[75]

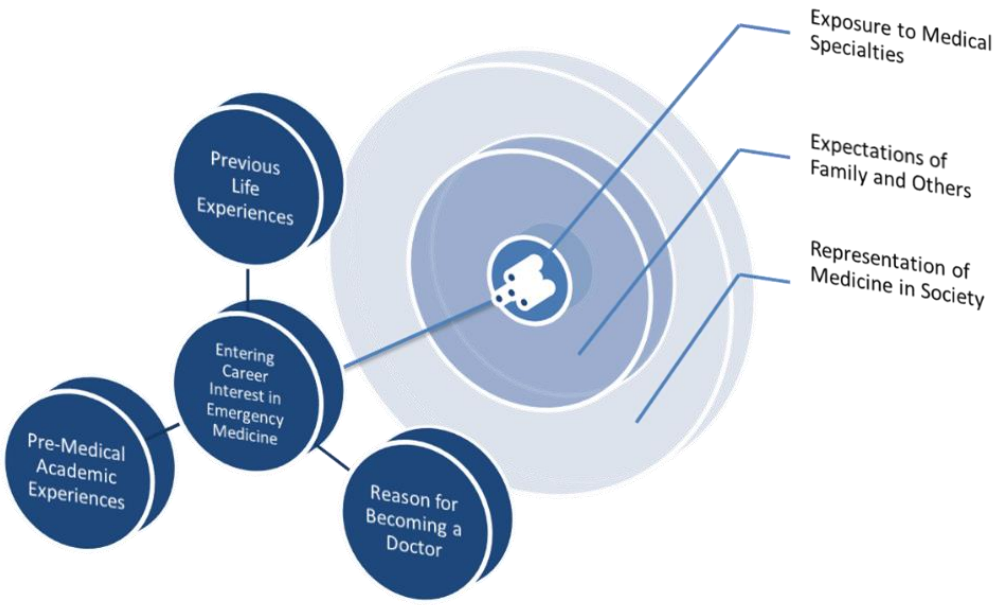
A second method in which a medical specialty is perceived as being prestigious comes from its larger social context. Lay persons have specific perceptions of which medical specialties are more prestigious,[59] though these often correlate with perceived income and not competitiveness for entry. Also, location may impact specialty prestige. For example, the relative ranking of medical specialties is fluid between studies in the United States,[76] the United Kingdom,[74] and Australia.[68] The apparent differences in competency and respect for different medical specialties experienced by medical students has even led to an "informal hierarchy" in some individual's minds.[74,77]

Related to prestige is expected income.[59] Clear differences exist with respect to expected income by specialty, with procedurally based specialties generally having much higher average salaries.[78] In the general distribution, this places specialties such as plastic surgery, orthopedics, and cardiology at the top of the income ladder, with pediatrics, internal medicine, and family medicine near the bottom.[78] For purposes of this dissertation it is important to note that emergency medicine is generally in the "middle third" of medical specialties with regard to income.[78]

Based on the available literature and empiric evidence, I propose that the initial career interest in a specialty, in this case emergency medicine, is based on personal interests, experiences, general exposure, and societal expectations and influences (Figure 2). I have reorganized the factors described in the cited articles from just correlative lists into the framework shown in Figure 2 to better illustrate the role of both individual experiences and interests and the constraints and expectations of society on a single medical student.

As medical students move through their education, their entering specialty interest may be modified by both personal development as well as programmatic and cultural factors based on their specific medical school. Self-efficacy has been applied to career choice in multiple fields using Bandura's social-cognitive theory.[29] Bandura defines self-efficacy as one's belief in his/her ability to influence their cognitive response to a situation.[79] This response influences a subject's ability to persist in their attempts, despite adversity, and to eventually succeed in

Figure 2: Entering Career Interest



specific situations.[79] Betz applied this theory to career selection; paying specific interest to fields that are traditionally male-dominated, such as the sciences and medicine.[29] Lent demonstrated that self-efficacy theory successfully accounted for significant differences in grades and career option beliefs.[30]

Applied to the medical education context, self-efficacy can be used to explain some of the previously described factors that have been shown to correlate with specialty choice where intellectual challenge and ability has been described as a major consideration.[80] For example,

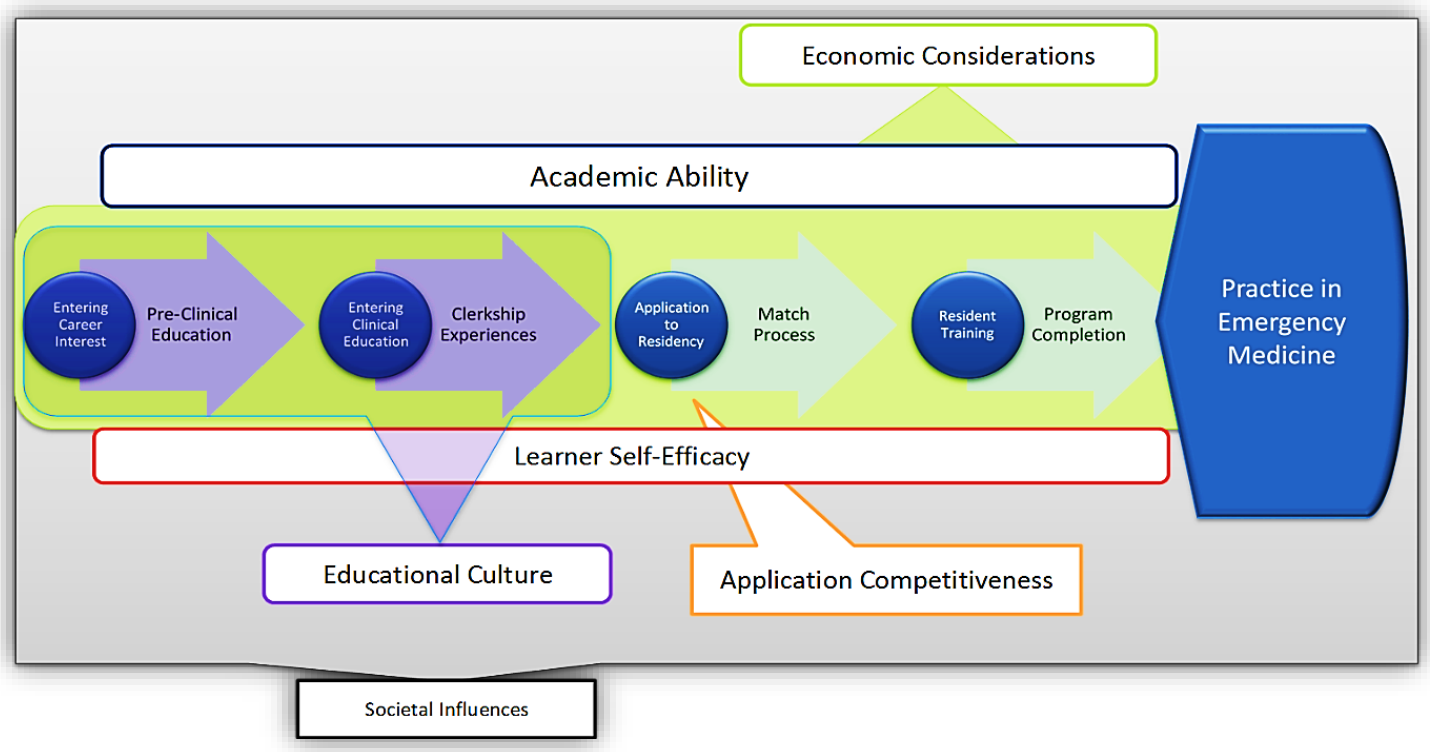
there are significant differences reported in specialty selection based on the gender of the physician.[46] The importance of family to the candidate has been suggested as a possible explanation for this phenomenon [81] or alternatively a difference in baseline interest along gender lines has been proposed.[80] However evidence that is contradictory to both hypothesis has been shown regarding female increased preference for lifestyle control[82] and a lowered enthusiasm to pursue competitive fields in which they are underrepresented.[83] The lack of successful role-models in academic medicine and the limited perceived potential for promotion as a result of gender[84,85] could explain these differences using a self-efficacy approach.

A complementary framing system for specialty selection to the social-cognitive approach is social learning theory. Krumboltz used social learning theory to describe a theoretical framework regarding career selection. It focuses on four major areas: genetic endowment, environmental conditions, learning experiences, and task approach skills.[31] These factors provide additional influences beyond self-efficacy that are worth consideration in attempting to explain career interest in emergency medicine. Genetic endowment (in this case measures of intellectual ability) has low variability between medical students in such a highly-selected population and thus is less likely to be a major consideration. Learning experiences and task approach skills are important considerations at the multiple educational steps that precede graduate medical education as previously illustrated in Figure 1. Of specific interest to medical educators is how the learning experiences in medical school shape career interest[86,87] as this represents an area that of potential intervention. Similarly, natural factors that warrant consideration include clinical exposure; time spent in the desired field, and perceived likelihood of success. In line with social learning theory, environmental factors such as financial barriers to career choice, school and emergency medicine departmental culture, and societal expectations all

have a role in applying a social-cognitive approach to the questions of specialty selection. Figure 3 diagrams the longitudinal process of specialty selection including several previously unexamined, but possibly important factors.

Medical students individually consider the factors described above using their own values to weigh their relative importance. How medical students practically make these decisions fits a bounded rationality model, which incorporates limitations, such as incomplete

Figure 3: Longitudinal Approach to Specialty Selection



search behavior, while still explaining decision-making using a rational, systemic approach. This model of decision-making has previously been used in the evaluation of academic medical career selection, which has many similar considerations to specialty selection.[61] Specialty selection is an ongoing process that continues through the medical education process and is constrained by

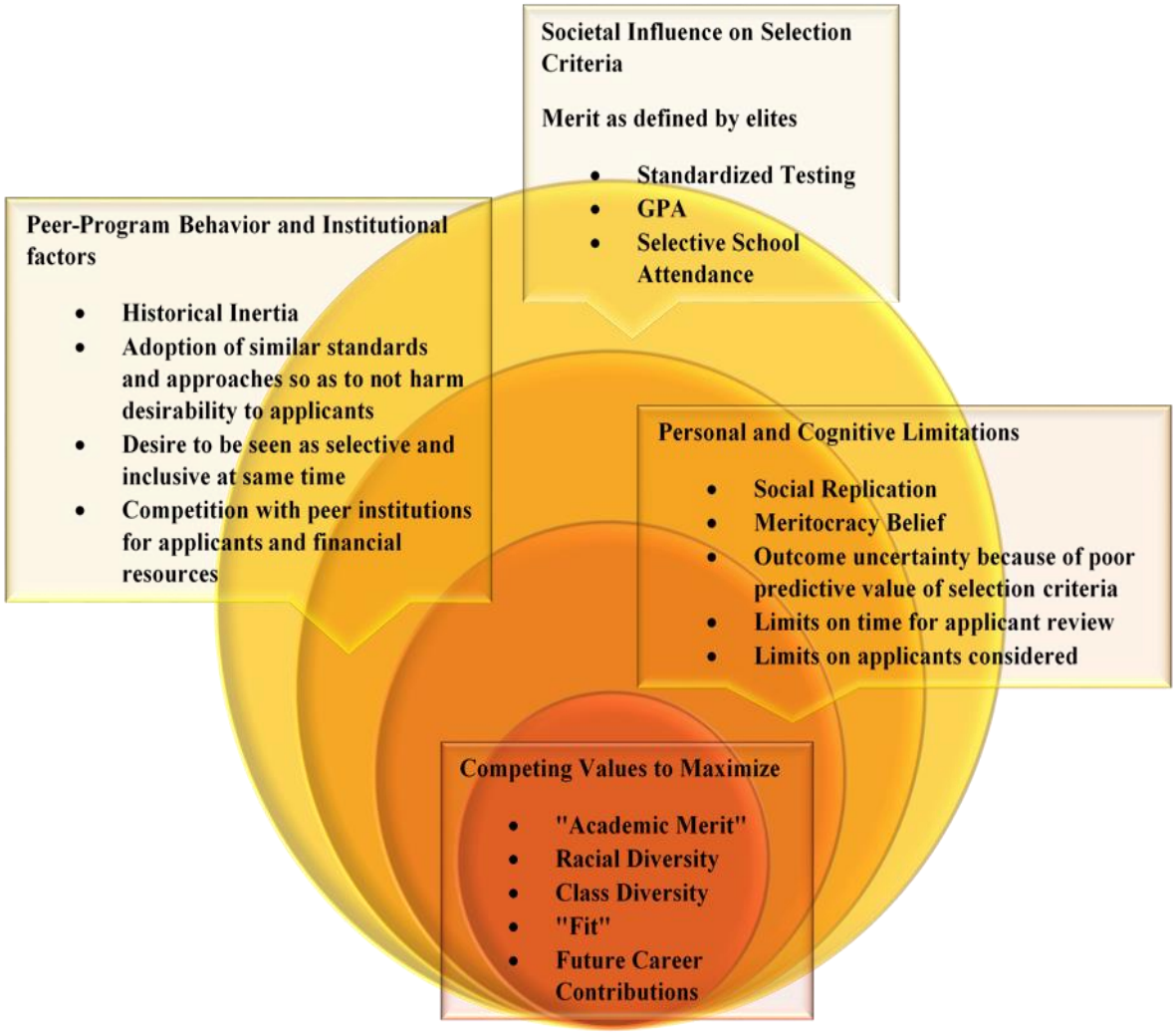
personal interests and ability, but to date the limitations based on additional factors suggested by the above theoretical constructs have not been considered.

Residency selection decisions

At the time of rank list generation, I posit that residency program officers approach selection decisions in a manner that they believe will maximize benefits for their institution. Similarly, I hypothesize that residency applicants approach their rank list to emphasize the needs they value most. Although different residency programs may have different points of emphasis in terms of their overall mission, rational decision makers are expected to make judgements that increase the likelihood of achieving their institutional goals. Similarly, residency applicants may value some aspects of training programs higher than others, but are also trying to find programs that meet as many of their needs as possible. The literature on bounded rationality informs us that both groups must make decisions without comprehensive information about all aspects of their decisions. Residency program faculty are limited by incomplete knowledge of their applicants and all possible alternative applicant, and by biases imposed by society and the faculty member's own cognitive process. Adding to these limitations, program directors in emergency medicine residencies make decisions with a significant degree of uncertainty their prediction of an applicant's likely future performance. Applicants experience similar constraints regarding incomplete knowledge, alternatives, and predictive ability regarding each program. Taken in aggregate, these limitations result in deviations from "rational" behavior. The deviation observed from what would be expected on ranked lists that were informed by perfect, unbiased

information and those made by can be explained by unintended restrictions on decision-making operation (Figures 4 and 5).

Figure 4: Program Decision Making Model



As represented in Figure 4, program directors are faced with multiple layers of constraints on their potential options in terms of ranking their applicants. Some behavioral restrictions, such as time to review applications, may be obvious to individual decision makers. Many other constraints are obscured from casual consideration by residency faculty members. Competing values that program directors are attempting to balance when making selection choices are represented at the center of Figure 4. Each of the competing values in the innermost

circle are likely desirable to every program. However, the relative importance of any of these values will vary by institutions and individuals. For example, some residency programs have identified the creation of physicians who practice in underserved areas as a major programmatic mission.

Other alternatives include the production of physicians who will enter academic roles as researchers and teachers, physicians with specific fellowship interests, or physicians who will practice in the same location as the training program. In each of these cases, interview offers, and rank list location may be different depending on program goals. Residency programs can be assumed to consider all the factors at this level, but in practical application time and resource constraints result in the prioritization of some values over others.

Residency applicant behavior can also be explained using a similar framing as that employed by program directors. Similarly, residency applicants weigh many competing values to emphasize in their decision-making process (Figure 5). These factors often include considerations of how strong of a reputation or how competitive a program is, the location of the program, variations in curriculum, and perceived "fit" with the culture of the residents and faculty at the program, mentorship they anticipate receiving, and other specific career considerations. In many ways, the actual individual programmatic strengths in these areas for each training program an applicant is considering is even more nebulous than the core factors considered by the programs themselves. For example, programmatic strength is often measured by applicants based on the USMLE board scores of the previous residents, the specialty board pass rates, and the reputation of the program and its affiliated institution. Unfortunately, these metrics provide little information about the actual ability of a residency program to train physicians and thus some applicants turn to poorly considered ranking systems to aid their search

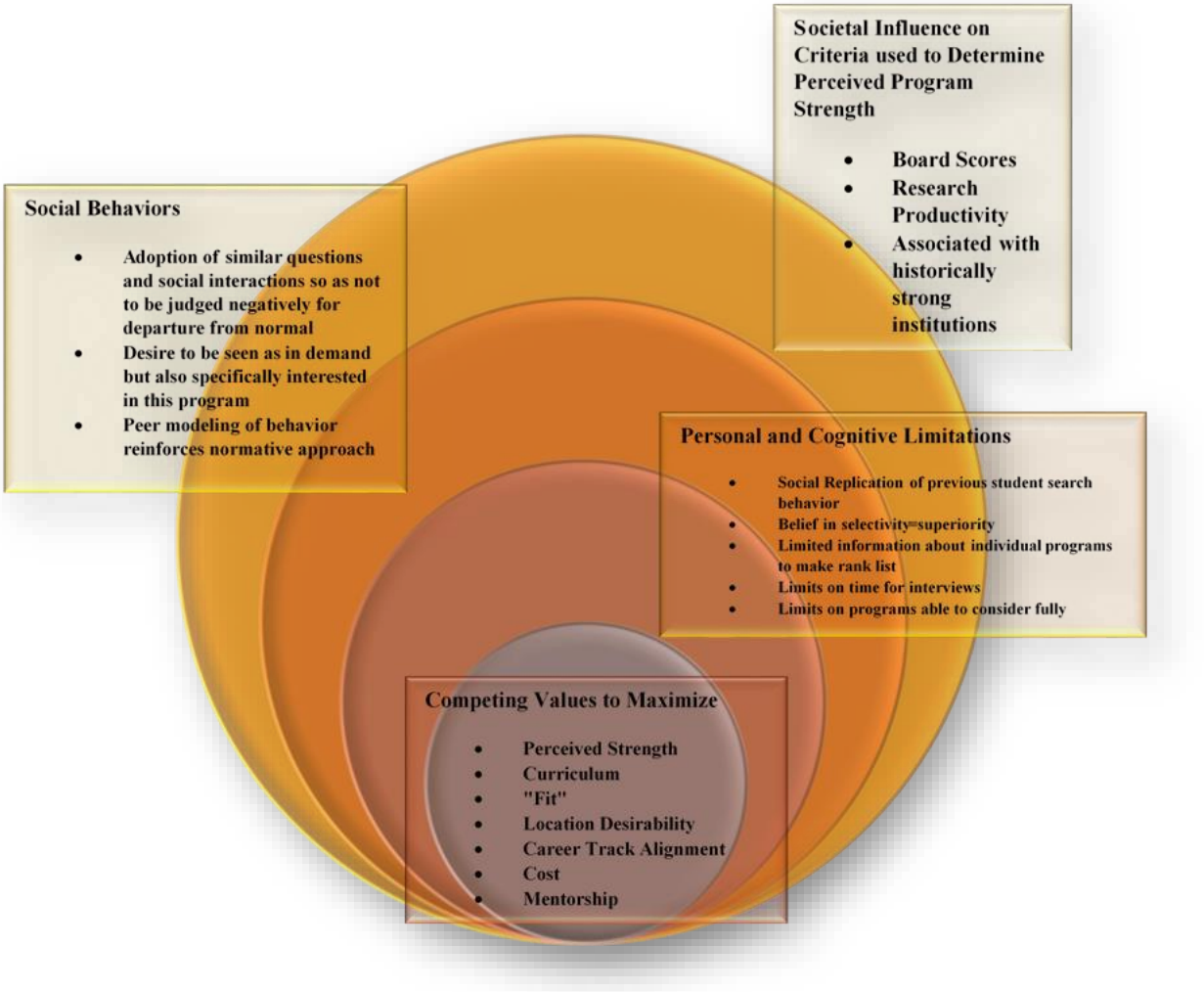
behavior.[88] Similarly, cultural fit, as experienced in the interview day, is often listed as a key consideration in resident decision making.[88] However, focusing on the interview day experience may result in making a key career choice based largely on a few hours of interpersonal contacts, believing it is representative of what they are likely to experience during their multiple years of training. Finally, while the location of the training program, including its proximity to family and partners, social options, and other lifestyle benefits, are clear at the time of resident applicant decision making, the longer-term ramifications of training location on career choices may be less obvious.

Cogitative limitations, maladaptive search behaviors, and biases of decision makers

The next circle in both figures (4 and 5) represents decision-making limitations based on manifestations of social bias, cognitive limitations, and minimal demonstrated correlation between selection factors and desired outcomes in resident selection. For example, whereas residency applicants can theoretically apply to every program in their choice specialty, they still have a very limited number of possible days that they can interview at prospective sites and must pay to apply and travel for interviews.[89-93] As some of the most important actors used by applicants in making their decisions are only available as a result of the interview process,[88] many are faced with removing more than 90% of their options based on very limited and incomplete information. Here again, this is where the perceptions of peers about programs and unvalidated ratings systems can result in a decision-making process that greatly deviates from one that can maximize the values of the applicant decision maker. While residency applicants realize that they are limiting their options to only programs from which they accept an interview

offer, they may not be entirely aware of how the programs they are considering are shaped by factors that are not as important to them personally.

Figure 5: Applicant Decision Making Model



Similarly, most program directors realize the limits on their available time to review applications. This realization results in the use of specific strategies to complete their work. However, some program directors may not recognize the unintended consequences of these choices. To expediate the applicant review process, a common solution is to use information technology to sort based on selection criteria. Currently, the Association of American Medical

Colleges (AAMC) provides applicant data through the use of the Electronic Residency Applicant Service (ERAS).[94] Sorting options in ERAS can make the process of reviewing applications quicker by organizing applicants on numeric metrics and excluding from consideration applications below an institutional threshold. Given the ease of sorting numerical vales compared to whole application review, saving time in this way has the effect of increasing the importance of quantitative metrics (such as USMLE) by establishing a necessary score for the more complete application review. These concepts are illustrated in the "Personal and Cognitive Limitations" ring of Figure 4.

Surviving the initial screening of applications with lower quantitative selection metrics does not guarantee an equal chance at admission. Applicants who are not rejected on initial screening still have their likelihood of success affected by "loss aversion" on the part of program directors. Loss aversion, and its interaction with an optimistic/pessimistic personal outlook, has a role in residency selection by affecting the risk-taking behavior of decision makers. Although serious personal risks to program directors (e.g., a financial penalty or demotion) are unlikely, less severe or obvious personal consequences may take the form of decreased prestige or trust in their judgment. Programmatically a resident who performs poorly and requires remediation or dismissal can result a number of serious consequences (program review, program probation, increased resident unhappiness, etc.) for the institution.[95] Decision makers who place a high premium on preventing loss will be less likely to take a risk on admitting an applicant with lower USMLE scores even though standardized test scores are poorly associated with failure and attrition rates.[96] Personal experience with a poorly performing or problematic resident in this context can reinforce a loss prevention strategy and may anchor decision-making by program directors. Triggering excessive concerns of potential failure as a result of a loss prevention

strategy can hurt underrepresented minority students as the have average scores that are lower on standardized tests.[13] Loss aversion may therefore represent an unstudied cause of persistent inequity in medical student diversity. As above, these concepts are shown in the "Personal and Cognitive Limitations" ring of Figure 4.

In addition to loss aversion bias, other maladaptive selection behaviors exist as personal predispositions in judging applicants via social interactions. Social reproduction theory[97] describes the desire to recruit and support people like ourselves and is one way that can be used to explain student groups with equal academic qualifications but lower overall admission rates, such as Asian-American students.[98] The prominent role of the residency interview and the idea of program fit are key mechanisms through which social reproduction is applied in this context. Because the majority of academic physicians in the U.S. are white men,[33] a difference in social interests and cultural experiences could result in a decreased social connection between underrepresented minority students and interviewers, with a theoretical decrease in interview scores for URiM applicants.

An additional important set of cognitive biases to consider in the process of interview offers and applicant scoring is the idea of implicit bias.[99] Implicit bias is defined as "the attitudes or stereotypes that affect our understanding, actions, and decisions in an unconscious manner. Activated involuntarily, without awareness or intentional control."[99] Implicit bias against people with dissimilar racial and ethnic backgrounds has been studied across a number of professional and scholarly domains,[99] including academic medicine.[100] To date there has been little to no research that quantifies the potential role of social stratification and bias in resident selection. "Matched pair testing" research from the professional hiring literature have explored the effect of implicit bias in a way applicable to resident interview selection.[101,102] In studies utilizing this

type of design, mock applications are created that vary in a single specific potential source of bias (e.g., racial identity) while being the same in all other aspects. These studies show the importance of race and ethnicity in receiving an interview, where those that are perceived to be white have higher odds of success. Thus, given the absolute requirement to be interviewed to match and the relative importance of the residency interview to be ranked highly, implicit bias has the potential to introduce similar socioeconomic and racial bias in the current interview process.[90] By having such a prominent role, the resident selection interview exacerbates the presence of these while having a limited ability to actual predict and rank applicants for future success.[90]

As has been demonstrated repeatedly in the medical education literature, the predictive value of current selection factors is weak when measured early in a learner's career and is largely unable to project long-term success.[103] The fact that decision makers are often working from a faulty premise—that selection factors correlate with desired long-term outcomes regarding residents[89]—is an important final consideration. Program directors are attempting to predict future success in residency and professional practice based on application information that provides very little predictive utility. Therefore, program directors often apply information in making selections that are not aligned with achieving their desired results. Residency applicants also fall victim to this fallacy in two ways. First, applicants who conflate higher average applicant scores and competitiveness to match at a program as a signaling mechanism for education quality and program merit. Second by using specialty board passage rates at the completion of residency training as a sign of a programs ability to properly prepare physicians for practice and not more related to the board certification process using standardized testing. The results of specialty board tests more properly describe the ability of residency programs to

prepare their trainees to take that specific test and are of course significantly moderated by the incoming ability of the programs trainees. This limits their use as a marker of success and thus should not be considered validation of current selection factors.

Peer program behavior and institutional factors

Institutional and professional biases affect individual faculty decision-making in residency selection. The residency selection process is largely standardized through the use of ERAS as a centralized online single application.[94] The standardization of the initial application process across programs has the effect of providing normative feedback for program directors and applicants on what is important to consider when choosing residency programs. Residency programs that differ from the norms (such as employing an alternative interview process such as the Multi-Mini Interview)[32] may be placed at a competitive disadvantage. Put another way, applicants may make a reasonable decision that their time is more valuable than the added benefit of applying to an additional program. Less prestigious residency programs and institutions looking to enhance their applicant pool would be at greatest risk in this scenario.

In addition to providing normative metrics for student selection, standardization on admissions criteria allows for the creation of easily distributed "selectivity" metrics for residency programs. If the assumption is that the most desirable residents are the ones with the highest scores on the universal metrics contained within ERAS, it follows that the most "selective" programs will have residents with the highest average scores on these metrics. As residency programs exist in a competitive market for students, faculty, and grant funding, the appearance of selectivity (often confused with merit) has policy ramifications at many levels, including the

obvious one of admissions strategy. Recent research has focused on studying the importance applicants place on matching at the "best programs"[88] and may result in a cycle that maintains the status quo in the selection process.

Taken together, the standardization of the application and the establishment of selectivity based on easily comparable numeric metrics have resulted in a significant inertia to maintain the *status quo* at the expense of experimentation with more innovative selection processes. As discussed above, any deviation from standard practices is likely to result in a competitive disadvantage and potential loss of prestige for the individual program. It is likely that only programs at the extremes (highly prestigious programs whose positions are assured and residency sites who have little to lose) are likely to make substantive change to their admissions processes.

Societal influence on selection criteria

At the outermost level in Figures 4 and 5 is the external societal influence on selection factors used in the education system. Despite the poor performance of medical education selection factors in predicting which students will succeed, medical school admissions officers continue to rely largely on the traditional approaches.[45] Similar reliance by program directors on selection factors that do not predict success has also been described in the graduate medical education literature.[89] The continued use of imperfect selection factors by institutional stake holders is explained to some degree by the issues discussed previously, but other considerations are also important. In addition to the cognitive constraints on decision makers, the selection factors themselves have long been claimed to be consistent with "merit." Therefore, selection

based on the traditional factors used in medical education may claim to be a "fair process" regardless of their predictive success.

Educational scholarship has explored how admissions policies have long term effects, including inequality in training program access and class stratification. To ground further work in the medical education context, three different theoretical explanations developed in higher education are provided below. Historically, medical school admissions have had systemic preferences for admitting some groups while imposing barriers for others. While less codified in residency selection, as described above, the pool of applicants to residency is largely set at the stage of medical school admissions. In both educational processes, groups with special status can and have changed over time as has the manner in which the classifications were determined. These shifting entrance opportunities has been described by Karen's Gatekeeper theory.[104] An example of this idea in practice is the specific status of Asian-American students in medical school applications. Asian-Americans are generally classified as "minorities" in most demographic reports; however, they are not underrepresented in medicine in the data and classifications provided by the Association of American Medical Colleges (AAMC). Therefore, Asian-American students are often classified in the same groups as white students and do not have the same "preferential" admission gate as other traditional minority students. While important in the consideration of medical school admissions, residency selection does not have the same clear "admissions gates." While URiM recruitment is a consideration in residency selection, the rank list mechanics of the match process makes the gate frame less applicable. Despite its lack of direct application to residency selection, as medical school admission is a necessary condition to be a part of the potential applicant pool to residency, Gatekeeper theory is an important explanation of the upstream constraints.

Specifically focusing on persistent inequality in representation in educational programs, Alon's Exclusion and Adaption (E&A) theory describes the role of elites in modifying selection factors. E&A explains inequality as a function of elites using increasingly stringent admissions criteria to exclude others as well as using their resources to adapt to maximize their children's ability to perform well on current selection factors.[105] Elites in this context can be assumed to be those with greater economic and social power and usually are over-represented groups in selective educational environments. In contrast to the predominate thinking about the MCAT and the United States Medical Licensing Examination (USMLE) steps, as a potentially biased but the best possible tests of student aptitude, E&A argues that standardized tests work against greater inclusivity. Standardized testing's prominence in medical education coupled with the availability of costly test preparation programs, like the SAT/ACT, could be an advantage to students from higher socio-economic status. Using the example of Asian-American students from the previous discussion on gatekeeping, an E&A framing device offers an alternative explanation.[105] Alon might argue that as Asian-Americans became increasingly competitive with whites and other traditionally favored groups, their relative competitiveness was mitigated though a number of policy initiatives by those seeking to maintain the privileged position of white applicants.

E&A can also be applied to the measures often reported by residency programs to potential applicants. Those programs with residents with high scores on USMLE exams and specialty board scores are likely to promote these results as well as imply their importance as marks of merit. Similarly, well established programs with more senior faculty are much more likely to be able to use common research productivity metrics, such as papers published and citation patterns, to their advantage over newly established programs. In both cases, the

institution and promotion of metrics of merit strengthen the hegemony of more established, well-known residency programs without providing additional information regarding the actual benefits of the education they can provide.

A final theoretical frame for residency selection can be found in the business literature which includes several concepts of social replication. Persistent social stratification has been explained in elite firm hiring practices in professional hiring using this approach. In this example nonacademic factors that are associated with higher social status become strong predictors of interview evaluation scores.[106] Classic examples of this are phenomena is an increased likelihood of hiring applicants with common experiences in expensive camps, sports that are more common amongst the elite (e.g., crew, lacrosse), and participation in selective social and eating clubs. Bonds created through these common life experiences can result in unconscious bias towards certain applicants and are often expressed unintentionally versus as explicit discrimination. Interviews are considered key factors in the selection of both medical students[107-109] and residents.[32,60,89,90] In the case of residency selection, applicant-program fit is considered to be of major import to both parties and is mostly thought to be established as part of the interview process.[88] The majority of academic physicians are affluent, white males[33] and therefore social and cultural fit is most likely to benefit applicants who have similar backgrounds. Similarly, if the most well established and respected programs are predominantly populated with affluent, white males this may result in a signal to residency applicants to consider programs where they feel a higher level of "fit." Whether as a result of one of the above mechanisms or many other possibilities there are undeniably persistent systemic issues of under-representation in medicine in general, and emergency medicine specifically,[34] for some minority groups.[37]

Medical education as part of a larger system

Theories that describe the sociological determinants of the selection metrics expands our understanding of the persistence of the selection factors currently employed in medical education. Medical schools and graduate medical education programs are committed to a "meritocratic" selection system.[110] Presumably most admissions officers in medical school and residency program directors are aware of the previous research on selection factors in their field. Despite the awareness of systemic inequality in the educational system in the U.S. and potential bias in standardized testing, academic metrics such as GPA, MCAT, and USMLE are still considered a reasonable metric for selection.[107,111] To understand how medical education is subject to larger sociological pressures to maintain inequality of opportunity, a consideration of the larger educational system is important (Figure 6).

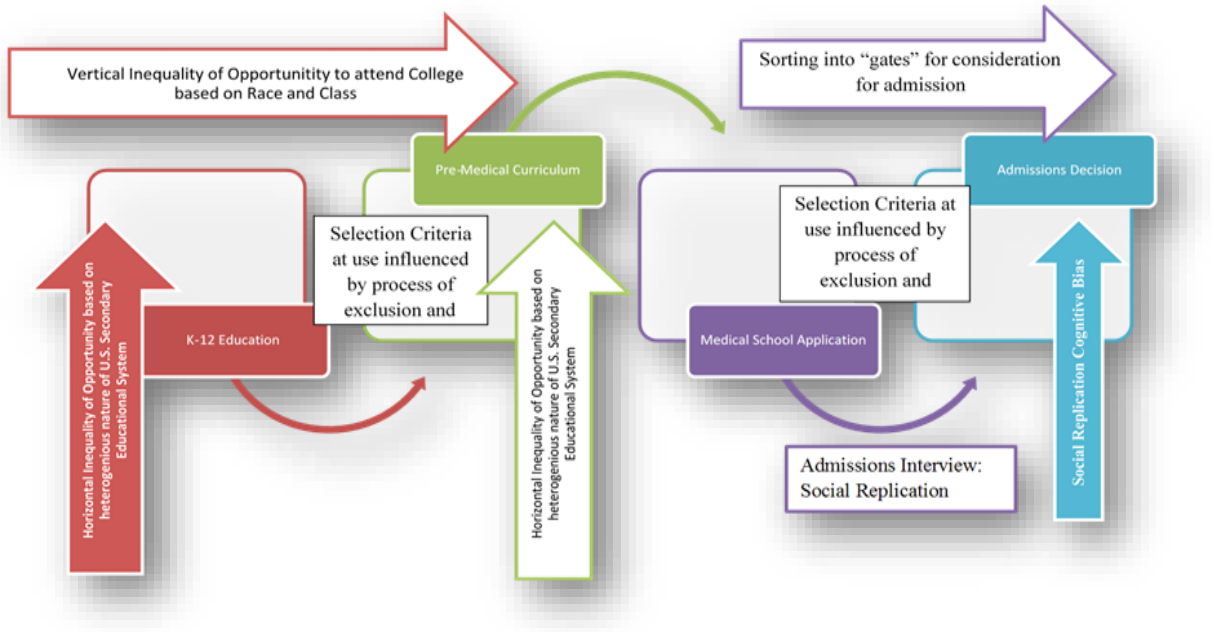
Applicants to medical school have undergone many previous educational experiences and selection processes before considering applying to medical school. As students advance through the U.S. educational system, they are increasingly subjected to both horizontal inequalities among educational institutions and vertical inequalities in obtainment of educational credentials that limit the potential applicant pool to medical school. These represent the "headwaters" to the medical education "river" (Figure 6). I use this analogy as while the entrances and exists from the medical education system are limited, the initial tributaries into medical school are much more complex and varied.

Applying Maximally Maintained Inequality (MMIt),[112] increased access to a new vertical opportunity (such as college attendance) can be mitigated by differences in perceived worth of attendance at more selective institutions (horizontal inequality) by a potential student. In the

case of medical school admissions, those students who attended the most selective institutions are often the most desirable for residency selection, even if the pathway to attendance at those institutions was largely set by a series of selection processes based along class segregation in the early K-12 system. While MMIt is in play in the larger educational system and thus the pipeline to consideration for medical school, the articulation process between college and medical school is better explained through a combination of gatekeeper theory and Alon's Exclusion and Adaptation (E&A) (Figure 6) as described previously. The history of medical school admissions reveals systemic preferences provided to certain groups compared with additional barriers to admission for others. In both cases, the groups with special status have changed over time as has the way the classifications were determined. Returning once again to the example of Asian-American students offered in the previous section can help to illustrate this idea. White over-representation is maintained in several ways. The first modification results in the movement of Asian-Americans from "minority status" to placement with white students. A second intervention mitigates Asian-Americans' high achievement on overall admissions metrics with the introduction of the idea of "school fit." Here social replication of students who are like academic physicians (often white, affluent, and male) are considered to "fit" the intangibles of what is expected of a future physician. Finally, the definition of medical school class diversity was changed in a manner that was less beneficial to Asian-Americans but potentially beneficial to white students who had lower admissions metrics but might be considered unusual in other demographics (e.g., a student from Alaska). Together these initiatives allowed for white students to continue receiving the highest possible likelihood of admittance, whereas students of color were either limited by classification as "non-URiM" status or through use of the MCAT in groups who traditionally scored lower on standardized tests. Taken together, students interested

in medicine must navigate several potential barriers in order to navigate their way to the beginning of their medical education training (Figure 6).

Figure 6: Headwaters into Medical Education



A clearer example of standardized testing being repurposed as a selection factor is the USMLE steps. Designed as pass/fail exam,[113] the USMLE numerical score has been extensively used as a continuous factor with higher scores indicating better applicants.[114] However, in emergency medicine for example, the USMLE has only been shown to poorly predict American Board of Emergency Medicine In-service Exam scores [115] and the pass/fail line was able to reproduce the majority of the detected correlation. In primary care context, USMLE was a very poor predictor of clinical ability as measured by standardized patient testing [116] and prompted the authors of the study to advocate the addition of new measures. Despite research of this type, the use of USMLE as an indicator of applicant ability as a continuous measure continues.[117] The theoretical frameworks would suggest that this is because it provides a benefit to maintain the *status quo* enjoyed by those currently overrepresented in the field.

Linking the Frameworks

The pipeline into emergency medicine is a complex process by itself but it is also situated within a larger educational and sociological context. Given the complexity of factors affecting entry into medical education and successful persistence into emergency practice, a comprehensive approach needs to include multiple points of inquiry. Analysis at both individual and organizational level and from the perspective of the learner and the selection officer are important. It is also important to consider the longitudinal nature of medical training and how culture and curriculum can have a cooling out function for certain groups.

At a systems-level, the pipeline into emergency medicine is a series of educational processes and contexts that begin in the K-16 realm and last into clinical practice. For purposes of specialty selection, the two most important phases include K-16 education with admission into medical school and medical school training and selection into a residency program. Entry into medical education and the residency is a function of sociological pressures on admissions processes, ideas of merit, established professional practice and the results of the larger education pipeline context (Figure 6). After being admitted to medical school, learners progress through a series of educational experiences that are modified through personal ability, learner self-efficacy, educational culture, and general societal influences (Figure 3). Taken together, these two models are the scaffolding where additional specific key moments can be studied in greater depth.

During the residency matching process, the behaviors of selection officers and learners are both important. Ranking applicants for a program match list and ranking programs by a single applicant are both appropriately explained by a bounded-rationality approach. The explicit considerations of this process are illustrated in Figures 4 and 5 for residency rank list

generation. An important additional mechanistic consideration can be found in the process of simultaneous decision making occurring on the part of both the applicant and the program. Unlike in college and medical school admissions processes, where an applicant may apply to many institutions and receive multiple admissions offers before ultimately deciding on one school in which to enroll, the residency match process finds both the applicant and program directors acting at the same time, each without knowledge of the other's choices. As such, applicants must rank programs without knowing whether they have a reasonable chance of acceptance on the part of the program. Similarly, programs have less control in building a class than in the other cited examples as all selection occurs simultaneously in the residency match. As such the losing an applicant that would enrich the diversity of a residency program to another competing program cannot be compensated by changing their other selection choices until next year's match. Programs create their ranked lists and then must live with who they receive through the match, even if this results in a residency class that is less desirable or unbalanced in terms of the program's priorities.

While presented as separate processes, it is also important to realize that the individual application decision level (Figure 1) is nested in the larger societal framework (final box of Figure 2 and "Match Process" of Figure 4). The individual selection decision comes as a result of factors that may have preceded the application process by years and include numerous admissions, curricular, and assessment decisions not necessarily apparent to the individual making the admissions decision. Figures 2 and 4 represent the factors at the ends of these chains of events (at the medical school and residency level, respectively). In contrast to the above, individual learner behavior is represented in Figures 3 and 5. Figure 3 represents the starting point for learner attitudes regarding specialty selection when beginning medical school, an

important snapshot in the pipeline process. The moment in time shown in Figure 3 accounts for pre-conceived notions regarding medical career choice of students and is the natural starting location for policy makers at medical schools looking to affect change through curricular and cultural interventions. As described earlier, Figure 5 shows their decision-making process at the time of rank list creation. Finally, Figure 4 also includes the larger educational process for learners in medical education, including individual factors such as ability and self-efficacy in addition to more systemic influences.

Equally important to an understanding of the nested and interrelated aspects of the individual and organizational structures is the dynamic interplay between the frameworks. For example, the idea of academic merit is one of the competing values at the core of that individual residency program decision-maker model. However, as demonstrated in the larger scale sociological frameworks, what constitutes merit is a socially constructed idea and not necessarily an objective metric of applicant ability.

A second example of the integration between macro and micro levels is how a gatekeeping function can influence the behavior of an individual admissions decision maker. For example, applications can be sorted into specific "gates" for admission and reviewed by a single specific admissions team to compare "similar applicants." If that specific "gate" consisted of only individuals who are underrepresented minority in-state applicants, the relative beneficial impact for admission of those specific applicant factors might be mitigated. While in this example, an institution may view racial diversity and in-state balance as important enough to create a separate review process, when the admissions officer reviews the applications in comparison with only other like files, these qualities no longer distinguish potential students. A dilution of effect, in this case of URiM and in-state status, may be the result of well-meaning

practices that have unexpected results. In other words, the value of being in-state and from an underrepresented background may have a greater importance when comparing against other applicants without these factors.

In the residency context, local applicants from the medical school where the residency program is situated may be evaluated by a different group of faculty members which may change the relative importance of some factors over others when compared with the larger applicant pool. An applicant might have a very strong letter from a local faculty member that is known to be less than glowing in most recommendations. Here again, the relative importance of that letter may be different given its situation in the larger context. In both cases, the overall competitiveness of an applicant from one of these gates might be diminished by shifting the comparison group. In the previous examples, as well as many others, taking the combined frameworks as one integrated process provides a more comprehensive explanation for the current state of affairs in medical education. The following studies are designed with these ideas in mind. By connecting multiple data sources, the theoretical explanations provided in the previous section can be more completely mapped onto variables for study.

Chapter Three: Methodology

Overall Approach

My theoretical framework for explaining the emergency medicine pipeline process is a combination of several different theoretical paradigms from outside of medical education. A direct application to the medical education setting is based on creating a large-scale database from multiple preexisting sources. Multiple nationally representative datasets will be combined to maximize the coverage of the processes discussed, the statistical power of the estimates produced, and the generalizability of the results. The construction of such a dataset is possible by merging information currently held in separate databases by the AAMC and the American Medical Association (AMA) using individual identifiers shared across datasets. This new database allows for consideration of attitudinal factors over the course of an individual's medical education. Although the use of secondary data analysis has limitations (e.g., data collection not specifically designed toward the current research question and cumulative effect of missing data with the addition of each new database), these limitations can be mitigated and, in the end, are not likely to make this method less desirable than other approaches.

Data Sources and Measures: As described above, multiple nationally representative datasets maintained by the AAMC and AMA were combined to form a single database. The relative contributions of each data source are provided below.

Matriculating Student Questionnaire (MSQ): a national questionnaire from the Association of American Medical Colleges (AAMC) administered annually to U.S. matriculating

medical students assessing topics including pre-medical experiences, the medical school selection process, choosing medicine as a career, and future career plans and interests.

Graduation Questionnaire (GQ): a national questionnaire administered by the AAMC. It is an important tool for medical schools to use in program evaluation and to improve the medical student experience. It includes questions about the experiences of the medial student during their time at medical school, future career plans, satisfaction with their training to date, and other feedback about the individual school culture and the overall professional education process.

American Medical College Application Service (AMCAS): is the AAMC's centralized medical school application processing service. Most U.S. medical schools use AMCAS as the primary application method for their entering classes. This database contains academic and demographic factors of applicants to medical school.

Electronic Residency Application Service (ERAS): a national dataset of applicant data from the AAMC that is collected through their application to the National Residency Match Program (NRMP). ERAS is also the means by which program directors receive information about applicants. An additional research data use request was accepted by the National Board of Medical Examiners (NBME) for inclusion of U.S. Medical Licensing Exam (USMLE) scores contained in ERAS.

American Medical Association Physician Masterfile (AMAPM) is a national dataset that includes current and historical data for more than 1.4 million physicians, residents, and medical students in the United States. A record is established when individuals enter medical schools accredited by the Liaison Committee on Medical Education (LCME), or in the case of international medical graduates, upon entry into a post-graduate residency training program

accredited by the Accreditation Council for Graduate Medical Education (ACGME). As a physician's training and career develop, additional professional certification information is added to their Masterfile record. These data sources are merged to provide a comprehensive empirical examination of the process that is residency selection. This integrated data set is used as the database for the three research studies proposed in the next section.

General Study Design

Each of the studies uses secondary data of 46,776 students who applied for residency training in the U.S. from 2005 through 2010. This six-year cohort was selected for several reasons, including the relative stability of survey items, consistency of survey formats, selection factors consistency, and that enough time elapsed for subjects to have completed their training. Institutional IRB review was solicited, and the study was found not to require additional regulation or assessment. The data used in this study was made available after an initial research proposal data request through the AAMC website[118] followed by refinement in collaboration with AAMC Data Operations and Data Stewards from 2015-2017. Inclusion of USMLE scores were made possible through a previous relationship between the AAMC and the National Board of Medical Examiners (NBME) and a separate data licensing agreement. Active data licensing agreements exist with both entities for purposes of these studies. Statistical analysis was performed using Stata version 12.1.[119] Each of the three studies examined several individual factors and dependent variables using binary logistic regression modeling. The details of each study methodology are provided below:

Research Study One

Question One: As a student in medical school approaches the time of application to residency, what factors correlate with an interest in emergency medicine? ***Primary Outcome:*** EM Career

Interest at time of graduation. Career specialty interest was derived from the response to the specific item: "When thinking about your career, what is your intended area of practice?" on the AAMC Graduating Questionnaire. Responses were then recoded as either "emergency medicine" or all other specialty choices collapsed into a single response, "not emergency medicine." ***Analytic Approach:*** A secondary data analysis of student cohorts in the combined data set from the entering medical school classes of 2005 through 2010 was undertaken. Statistical analysis included a binary logistic regression model with residency interest as the DV and student characteristics (including demographic, academic, and attitudinal factors as above) and other factors used as explanatory variables. Multinomial logistic regression was considered, however given the number of individual specialty options interpretation of these results would be extraordinarily difficult. As such dissemination and policy change would be limited.

Hypotheses: The importance of a balanced work-life lifestyle and desire for a higher future income, which have been shown through survey research to be principal positive factors influencing medical student career choice toward emergency medicine, will still be correlated with increased likelihood of choosing emergency medicine. Additional factors including academic ability, gender, and underrepresented minority status (URiM) will also prove to be significant in persistent interest toward specialization in emergency medicine. After controlling for academic qualifications, female and URiM applicants will each have a lower probability of applying to emergency medicine. ***Question Rationale:*** The current medical education literature in this area is limited. It has considered some important decision-making values, such as salary, practice type, and work-life balance, but has not considered several additional altitudinal considerations. By expanding the factors under consideration, a more complete picture of students interested in emergency medicine emerges.

Research Study Two

Questions: Is there a lower likelihood of planning for a career in EM at graduation for women and URiM students? If so, did this reduced propensity in interest existed at the time of medical school entry or developed during medical school? Finally, does the odds of a career interest in EM at graduation translate into lower persistence of women and URiM physicians into emergency medicine practice after the conclusion of their training? ***Primary Outcome:*** Change in emergency medicine specialty interest. Entering specialty interest was derived from the MSQ item: "What general specialty are you considering?" Graduating specialty interest was derived from the GQ item: "When thinking about your career, what is your intended area of practice?" Career in EM was obtained from the AMA Masterfile reported career specialization. Responses were recoded as either "emergency medicine" or "not emergency medicine." ***Analytic Approach:*** Utilizing the same combined database, multiple binary logistic models were estimated comparing how changes in career interest are explained by individual medical student factors and medical school experiences over the time from school onset to graduation ***Hypothesis:*** A "cooling out" of women and URIM students' interest in emergency medicine will be observed even when other academic metrics of competitiveness are considered. ***Question Rationale:*** Specific focus will be on non-academic factors that would represent cooling out of physicians from underrepresented backgrounds and women. To understand issues of underrepresentation in emergency medicine, policy makers need to understand their temporal basis. This study helps to examine if differing career interests in emergency medicine is the result of attitudes formed prior to entering medical school or because of medical school experiences. With this information, more targeted policy intervention may be possible.

Research Study Three

Question: Are there common patterns between medical specialties in the manner in which student career interests change between the beginning of medical school and graduation?

Primary Outcome: An expansion of the approach in study two to include several additional medical specialties (internal medicine, pediatrics, OB/GYN, and surgery). ***Analytic Approach:*** Utilizing the same combined database, multiple binomial logistic regression models will be estimated using as explanatory variables the same factors used in Study Two. ***Hypotheses:*** First, female and male students are likely to enter medical school with similar interest in fields like internal medicine and surgery and women will have higher odds of an interest in fields with typically more female physicians such as pediatrics and OB/GYN. Second, URiM students will have similar entering interest across the four specialty areas of study compared to non-URiM peers. Third, women will have evidence of both "cooling out" and under-recruitment relative to men in those medical specialties that are traditionally male dominated. Fourth, URiM medical specialty interest will remain relatively stable from entry of medical school through to medical school graduation. ***Question Rationale:*** Career interest in emergency medicine does not occur in a vacuum, but is instead arrived upon, after consideration of other medical career options. Understanding how EM may be similar or different than other medical specialties in recruitment and "cooling out" of medical students is necessary in order to understand the conclusions drawn from Study One and Two. Additionally, this work allows for more generalized study of the career decision making process of medical students.

Power Considerations Sample size estimates are based on assumptions of alpha = 0.05, power = 0.80, and the number of independent predictors in a given regression equation = 10. A sample of 330 will enable the detection of an effect size of 5% of the variance of the dependent variable. This is considered a small to medium effect size. This sample size of 330 is expected to be less

than 5% of the applicants in any sub-group analysis. Within the multiple studies performed in this dissertation the effective sample changed dramatically. The largest sample used was greater than 41,000. The smallest sub-group analysis was 570. As such all study analyses were powered to detect at least an effect size of 5% in the dependent variable and in many cases much smaller effect sizes.

Chapter Four: Diversity in Emergency Medicine: Are We Supporting a Career Interest in Emergency Medicine for Everyone?

Objective: Women and Underrepresented in Medicine (URiM) students are less likely than their peer to apply for residency in emergency medicine (EM). URiM students are from racial/ethnic populations that are underrepresented as physicians relative to the general population. The factors that result in lower application rates from women and URiM groups are inadequately described in the literature.

Hypothesis: Female and URiM students have lower interest in EM even after controlling for academic ability, student indebtedness, and common career values consistent with EM career interest.

Methods: Secondary data analyses was conducted on a cross-section of all residency applicants from 2005-2010. Data sources included (AMCAS, ERAS, Graduating Questionnaire). Data linkage was by the AAMC and provided de-identified to the authors. A binary logistic regression model (BLM) was fitted with the outcome variable planned career into EM versus another specialty on the Graduating Questionnaire. The BLM independent variables included Demographics, Student Attitudes, Debt, GPA, Standardized Tests, and Medical School Experiences.

Results: The BLM included 16,875 individuals. Being female (OR: 0.76) and from a URiM background (OR: 0.65) independently correlated with lower EM interest. Age, medical debt, importance of work-life balance, confidence in specialty choice, and plan to care for underserved populations were positively associated EM interest. Importance of specialty competitiveness and importance of mentorship advice were correlated with lower EM interest.

Conclusions: Female and URiM medical students were less likely to plan for a career in EM. This correlation remained significant even when controlling for other previously identified factors that have predicted a career in EM.

Introduction

The process by which medical students choose a specialization is incompletely understood, but vitally important as it has ramifications for several aspects of the health care system. An obvious and primary effect of student specialty choice is in its role in defining the composition of the future physician workforce.[120-122] A second major issue related to the specialty choices of medical students is related to how representative of society any given field's practitioners are.[24,33,123] A third, and perhaps less obvious issue is related to the previous two: how medical specialty selection directly affects patient care.

Emergency medicine (EM) as a specialty has lower rates of application from Underrepresented in Medicine (URiM) and female students than would be expected from the general U.S population or based on graduating medical school classes demogrpahics.[46,124] For purposes of this study we have used the definition of URiM students as described by the Association of American Medical Colleges (AAMC): "… those racial and ethnic populations that are underrepresented in the medical profession relative to their numbers in the general population."[125] White and Asian students are classified as Non-URIM under this definition. Black/African American, Hispanic/Latinx, Native American, Native Pacific Islander, and Multi-Racial students are considered from URiM backgrounds under this classification scheme. While much more complex in its comparisons across racial groups, the respective number of white applicants is higher than would be expected from graduating medical school classes (Table 1). Gender balance is a separate issue from URiM representation but with similar concerning findings. Women make up over 50% of the general population, almost 48% of graduating medical students (and rising), but only about 36% of EM applicants. If application trends are to

change, an evidence-based, targeted intervention aimed at addressing potential barriers to entering EM for female and URiM students should be developed.

Table 1: URiM Representation

U.S. Census vs U.S. Medical School Graduates vs EM Applicants

	2016 *US Census Estimates (%)*	*2016-17* *Medical School Graduates (%)*	*2017-18* *Emergency Medicine Applicants (%)*
American Indian/Alaskan Native	1.30%	0.16%	0.16%
Black/African American	13.30%	5.55%	3.92%
Hispanic/Latino/Spanish Origin	17.80%	5.10%	5.13%
Native Hawaiian/Pacific Islander	0.20%	0.06%	0.06%
Other		1.82%	1.90%
Multiple Race/Ethnicity	2.60%	7.66%	7.13%
Asian	5.70%	20.81%	19.54%
White	61.30%	56.48%	59.58%
Unknown		1.01%	0.98%
URiM as Defined by AAMC			

Comparison of racial and ethnic background of individuals in the general U.S. population, graduating medical students in the U.S., and applicants to EM residency programs in the U.S. Data Sources: AAMC Data Warehouse, US Census Bureau

A diverse emergency physician workforce has important patient care ramifications in addition to traditional concepts of societal equity in educational opportunity. URiM physicians often choose to practice in medically underserved locations at higher rates than other students.[126-128] Medically underserved populations have also reported increased trust in URiM providers with an associated improvement in clinical utilization. Physician trust can have measurable

patient care outcomes including compliance with physician recommendations[129] and decreased hospitalizations and emergency room utilization in the elderly population.[130] More recently, female patients treated by male physicians have been shown to have worse outcomes when evaluated in the emergency department for acute coronary syndrome.[131] Specifically, female patients had decreased mortality when cared for by female physicians (male patients had similar mortality rates as the female patient-female physician group in both physician gender groups).[131] Therefore the demographic composition of emergency medical practitioners is more than an issue of social justice as it affects patient trust and patient care outcomes.

Studies focused on medical career choice, including those related to EM, have generally relied on surveys of candidates which ask subjects to retroactively consider several factors related to their decisions.[17,18,132] The most commonly reported findings from such surveys in EM suggest that differences in career choices are often based on income preferences and perceptions of work-life balance.[15,19,20] The ability to care for underserved populations has also been described as a draw to the field of EM by URiM students.[133] However the current literature has several important gaps. First and foremost, it was not designed to examine if the identified career preferences explained the persistently limited numbers of EM applicants from women and URiM students. Second, previous studies have not controlled for the importance of academic performance and match competitiveness on medical specialty career-selection. Third, previous research has generally only considered a limited number of factors in any single study or had relatively small samples of students. Finally, earlier methodological approaches have not included multivariate regression to compare and control for the relative effect sizes of all of the preceding factors in a robust way. As such, how these factors combine and contribute to a lack of diversity in EM is not clear from the current literature. We hypothesize that being a female or

URiM student will be independently related to interest in a career outside of EM, even after controlling for all other factors included in the model.

Methods

Study Design: The study uses secondary data of 46,776 students who applied for residency from 2005 through 2010. The specific six-year cohort from 2005-2010 was selected for several reasons including the relative stability of survey responses, survey formats, selection factors consistency, and AAMC data availability. Institutional IRB review was solicited, and the study was found not to require additional regulation or assessment. Statistical analyses included fitting a binary logistic regression model with career specialty plan as the dependent variable and student demographics, academic characteristics, and personal values included as explanatory variables. Career specialty interest was derived from the response to the specific item: "When thinking about your career, what is your intended area of practice?" on the AAMC Graduating Questionnaire. Responses were then recoded as either "emergency medicine" or all other specialty choices collapsed into a single response, "not emergency medicine."

Data Sources: Multiple nationally representative datasets were combined to create the sample used in the analysis. Data sources were combined using common individual identifiers (AAMC ID) by the AAMC and provided to the authors in a de-identified version. The data used in this study was made available after an initial research proposal data request through the AAMC website[118] followed by refinement in collaboration with AAMC Data Operations and Data Stewards from 2015-2017. Inclusion of USMLE scores were made possible through a previous relationship between the AAMC and the National Board of Medical Examiners (NBME) and a separate data licensing agreement. Active data licensing agreements exist with both entities for purposes of this study. The contributions from each data source are:

Graduation Questionnaire (GQ): a national questionnaire administered by the AAMC to U.S. graduating medical students including medical school experiences, specialty selection, and future career plans and interests. Additional details regarding the survey are available at https://www.aamc.org/data/gq/

AAMC Applicant Matriculant File (AAMF): represents the applicant data from the AAMC's AMCAS centralized medical school application processing service. The AAMF database contains academic and demographic factors of applicants to medical school via AMCAS. All but nine U.S. medical schools use AMCAS as the primary application method for their entering classes (eight Texas-based schools use a state-specific application).[134]

Electronic Residency Application Service (ERAS) is a national dataset of applicant data from the AAMC that is collected through their application to the National Residency Match Program (NRMP). ERAS is also how program directors receive information about applicants.

U.S. Medical Licensing Exam (USMLE) USMLE Step 1 and Step 2 CK were included in the data. These two tests are often used as part of the residency application review process.

Measurements: Explanatory variables were selected based on the conceptual framework and the preexisting literature. Each individual's academic metrics and likely match competitiveness, their level of educational debt, and concepts from two major applicable theoretical frames (Bounded Rationality Theory[61,135,136] and Bandura's Theory of Self Efficacy) were incorporated.[29,30,79] While a complete discussion of the theoretical framework is beyond

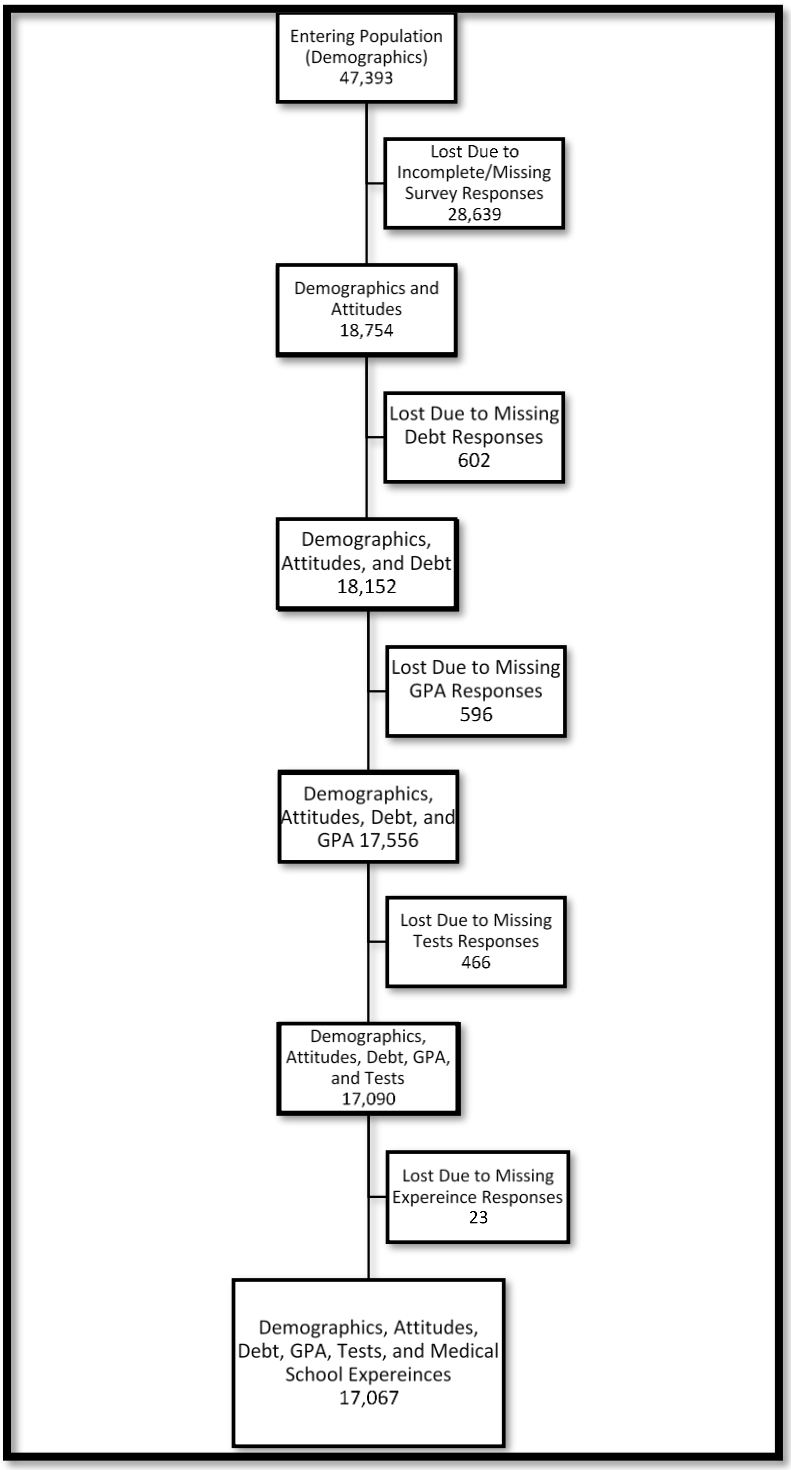
the scope of this article, three central concepts from the study's theoretical approach are key to understanding the design. One, Bounded Rationality Theory integrates an individual's cognitive limitations and incomplete information availability on their ability to maximize personal values,[135,136] Two, self-efficacy is one's belief in his/her ability to influence their cognitive response to a situation and thus persist in achieving their goals, despite adversity.[79] Three, self-efficacy is thought to be created through positive academic experiences and mentorship.[79] Study subject demographics are provided in Appendix 1, including both the original sample and the effective sample used in the final statistical model. Both groups are generally similar in their interest in a future EM career, gender distribution, URiM status, and other academic variables (Appendix 2). The URiM variable represents a binary recoding of a self-reported racial/ethnic identity to either non-URiM (white or Asian students) or URiM student (groups as demarcated in Table 1). Table 2 details the distribution of Likert-like survey responses included in the final model. Each of the independent variables considered in the study was placed in a theoretically-derived grouping (Appendix 3) and added one group at a time. A Flow Diagram illustrating the evolution of the Final Data Set (17,067) from the original parent set (47,393) derived from the combination of the different data sources is shown in Figure 7. In reviewing the decrease in effective sample size due to survey responses, any missingness is due in large part to changes in survey items included in the actual survey (year to year) and not from individuals not responding to any single item on a survey.

Table 2: Aggregate Survey Responses

Importance of Factor	Observations	No Influence	Minor Influence	Moderate Influence	Strong Influence
Work-Life Balance	18,641	1,730 (9.3%)	3,458 (18.6%)	6,477 (34.8%)	6,976 (37.4%)
	17,067	1,584 (9.3%)	3,161 (18.5%)	5,937 (34.8%)	6,385 (37.4%)
Specialty Competitiveness	46,599	17,511 (37.6%)	13,293 (28.5%)	12,420 (26.7%)	3,375 (7.2%)
	17,067	6,994 (41.0%)	4,963 (29.1%)	4,063 (23.9%)	1,047 (6.0%)
Specialty Personality	27,601	198 (1.0%)	604 (2.2%)	3,756 (13.6%)	23,043 (83.5%)
	17,067	138 (0.8%)	372 (2.2%)	2,425 (14.1%)	14,132 (82.9%)
Specialty Content	27,592	169 (0.6%)	623 (2.3%)	4,654 (16.9%)	22,146 (80.3%)
	17,067	112 (0.7%)	376 (2.2%)	2,900 (17.0%)	13,679 (80.2%)
Average Salary	46,600	10,138 (21.8%)	14,918 (32.0%)	16,051 (34.4%)	5,493 (11.8%)
	17,067	4,723 (27.7%)	5,603 (32.8%)	4,974 (29.1%)	1,767 (10.4%)
Mentor Advice	46,562	4,861 (10.4%)	7,128 (15.3%)	14,866 (31.9%)	19,707 (42.3%)
	17,067	1,924 (11.3%)	2,408 (14.1%)	5,208 (30.5%)	7,527 (44.1%)
Family Expectations	46,577	19,197 (41.2%)	11,232 (24.1%)	10,555 (22.66%)	5,593 (12.0%)
	17,067	7,945 (46.6%)	4,011 (23.5%)	3,338 (19.6%)	1,773 (10.4%)
Debt Level	46,574	23,970 (51.5%)	11,167 (24.0%)	7,888 (16.9%)	3,549 (7.6%)
	17,067	9,297 (54.5%)	3,926 (23.0%)	2,683 (15.7%)	1,161 (6.8%)

Liker-like scale responses to the survey questions on the AAMC Graduating Questionnaire. Each item asks the respondent to rate the importance of the factor in making their medical specialty career choice. Top row of each item is the absolute number of responses and the bottom row represents responses included in the final logistic regression model.

Figure 7: Flow Diagram Illustrating the Evolution of the Final Data Set



Alterations to the effective study sample as additional variables were added to the logistic regression model

Analytic Approach: Interest in a post-graduation career in EM, the dependent variable, was defined as selecting emergency medicine to the question "When thinking about your career, what is your intended area of practice?" (1=interested in EM; 0=interested in another medical specialty). This dependent variable was regressed on several factors thought to correlate with interest in a future EM career. Given the dichotomous nature of the outcome variable, binary logistic regression was used to fit these models.[137] An Area Under the ROC was calculated and a likelihood ratio test was performed comparing more saturated models with simpler, nested models. Finally, sub-models that included only female or URiM students were created and the resultant factor coefficients contrasted visually with the general model (Appendix 4).

Results

In the sample, there are more men than women (52.2% vs. 47.8%, respectively). URiM students represent 15.7% of individuals in the sample, compared to the combined group of White and Asian students (83.6%). The overall model is presented in Table 3. Likelihood ratio test indicated significant improvement in model fit with each variable group addition, compared with the simpler, prior model. Area under the ROC was .7629 indicating fair accuracy in predicting an interest in a future career in emergency medicine within the study cohort. Non-significant Pearson's and Hosmer-Lemeshow Goodness of Fit tests were consistent with equal model fit across subgroups within the effective sample. The following individual results represent the relative change associated with each variable when others are kept constant.

Answering the research question, being female and from a URiM background were associated with a lower odds ratio of an interest in EM, even after controlling for other possibly confounding factors (Shaded in Table 3). Women had odds of a planned career in EM specialty

that were 25% lower than their male peers (OR 0.75, 95% CI 0.66 – 0.85). URiM students had odds of a planned career in EM that were 32% lower than their majority peers (OR 0.68, 95% CI 0.57 – 0.82). Comparisons of logistic coefficients between the general model of all students and sub-models consisting of only female and only URiM students demonstrated generally consistent effect sizes across all attitudinal factors. This is consistent with each individual factor having a similar effect in predicting specialty selection in the general model and in both subgroups (Appendix 4).[138]

The results indicate that for each additional $10,000 of medical school debt, the student is about 2% more likely to report a planned career in EM (Table 3). Many of the students' self-reported values in choosing a medical specialty were also significantly correlated with EM career interest. Students who placed high importance on Work-Life balance were much more likely to plan on an EM career. Specifically, for each increase in the categorical importance of this factor (for example from Minor Influence to Major Influence), there was an associated 118% increase in their odds (OR 2.18, 95% CI 2.01 – 2.38. In contrast, for those students who rated specialty competitiveness and the importance of advice by their mentors as one category more important they were 18% (OR 0.82, 95% CI 0.76 – 0.88) and 29% (OR 0.71, 95% CI 0.68 – 0.75) less likely to plan on a career in EM, respectively. Students who expressed an interest in working with underserved populations were much more likely (71%) to plan on a career in EM (OR 1.71, 95% CI 1.57 – 1.87). Conversely, as the relative importance of expected salary increased so did the likelihood of choosing EM (OR 1.14, 95% CI 0.76-0.88). Finally, increased confidence in specialty choice was associated with a 40% increase in the odds of entering EM over other options (OR 1.40, 95% CI 1.25-1.57).

Table 3: Odds of a Planned Career in EM at Graduation

VARIABLES	Odds Ratio	OR 95% Confidence Interval	Logit coefficient	LC 95% Confidence Interval
Female	**0.75*** (0.047)**	**0.664 - 0.850**	**-0.29*** (0.063)**	**-0.410 - -0.163**
Age in Years	1.03** (0.010)	1.007 - 1.048	0.03** (0.010)	0.007 - 0.047
Underrepresented in Medicine (URiM)	**0.68*** (0.064)**	**0.567 - 0.819**	**-0.38*** (0.094)**	**-0.568 - -0.200**
Work Life Balance	2.18*** (0.093)	2.009 - 2.375	0.78*** (0.043)	0.698 - 0.865
Specialty Competitiveness	0.82*** (0.031)	0.759 - 0.879	-0.20*** (0.037)	-0.276 - -0.129
Specialty Personality	1.06 (0.091)	0.897 - 1.258	0.06 (0.086)	-0.108 - 0.229
Specialty Content	0.90 (0.066)	0.775 - 1.034	-0.11 (0.074)	-0.255 - 0.033
Expected Salary	1.13** (0.046)	1.044 - 1.225	0.12** (0.041)	0.043 - 0.203
Advice from Mentor	0.71*** (0.020)	0.675 - 0.753	-0.34*** (0.028)	-0.393 - -0.284
Family Expectations	0.96 (0.028)	0.909 - 1.018	-0.04 (0.029)	-0.095 - 0.018
Importance of Debt	0.99 (0.039)	0.917 - 1.070	-0.01 (0.039)	-0.087 - 0.068
Had Pre-Medical Debt	1.06 (0.067)	0.940 - 1.204	0.06 (0.063)	-0.062 - 0.185
Received Scholarship	1.01 (0.062)	0.899 - 1.143	0.01 (0.061)	-0.107 - 0.133
Medical School Debt in $10,000	1.02*** (0.004)	1.007 - 1.023	0.01*** (0.004)	0.007 - 0.023
Non-Medical School Debt in $10,000	0.98 (0.021)	0.941 - 1.022	-0.02 (0.021)	-0.061 - 0.022
Cumulative Science GPA (per 1-point increase)	1.00 (0.002)	0.998 - 1.007	0.00 (0.002)	-0.002 - 0.007
Cumulative Overall GPA (per 1-point increase)	0.99** (0.003)	0.988 - 0.998	-0.01** (0.003)	-0.012 - -0.002
MCAT Total Score (per 1-point increase)	1.03*** (0.009)	1.017 - 1.052	0.03*** (0.009)	0.016 - 0.050
USMLE Step 1 Score (per 1-point increase)	0.99*** (0.002)	0.982 - 0.991	-0.01*** (0.002)	-0.018 - -0.009
USMLE Step 2 CK Score (per 1-point increase)	1.01*** (0.002)	1.007 - 1.015	0.01*** (0.002)	0.007 - 0.015
Number of Publications (Per publication)	0.96*** (0.009)	0.945 - 0.982	-0.04*** (0.010)	-0.056 - -0.018
Research Experiences	0.85*** (0.018)	0.811 - 0.882	-0.17*** (0.022)	-0.210 - -0.125
Awarded AOA Prior to Application	0.77** (0.077)	0.637 - 0.939	-0.26** (0.099)	-0.451 - -0.062
Confidence in Specialty Choice	1.39*** (0.080)	1.245 - 1.559	0.33*** (0.057)	0.219 - 0.444
Plan to Practice with Underserved Populations	1.71*** (0.077)	1.570 - 1.870	0.54*** (0.045)	0.451 - 0.626
Constant	0.02*** (0.016)	0.00458 - 0.0925	-3.88*** (0.773)	-5.387 - -2.380

*Observations: 17,067; Standard errors in parentheses *** p<0.001, ** p<0.01, * p<0.05*

Academic variables were also included in the model to account for potential differences in applicant competitiveness. Students who had been elected to Alpha Omega Alpha (AOA), a competitive medical honor society, prior to application were much less likely to plan on a career in Emergency Medicine (OR 0.77, 95% CI 0.64 – 0.94). Students with more research experiences and increased scholarly production each had a lower odds of choosing EM. For each

additional research experience the odds of choosing EM was 15% lower (OR 0.85, 95% CI 0.81-0.83) and for each additional academic publication it was 4% lower (OR 0.96, 95% CI 0.95 – 0.98). Other academic variables, such as grades and tests, were also statistically significant, however their effect size was quite small (to the point of being practically insignificant) and their relative impact on a career in EM contradictory (Table 3).

Limitations

There are several limitations worth noting. First, this study utilizes some survey data and the questions used may not ideally capture the constructs of the conceptual framework employed. However, the items included in the AAMC surveys are largely identical to those used in similar career decision studies in emergency medicine and in other medical fields.[132] With regard to the issue of veracity of the data collected prior to this analysis, the source of the information is critically important. The academic information contained in this study comes directly from the organization that provides the application software. Unlike many other similar studies, there is no self-reported data on scores, grades, and other academic factors from students, which can result in misreporting of such data.

A second potential limitation is a result of using survey-based data which can be limited by non-response issues. In this case, the change of an item in the survey over the timeframe of the analysis limited the sample size to over 17,000 subjects (Figure 7). While this has the potential to bias the results, there is no clear reason to believe that there are major differences between respondents pre and post survey item change (Appendix 1).

Discussion

The results support the hypothesis that female and URiM students have less interest in a future career in EM at the time of medical school graduation. This finding is true even when controlling for different interests, academic competitiveness, debt load, and other factors. To our knowledge this study provides the first evidence that demonstrates that continued issues with recruiting a diverse EM workforce for the future may be the result of currently undefined factors. This study was especially well positioned to find such differences, as discussed in Chapter 3 it was powered sufficiently to find even small effect sizes with regard to a planned career in EM.

Prior to this study, stakeholders in EM could consider several explanations for why female and URiM student were less likely to choose EM that were based on individual preferences and not a result of external forces on the process. Specifically, explanations that focused on women and URiM students having different values or preferences as medical students that result in less career interest in EM. Those explanations are not supported by the results. Controlling for the importance placed on career attributes and values that have been shown to be correlated with an interest in EM, academic competitiveness to match in EM, and the importance of service to underserved populations in the decision-making model did not correct for the observed lower graduating career interest in EM for female and URiM students.

In addition to the primary results regarding future emergency medicine workforce diversity, several other interesting findings were provided as a result of this large-scale, multi-variate analysis. First, those students who put a lower priority on the importance of specialty competitiveness were less likely to plan on a career in EM. This finding holds even when controlling for academic metrics of match competitiveness and thus maybe a previously undescribed personality factor correlated with future EM physicians. Another unexpected result was that the greater the level of importance placed on the advice given by their mentor by an

individual, the less likely they planned on a career in EM. The study was not designed to determine the nature of the advice given by mentors or why for those who considered it most important it would be associated with choosing a career outside EM. It may be simply where undecided students were going for career advice. Medical students have less exposure to EM than many other choices within the first 2 years of medical school[139] and EM clerkships generally occur in year four of training.[140] Delayed exposure in meeting academic emergency physicians likely results in more undecided students having mentorship from other specialties.

The study design's inclusion of both attitudinal data regarding salary and debt as well as actual debt level as reported in dollars provided some additional novel findings from the study. As students placed higher importance on their future expected salary and higher total debts amounts, they were more likely to have reported a planned career in EM. Prior research has suggested that higher debt levels may affect medical specialty career choice toward higher paying medical specialties and away from lower paying ones.[86,132,141,142] While the effect size seen in the results may seem to translate to a very minor change in behavior, in the case of medical school debt, which can easily reach hundreds of thousands of dollars, the cumulative effect may be quite large. A recent study placed the median medical school debt at $190,000. [143] Using this medical debt estimate, for those with median debt we would expect there to be a 38% increase in the likelihood stating a primary career interest EM over those not in debt. Interestingly, the reported importance of debt as a selection consideration was not significant when the amount of debt itself was considered. This may represent a disconnect between self-reported values and actual selection behavior which has not been previously described in studies that only considered student's self-reported values.

Conclusions

In conclusion, our study was able to better characterize the factors which correlate with a planned career in EM. Most importantly, the observed differences in representation of women and URiM students amongst students who reported their interest in a future in emergency medicine is not explained by differences in career attitudes or any other factor in the dataset. This finding should serve as a wakeup call to EM medical educators to critically analyze what other factors may be influencing decreased interest in EM. Studying aspects of our own behavior as practicing emergency physicians is a good first step. Examining our specialty's cultural norms, our patterns of social engagement with learners, and the level to which we are welcoming to all medical students must be scrutinized if we are to identify the underlying factors which underlie our results.

Chapter Five: Underrepresented in Emergency Medicine: Are Medical Schools "Cooling Out" Interest in Emergency Medicine?

Purpose: Women and Underrepresented in Medicine (URiM) medical students are less likely to plan on a career in emergency medicine (EM) even after controlling for numerous other factors. Identifying whether medical students from these groups have baseline differences in their career interests or if the lower likelihood in planning a career in EM develops during medical training is critically important for the specialty.

Methods: A secondary data analyses was performed on all medical students who applied to ERAS from 2005-2010. Binary logistic regression models (BLM) with the outcomes: a planned career in EM at medical school entry, planned career in EM at graduation, and continued practice in EM were fitted. Regression models included demographics, student attitudes, debt, undergraduate GPA and standardized test scores, and, medical school experiences.

Results: URiM students expressed less interest in a career in EM when entering medical school and at graduation. Women were less likely to be planning to have a career in EM by the time of medical school graduation. After residency, both female and URiM students had similar persistence in EM as all other emergency physicians.

Conclusions: Women were less likely to develop a career interest in EM in this study than men. While URiM students were less interested in EM generally, those initially interested in EM may be subject to a "cooling out" effect. Increasing the diversity of new EM physicians needs a multi-level evidence-based intervention.

Understanding medical student specialty selection has been a topic of inquiry for several decades,[53] however much is still unknown. Survey-based studies have demonstrated entering medical students often begin their studies with clear attitudes and preferences regarding the area in which they plan to practice.[54,55] These studies, however, have reported conflicting evidence on how stable these preferences remain through medical school. Factors demonstrated to have a role in career interest at the beginning of medical school include lifestyle issues, expected income in the various medical specialties, procedural orientation, societal prestige outside medicine, and the respect of peer physicians within the profession.[56,57] While many of the factors that affect initial career interest are outside the control of medical educators, one's eventual medical specialty choice is likely related to both a student's entering career interest (shaped by the factors noted above) as well as their experiences during medical school (Figure 3). As such, as medical students move through their education, their entering specialty interest may be modified by both personal development as well as programmatic and cultural factors. Understanding these relationships may allow medical educators to understand and potentially affect individuals' career choices.

Background: Work on career selection into emergency medicine (EM) has not adequately explained the lower interest by female and underrepresented in medicine (URiM) students.[144] Controlling for factors such as academic competitiveness, debt, career attitudes and aspirations, women and URiM students still had significantly lower interest in the field of EM.[144] We have conceptualized student career selection at the time of medical school completion as a series of nested influences (Figure 5). Herein we examine when the lower likelihood of planning for a career in EM among women and URiM students can be identified. Specifically, are career

interest differences due to factors that predate students' entry into medical education or due to hidden influences during medical school that is making a career in EM less desirable?

Conceptual Framework: Self-efficacy has been applied to career choice in multiple fields using Bandura's social-cognitive theory.[29] Bandura defines self-efficacy as one's belief in his/her ability to influence their cognitive response to a situation.[79] This response influences a subject's ability to persist in their attempts, despite adversity, and to eventually promote success in specific situations.[79] Betz applied this theory to career selection, paying special attention to fields that are traditionally male-dominated, such as the sciences and medicine.[29] Lent demonstrated that self-efficacy theory successfully accounted for significant differences in grades and confidence in perusing more competitive career options.[30]

Similarly, learner persistence in the face of adversity has also been studied within the higher education literature. In the case of students choosing to enter a less competitive field or who otherwise change their career aspirations as a result of negative feedback from their educational experiences, the process is often referred to as a "cooling out" function.[145-147] While initially thought to be a relatively benign process of student aspirational redirection,[145] the potential for cooling out based on gender and racial background, not academic ability, has become a more common negative connotation for the term.[146,148]

With this in mind, it is important to consider an appropriate way to test for cooling out in medical specialty selection. Two major theoretical families of thought exist in the higher educational literature on student departure from college: those that are based on Tinto and those that are related to work by Bean.[149] Tinto's empirical work on student departure is conceptualized as being due to several factors, most importantly the degree to which a student is

socially integrated into college. Conceptually, Tinto's social integration construct is based on Durkeim's work on suicide.[147,149] Bean argued that learner dropout from college could be understood using approaches similar to those used to study worker turnover.[150] In developing this model of learner dropout, he and his colleagues adapted both preexisting theoretical constructs[151] and tested his causal model across multiple student sub-populations.[152-154] Their research also provided policy implications for educators wishing to modify (and improve) environmental factors that tended to lower student persistence in college.[149] Both models have merit and both in informed the approach.

Objectives: To test whether, in this sample, there is a lower likelihood of planning for a career in EM at graduation for women and URiM students, and if so, whether this reduced propensity in interest existed at the time of medical school entry or developed during medical school. Also to test whether any lower career interest in EM at graduation translated into lower persistence of women and URiM physicians into emergency medicine practice after the conclusion of their training. We hypothesized that career interest in EM for both women and URiM students would be at a similar level as all other students at the beginning of medical school, that a "cooling out" of interest would be demonstrated and could account for lowered likelihood of a planned career in EM. However, we also hypothesized that women and URiM physicians would exhibit no difference in their emergency medicine career persistence after medical school graduation. As such, a finding of no difference would be consistent with EM being an equally good career fit for all interested medical students.

Methods

Study Design: The study uses secondary data of 46,776 students who applied for residency training in the U.S. from 2005 through 2010. This six-year cohort was selected for several reasons, including the relative stability of survey items, consistency of survey formats, selection factors consistency, and that enough time elapsed for subjects to have completed their training. Institutional IRB review was solicited, and the study was found not to require additional regulation or assessment.

Data Sources: Multiple nationally representative datasets were combined to create a database of all students with electronic records held by the Association of American Medical Colleges (AAMC) who applied for residency through the Electronic Residency Application Service (ERAS) from 2005 through 2010. Data were provided by AAMC, the National Board of Medical Examiners (NBME) and the American Medical Association (AMA). The contributions from each are:

Matriculating Student Questionnaire (MSQ): AAMC national questionnaire administered annually to U.S. matriculating medical students assessing topics including pre-medical experiences, the medical school selection process, choosing medicine as a career, and future career plans and interests.

Graduation Questionnaire (GQ): AAMC national questionnaire administered to U.S. graduating medical students including medical school experiences, specialty selection, and future career plans and interests.

AMC Applicant Matriculant File (AAMF): This database contains academic and demographic factors of applicants to medical school derived from the American Medical College Application Service (AMCAS).

Electronic Residency Application Service (ERAS) National dataset of residency applicant data provided from the AAMC.

U.S. Medical Licensing Exam (USMLE) USMLE Step 1 and Step 2 CK were included in the data with consent from the NBME.

American Medical Association Physician Masterfile (AMAPM) is a national dataset that includes current and historical data for more than 1.4 million physicians, residents, and medical students in the United States.

Measurements: Entering specialty interest was derived from the MSQ item: "What general specialty are you considering?" Graduating specialty interest was derived from the GQ item: "When thinking about your career, what is your intended area of practice?" Career in EM was obtained from the AMA Masterfile reported career specialization. Responses were recoded as either "emergency medicine" or "not emergency medicine." Explanatory variables were selected based on the conceptual framework and the preexisting literature (Table 4). As different questions were asked on the MSQ and the GQ not all items appear in all three regression models. Similar career desirability attitudinal items were used as appropriate to the dependent variable (entry career interest used items from the MSQ and graduating interest and practice used GQ). The decrease in effective sample size due to survey responses is due in large part to changes in survey items included in the actual survey (year to year) and not from individuals not responding to any single item on a survey.

Analytic Approach: Each of the three dependent variables defined above (entering specialty plans, graduation specialty plans, and EM practice) were independently regressed on several factors thought to correlate with the outcome. Three additional logistic regression models were

fitted to examine how entering career plans correlated and explained graduating career plans. Given the dichotomous nature of the outcome variable, binary logistic regression was used to fit these models.[137,138] Stata 12 was used for performing the analysis.[119]

Table 4: Variables

VARIABLE SUBGROUP NAMES	VARIABLES WITHIN EACH SUBGROUP	SOURCE
DEMOGRAPHICS	Gender Age URiM Status	*Electronic Residency Application Service (ERAS)*
ENTERING ATTITUDES	Opportunity for Authority Opportunity for Patient Contact Opportunity for Control Opportunity for Decision-Making Opportunity for Expertise in Specialized Area Opportunity to Make a Difference Opportunity for Research Chose Medicine to Limit Stress	*Matriculating Student Questionnaire (MSQ)*
GRADUATION ATTITUDES	Work-Life Balance Specialty Competitiveness Specialty Personality Specialty Content Expected Salary Advice from Mentor Family Expectations Debt Level	*Graduation Questionnaire (GQ)*
DEBT LEVEL	Had Pre-Medical Debt Received Scholarship Medical School Debt in $10,000 Non-Educational Debt in $10,000	*Graduation Questionnaire (GQ)*
ENTERING GPA	Overall GPA Science GPA	*AAMC Applicant Matriculant File (AAMF)*
STANDARDIZED TESTS	MCAT Total Step 1 Score Step 2 CK Score	*AAMC Applicant Matriculant File (AAMF)* *U.S. Medical Licensing Exam (USMLE)*
MEDICAL SCHOOL ACTIVITY	Number of Publications Research Experience Awarded AOA prior to application Confidence in Specialty Choice Planned Practice with Underserved Populations	*Electronic Residency Application Service (ERAS)*
DEPENDENT VARIABLES	Entering Career Interest in EM Planned Career in EM Current Practice in EM	*Matriculating Student Questionnaire (MSQ)* *Graduation Questionnaire (GQ)* *American Medical Association Physician Masterfile (AMAPM)*

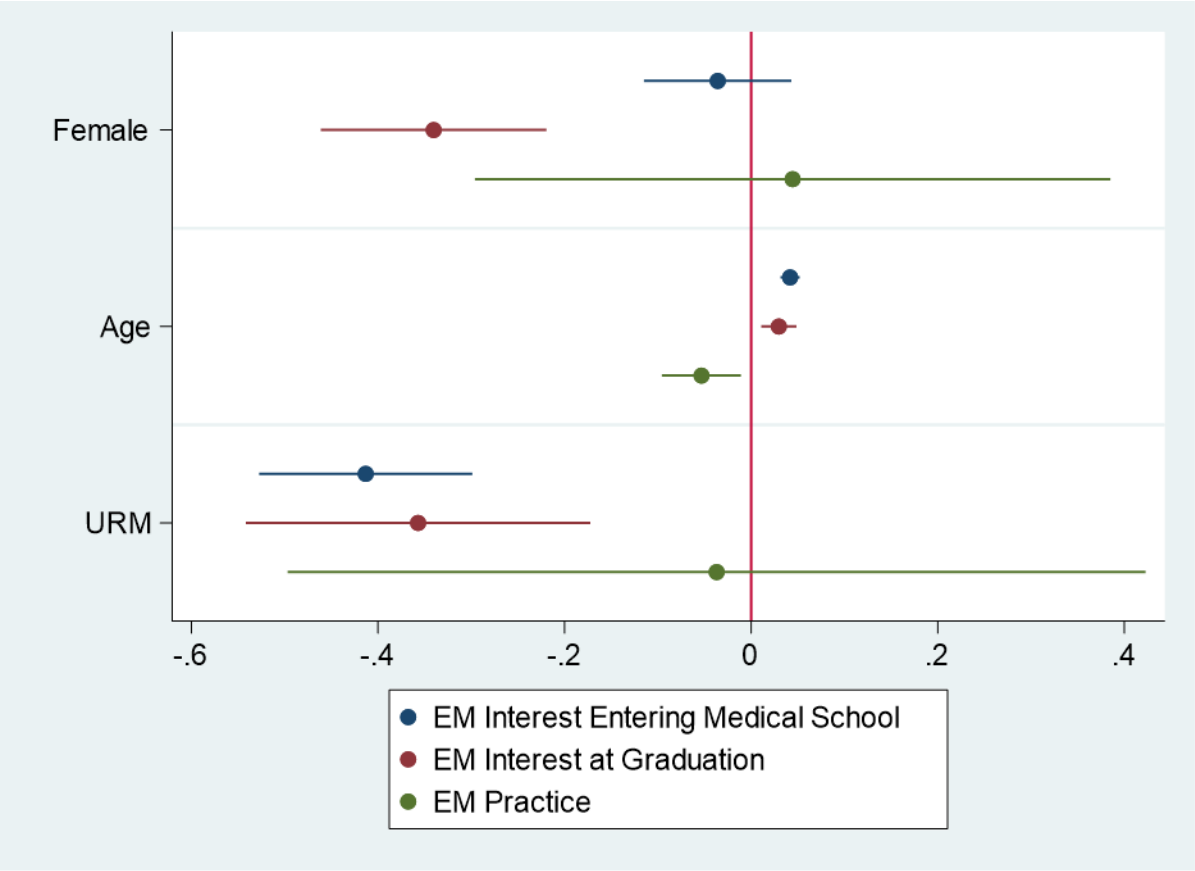
Results

Results of all three regression models are displayed in Table 5. Variables in each model included academic ability, previously identified career interest factors, medical education debt and residency application competitiveness. Examining the results related to research question, being female vs. male was not correlated with a significant difference in plans for a career in EM at the start of medical school (OR 0.96 95% CI 0.89-1.04). At the time of graduation, women had significantly lower odds of planning on a career in EM than men (OR 0.71 95% CI 0.63-0.80). URiM students were significantly less likely to report interest in a career in EM both when entering medical school and again at graduation (OR 0.66 95% 0.59-0.74 and OR 0.70 95% CI 0.58-0.84, respectively). Being female (OR 1.05 95%CI 0.74-1.47) or from a URiM background (OR 0.96 95% CI 0.61-1.53) was not associated with a difference in the eventual practice of EM if the student planned to enter the field at the time of graduation. Age was positively related with expressing plans for a career in EM at medical school matriculation (OR 1.04 95% CI 1.03-1.05) and at graduation (OR 1.03 95% CI 1.01-1.05) but was negatively related to continued practice in emergency medicine (OR 0.95 95% CI 0.91-1.00). The coefficients of all three demographic variables are displayed in Figure 8 for comparison.[138]

Table 5: EM Interest at Three Points in Medical Career

	EM Interest on Entry to Medical School					EM Interest at Graduation				Emergency Medicine Practice			
Entering Variables	Odds Ratio	OR 95% Confidence Interval	Logit coefficient	LC 95% Confidence Interval	Graduating Variables	Odds Ratio	OR 95% Confidence Interval	Logit coefficient	LC 95% Confidence Interval	Odds Ratio	OR 95% Confidence Interval	Logit coefficient	LC 95% Confidence Interval
Female	**0.96 (0.039)**	**0.891 - 1.044**	**-0.04 (0.040)**	**-0.115 - 0.043**	**Female**	**0.71*** (0.044)**	**0.630 - 0.803**	**-0.34*** (0.062)**	**-0.461 - - 0.219**	**1.05 (0.182)**	**0.744 - 1.470**	**0.04 (0.174)**	**-0.296 - 0.385**
Age	1.04*** (0.005)	1.032 - 1.053	0.04*** (0.005)	0.031 - 0.052	Age	1.03** (0.010)	1.011 - 1.050	0.03** (0.010)	0.011 - 0.049	0.95* (0.020)	0.909 - 0.989	-0.05* (0.022)	-0.096 - - 0.011
URiM	**0.66*** (0.039)**	**0.590 - 0.742**	**-0.41*** (0.058)**	**-0.527 - - 0.299**	**URiM**	**0.70*** (0.066)**	**0.582 - 0.842**	**-0.36*** (0.094)**	**-0.542 - - 0.172**	**0.96 (0.226)**	**0.609 - 1.526**	**-0.04 (0.235)**	**-0.497 - 0.423**
GPA	1.00*** (0.001)	0.996 - 0.999	-0.00*** (0.001)	-0.004 - - 0.001	GPA	1.00*** (0.001)	0.993 - 0.998	-0.00*** (0.001)	-0.007 - - 0.002	1.01 (0.003)	1.000 - 1.011	0.01 (0.003)	-0.000 - 0.011
MCAT	0.98*** (0.005)	0.971 - 0.991	-0.02*** (0.005)	-0.029 - - 0.009	MCAT	1.04*** (0.009)	1.019 - 1.053	0.04*** (0.008)	0.019 - 0.052	1.01 (0.023)	0.966 - 1.055	0.01 (0.023)	-0.035 - 0.054
Opportunity for Authority	0.91*** (0.015)	0.882 - 0.942	-0.09*** (0.017)	-0.126 - - 0.060	USMLE Step 1	0.99*** (0.002)	0.983 - 0.992	-0.01*** (0.002)	-0.018 - - 0.008	1.00 (0.007)	0.991 - 1.017	0.00 (0.007)	-0.009 - 0.017
Opportunity for Patient Contact	0.54*** (0.011)	0.523 - 0.564	-0.61*** (0.019)	-0.648 - - 0.572	USMLE Step 2	1.01*** (0.002)	1.006 - 1.015	0.01*** (0.002)	0.006 - 0.014	1.01** (0.005)	1.003 - 1.024	0.01** (0.005)	0.003 - 0.024
Opportunity for Control	1.09*** (0.023)	1.043 - 1.134	0.08*** (0.021)	0.042 - 0.126	Work/Life Balance	2.22*** (0.085)	2.056 - 2.389	0.80*** (0.038)	0.721 - 0.871	1.09 (0.130)	0.861 - 1.374	0.08 (0.119)	-0.149 - 0.317
Opportunity for Decision-Making	2.11*** (0.046)	2.022 - 2.202	0.75*** (0.022)	0.704 - 0.789	Specialty Personality	1.02 (0.074)	0.884 - 1.175	0.02 (0.072)	-0.123 - 0.161	1.40 (0.264)	0.964 - 2.024	0.33 (0.189)	-0.037 - 0.705
Opportunity for Expertise in Specialized Area	0.76*** (0.015)	0.736 - 0.794	-0.27*** (0.019)	-0.306 - - 0.231	Specialty Competitiveness	0.85*** (0.026)	0.800 - 0.902	-0.16*** (0.031)	-0.223 - - 0.103	1.21 (0.125)	0.990 - 1.483	0.19 (0.103)	-0.010 - 0.394
Opportunity to Make a Difference	1.27*** (0.058)	1.162 - 1.389	0.24*** (0.045)	0.150 - 0.329	Mentor Advice	0.71*** (0.019)	0.676 - 0.749	-0.34*** (0.026)	-0.392 - - 0.289	0.94 (0.073)	0.807 - 1.093	-0.06 (0.077)	-0.214 - 0.089
Opportunity for Research	0.78*** (0.013)	0.752 - 0.802	-0.25*** (0.016)	-0.285 - - 0.221	Medical School Debt	1.02*** (0.004)	1.009 - 1.024	0.02*** (0.004)	0.009 - 0.024	1.00 (0.011)	0.977 - 1.019	-0.00 (0.011)	-0.024 - 0.019
Chose Medicine to Limit Stress	0.98 (0.021)	0.942 - 1.022	-0.02 (0.021)	-0.060 - 0.022	Publications	0.96*** (0.010)	0.942 - 0.982	-0.04*** (0.011)	-0.060 - - 0.018	1.03 (0.024)	0.985 - 1.081	0.03 (0.024)	-0.015 - 0.077
					Research Experiences	0.85*** (0.018)	0.816 - 0.887	-0.16*** (0.021)	-0.203 - - 0.120	0.99 (0.062)	0.871 - 1.116	-0.01 (0.063)	-0.139 - 0.110
					Elected to AOA	0.76** (0.074)	0.628 - 0.920	-0.27** (0.097)	-0.465 - - 0.084	0.49** (0.135)	0.289 - 0.844	-0.71** (0.273)	-1.241 - - 0.170
					Confidence in Specialty Choice	1.36*** (0.074)	1.223 - 1.513	0.31*** (0.054)	0.201 - 0.414	1.66*** (0.226)	1.267 - 2.164	0.50*** (0.137)	0.237 - 0.772
Work with Underserved	1.37*** (0.039)	1.297 - 1.450	0.32*** (0.028)	0.260 - 0.371	Work with Underserved	1.65*** (0.070)	1.514 - 1.790	0.50*** (0.043)	0.415 - 0.582	1.23 (0.155)	0.964 - 1.579	0.21 (0.126)	-0.037 - 0.457
Constant	0.10*** (0.041)	0.0462 - 0.222	-2.29*** (0.400)	-3.074 - - 1.505	Constant	0.02*** (0.011)	0.00370 - 0.0613	-4.20*** (0.716)	-5.599 - - 2.791	0.00** (0.008)	8.99e-05 - 0.177	-5.52** (1.935)	-9.316 - - 1.733
Observations	41,047					17,452				1,458			
Robust Standard Errors in parentheses *** p<0.001, ** p<0.01, * p<0.05													

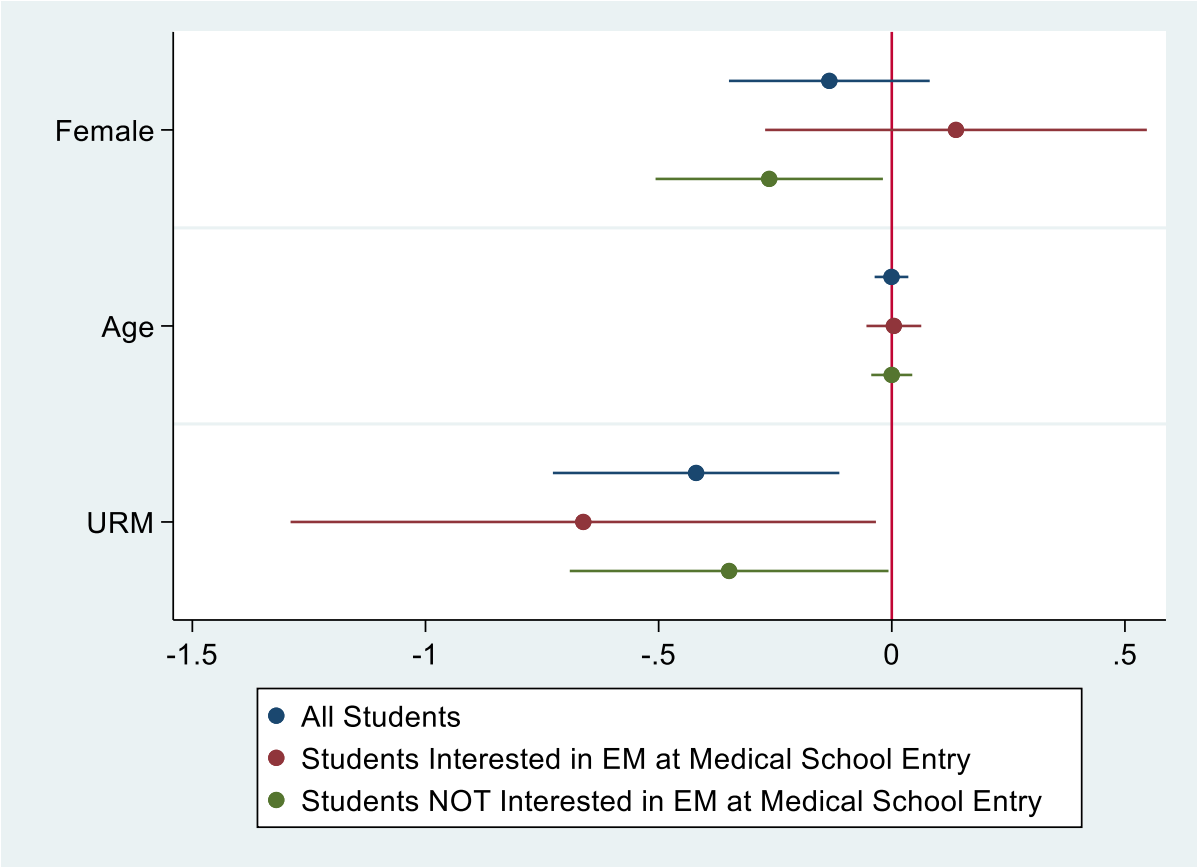
Figure 8: EM Career Interest Comparison Across Time



Variables outside of demographics were also considered. More importance placed on the opportunities for control, decision-making, making a difference, and working with the underserved were associated with a significantly greater likelihood of a planned career in EM at medical school entry (Table 5). Greater importance placed on an opportunity for authority, patient contact, and research increased, students were less likely to report a career plan in EM (Table 5). Regarding a planned career in EM at graduation, the importance of work-life balance, confidence in specialty choice, and amount of medical school debt were all associated with higher likelihood of an EM career (Table 5). Students who were elected to AOA, who more

highly valued advice from mentors, who found specialty competitiveness more important, and who reported increased research experience and publications were less likely to enter EM after graduation (Table 5). For example, students who had been elected to AOA prior to application were 24% less likely to plan on a career in Emergency Medicine (OR 0.76, 95% CI 0.63 – 0.92). Similarly, for each additional research experience, the odds of choosing EM was 15% lower (OR 0.85, 95% CI 0.82-0.89) and for each additional academic publication it was 4% lower (OR 0.94, 95% CI 0.95 – 0.98).

Figure 9: EM Graduation Interest Controlling for Medical School Entering Interest



Other academic variables, such as grades and tests, were also statistically significantly related to the outcome variables. Their inclusion was based on their theoretical importance in decision-making for individuals. However, each of these variable's effect size on the outcomes were quite small and not of practical significance. Additionally, academic variables were not considered factors that could be modified for recruitment and their relative impact on a career in EM was contradictory (Table 5).

When career plans for EM at medical school entry were included in the model, the difference between men and women at graduation no longer reached statistical significance (Table 6). Female students who did not begin medical school interested in emergency medicine had a significantly lower likelihood of reporting a career plan in EM than men at graduation (OR 0.77 95% 0.60-0.98). URiM students were less likely to plan on a career in EM at graduation even when controlling for their entering interest (OR 0.66 95% CI 0.48-0.89). URiM students who expressed a planned career in EM at the start of medical school were less likely than their peers to still report a planned career in EM at graduation (OR 0.52 95% CI 0.28-0.97). URiM students who began without an interest in EM were also less likely to develop one compared to their peers (OR 0.71 95% CI 0.50-0.99). A comparison of the coefficients of these sub-analyses is illustrated in Figure 9.

Table 6: Comparisons of Students Based on Initial Career Interest

	All Students				Students Interested in EM at MS Entry				Students NOT Interested at MS Entry			
VARIABLES	Odds Ratio	OR 95% Confidence Interval	Logit coefficient	LC 95% Confidence Interval	Yes Odds Ratio	Yes OR 95% Confidence Interval	Yes Logit coefficient	Yes LC 95% Confidence Interval	No Odds Ratio	No OR 95% Confidence Interval	No Logit coefficient	No LC 95% Confidence Interval
Entering Interest	13.43*** (1.576)	10.67 - 16.91	2.60*** (0.117)	2.368 - 2.828	Yes				No			
Female	0.87 (0.096)	0.705 - 1.085	-0.13 (0.110)	-0.349 - 0.081	1.15 (0.240)	0.762 - 1.728	0.14 (0.209)	-0.272 - 0.547	0.77* (0.096)	0.603 - 0.981	-0.26* (0.124)	-0.507 - - 0.019
Age	1.00 (0.018)	0.964 - 1.036	-0.00 (0.018)	-0.037 - 0.036	1.00 (0.030)	0.947 - 1.065	0.00 (0.030)	-0.054 - 0.063	1.00 (0.022)	0.957 - 1.045	-0.00 (0.022)	-0.044 - 0.044
URiM	0.66** (0.103)	0.483 - 0.894	-0.42** (0.157)	-0.727 - - 0.112	0.52* (0.165)	0.275 - 0.967	-0.66* (0.320)	-1.289 - - 0.034	0.71* (0.123)	0.501 - 0.993	-0.35* (0.174)	-0.691 - - 0.007
GPA	1.00 (0.002)	0.992 - 1.000	-0.00 (0.002)	-0.008 - 0.000	0.99 (0.004)	0.987 - 1.002	-0.01 (0.004)	-0.013 - 0.002	1.00 (0.002)	0.992 - 1.001	-0.00 (0.002)	-0.008 - 0.001
MCAT	1.03 (0.015)	1.000 - 1.058	0.03 (0.014)	-0.000 - 0.056	1.02 (0.029)	0.962 - 1.074	0.02 (0.028)	-0.039 - 0.072	1.04* (0.018)	1.002 - 1.072	0.04* (0.017)	0.002 - 0.069
Step 1	0.99** (0.004)	0.980 - 0.996	-0.01** (0.004)	-0.020 - - 0.004	0.98** (0.008)	0.963 - 0.993	-0.02** (0.008)	-0.038 - - 0.007	0.99 (0.005)	0.982 - 1.001	-0.01 (0.005)	-0.018 - 0.001
Step 2 CK	1.01 (0.004)	0.999 - 1.014	0.01 (0.004)	-0.001 - 0.014	1.02** (0.007)	1.006 - 1.033	0.02** (0.007)	0.006 - 0.033	1.00 (0.004)	0.994 - 1.010	0.00 (0.004)	-0.006 - 0.010
Work with Underserved	1.73*** (0.122)	1.509 - 1.988	0.55*** (0.070)	0.412 - 0.687	1.48** (0.206)	1.127 - 1.944	0.39** (0.139)	0.120 - 0.665	1.84*** (0.159)	1.554 - 2.181	0.61*** (0.086)	0.441 - 0.780
Work/Life Balance	2.40*** (0.157)	2.108 - 2.725	0.87*** (0.065)	0.746 - 1.002	2.08*** (0.241)	1.662 - 2.615	0.73*** (0.116)	0.508 - 0.961	2.66*** (0.242)	2.226 - 3.180	0.98*** (0.091)	0.800 - 1.157
Specialty Personality	1.16 (0.161)	0.882 - 1.522	0.15 (0.139)	-0.126 - 0.420	0.97 (0.235)	0.606 - 1.562	-0.03 (0.241)	-0.501 - 0.446	1.17 (0.201)	0.832 - 1.636	0.15 (0.172)	-0.184 - 0.492
Specialty Competitiveness	0.89* (0.047)	0.799 - 0.984	-0.12* (0.053)	-0.224 - - 0.016	0.71** (0.077)	0.576 - 0.879	-0.34** (0.108)	-0.552 - - 0.129	0.94 (0.060)	0.831 - 1.068	-0.06 (0.064)	-0.185 - 0.066
Mentor Advice	0.71*** (0.032)	0.645 - 0.771	-0.35*** (0.046)	-0.439 - - 0.260	0.61*** (0.060)	0.507 - 0.742	-0.49*** (0.097)	-0.679 - - 0.298	0.73*** (0.040)	0.656 - 0.812	-0.31*** (0.054)	-0.421 - - 0.208
Medical School Debt	1.01 (0.007)	0.998 - 1.024	0.01 (0.006)	-0.002 - 0.023	1.01 (0.012)	0.986 - 1.035	0.01 (0.012)	-0.014 - 0.034	1.01 (0.008)	0.996 - 1.026	0.01 (0.008)	-0.004 - 0.026
Publications	0.97 (0.015)	0.945 - 1.002	-0.03 (0.015)	-0.056 - 0.002	1.00 (0.026)	0.950 - 1.054	0.00 (0.026)	-0.051 - 0.052	0.95* (0.019)	0.917 - 0.992	-0.05* (0.020)	-0.087 - - 0.008
Research Experiences	0.85*** (0.032)	0.794 - 0.918	-0.16*** (0.037)	-0.230 - - 0.085	0.87 (0.064)	0.757 - 1.007	-0.14 (0.073)	-0.279 - 0.007	0.85*** (0.038)	0.783 - 0.930	-0.16*** (0.044)	-0.245 - - 0.072
Elected to AOA	0.73 (0.124)	0.525 - 1.021	-0.31 (0.170)	-0.645 - 0.021	0.79 (0.240)	0.434 - 1.431	-0.24 (0.304)	-0.834 - 0.358	0.69 (0.150)	0.448 - 1.053	-0.38 (0.218)	-0.802 - 0.052
Confidence in Specialty Choice	1.36** (0.136)	1.113 - 1.652	0.30** (0.101)	0.107 - 0.502	2.20** (0.531)	1.367 - 3.526	0.79** (0.242)	0.312 - 1.260	1.20 (0.134)	0.967 - 1.495	0.18 (0.111)	-0.033 - 0.402
Constant	0.02** (0.028)	0.00169 - 0.276	-3.84** (1.301)	-6.385 - - 1.286	0.32 (0.828)	0.00216 - 48.58	-1.13 (2.557)	-6.138 - 3.883	0.02** (0.025)	0.000871 - 0.325	-4.09** (1.511)	-7.046 - - 1.125
Observations	7,254				570				6,684			
Robust Standard Errors in parentheses *** p<0.001, ** p<0.01, * p<0.05												

Discussion

Previously, it was found that women and URiM students were less likely to be interested in a career in emergency medicine by the time they reached medical school graduation.[144] These results are a potential explanation for the continued underrepresentation of EM physicians from both of these groups.[40,155] The results provided mixed support for the hypotheses as to the cause of this phenomena. Figure 8 demonstrates clear differences between when women and URiM students seem to develop plans to enter fields outside EM. As such the findings regarding both women and URiM students have different, but equally important policy implications.

First, the results indicate that career interest in EM among women decreases from the time of entry of medical school until graduation. It appears more likely that instead of a cooling out of interest for women who were originally considering emergency medicine, there may be a significant lack of recruitment from those who did not initially report a planned career in EM. This is best represented by examining the divergent outcomes for women based on their initial interest as shown in Figure 9. It appears that lowered representation of women in EM is not a result of education or life experiences prior to medical school. In fact, it was during medical school that the observed differences in the development of planned careers in EM occurred. This would imply that women's medical school experiences are the underlying cause of this change. Therefore, EM-based medical educators may be able to influence how women are recruited to a career in EM. This represents an opportunity for educational researchers to identify the factors contributing to this phenomena and educational leadership to address them.

On the other hand, students from an URiM background were less likely to plan on a career in EM both at the beginning of medical school and at graduation. In fact, URiM students

were less likely to plan on a career in EM even after controlling for their initial attitude toward the specialty. Most concerning, URiM students who had expressed a plan to enter EM at the beginning of medical school were 48% less likely to report a continued plan to enter the specialty when compared to their peers. This is consistent with a strong "cooling out" effect of URiM students away from EM and toward other fields. The combination of lower baseline interest and "cooling out" imply that work to increase URiM representation in EM is necessary at multiple stages of a student's development. First, increased URiM representation in EM may benefit from a conscious effort to increase awareness of the role EM plays in the care of underserved populations to pre-medical students as well as in society at-large to reshape preexisting perceptions of the field. Second, EM researchers must make a concerted effort to determine why interested URiM students eventually enter non-EM fields at graduation. Those same researchers must examine why URiM students are recruited at a lower rate from medical students who were not initially interested in the specialty when compared to their peers. Finally, educational leadership interested in addressing these disparities in representation must make the necessary, concrete changes suggested by this new evidence.

A final important implication from this study regards the entry into EM practice. No difference between women and men as well as URiM and non-URiM students in their eventual likelihood of entering EM practice was found. This is a valuable finding as it implies that EM is not more likely to cause women or URiM physicians to abandon the specialty during training or shortly afterward. As such, it is unlikely that the reason women and URiM are choosing to enter careers in other fields is because EM is inherently a worse career fit for them compared to their peers.

Several limitations of the study should be noted. First, survey data was utilized that was intended for other purposes and the questions used may not ideally capture the constructs of the conceptual framework employed. However, the items included in the AAMC surveys are largely identical to those used in similar career decision studies in emergency medicine and in other medical fields.[132] With regard to the issue of veracity of the data collected prior to this analysis, the source of the information is critically important. The academic information contained in this study comes directly from the organization that provides the application software and therefore is not student self-reported. A second potential limitation is a result of using survey-based data which can be limited by non-response issues and changes in the survey items over time. In this case, the change of an item in the graduation questionnaire over the timeframe of the analysis limited the sample size between medical school entry and graduation. In previous work, this issue was examined and it was found that the demographical distribution of the sample was extremely similar between the two groups.

Conclusions

The lower likelihood for women and URiM to plan on entering a career in EM is not explained by differences in career attitudes or academic ability in this dataset. By graduation women are significantly less likely to plan on entering EM. URiM students, in contrast, are less likely to express a plan to enter EM when entering and when completing medical schools compared to their peers. Improving representation in emergency medicine therefore may benefit from both within medical school interventions as well as more wide-ranging outreach about the specialty to the general public.

Chapter Six: Diversity of the Physician Workforce: How Does Career Specialty Choice Change as a Result of Medical School Experiences

Purpose: Women and Underrepresented in Medicine (URiM) medical students are less likely to plan on a career in certain medical specialties. To identify whether medical students from these groups have baseline differences in their career interests or if the lower likelihood in planning a career in certain medical specialties develops during medical school.

Methods: A secondary data analyses was performed on all medical students who applied to ERAS from 2005-2010. Binary logistic regression models (BLM) were fitted with the outcomes: a planned career in one of four medical specialties (Internal Medicine, Pediatrics, OB/GYN, and General Surgery/Surgical Specialties) at medical school entry and again at graduation. Regression models included demographics, student attitudes, debt, academic metrics, and, medical school experiences.

Results: Women were statistically less likely than man to be interested in a career in Internal Medicine and Surgery and more interested in Pediatrics and OB/GYN at the start of medical school. URiM students expressed more interest in a career in OB/GYN and Surgery when starting medical school. At graduation, women were still less likely to plan on a career in Internal Medicine and Surgery and more interested in OB/GYN and Surgery. URiM students were more likely to plan on a career in Internal Medicine and less likely Pediatrics.

Conclusions: Women have relatively stable preferences regarding planned medical specialties. In contrast, URiM students enter medical school more likely to plan on a career in OB/GYN and

Surgical careers but at graduation were more likely to plan on a career in Internal Medicine and less likely Pediatrics.

The medical education literature has suggested that students begin medical school with clear attitudes and preferences with regard to what specialty they plan to practice in.[54,55] However, these studies have reported conflicting evidence about the stability of these preferences through medical school graduation.[54,55] Lifestyle interests, expected income by medical specialty, procedural orientation, societal prestige outside medicine, and the respect of peer physicians within the profession have been reported as correlated with medical specialty selection.[56,57] While many academic experiences and opinions may be set prior to medical school, one's eventual career choice is a function of a student's entering career interest (Figure 2) and their experiences during their medical training (Figure 3). Understanding how medical specialty aspirations change over time may allow medical educators to better understand and support individuals' career choices.

Background: Previous work using this approach focused on career selection into emergency medicine (EM) as an important test case.[144] EM was selected because of issues of continued underrepresentation in the specialty despite its apparent alignment with the interests of both women and URiM students.[19,20,133] In that study, even when controlling for the factors of academic competitiveness, debt, career attitudes and aspirations, women and URiM students had significantly lower interest in EM.[144] Furthermore, women were less likely to develop a career interest in EM than men.[144] While URiM students were less interested in EM generally, those initially interested in EM were subject to a "cooling out" effect.[144]

Objectives: To test whether the lessons learned in the work in EM could be applied to a larger study of other major medical specialties and specifically compare each specialty's patterns

of recruitment and retention of women and URiM students. The literature has demonstrated two different potential mechanisms of change in career specialty selection: under-recruitment and "cooling out."

Conceptual Framework: Each individual's academic metrics and likely match competitiveness, their level of educational debt, and concepts from two major applicable theoretical frames (Bounded Rationality Theory[61,135,136] and Bandura's Theory of Self Efficacy)[29,30,79] were incorporated into a single model that was initially developed in our previous work. The three most central concepts derived from our incorporation of existing theories were the following: One, Bounded Rationality Theory integrates an individual's cognitive limitations and incomplete information availability on their ability to maximize personal values,[135,136] Two, self-efficacy is one's belief in his/her ability to influence their cognitive response to a situation and thus persist in achieving their goals, despite adversity.[79] Three, self-efficacy is thought to be created through positive academic experiences and mentorship.[79] Of specific applicability, self-efficacy theory has been applied in the study of female learner persistence in traditionally male-dominated fields, such as the sciences and medicine,[29] and differences in lowered career aspirations held by underrepresented students.[30] Unfortunately the use of secondary data limited the number of factors that were available to use as a self-efficacy construct.

Hypotheses: Informed by the conceptual framework and previous work in EM, several hypotheses are offered. First, female and male students are likely to enter medical school with similar interest in fields like internal medicine and surgery and women will have higher odds of an interest in fields with typically more female physicians such as pediatrics and OB/GYN. Second, URiM students will have similar entering interest across the four specialty areas of study

compared to non-URiM peers. Third, women will have evidence of both "cooling out" and under-recruitment relative to men in those medical specialties that are traditionally male dominated. Fourth, URiM medical specialty interest will remain relatively stable from entry of medical school through to medical school graduation.

Methods

Study Design: The study uses secondary data of 46,776 students who applied for residency using Electronic Residency Application Service (ERAS) from 2005 through 2010. Institutional IRB review was solicited, and the study was found not to require additional regulation or assessment.

Data Sources: Multiple nationally representative datasets were combined to create a database of all students with electronic records held by the Association of American Medical Colleges (AAMC) and the National Board of Medical Examiners (NBME). The contributions from each data source are:

Matriculating Student Questionnaire (MSQ): a national questionnaire from the Association of American Medical Colleges (AAMC) administered annually to U.S. matriculating medical students assessing topics including pre-medical experiences, the medical school selection process, choosing medicine as a career, and future career plans and interests.

Graduation Questionnaire (GQ): a national questionnaire administered by the AAMC to U.S. graduating medical students including medical school experiences, specialty selection, and future career plans and interests.

AMC Applicant Matriculant File (AAMF): represents the applicant data from the AAMC's AMCAS centralized medical school application processing service. This database contains academic and demographic factors of applicants to medical school.

Electronic Residency Application Service (ERAS) is a national dataset of applicant data from the AAMC that is collected through their application to the National Residency Match Program (NRMP). ERAS is also how program directors receive information about applicants.

U.S. Medical Licensing Exam (USMLE) An additional research data use request was approved by the National Board of Medical Examiners (NBME) to allow the inclusion of USMLE scores. USMLE Step 1 and Step 2 CK were included in the data.

Measurements: Explanatory variables were selected based on the conceptual framework and the preexisting literature (Table 7). The URiM variable represents a binary recoding of a self-reported racial/ethnic identity to either non-URiM (white or Asian students) or URiM student. Entering career specialty interest was derived from the response to the AAMC Matriculating Questionnaire specific item: "What general specialty are you considering?" Graduating **c**areer specialty interest was derived from the response to the AAMC GQ specific item: "When thinking about your career, what is your intended area of practice?" In both cases, responses were then recoded as either "interested in the specialty of study" (for example, "Internal Medicine") or all other specialty choices collapsed into a single response, "not interested" (in the same example, "Not Internal Medicine").

Analytic Approach: Eight primary binary dependent variables were examined. Four dependent variables were measures of a plan to enter a specific career at the beginning of medical school

(Internal Medicine, Pediatrics, OB/GYN, and Surgery) or not. The other four dependent variables were measure of a plan to enter a specific career (same four specialties) at the time of graduation or not. All dependent variables were regressed on several factors thought to correlate

Table 7: Variables

VARIABLE SUBGROUP NAMES	VARIABLES WITHIN EACH SUBGROUP	SOURCE
DEMOGRAPHICS	Gender Age URiM Status	*Electronic Residency Application Service (ERAS)*
ENTERING ATTITUDES	Opportunity for Authority Opportunity for Patient Contact Opportunity for Control Opportunity for Decision-Making Opportunity for Expertise in Specialized Area Opportunity to Make a Difference Opportunity for Research Chose Medicine to Limit Stress	*Matriculating Student Questionnaire (MSQ)*
GRADUATION ATTITUDES	Work-Life Balance Specialty Competitiveness Specialty Personality Specialty Content Expected Salary Advice from Mentor Family Expectations Debt Level	*Graduation Questionnaire (GQ)*
DEBT LEVEL	Had Pre-Medical Debt Received Scholarship Medical School Debt in $10,000 Non-Educational Debt in $10,000	*Graduation Questionnaire (GQ)*
ENTERING GPA	Overall GPA Science GPA	*AAMC Applicant Matriculant File (AAMF)*
STANDARDIZED TESTS	MCAT Total Step 1 Score Step 2 CK Score	*AAMC Applicant Matriculant File (AAMF)* *U.S. Medical Licensing Exam (USMLE)*
MEDICAL SCHOOL ACTIVITY	Number of Publications Research Experience Awarded AOA prior to application Confidence in Specialty Choice Planned Practice with Underserved Populations	*Electronic Residency Application Service (ERAS)*
DEPENDENT VARIABLES	Entering Career Interest in IM Planned Career in IM Entering Career Interest in Peds Planned Career in Peds Entering Career Interest in OB/GYN Planned Career in OB/GYN Entering Career Interest in Surgery Planned Career in Surgery	*Matriculating Student Questionnaire (MSQ)* *Graduation Questionnaire (GQ)*

with the outcome. Twelve additional secondary logistic models were fitted in four sets of three. These models' dependent variables were 1) a plan to enter a specific career at the time of graduation (or not) with the addition of entering interests as a control, 2) examining only students who had an entering plan to practice in the same field, and 3) examining only students who did not have an entering plan to practice in the same field. Given the dichotomous nature of the outcome variables, binary logistic regression was used to fit these models.[137]

Results

Results of the four regression models that assessed career interest at the time of school entry (Tables 8), the four models that assessed career interest at the time of graduation (Table 9), and the secondary models were statistically significant. Thus, the models including the regressors fit the data better than a simple model with only an intercept. Variables in each model included academic ability, previously identified career interest factors, medical education debt and residency application competitiveness.

In terms of results, female students were less likely than male students to plan to practice in internal medicine (OR 0.94 95% CI 0.88-0.996) or choose a surgical career (OR 0.44 95% CI 0.42-0.46) at medical school matriculation (Table 8). Conversely, women were more likely than men to plan for a career in pediatrics (OR 2.15 95% CI 2.03-2.28) and OB/GYN (OR 13.96.44 95% CI 11.72-16.64). The same gendered patterns remained at the time of graduation: women were less likely to plan to enter internal medicine (OR 0.75 95% CI 0.68-0.82) or a surgical field (OR 0.74 95% CI 0.68-0.80) and more likely than men to report a planned career in pediatrics (OR 2.86 95% CI 2.54-3.22) and OB/GYN (OR 7.25 95% CI 6.05-8.70) (Table 9). Comparisons

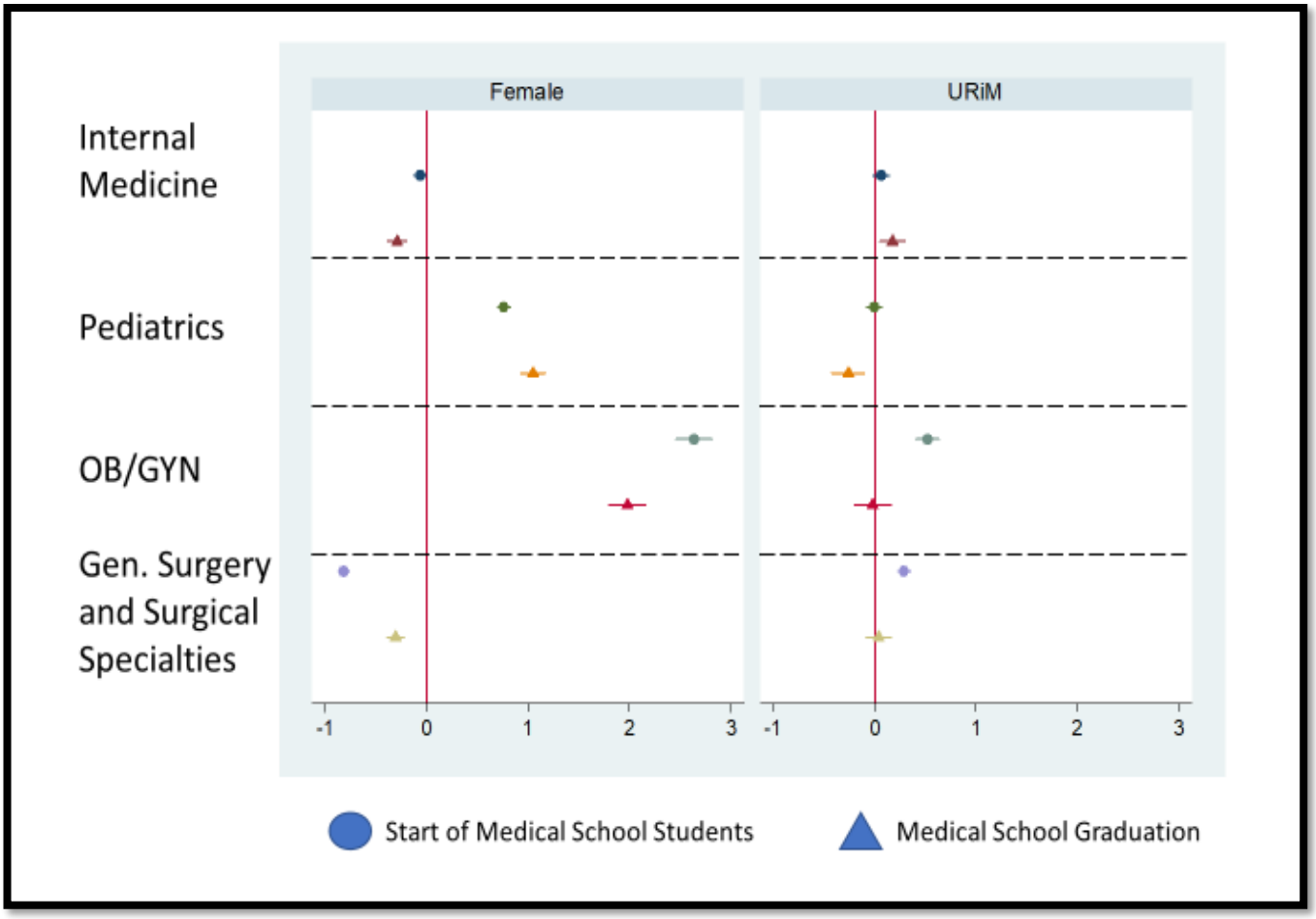
across medical specialties are displayed in Figure 10 and demonstrate relative consistency across time in career interests for women during the period of medical school education.

Table 8: Career Interest When Entering Medical School

	Internal Medicine		Pediatrics		OB/GYN		Gen. Surgery and Surgical Specialties	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Female	0.94* (0.029)	0.883 - 0.996	2.15*** (0.063)	2.029 - 2.275	13.96*** (1.251)	11.72 - 16.64	0.44*** (0.011)	0.420 - 0.463
Age	1.06*** (0.004)	1.049 - 1.065	0.92*** (0.005)	0.914 - 0.935	0.99 (0.008)	0.977 - 1.007	0.97*** (0.004)	0.962 - 0.978
URiM	1.07 (0.043)	0.989 - 1.157	1.00 (0.039)	0.927 - 1.078	1.68*** (0.097)	1.505 - 1.886	1.34*** (0.045)	1.254 - 1.429
GPA	1.00 (0.001)	0.999 - 1.001	1.00*** (0.001)	0.997 - 0.999	1.00*** (0.001)	0.995 - 0.998	1.00*** (0.000)	0.996 - 0.998
MCAT	1.03*** (0.004)	1.022 - 1.037	0.98*** (0.003)	0.977 - 0.991	0.98*** (0.006)	0.966 - 0.989	0.99* (0.003)	0.987 - 0.998
Worked with Underserved	1.11*** (0.024)	1.059 - 1.155	1.02 (0.022)	0.976 - 1.062	1.08* (0.041)	1.006 - 1.166	0.58*** (0.011)	0.563 - 0.606
Opportunity for Authority	1.07*** (0.014)	1.045 - 1.100	0.94*** (0.011)	0.917 - 0.961	1.07** (0.023)	1.028 - 1.119	1.04*** (0.011)	1.015 - 1.057
Opportunity for Patient Contact	1.19*** (0.021)	1.147 - 1.230	1.66*** (0.035)	1.596 - 1.732	1.31*** (0.044)	1.222 - 1.393	0.90*** (0.012)	0.877 - 0.922
Opportunity for Control	0.95*** (0.016)	0.916 - 0.977	0.97 (0.015)	0.942 - 1.001	0.92** (0.026)	0.876 - 0.977	1.04** (0.014)	1.013 - 1.067
Opportunity for Decision-Making	0.84*** (0.011)	0.816 - 0.858	0.90*** (0.010)	0.884 - 0.925	1.00 (0.020)	0.963 - 1.042	1.07*** (0.012)	1.047 - 1.093
Opportunity for Expertise in Specialized Area	0.97* (0.015)	0.937 - 0.995	0.92*** (0.013)	0.899 - 0.949	1.14*** (0.028)	1.089 - 1.199	1.37*** (0.019)	1.334 - 1.408
Opportunity to Make a Difference	0.94 (0.032)	0.882 - 1.009	1.25*** (0.059)	1.138 - 1.370	1.04 (0.083)	0.893 - 1.221	0.95* (0.025)	0.898 - 0.995
Opportunity for Research	1.27*** (0.015)	1.239 - 1.299	0.94*** (0.011)	0.921 - 0.963	0.86*** (0.016)	0.824 - 0.888	1.05*** (0.010)	1.035 - 1.075
Chose Medicine to Limit Stress	0.96* (0.016)	0.932 - 0.995	1.02 (0.016)	0.994 - 1.055	0.97 (0.026)	0.926 - 1.027	0.90*** (0.012)	0.880 - 0.925
Constant	0.01*** (0.003)	0.00643 - 0.0209	0.35** (0.124)	0.174 - 0.699	0.01*** (0.006)	0.00388 - 0.0337	1.72* (0.453)	1.026 - 2.884
Observations	41,047	41,047	64,214	64,214	64,214	64,214	64,214	64,214

Robust seeform in parentheses
*** p<0.001, ** p<0.01, * p<0.05

Figure 10: Career Interest at Onset and Graduation



Regarding URiM students, a different pattern of career interest emerged from the data. URiM students were more likely to plan for a career in OB/GYN (OR 1.68 95% CI 1.51-1.89) or a surgical field (OR 1.34 95% CI 1.25-1.43) than their non-URiM peers at medical school matriculation (Table 8). URiM students had no significant difference from non-URiM students in their reported interest in internal medicine or pediatrics at matriculation. At the time of medical school graduation, however, a different pattern emerged: URiM students were less likely to plan to enter pediatrics (OR 0.77 95% CI 0.66-0.82) and more likely to report a planned career in internal medicine (OR 1.19 95% CI 1.05-1.35) compared to non-URiM graduating

students (Table 9). No difference in the odds of a planned career in OB/GYN or a surgical field was found between URiM students and non-URiM students at the time of graduation. Comparison across medical specialties is presented in Figure 10. Together this represents a change in the patterns of career interest for URiM students from the beginning of medical school compared to graduation. At the beginning of medical school, URiM students had higher odds of a planned career in OB/GYN and surgery, but by graduation they had the same odds as non-URiM students to plan to enter those specialties. Conversely, URiM students and non-URiM students had similar odds to plan to enter internal medicine or pediatrics when beginning medical school, but URiM students were more likely to report a planned career in internal medicine and less likely to report a planned career in pediatrics when compared to their non-URiM peers.

The odds ratios for the secondary logistics regression models estimated are presented in Figure 11. Women had significantly lower odds of planning for a career in internal medicine or a surgical career even after controlling for their lower odds planning for such careers at the start of medical school (Figure 11). Compared to men, women were more likely to plan for a career in pediatrics at the time of graduation, even after controlling for the higher odds of initially planning to practice pediatrics. Female students who did report a plan to enter pediatrics at the start of medical school had higher odds than their matched male peers to express a plan to enter pediatrics at graduation (Figure 11). The same was true for women who did not express an initial interest in pediatrics when compared with similar men. Female students reported higher odds of a planned career in OB/GYN at graduation, even when initial career interest was controlled for in the model. However, women and men had no significant difference in being

Table 9: Career Interest When Graduating Medical School

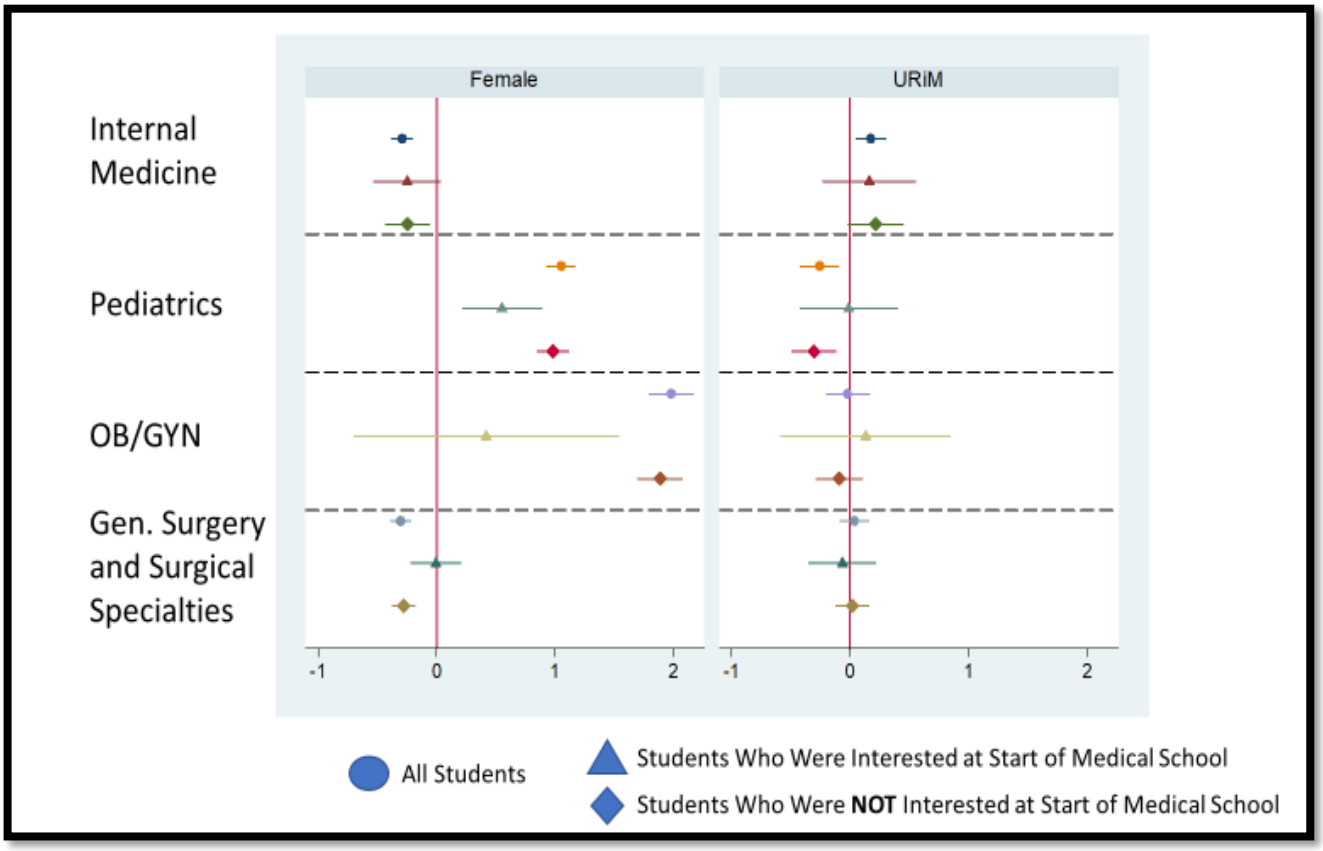
	Internal Medicine		Pediatrics		OB/GYN		Gen. Surgery and Surgical Specialties	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Female	0.75*** (0.035)	0.683 - 0.819	2.86*** (0.173)	2.542 - 3.221	7.25*** (0.672)	6.045 - 8.695	0.74*** (0.032)	0.679 - 0.803
Age	0.98** (0.009)	0.960 - 0.994	0.92*** (0.011)	0.899 - 0.942	0.98 (0.013)	0.953 - 1.005	0.99 (0.008)	0.978 - 1.009
URiM	1.19** (0.076)	1.053 - 1.350	0.77** (0.064)	0.658 - 0.908	0.98 (0.090)	0.819 - 1.175	1.04 (0.064)	0.923 - 1.173
GPA	1.00 (0.001)	0.998 - 1.002	1.00** (0.001)	1.001 - 1.005	1.00 (0.001)	0.996 - 1.001	1.00 (0.001)	0.997 - 1.001
MCAT	1.01 (0.006)	0.996 - 1.021	1.03*** (0.008)	1.016 - 1.048	0.98** (0.009)	0.958 - 0.994	1.00 (0.006)	0.986 - 1.009
USMLE Step 1	0.99*** (0.002)	0.989 - 0.995	0.98*** (0.002)	0.975 - 0.983	0.99*** (0.003)	0.982 - 0.993	1.02*** (0.002)	1.018 - 1.025
USMLE Step 2	1.01*** (0.002)	1.008 - 1.014	1.00 (0.002)	1.000 - 1.007	1.00 (0.002)	1.000 - 1.009	0.99*** (0.001)	0.984 - 0.989
Work with Underserved	0.97 (0.030)	0.912 - 1.031	1.15*** (0.044)	1.071 - 1.244	1.17*** (0.055)	1.066 - 1.280	0.88*** (0.025)	0.829 - 0.926
Work/Life Balance	0.84*** (0.018)	0.804 - 0.876	1.11*** (0.030)	1.057 - 1.175	0.45*** (0.014)	0.420 - 0.474	0.92*** (0.020)	0.884 - 0.962
Specialty Personality	0.79*** (0.032)	0.730 - 0.854	1.07 (0.063)	0.956 - 1.204	1.14* (0.067)	1.018 - 1.283	1.11* (0.050)	1.022 - 1.217
Specialty Competitiveness	0.92*** (0.023)	0.879 - 0.968	0.59*** (0.021)	0.556 - 0.637	1.14*** (0.041)	1.059 - 1.219	1.18*** (0.025)	1.127 - 1.227
Mentor Advice	1.33*** (0.031)	1.274 - 1.394	1.09** (0.029)	1.031 - 1.144	1.01 (0.031)	0.953 - 1.076	1.00 (0.020)	0.964 - 1.044
Medical School Debt	0.99*** (0.003)	0.983 - 0.993	0.99 (0.003)	0.988 - 1.001	1.01** (0.004)	1.005 - 1.021	1.00 (0.003)	0.992 - 1.002
Publications	0.99 (0.005)	0.985 - 1.004	1.00 (0.008)	0.981 - 1.014	0.98* (0.009)	0.960 - 0.997	1.01*** (0.004)	1.007 - 1.023
Research Experiences	1.01 (0.013)	0.982 - 1.034	0.92*** (0.017)	0.883 - 0.949	0.94* (0.021)	0.903 - 0.987	1.13*** (0.013)	1.106 - 1.158
Elected to AOA	0.99 (0.064)	0.869 - 1.120	1.04 (0.088)	0.885 - 1.231	1.17 (0.119)	0.962 - 1.431	1.18** (0.066)	1.054 - 1.313
Confidence in Specialty Choice	0.59*** (0.019)	0.554 - 0.628	0.88** (0.041)	0.802 - 0.961	1.13* (0.065)	1.008 - 1.264	1.35*** (0.052)	1.249 - 1.453
Constant	1.22 (0.701)	0.394 - 3.766	5.52* (3.973)	1.347 - 22.62	0.95 (0.815)	0.175 - 5.114	0.03*** (0.014)	0.00936 - 0.0722
Observations	16,679	16,679	17,475	17,475	17,475	17,475	17,475	17,475

Robust seeform in parentheses

*** p<0.001, ** p<0.01, * p<0.05

interested in OB/GYN at the time of graduation when reporting this interest at the start of medical school.

Figure 11: Graduating Interest Comparison



After controlling for entering career interest, the odds of reporting a graduating career plan for each specialty for URiM students are presented in Figure 11. URiM students had significantly higher odds of reporting a planned career in internal medicine at the time of graduation, even after controlling for their entering interest in that field (Figure 11). Conversely, URiM students had significantly lower odds of a final career plan in pediatrics when completing medical school even when their initial specialty selection was considered. No significant

difference between URiM students and non-URiM students was demonstrated in the other medical specialties when entering career plans were included in the model (Figure 11).

Several other academic variables, such as grades and tests, and career attitudinal factors were also statistically significantly related to the outcome variables. Their inclusion in the analysis was based on their theoretical importance in decision-making for individuals and a desire to control for the effect of these factors on decision making so that any gender and URiM differences found would be independent of performance measures and attitudes. The relative importance of each of these factors on either entering medical specialty plans or graduating career plans is outside the focus of this chapter. For those interested in reviewing the measured odds ratios of these factors in the model they can be found in Tables 8 and 9, respectively.

Discussion

The results demonstrate distinctive patterns in medical specialty career plans for both women and URiM students. Additionally, they show that there are clear differences between medical specialties in their retention and recruitment of students from those two groups. With regard to the study hypotheses, the patterns were more complex than those initially hypothesized.

Focusing on the first hypothesis, the results indicate that the specialties with a traditionally higher proportion of female physicians also had higher odds of women planning for a career in that field (pediatrics and OB/GYN). It was not explicitly hypothesized that women would have lower odds of expressing a planned career in internal medicine or a surgical career path, however, this is not entirely unexpected as there is a fixed number of graduating medical students. As such, if there are specialties where women are more likely to gravitate to, they are likely to be specialties with lower odds of interest by female students.

Regarding the second hypothesis, only two of the four medical specialty groups had statistically similar odds of planning to enter a specific specialty for both URiM and non-URiM students. Specifically, URiM students had higher odds of reporting a plan to practice in OB/GYN or in a surgical career. This result does not support the hypothesis that URiM students and non-URiM students would be similar in their interests across all four specialties. This appears to be a new finding in the medical literature. In a review of the literature, the studies related to entering medical school career plans were often smaller in scope,[156,157] more dated,[157-161] and did not include measures of academic competitiveness.[161-163] More to the point, they also did not specifically report correlations or information about race.[160,162,164,165] The results presented herein therefore prove to be a valuable addition to the literature. In the work focused on EM, differences in entering interest in the specialty were demonstrated when comparing URiM and non-URiM students. Therefore, the attitudes of pre-medical school prospects and the impressions they have about specific medical specialties may be a heretofore underappreciated cause of persistent underrepresentation in some specialties.

Examining the results on "cooling out" and under-recruitment of women to specific specialties, the latter appeared to be truer than the former. Women had lower odds of reporting an interest in internal medicine at the onset and completion of medical school, with a larger relative effect size demonstrated at graduation (OR 0.94 versus OR 0.75). While women expressed lower odds of a planned career in surgery, the relative effect size of gender was larger at the onset of medical school compared to at graduation (OR 0.44 versus 0.74). When controlling for entering interest, women were statistically significantly less likely than men to have an interest in internal medicine at graduation, including a lower odds of developing an interest when not interested at medical school entry (Figure 11). Women and men who were

interested in internal medicine at the start of medical school, had no significant difference in their interest in that specialty at graduation. These results suggest that under-recruitment is the more likely mechanism for lowered odds of female students expressing an interest in internal medicine. A similar pattern was also demonstrated within the surgical career category, with women having similar rates of maintaining a planned career in surgery as men if they entered medical school with this career path in mind, but lower odds of recruitment if not interested.

Considering the final hypothesis, the results did not support the hypothesis that URiM student specialty plans were relatively stable during medical school. Figure 10 shows where differences in specialty plans between URiM and non-URiM students appear to change between the beginning of medical school and at graduation. However, when entering career plans were considered, the differences between URiM and non-URiM students' specialty plan are no longer demonstrated in OB/GYN and surgery (Figure 11). Where changes in planned careers do exist, URiM students have higher odds of choosing internal medicine and lower odds of choosing pediatrics than their peers. In the case of the later, it appears to be a case of under recruitment and not "cooling out" of interest by URiM students who expressed plans of a career in pediatrics at the start of medical school (Figure 11). In more general terms, the URiM specialty care interest changes over the course of medical school, resulting in higher odds of these students choosing internal medicine and lower odds of choosing pediatrics. The medical school experiences that underlie what appears to be an under recruitment of URiM students to pediatrics is an important question that remains unanswered.

Taken as a whole, the results of this study have policy implications for each of the medical specialties examined as well as providing potential research directions for medical education in general. For internal medicine, the data indicates that women are being recruited to

their specialty at a lower rate than men. The difference between women and men in the rate of cooling out was not statistically significant but did tend to lower retention of women than men. These findings could suggest (to internal medicine educators) that the experiences of female students during medical school may result in lower odds of them planning on entering their specialty. The opposite appears true for URiM students regarding internal medicine. In that case, URiM students appear more likely to have plans to enter internal medicine at graduation than when they begin medical school.

The findings in pediatrics are generally opposite those in internal medicine. Women had higher odds of a planned career in pediatrics at the beginning of medical school and at its completion. Pediatrics seems unlikely to have issues of female representation in terms of the number of future residents, but if this is true it may result in fewer *male* pediatricians. Importantly, pediatrics may have issues recruiting URiM students to the field. When medical school begins, URiM students are as likely as non-URiM students to plan on a career in pediatrics. However, by the completion of school, URiM students had lower odds of reporting a plan to enter pediatrics, even after controlling for their initial career plans (Figure 11). The decrease in the odds of URiM students entering pediatrics appears to be a result of a lower rate of recruitment from students who did not begin medical school interested practicing in the field.

OB/GYN has similar findings regarding the gender distribution of interested medical students as pediatrics, with one exception. As in pediatrics, women had higher odds than men to be interested in OB/GYN both at the beginning of medical school and at its completion. However, unlike in pediatrics, women and men interested in OB/GYN at the beginning of medical school still had similar interest at graduation. Regarding URiM plans in OB/GYN, URiM students had higher odds of reporting a planned career in OB/GYN than their non-URiM

peers at medical school matriculation. However, by the time of medical school graduation there was no difference between the two groups.

Finally, findings regarding surgical career interests were similar to internal medicine with regard to gender and OB/GYN for URiM students. Women were less likely to express a plan to enter surgery at the start and conclusion of medical school. Lower odds of expressing a plan for a surgical career at graduation were still present for women when their entering interest was considered. The difference between men and women, in this case, arising from lower recruitment of women (Figure 11). At medical school matriculation, URiM students had higher odds of reporting a planned career in surgery than their non-URiM peers. However, by the time of medical school graduation there was no difference between the two groups.

Conclusions

Women and URiM students have differences in their planned specialty of practice that can be identified at the start of medical school for some fields. Worsening underrepresentation in some medical specialties is more likely the result of under-recruitment than "cooling out" of interest.

Chapter Seven: Conclusions

Performance of Existing Theoretical Models within this Dissertation

Prior to the completion of the analysis, several hypotheses were formulated based on the available literature and my composite theoretical framework. The conceptual framework for this dissertation was created in part to move the theoretical underpinning of medical education research forward. In many ways, medical education is a rapidly maturing area of specialized expertise with an expansion of both formal training programs[166-168] and professional recognition.[169-172] As part of this maturation, the application and development of unique medical education theoretical frameworks remains in its infancy despite numerous calls for work dedicated to this endeavor.[173-175] Two possible reasons for the lower importance placed on theory in medical education research are that the articles are subject to much shorter length restrictions[176] than the typical higher education journals[177] and the strong preference for "empirical" work,[178-180] especially articles using quantitative methods.[181-183] As such, a dissertation such as this one, provides a largely unique opportunity for a more expansive development of theory for medical education research use.

Despite anchoring each hypothesis using theory and the prior literature, many of the results were not consistent with those expectations. Perhaps this should not be surprising as most of the theory that informed the research beyond previously published empirical results came from fields that do not have some of the same structural and culturally unique issues specific to

medical education. Reviewing each hypothesis in turn is helpful for examining why this may have occurred and how it may reshape the application of previous education theory to the medical education context, and ultimately lead to the creation of medical education specific models of career selection.

The first of the three studies hypothesized that the importance of a balanced work-life and desire for a higher future income, which had been shown through survey research to be principal factors influencing medical student career choice, would be correlated with increased odds of reporting a planned career in emergency medicine. Additional factors including academic ability, gender, and underrepresented minority status (URiM) would also prove to be significantly correlated with planned specialization in emergency medicine at graduation. Most importantly, I hypothesized that controlling for academic qualifications, female and URIM applicants would each have lower probabilities of applying to emergency medicine.

For the most part, the results from Study One supported the research hypotheses. In the study, the previous factors associated with a plan to enter EM, such as work-life balance and income choices, were included in the analysis. Women and URiM students were shown to have lower odds of a planned career in EM even when controlling for other factors. However, academic ability was inconsistently associated with the odds of a career in EM, in that some variables were positively associated, and some were negatively associated. These academic variables were both controls for competitiveness but also thought to potentially correlate with experiences that would result in increased self-efficacy. Unfortunately, the nature of the available factors, such as grades and test scores, only provides a portion of the information necessary to describe self-efficacy. Grades and test scores can provide positive academic opportunities, however there is no information available regarding each learner's response and

internalization of these results. Without this key second piece of data, estimating self-efficacy with only positive academic experiences without learner reaction is limited.

For Study Two, I hypothesized that a "cooling out" of women and URiM students' interest in emergency medicine would be observed even when other academic metrics of competitiveness are considered. This was not supported completely. Women and men had the same odds of "cooling out" from EM. The odds of women planning on entering EM at graduation were, however, lower than men. In contrast to the hypothesized relationship, women had lower odds of being recruited to EM not increased "cooling out."

URiM students did have results that supported the hypothesis of "cooling out." In the study, URiM students had higher odds of "cooling out" than their non-URiM peers. URiM students also had significantly lower odds of being recruited to EM in addition to the "cooling out" that was hypothesized. This was similar to what was seen with women. Taken together, it would seem that while there may be experiences that lower the likelihood of URiM students to persist in plans to enter EM, the more general mechanism for both women and URiM students is likely a lack of "turning on" to the field and not "cooling out."

The results of Study Three also support the conclusion that a lack of "turning on" in recruitment may be the more general mechanism. This finding does not support the hypotheses regarding "cooling out" as the more common mechanism of underrepresentation. Of the four specialty options considered, only pediatrics demonstrated findings that would be consistent with "cooling out" and only in the case of women. In contrast, under recruitment was a potential mechanism in internal medicine, pediatrics, and surgery. Taken in total, it must give question to the belief that the process of medical specialty career selection is best represented in a student persistence model. As women and URiM students both maintained a similar stability in their

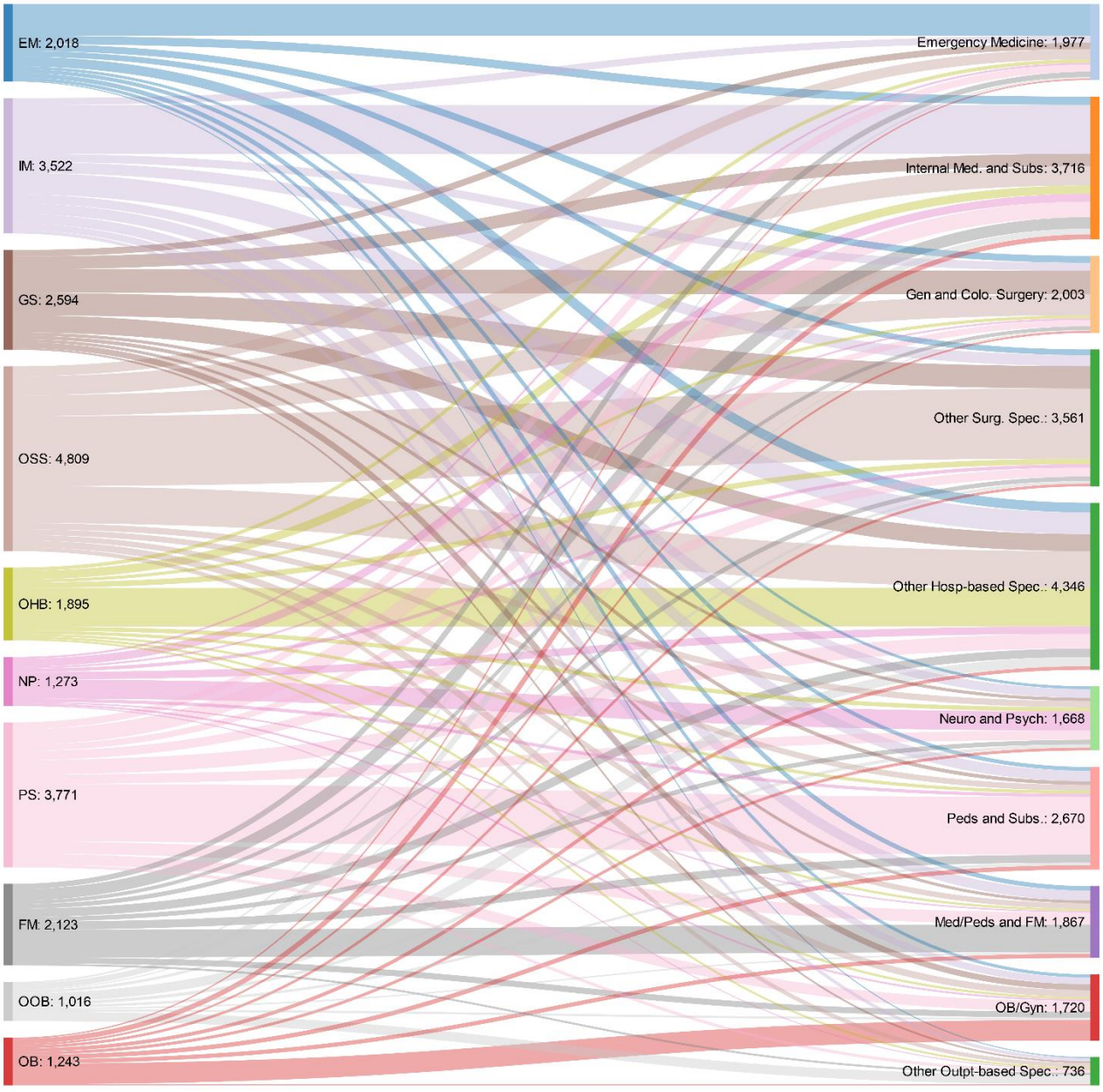
career plans as their peers, a different theoretical paradigm may prove more applicable. As a result of my experiences with these studies and my familiarity with higher educational theory I propose the following new specific model for medical specialty career selection.

Informing a New Theoretical Model Specific to Medical Education

The process by which medical students choose their medical specialty is highly complex and has several largely unique features that are not captured in the existing non-domain specific theoretical literature. This dissertation specifically attempted to make the complexity of that career selection process more understandable with several mechanistic simplifications, including the timeframe and outcome variables used. However, that same complexity still exists and should inform future research now that the groundwork from the studies conducted as part of this research plan are completed. As an example of the substantial level of complexity occurring as medical students consider and change their planned specialization, the visualization of student specialty movement within the dissertation dataset between ten large groupings of specialty choices is provided in Figure 12. Despite the chaotic appearance demonstrated from students moving between these groups it is important to remember that it is still an oversimplification of the true amount of flux between medical specialties as each specialty grouping actually represents several individual career paths. One could become disheartened by such an illustration as it does not immediately provide an obvious pattern of behavior to build a conceptual understanding of the whole. However, after the completion of this dissertation, review of the results, and remapping of concepts to the original conceptual framework it

becomes obvious that several additional ideas can be included to better fit the observed process for medical education and begin to provide more order to the perceived chaos.

Figure 12: Change in Medical Student Planned Career Specialization



I propose the adoption of a lack of "turning on" of some students to a specific medical specialty as a description of the mechanism demonstrated by my findings. The idea of

recruiting, attracting, or "turning on" a student to a specific specialty path does include many of the same concepts as those employed when discussing persistence in higher education. First, both would seem to include an application of the ideas of self-efficacy and the importance of positive educational experiences. In the case of "turning on" the importance of career self-efficacy and learner self-efficacy are important. Positive academic experiences can increase learner self-efficacy which could make matching in a competitive field appear more obtainable to the student. However this would not specifically steer a student toward EM.

Given the results of the previous studies, some event or events must occur that results in a student considering a specialty path outside of their initial career plans. This may include a positive experience with an EM physician or positive reinforcement in an EM elective. Positive reinforcement by EM faculty should increase career self-efficacy and support a sense of career fit for the individual. If this is the case, the next question must be why men and non-URiM students are seemingly having these events happen more often than their peers. Bias in grading or in verbal feedback may represent one possible mechanism. Further study should be undertaken to definitively identify the nature of "turning on" events for EM, however some possibilities are already clear.

Building from the idea of "turning on" is the consideration of a necessary but not solely sufficient level of perceived openness for all students to consider every specific medical specialty. While the existing theoretical literature can help inform the search for positive experiences that recruit students to EM, a broader approach might be necessary. A lack of cultural competency, and therefore a welcoming environment for all students, have been posited as a mechanism for "cooling out" of interest.[184] An alternative interpretation would be to see cultural competence as a necessary but not sufficient prerequisite to allow positive experiences to

occur prior to specialty selection. Students from underrepresented backgrounds cannot have the necessary positive experience to consider fields such as EM if they never feel welcome enough to even enter the larger culture of the field. An application of social replication theory may help develop this new line of theoretical explanation.

Social replication has often been cited as a means of introducing bias in hiring and recruitment practices.[106,185,186] When making connections, it is not uncommon to look for common activities, experiences, and interests to bridge the initial awkward phase of getting to know a new person.[106] As the majority of current academic EM physicians are white men, the initial social connections along common experiences may be easiest for white, male medical students. It would seem likely then, that social comfort is of equal importance to "turning on" in modulating the effectiveness of outreach factors. Therefore, under recruitment might be described as issues of "out group" social discomfort and its impact on academic success.[187]

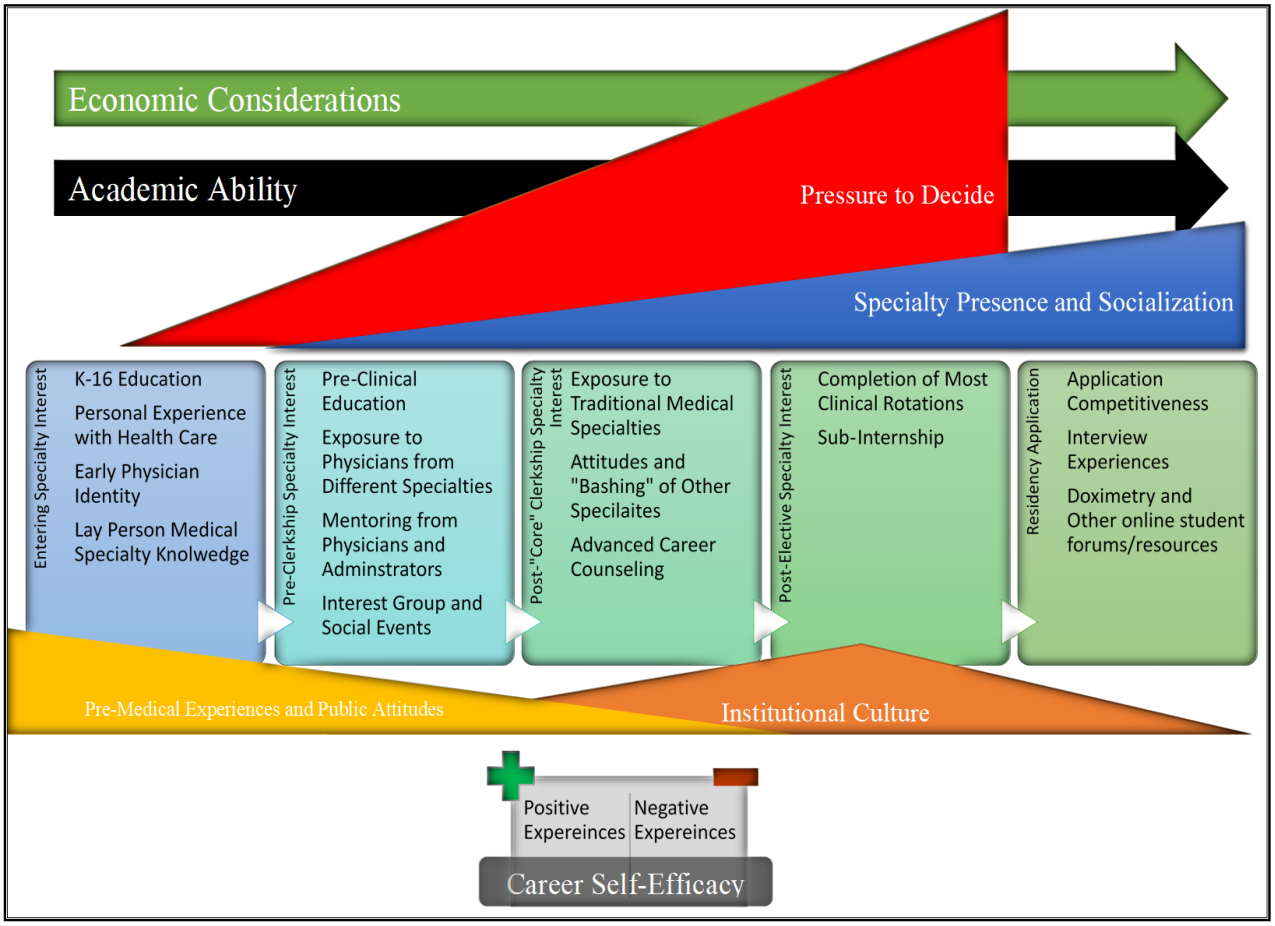
Historically, much of the work on learner acculturalization has focused on minority students at white-majority educational institutions.[188,189] Less work seems to have been devoted to the positive steps faculty from the "in group" can make to minimize this specific social discomfort for minority students. Inclusion of social connection factors considered in student departure models, such as Tinto's,[147] could be used to measure these concepts in the aggregate. Alternatively, qualitative work aimed at detailing social comfort between "in-group" and "out group" could be used to understand the social barriers to successful recruitment. Of course, a mixed-methods study might incorporate both methods. In any case it seems that issues of underrepresentation in specific medical specialties would be better phrased as a lack of building up of interest instead of a preventing dropping out.

The idea of building up a series of positive experiences necessary to consider fields such as EM, leads to a third important structural consideration for medical career specialization decisions that is absent from theories from other domain: the common sequencing found in medical school curriculum. Historically, medical school curriculum have used a "two pre-clinical by two clinical years" made popular in the sentinel Flexner Report from over 100 years ago which called for the adoption of this model and overall standardization of medical education.[190,191] While incorporation of a standardized curricular rigor has paid incredible dividends in more rigorous medical education,[191] it has also created several curricular norms that have structural effects, both in pedagogy and care delivered.[190,191] An underappreciated effect of the "Flexner model" is that it provides medical students earlier exposure and longer time for recruitment to certain medical specialties both in the pre-clinical years and as "core clerkships."[192] Even as medical school curricula have adopted organ-system based,[193] problem-based,[194,195] and competency-based curricula,[196] many of these inherent disparities for some medical specialties persist. For example, EM clerkships generally occur later (year four versus year three) than other "core" or "required" clerkships.[140] In some cases, EM still remains "elective"[140] despite its relative importance in the delivery of care in the United States being now on par or greater than many "core clerkship" specialties.[3,197] The designation as "core" in the development of physicians and the earlier opportunity to develop mentorship relationships represent clear and systemic advantages for some medical.

Taking additional considerations noted above and the results from the three studies in this dissertation, I propose two new models (Figures 13 and 14) that revise and expand on those initially proposed in the introductory chapter. The first of these new frameworks, the longitudinal framework in figure 13, has several benefits over its predecessor. First, it increases

the granularity of the stages of specialty selection for medical students by expanding the distinct stages of the curricular process as well as specifying where distinct factors are most likely to apply (Five squares across the middle of figure 13 represent this portion of the model). Second, it illustrates the relative temporal importance of several factors that have importance depending on the specific specialty selection phase (Triangle shapes indicating increased importance with greater height). These factors include the importance of an individual specialties' presence in the

Figure 13: Longitudinal Conceptual Framework



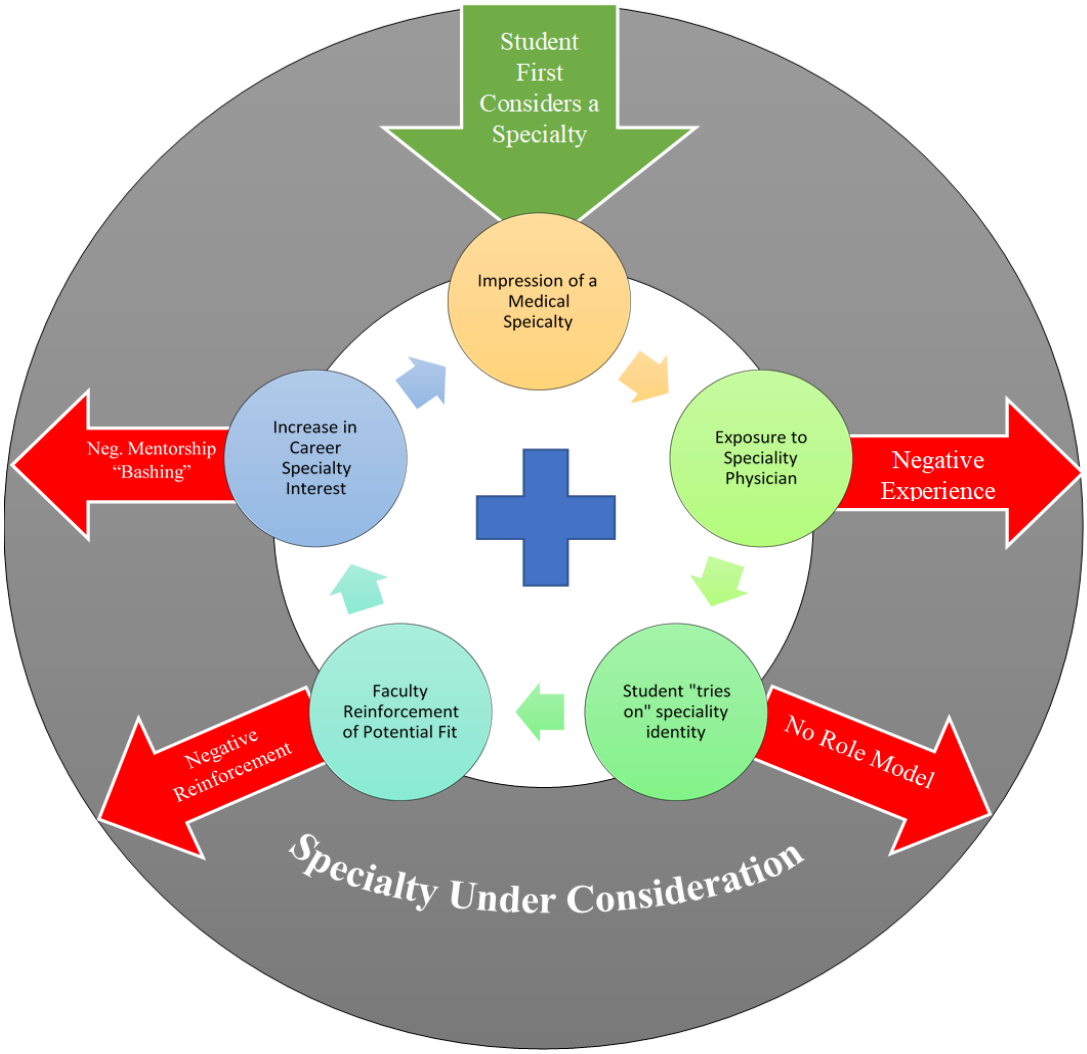
curriculum and socialization with junior medical students (blue wedge), institutional culture and specialty hierarchy at each specific medical school (orange wedge), and the rising pressure on students to commit to a specific specialty (red wedge) in order to maximize their competitiveness (research in that specialty, mentorship with recognizable faculty, away rotations, etc.). Third this

new version maintains the factors “academic ability” and “economic considerations” from the previous framework but make an important distinction between them (the arrows) and the other longitudinal factors. As academic ability and economic considerations are more like to have relatively stable effects on career choice, or if there are changes, be subject to individual, personal variation not predicable in the same general, temporal fashion as the other longitudinal factors (wedge factors). The final reconceptualization is refining the ideas of self-efficacy to the specific category of “career self-efficacy” as something that increases or decreases depending on positive experiences with each specific medical specialty. This idea is more clearly demonstrated in the new cyclic model of specialty consideration represented in figure 14.

A second potentially underappreciated aspect of medical specialty selection is that the student’s decision is not final until they submit their residency match list. As a result of the extended period available for students to make, and change, their decisions a cyclic process is likely exists. As displayed in figure 14, based on the literature and my experience, students move through a cycle of interactions in exploring a specific medical specialty as a potential career choice. Positive interactions move learners forward (clockwise) along the cycle whereas negative interactions may cause students to look at other medically specialty options. Of course, in most cases a single positive or negative episode will not convince a student to commit to a specialty or totally abandon it as a possibility. Instead, I posit that with each rotation with positive feedback, the learner moves centripetally, eventually arriving at the center with a strong commitment to a specialty and higher confidence in their choice. Alternatively, with repeatedly negative experiences, the learner may find themselves moving farther away from choosing that

specialty. Eventually, given enough negative pushes to the outside, the learner leaves that specialty option behind like a satellite leaving orbit.

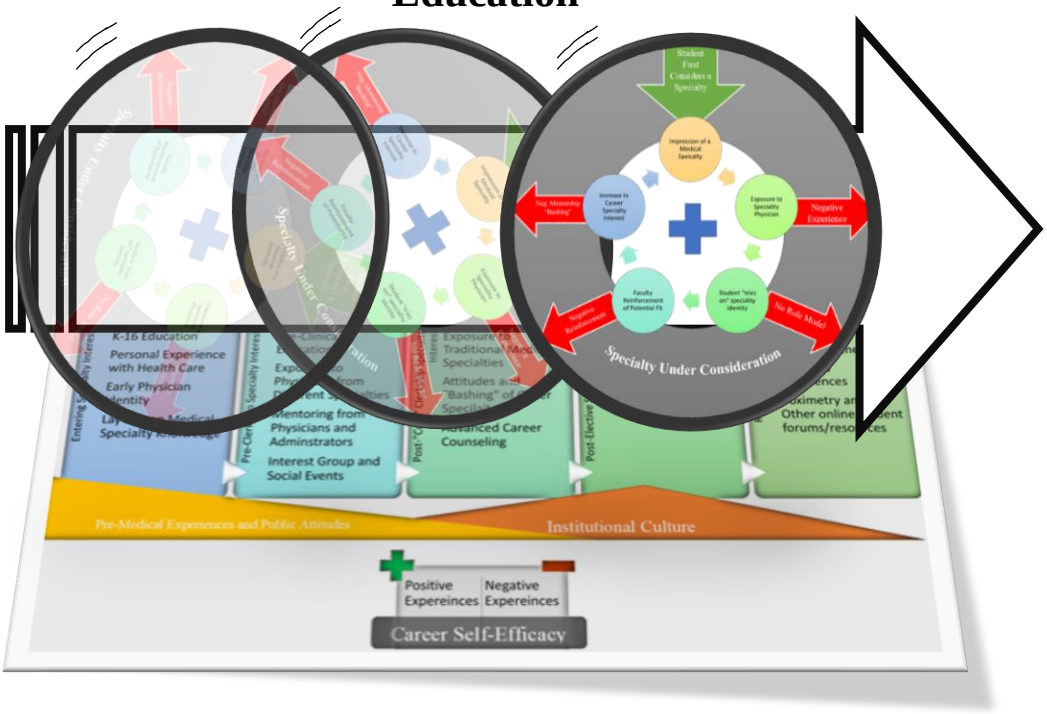
Figure 14: Specialty Selection Cycle



While the models in figures 14 and 15 can be seen as independent of one another in order to explain the structural and personal decision-making aspects of specialty selection, respectively, combining them provides a more complete understanding of the overall process. The overall shape of figures 14 and 15 not accidental. As an extended metaphor consider the following: the main process steps shown in Figure 14 act as pavers in a road, with Figure 15 acting as a "wheel" rolling toward the completion of medical school (Figure 16). Continuing this

metaphor, positive and negative structural issues can act as bumpers that constrain the overall range options students might consider. Similarly, a negative institutional culture or negative experiences may act as "potholes" that jar the path of the student's self-reflective cycle from one specialty to choice to another. Finally, as pressure increases on the learner to commit to their

Figure 15: Medical Student Progressing Through Their Education



specialty selection, the turning of the "wheel" accelerates, amplifying the positive and negative effects of figure 15. Taken together, Figure 16 represents an easily understandable yet intricate representation of specialty selection specific to medical education.

Policy Implications for Emergency Medicine

The three studies included in this dissertation provide a complex, and potentially troubling, picture of the longitudinal process of how medical students' career interests develop.

As the overall focus of the investigation was emergency medicine, the implications of the results are clearest in that field. Unfortunately for EM, the results from each study suggest conclusions that should be deeply concerning for educators and policy makers invested in the future of the specialty.

The first, and least methodologically complex study in the dissertation established that the lower odds of women and URiM students planning to enter EM could not be explained using any of the factors included in the analysis. The analysis included all the factors used in prior studies of EM career interest and added several others. The results indicate that the persistent underrepresentation is not explained by competitiveness or career values, but likely to be explained by things not identified in the literature. As a result, EM educators have a major issue on their hands. Women and URiM students were less interested in the practice of EM because of some currently undefined educational experience or personal factor. If EM is going to adapt and better mirror the representation of women and minorities both inside medicine, and more universally within the general U.S. population, these unobserved factors need to be identified and used in studies like this in order to remedy the underrepresentation problem.

Study Two in this dissertation was designed to identify why interest in EM might be different for women and URiM medical students. Identifying the underlying mechanism that accounts for the difference between groups of students on their odds of planning on a career in EM occurs is exceedingly difficult. Without this information, finding a remedy to these issues is incredibly challenging. More practically, if educators were to design an intervention without understanding the timing or the specific relationships between gender, race, and a planned career in EM such an intercession would be unlikely to succeed. Further study will be necessary to bridge the gap between what is currently known and why the current state of affairs persists. In

my opinion, EM needs a targeted, evidence-based corrective action to address its persistent issues in physician diversity and that can only be accomplished in concert with rigorous ongoing study of the problem. To achieve this, we must continue to build a research literature that can inform policy makers.

As noted in Chapter Five, women and men begin medical school with similar odds of reporting a plan to enter EM. However, by the time their medical school career is completed, women are much less likely to relate to a career plan in the field. These results identify that men and women's odds of entering a career in EM seem to diverge during the course of their medical training. Furthermore, when considering entering career plans, the data suggests it is more likely that instead of a cooling out of interest for women who were originally considering emergency medicine, there may be a significant lack of recruitment of those who did not initially report a planned career in EM. This is represented in the divergent outcomes for women based on their initial interest as shown in Figure 8. Specifically, it appears that women were less likely than their male counterparts to be recruited to EM if they did not enter medical school interested in EM.

Study Two demonstrated that pre-medical training and experiences may place EM at a disadvantage in recruiting and retaining URiM medical students to the specialty. URiM students had lower odds to plan a career in EM both at the beginning of medical school and at graduation. In fact, URiM students were less likely to plan on a career in EM even after controlling for their initial attitude toward the specialty. Consistent with a "cooling out" effect, URiM students who had expressed a plan to enter EM at the beginning of medical school were 48% less likely to report a continued plan to enter the specialty at graduation when compared to their peers. While it had a smaller effect size than the "cooling out" of interested students, URiM students also had

lower odds of being recruited to EM when they entered medical school with another career plan in mind. The combination of lower baseline interest in EM, decreased recruitment, and a strong "cooling out" effect imply that work to increase URiM representation in EM is necessary at multiple stages of a student's development.

Given the lower odds of URiM medical students expressing a plan to enter EM when they began medical school, EM may benefit from concerted efforts to publicize its role in the health care system. A conscious effort to increase awareness of the role that EM plays in the care of underserved populations to pre-medical students, as well as in society at-large, could reshape and improve preexisting perceptions of the field. Second, focused research must be undertaken to determine what experiences in medical school for URiM students result in either the significant "cooling out" or under recruitment. To create educational interventions with a high likelihood of success, a concerted effort to determine why interested URiM students eventually enter non-EM fields at graduation and when that decision occurs must be identified.

The research study described in Chapter 6 provides context for the findings in EM. It accomplishes this by making comparisons to the several other large medical specialties. Unfortunately, the results in Chapter 6 do not alleviate the distressing news for those interested in a diverse emergency physician workforce. As seen in that study, specialties with a traditionally higher proportion of female physicians also had higher odds of women planning for a career in that field when they started medical school (pediatrics and OB/GYN). On the other hand, some medical specialties with currently lower numbers of female physicians also had lower odds of a planned career in that area at the start of medical school. This was true for internal medicine and the surgical specialties. As such, unlike in EM where underrepresentation of women seems to derive from lower recruitment during medical school, these specialties'

issues of gender balance may be in part outside the direct control of medical educators. That said, both internal medicine and the surgical career category also had patterns that favored under recruitment and not "cooling out" of women, just as was seen in EM. As such, it appears that in the three medical specialties that have a lower representation of women in medical practice, all had at least a component of under recruitment. However, only EM started with equal odds of interest at the start of medical school.

Regarding URiM students, Study Three demonstrated that these students do not have static career plans, and recruitment to some specialties is possible as a result of experiences during medical school. This is consistent with the proposed conceptual framework introduced earlier in this chapter. For internal medicine the odds of an URiM student expressing a plan to enter the field at graduation increased when controlling for their initial career interests. This would suggest that even though EM has lower odds of being the initial career interest for URiM students, it should be possible to recruit these students to the specialty. Unfortunately, as seen in Chapter Five, URiM students are much less likely to maintain or develop an interest in EM when compared to their non-URiM peers. As such, EM must recognize that even though these students may not be interested when beginning school, the rate of URiM students becoming emergency physicians is also a directly related to experiences during medical school. This should further illustrate the need for an educational intervention aimed at increased recruitment during medical school. The programs could include outreach programs that match students with EM physicians early in medical school and efforts toward creating a more welcoming culture for students of color.

While the above policy suggestions are likely to incrementally improve recruitment, policy makers, thought leaders, and champions of emergency medicine should consider even

more aggressive approaches. Recruitment to EM is affected by its overall placement in the curriculum and its prominence during medical school instruction. Medical students have limited contact with the full range of medical specialties early in the pre-clinical years, pressure to make an early career decision to be competitive for matching, and finite mental resources to spend thinking and rethinking these decisions. This is especially true for EM. While this is an important consideration in modeling the decision-making of medical students (Figures 14 and 16) and should inform emergency medicine's specialty leadership and policy makers, it only tells part of the story.

As discussed earlier, medical students have demonstrably less exposure to EM than many other choices within the first two years of medical school.[139] Compounding this issue, EM clerkships generally occur in year four of training, in comparison to the majority of the "core specialties" which occur earlier. Depending on a student's specific schedule, the temporal placement of EM may be too late in the process to effectively recruit students to the specialty.[140] Also, while mentorship is critical for the success of EM physicians,[192] the delayed exposure for students in meeting academic emergency physicians likely results in students having mentorship from other specialties. Thus, the importance placed on mentorship, the lower numbers of female academic physicians, and the delay in clinical exposure represents potential mechanisms that may explain the observed lower odds of recruitment of women to EM. This is an example of how EM is often placed in a systemically disadvantaged position in the specialty recruitment process that is not in keeping with its overall importance in healthcare delivery.

In order to combat, and potentially remove, the structural disadvantages for EM in the recruitment of students, several interventions should be considered. These interventions are especially important to recruit students who have not (a priori) identified EM as a likely career

choice. First, EM should prioritize and incentivize its medical educators to assume a more prominent role in the delivery of pre-clinical education. Where EM faculty may best fit in the delivery of pre-clinical education may differ based on the specific curriculum philosophy at use at their medical school. For example, in organ or system-based models, EM may not have an immediately clear relationship to a specific area, unlike say OB/Gyn and the Reproductive system. As such, EM's educational leadership must make special effort to find space for their faculty to deliver clinical topics related to EM in multiple organ-based units. That may include providing clinically relevant application of basic science concepts or the providing of bedside ultrasound for anatomy instruction as two examples. To foster integrative education such as this, senior EM leadership will need to be active in reaching out to other medical school leaders in order to find opportunities for the educators in curricular blocks led by colleagues from other medical specialties. Alternatively, in problem-based and chief concern-based pre-clinical education, the role of emergency physicians as the problem solvers and masters of the undifferentiated patient must be emphasized to medical school leadership in order to place EM faculty prominently in teaching diagnostic reasoning content to students. In both cases, EM needs its faculty to push themselves to find new and unique ways to contribute in early medical student instruction.

A second remedy to the structural disadvantages that EM currently labors under is increasing the number of EM-based faculty in mentorship roles, senior leadership roles, and in the socialization/professional identify development phases of medical school curriculums. Emergency physicians must work to control, and positively influence, the narrative to students about the options and benefits a career in EM can provide. In our absence, other physicians will reasonably advocate for the benefit of their own medical specialties. This is not to accuse our

colleagues from other medical specialties as having nefarious intent, instead it is only natural to perceive one's own medical specialty in a positive light and wish to share that belief with the students they mentor and teach. However, as faculty in mentorship roles turn the best and brightest, especially those that do not have a strong sense of their specialty plans, toward their own interests EM loses out. For EM to be more successful in recruiting earlier in the process, the specialty must have "boots on the ground" during the formative phase of physician identity creation for junior medical students.

EM faculty must also advocate for their own specialty's fair share at the medical school leadership table. While EM is a relatively new specialty, it is increasingly one of the most important players in the delivery of healthcare in the United States.[198] As primary care specialties have less and less capacity to care for the acutely sick and or those with unscheduled needs, EM has assumed the responsibility of diagnosis and treatment of the urgent and undifferentiated patients in addition to its historical role in emergency care.[199] Similarly, EM has taken on increasing influence in supplying observational care,[200] bedside and off-hour imaging interpretation,[201-203] telemedicine,[204] and critical care[205-209] for many hospitals in order to supplement the existing capacity of those specialties. EM has long prided itself as the specialty that can find a way to make things work. Now it needs to assert its own importance in the specialty hierarchy commensurate with all it does in health care.

"Anyone, Anything, Anytime" is how many emergency physicians describe their practice.[210] Increasingly EM has been asked to do just that. In the current health care system, emergency departments are routinely placed in the position of solving outpatient and inpatient capacity issues,[211-213] triaging disasters and epidemics,[211,214] determining the fair distribution of limited medical resources,[212,215] and acting as the face of American healthcare to millions.[198] As

such EM medical education leaders should no longer accept its placement as an elective or non-core component within medical school teaching. EM deserves a seat at the table, with the same stature as internal medicine and surgery, when rotation schedules are determined, and resources allocated. This may seem unbelievable when it was in the last one to two decades that many academic departments of emergency medicine first received independence from being division of internal medicine and surgery. However, the importance of EM can no longer be denied, its contributions to hospitals mitigated, or its unique position as a place of learning ignored.

Future Research Directions

Consideration of both the policy implications and theoretical framing ramifications of the studies included in this dissertation lead to several directions for future research. EM appears less inviting to women and URiM students who did not see it as their initial career choice. Additionally, the lower odds of planning to enter a career in EM are not primarily the result of "cooling out" of entering interest in the field. Why this is the case constitutes the next step of inquiry.

As described in the theoretical implication section, a potential cause of decreased recruitment may be too few positive or too many negative experiences for students considering EM. One possible mechanism for limited positive experiences comes from persistent social discomfort for faculty and students in making meaningful connections. In other words, because academic EM is currently dominated by white men, it is harder for students of color and women to bridge the initial social gap and be comfortable in the field, if they had not already identified as a potential emergency physician when beginning school. Supporting, or disproving, this

theory should provide an opportunity for new investigation in several areas. First, a quantitative study could be designed that could test the relative importance of emergency medicine faculty diversity on recruitment of women and URiM students to EM. Such a study could use a similar database as the one employed for this dissertation with the inclusion of institutional identifiers and institutional level demographics. This was not initially pursued due to concerns about potential reidentification of learners in the database given the limited numbers of medical schools and residency sites in some states and regions. Of particular concern for data holders was the reidentification of USMLE scores and grades for both individuals and learners. A future study may be possible using both de-identified learners and de-identified institutions with additional controls and conditions as needed by data stakeholders.

A second potential study would use qualitative methods. To attempt to understand why medical students become interested in different medical specialties from those they planned on practicing when first admitted to medical school. Interviews of students who changed specialty career plans during medical school would represent an obvious first step. Identifying themes in these students' experiences and the manner in which new specialty choices were first identified could help to inform the development for a recruitment-based theoretical framework of medical specialty selection. Alternatively, interviews or the use focus groups of students who attended early interest group meetings for specific medical specialties but did not persist in those fields would also be beneficial. Detailing those students' experiences in their initial social contact with a new medical specialty may help better understand whether my assertion that social discomfort is a major and under-described mechanism in specialty selection for learners with backgrounds different from those that are prevailing in academic physicians is right.

A more costly, but potentially more enlightening study, would be to follow students over the course of their medical school career to understand who might change their plans and why. Whether through interviews, focus groups, and/or well-designed survey instruments, having learners describe why they made their specialty selection is necessary. Having the ability to observe the process of specialty selection as it occurs through the lens of the proposed conceptual framework different themes might emerge as a result of questions focused on these concepts.

While a qualitative study would not be designed to create generalizable knowledge, having enough resources to include learners from diverse backgrounds, diverse career interests, and at different institutions and then follow them longitudinally through their medical school career would provide unprecedented opportunity for theory development and refinement. Variation along all these levels of diversity could help to explore the proposed mechanisms more thoroughly. Such an addition to the theoretical literature would not just benefit the study of EM specifically, even though these ideas are largely based on the findings in that specialty. Given the findings in the third study, the development of a new theoretical mechanism for this process could inform research in many medical specialties and not just EM. As discussed elsewhere, medical education research in this area has been largely empirically based and without its own specific theoretical frameworks. Applying the framework created in this dissertation for future research could act as a signaling mechanism of the need for additional theory creation by medical educators as well as spur others to study this problem to either affirm or refute the assertions made here.

Another major gap in the current literature is in the articulation between the K-16 system and professional education. Little to no research currently bridges the gap between the pre-

medical world where the decision to become a physician occurs and the training of physicians happens. The concept of what it means to practice medicine is formed throughout an individual's lifetime but to date it has not been studied in a manner that accounts for this longitudinal practice. As seen in multiple specialties studied in this dissertation, medical students enter their professional training with different career specialty plans that have correlations along gender and minority status lines. Little research has explored the preliminary physician identity formation that occurs prior to the start of medical school and certainly not prior to undergraduate training. As such, this is an area ripe for investigation using quantitative approaches to determine how individual factors, educational experiences, other factors affect professional career choices. Such a study could be conducted in a relatively cost-effective manner utilizing a secondary data analytic approach as was done in this dissertation. In addition to the data sources used here (AAMC, NBME, AMA), the inclusion of national data from the National Center for Educational Statistics (NCES) which administers several, cohort based longitudinal studies of students in early childhood, elementary school, secondary school, and postsecondary school, could bridge the K-16 to professional education gap. Additional potential sources include those held by the Higher Education Research Institute (HERI) and the Cooperative Institutional Research Program (CIRP) which complete their own longitudinal studies.

In addition to large-scale quantitative research along the educational spectrum from K-16 through professional education, qualitative research opportunities abound in this same topic. Some early qualitative studies could be designed to examine how individuals develop their own sense of professional identity, how that is challenged by the current status quo, and how some individuals overcome persistent negative influences to enter specific fields. Such research could

help to answer why such patterns of unequal representation amongst medical specialties form and persist. More importantly this work could be used to describe how unequal recruitment could be amenable to change. As was seen in many of the medical specialties examined, "cooling out" does not appear to be a major mechanism explaining under representation, therefore it stands to reason that necessary to employ to effect change. Identifying potential policy levers that can encourage interest in medical specialties that have issues in diversity in the pre-medical time frame would be a major accomplishment.

A final area of research that could directly build of the work in this dissertation is the creation of a dedicated study with data collection aimed at answering career selection specifically. As described in several of the limitation sections of the individual studies, the ideal factors and constructs that were suggested by the theoretical framework were not available in the pre-existing dataset used in this dissertation. Additional institutional-level and geographical/regional data could provide more information about site characteristics that may correlate with higher levels of successful recruitment to EM (or any other specialty). Also, the actual "match" process was not able to be examined in this study, instead data on either side of the "match" was used to study its outcomes. This was done, in part, because when requests for data from the National Resident Match Program (NRMP)[216] were made, the author was informed that individual level data was not provided to outside researchers or organizations. Should the NRMP change this policy, researchers[217] would be able to more effectively study career development in medical education. Maybe even more importantly, students applying for residency would have significantly more accurate information about their likelihood to match into a specific specialty in order to make informed decisions. Such information has the potential to dramatically change specialty application behavior,[217] numbers of interviews accepted and

attended,[218] and decrease the need for the "scramble match"[219-221] by giving students data-driven predictions on all aspects of their own match strategy. All of which are likely to lower the exorbitant cost of residency application for students[222-225] and administrative costs for graduate medical education programs.[91,226]

A prospective study, using the existing data gathering approaches of the AAMC, supplemented with several additional data gathering events, and including the addition of the variables described in the preceding paragraph could yield additional details and conclusions. By studying several cohorts of medical students as they move through the professional education system, we could more adequately answer many of the questions that are still unclear at this time. A multi-event panel database as could be created in this manner and would thus lend itself to event-history analysis of specialty selection. Using an event-history approach could directly identify times when students are most likely to make career plan changes and thus intervention might be most fruitful. Similarly, if a prospective approach were endorsed by the AAMC and the NBME additional institutional level variables would allow for hierarchical modeling which could control and describe institutional effects. In addition to the benefits for medical education researchers, such information could help faculty members more effectively counsel medical students and policy makers project the future health workforce

Final Conclusions

The results in this dissertation represent a significant increase in the understanding of medical specialty selection. Much of that new knowledge may indicate the need for the development of new theoretical frameworks about the process of specialty selection, as well new

considerations of educational and policy initiatives that target students at different times during the education process. I have attempted to address the former in the final chapter of this dissertation. By expanding the time frame during which policy makers might try to influence specialty career selection, different types of student recruitment interventions will be necessary compared to those that have been previously employed. Maybe even more importantly, as the underlying mechanisms at work in specialty selection are better described and understood, the focus of recruitment might need to adapt to incorporate more ideas of social comfort and combat social replication.

When designing the studies discussed herein, a pipeline seemed a very appropriate analogy. In that framing, women and URiM students were lost to the specialty of EM like leaks from a broken pipe. Instead it would appear a different analogy is more apt: a highway to EM. In this framing, diversity in EM is hampered not by too many women and URiM students getting off on at an exit ramp, rather the problem is instead there not being enough enticing on ramps. Similarly, medical educators need to "smooth the road of potholes" so that an interest in emergency medicine can develop successfully. The next generation of EM educators and researchers must work better to identify where these "ramps" already exist and to strengthen them. Perhaps most critically we must "build" many new ones without the structural limitations of the past if the specialty is going to more clearly represent the larger and increasingly diverse population. Emergency physicians must dedicate themselves to this goal if we are to provide the best possible care to every one of our patients.

Appendices

Table Appendix 1: Demographics

	Entering Population Number (%)	Final Study Population Number (%)
Interest in EM	3,733 (8.0%)	1,423 (8.3%)
Female	22,482 (48.1%)	8,151 (47.8%)
URiM	7,794 (16.5%)	2,683 (15.7%)
Elected to AOA at time of Application	7,652 (16.4%)	2,885 (16.9%)

Demographical information for all individuals within the database with at least the four above variables and for those subjects with data for all variables in the final logistic regression model

Table Appendix 2: Individual Variables

	Entering Population Mean (SD)	Final Study Population Mean (SD)
Age	28.2 (3.0)	28.2 (2.9)
Total GPA	3.63 (0.28)	3.64 (0.27)
Science GPA	3.57 (0.35)	3.58 (0.34)
MCAT Total	30.0 (4.3)	30.5 (4.2)
USMLE Step 1 Score	223.4 (20.0)	226.5 (19.4)
USMLE Step 2 CK Score	229.3 (21.4)	233.2 (20.8)
Publication and Other Scholarly Outputs	2.7 (4.5)	3.1 (4.9)
Research Experiences	2.2 (1.7)	2.3 (1.7)

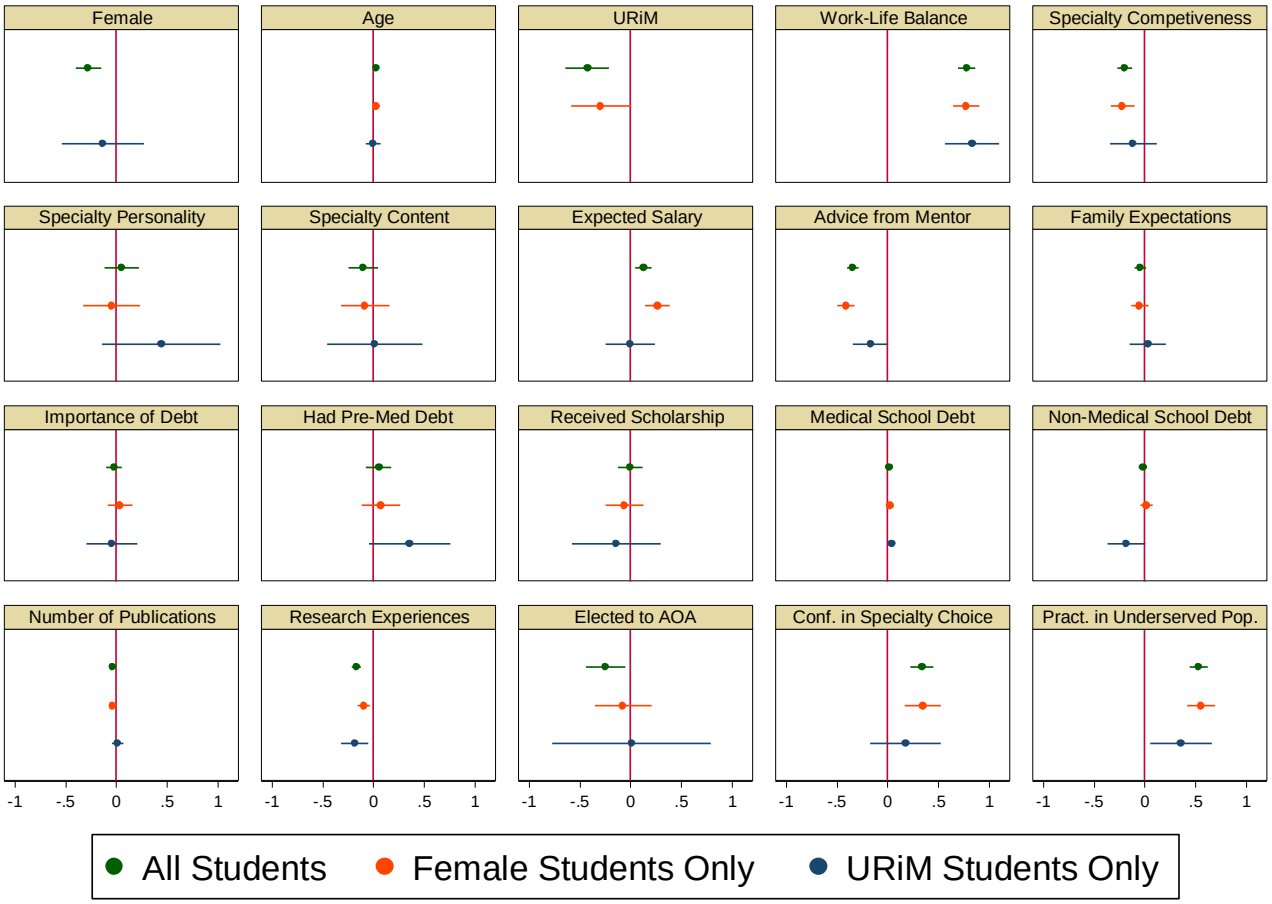
Demographical information for all individuals within the database with at least the eight above variables and for those subjects with data for all variables in the final logistic regression model

Table Appendix 3: Variable Subgroups in Study One

VARIABLE SUBGROUP NAMES	VARIABLES WITHIN EACH SUBGROUP
DEMOGRAPHICS	Gender Age URiM Status
ATTITUDES	Work-Life Balance Specialty Competitiveness Specialty Personality Specialty Content Expected Salary Advice from Mentor Family Expectations Debt Level
DEBT LEVEL	Had Pre-Medical Debt Received Scholarship Medical School Debt in $10,000 Non-Educational Debt in $10,000
ENTERING GPA	Overall GPA Science GPA
STANDARDIZED TESTS	MCAT Total Step 1 Score Step 2 CK Score
MEDICAL SCHOOL ACTIVITY	Number of Publications Research Experience Awarded AOA prior to application Confidence in Specialty Choice Planned Practice with Underserved Populations

Variables included in the analysis, grouped by theoretically derived theme. Each subgroup was added to the model in series with "Demographics" first and "Medical School Activity" added last to form the final logistic regression model

Figure Appendix 4: Comparative Importance of Factors in Choosing EM



Each graph represents the relative effect of the individual factor on a planning for a career in emergency medicine. Three separate samples are reported including All students, Only Female Students in the Model, and Only URiM Students in the Model. Academic Control variables (Grades and Standardized Test Scores) were also included in model but not displayed in above. Bars represent 95% Confidence Interval. X-Axis represents Logistic coefficients centered around 0 represented as a red line.

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