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Success of a pre-medical master's degree program in preparing students for medical careers

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Abstract

A substantial number of qualified college graduates in the United States and Canada fail to secure admission to medical school because their undergraduate academic performance is not deemed to be competitive by medical school admissions committees. The aim of this report is to describe the success of the Master of Arts in Medical Sciences (MAMS) program at Boston University School of Medicine (BUSM) in preparing students with non-competitive undergraduate credentials to gain admission into medical school. Several independent sources of information about student performance including MAMS application data, Boston University academic transcripts, and medical school acceptance information were assembled in a unified database for this longitudinal study. The privacy of individual students was maintained and no names or other data that are individually identifiable are presented in this communication. As indicated herein, admission to both U.S. and non-U.S. medical schools (allopathic and osteopathic) are included in these analyses. We also examined the residency placements of a cohort of MAMS graduates who matriculated at the BUSM MD program (MAMS/MD), since these are the only students for whom we know the placements that resulted from the National Resident Match Program (NRMP). The MAMS program has been in existence for more than 25 years and has educated more than 2500 students with approximately 70% of graduates admitted to medical school. The MAMS/MD students performed well in medical school and secured high quality residency positions. Graduate programs in medical sciences in a medical school environment are important vehicles for preparing and increasing the pool of academically qualified medical school applicants who will become successful medical school students in the near term and effective practitioners in the long term.

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1. Introduction

For more than 25 years, Boston University School of Medicine has offered the Master of Arts in Medical Sciences program to prepare students for admission to medical school or an allied health field. The MAMS program was designed to provide an opportunity for students to improve their academic qualifications and thereby increase their chances for admission to medical schools, not only to BUSM but also to any other U.S. or non-U.S. medical school. Many MAMS matriculants had previously applied to medical schools but were unsuccessful in gaining admission.

The BUSM MAMS program was created to help students who were deemed to have the potential to handle the rigors of medical school and who were committed to acquiring a solid basic science (biomedical science) foundation. For many BUSM MAMS program matriculants, the inability to secure admission to a U.S. medical

school immediately after college was attributed to low Medical College Admission Test (MCAT) scores, low undergraduate grade point average (UGPA), or both (Mitchell 1990; Julian 2005; Salvatori 2001). The MAMS program was designed to allow students to complete the degree requirements within one calendar year so that they could proceed to medical school in the next academic year. Completion of the program in one calendar year is possible since BUSM teaches the equivalent of four semesters in one calendar year (fall, spring, and two summer terms). However, the U.S. medical school application process is typically completed during the summer of the year prior to medical school entry. As such, it became clear that most MAMS students would apply to medical school after one year in the MAMS program and would matriculate into medical school two years after entry into the MAMS program. Some students gain admission to medical school after one year in the MAMS program, but most students gain admission after two or more years.

The distinguishing characteristic of the BUSM MAMS program was that students took classes either with first year students in the BUSM MD program or in sections of the same first year medical school courses that are offered exclusively for MAMS students. Initially, MAMS students took classes alongside students in the first year MD program; however, as the MAMS program grew in size, BUSM created separate sections for MAMS students only. MAMS students were able to take all first year MD basic science courses except gross anatomy. MAMS graduates who subsequently matriculate in the BUSM MD program are given advanced standing credit for all first year MD classes in which they earned a grade of B or higher while enrolled in MAMS program. Students who have enrolled at certain other medical schools have reported that similar policies are in effect.

The signature strengths of the BUSM MAMS program have been the opportunities to enroll in first year MD classes and, for many, the chance to complete a research thesis in a basic science or clinical laboratory. To date, BUSM MAMS students have benefited from BUSM's traditional MD curriculum with discrete courses that are scheduled within the confines of a semester schedule. Like many other medical schools, BUSM plans to implement a fully integrated first year curriculum for the entering MD class of 2013. This curricular change may not permit future MAMS students to take advantage of the first year MD course offerings.

The essential questions that are addressed by this study were whether students who matriculated into and graduated from the MAMS program with quantifiably lower undergraduate academic qualifications could secure admission to medical school and perform as well in medical school as traditional 4-year MD students who had stronger undergraduate records, higher MCAT scores, and successfully transitioned to medical school immediately after their undergraduate studies. A second aim of this study was to examine the post-MD graduation residency placements of BUSM MAMS/MD graduates and compare them with the placements obtained by BUSM MD graduates who entered medical school following the traditional four year undergraduate preparation. This latter study provides a means to address the impact of the BUSM MAMS program on increasing the physician workforce.

2. Methods

2.1. Data collection

Several sources of academic performance data, including BUSM MAMS application data, Boston University academic transcripts, and medical school acceptance information from the Association of American Medical College's Advisor Information System (AAMC AIS), were used to assemble a unified, password-protected database for this study. Student data were tracked from MAMS application to graduation from the MAMS program as well as medical/other professional school entry. BUSM MAMS/MD matriculants were tracked until their MD graduation to assess their academic performance throughout the MD program and to ascertain their residency placements. In addition, a cohort of students who entered the BUSM MD program following the traditional four-year undergraduate preparation was assembled to facilitate comparisons between this cohort and the MAMS/MD students with regard to academic performance and residency placement.

Table 1. Number of annual applicants, admits and matriculants to the MAMS program

Year	Applicants	Admits	Matriculants
1985	2	2	2
1986	11	11	6
1987	64	56	25
1988	53	45	21
1989	66	63	38
1990	98	78	52
1991	150	111	89
1992	226	151	87
1993	373	170	82
1994	362	153	79
1995	374	164	80
1996	451	202	97
1997	372	231	99
1998	246	173	88
1999	229	177	71
2000	214	170	89
2001	197	141	73
2002	292	224	125
2003	340	255	142
2004	376	295	171
2005	442	306	189
2006	518	373	200
2007	582	377	192
2008	533	368	189
2009	604	391	186
Totals	7173	4687	2472

3. Results

From 1985 to 1991, the early years of the BUSM MAMS program, almost all of the students who applied to the program were accepted and approximately half of these admitted students ultimately chose to matriculate. The program quickly grew and the actual numbers of applicants and matriculants through Fall 2009 are displayed in Table 1. BUSM MAMS matriculants came from a number of prestigious institutions. Table 2 indicates the number of MAMS graduates who entered medical school each year, including those who entered the BUSM MD programs. It is important to note that the students who are recorded as entering medical school in a particular year entered MAMS at some time prior to that date.

In order to assess the impact of the MAMS program on medical school admissions, we first analyzed the cohorts of students who were admitted to the BUSM MD program from 1999 to 2003. We compared the credentials of the 309 students who entered the BUSM MD program (i.e., excluding students in the MD/PhD program) directly after their undergraduate training (4-year students) with those of the 129 students who entered the BUSM MD program after completion of the BUSM MAMS program. As expected, the average undergraduate GPA of the 4-year students was significantly higher than the average undergraduate GPA of BUSM MAMS graduates in the BUSM MD program (Figure 1). It is important to note that more than 60% of these entering MAMS/MD students had achieved a graduate GPA of 3.50 or higher (data not shown).

When compared with students in the BUSM MD 4-year cohort, the BUSM MAMS/MD students performed very well in the MD program. All BUSM MAMS/MD students successfully completed the MD program and the United States Medical Licensing Examination (USMLE) Step 1 and 2 scores were comparable. Further, academic performances in medical school, as indicated by grades reported on student transcripts and a review of records of students who were inducted into Alpha Omega Alpha, the medical school honor society, were not significantly different.

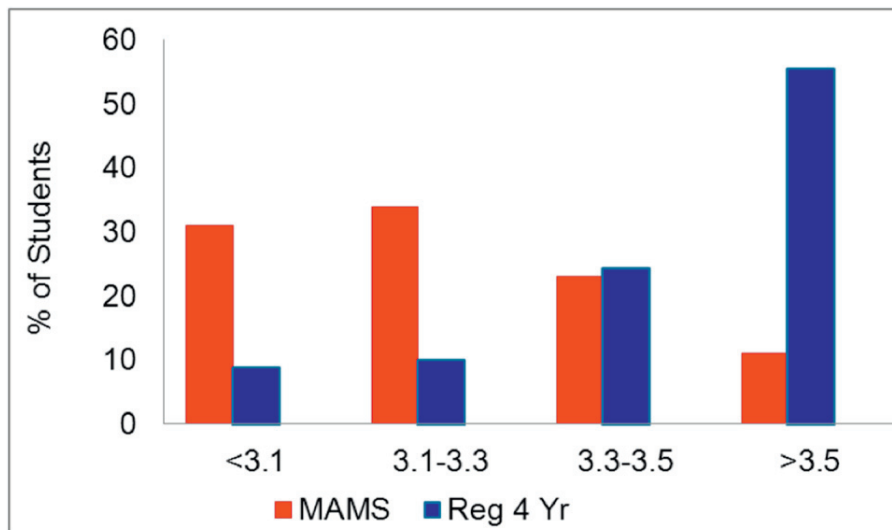


Figure 1. Distribution of UGPA of 4-YR and MAMS students entering BUSM MD program from 1999 to 2004

With a more sophisticated tracking system in place, we next examined the parameters that are thought to predict successful admission to medical school. We noted that the year of MAMS matriculation does not explicitly determine the year of medical school admission. The medical school acceptance data presented in Table 2 for a particular year represent a cumulative number of students who completed the MAMS program in prior years.

Table 2. Number of annual acceptances of MAMS graduates to any medical school and BUSM

YEAR	Admitted To Any Medical School	Admitted To BUSM	Admitted To BUSM/MD/PhD
1985	0	--	--
1986	0	--	--
1987	5	3	1
1988	11	6	0
1989	24	15	0
1990	21	14	1
1991	21	18	3
1992	36	25	3
1993	31	13	1
1994	55	26	3
1995	52	22	2
1996	58	21	2
1997	67	28	1
1998	69	27	2
1999	71	32	2
2000	67	25	2
2001	68	27	3
2002	68	25	1
2003	62	29	1
2004	79	31	1
2005	98	29	3
2006	83	20	2
2007	125	36	2
2008	105	31	1
2009	132	19	2
TOTALS	1408	522	39

For example, 83 MAMS graduates were admitted to medical school in 2006, but that cohort of students entered the MAMS program as early as 2002. As a result of this analysis, we became aware of the significant lag time between matriculation into MAMS and MD admission. We noted that some MAMS graduates may not enter medical school until five or more years after MAMS entry. This is illustrated in the acceptance data for the MAMS entering class of 2003 that are presented in Figure 2. The students from the MAMS entering class of 2003 were accepted to medical school over a period of at least five years (Figure 2, upper panel). Similar results were obtained from the analysis of MAMS matriculants in year 2004 (Figure 2, lower panel). This trend of significant lag time to MD admission is true for all MAMS cohorts including the most recent years.

Table 3. Summary of MAMS Matriculants Acceptance to Medical School and Other Health Professional Schools

	Year Matriculated		
	2003	2004	2005
A. TOTAL Student Matriculants	142	170	189
Applied to Med School	121	136	159
Allopathic Accepted*	85	85	113
% of Applied	70.3%	62.5%	71.1%
Osteopathic Accepted*	8	18	6
Non US Accepted*	7	8	6
All Med School Accepted	100	111	125
% of All Applied	82.7%	81.6%	78.6%
B. Other Professional Schools			
Dentistry	2	2	2
PhD	3	1	1
Physician Assistant	1	0	0
Nurse Practitioner	1	0	0
Law	0	2	0
C. Total Acceptances All Schools	107	118	128

Table 3 presents the cumulative acceptance data for U.S. allopathic, U.S. osteopathic, and non-U.S. medical schools for the 2003, 2004, and 2005 MAMS matriculants. It is possible that some matriculants from these cohorts may have been admitted to medical school after data collection for this study was concluded. Table 3 includes some of the alternatives to medical school that MAMS students have pursued including dental, graduate and law school, as well as physician assistant and nurse practitioner programs.

To gain insight into the correlation between academic credentials and admission to medical school after completion of the MAMS program, we examined the number of acceptances as a function of highest total MCAT score and MAMS GPA. Approximately equal numbers of MAMS graduates did not retake the MCAT during or after MAMS enrollment as those who did retake the test. For students who took the MCAT multiple times, the highest score achieved in a single attempt was used to calculate the average MCAT score for this analysis. Interestingly, there was substantial increase in the total MCAT scores for many students who elected to take the test multiple times. For the 2003-2005 MAMS matriculants, the number of successful acceptances to medical school as a function of MCAT score and MAMS GPA are shown in Table 4. For example, of the 17 medical school applicants who achieved a MAMS GPA between 3.40 and 3.49 in the MAMS program and a total MCAT score of 30 or 31, eleven (64.7%) were admitted to medical school. A small number of student records did not report MCAT scores and were eliminated from this portion of the study.

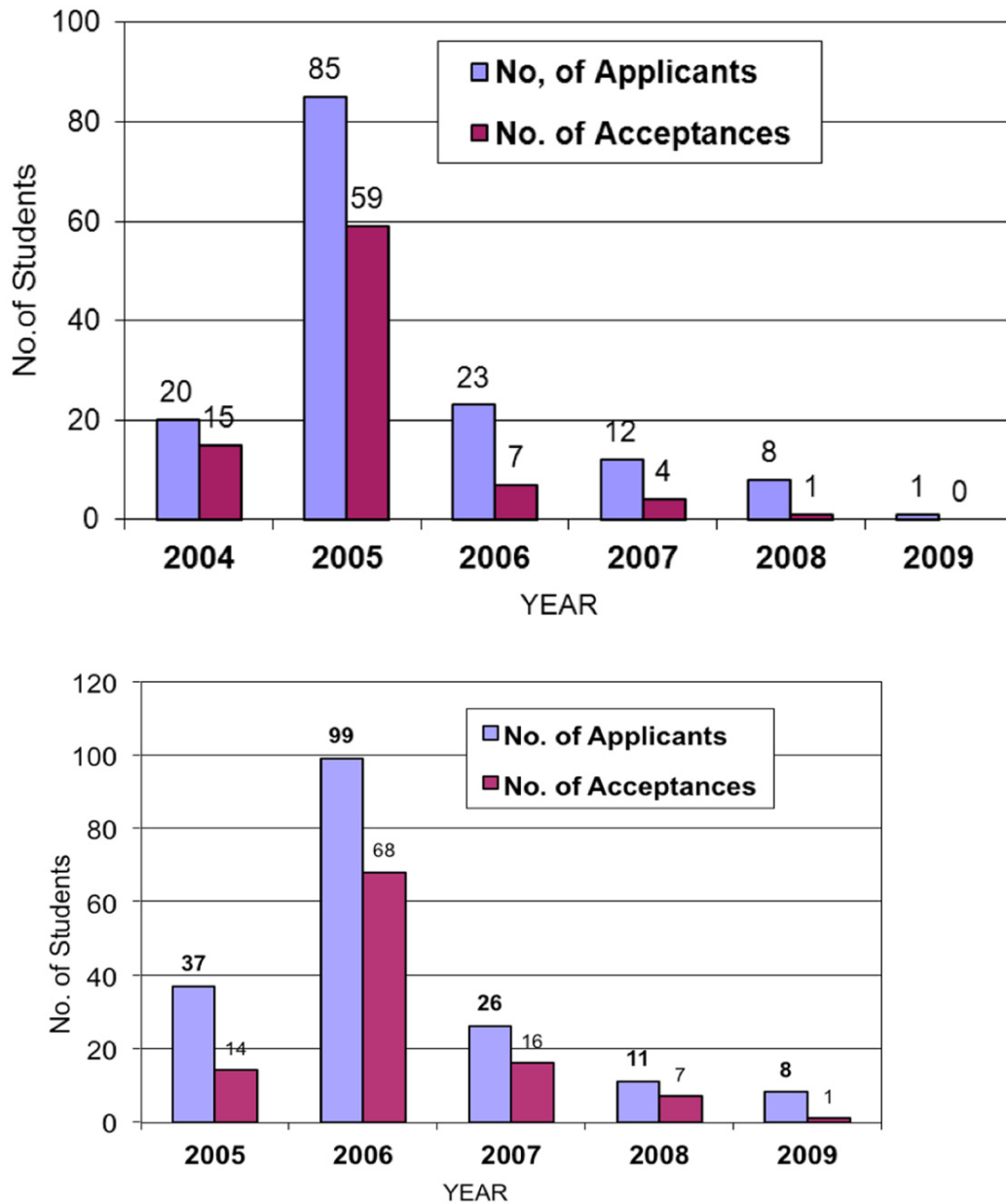


Figure 2. The relationship between applications and admissions to medical school for MAMS graduates.

Upper panel represents the number of applicants to medical school and the number of those applicants that gained an acceptance to an allopathic medical school for the MAMS 2003 matriculants. Lower panel represents the data from the MAMS 2004 matriculants for acceptance to allopathic and osteopathic medical schools.

Table 4. An analysis of 2003 - 2005 MAMS matriculants accepted to medical school as a function of highest total MCAT achieved and MAMS GPA

		Highest Total MCAT Achieved									Overall	
		>32	30-31	29	28	27	26	24-25	<24	Totals	Success	
MAMS GPA Achieved	>3.50	Applied	62	52	21	28	15	4	11	11	204	>3.50
		Accepted	59	45	19	21	12	4	9	4	173	
		% Success	95%	87%	90%	75%	80%	100%	82%	36%		85%
	3.40-	Applied	15	17	6	5	7	1	2	4	57	3.40-
	3.49	Accepted	12	11	4	4	4	1	1	2	39	3.49
		% Success	80%	65%	67%	80%	57%	100%	50%	50%		68%
	3.30-	Applied	11	9	5	4	2	5	6	4	46	3.30-
	3.39	Accepted	10	6	4	3	2	3	3	2	33	3.39
		% Success	91%	67%	80%	75%	100%	60%	50%	50%		72%
	3.10-	Applied	5	9	9	6	6	5	8	2	50	3.10-
	3.29	Accepted	5	4	5	3	3	3	5	1	29	3.29
		% Success	100%	44%	56%	50%	50%	60%	63%	50%		58%
	<3.10	Applied	5	9	5	3	5	1	5	8	41	<3.10
		Accepted	5	2	1	2	2	1	0	2	15	
		% Success	100%	22%	20%	67%	40%	100%	0%	25%		37%
Totals	Applied	98	96	46	46	35	16	32	29	398	Totals	
	Accepted	91	68	33	33	23	12	18	11	289		
	% Success	93%	71%	72%	72%	66%	75%	56%	38%		73%	
MCAT		>32	30-31	29	28	27	26	24-25	<24			
Overall Success		93%	71%	72%	72%	66%	75%	56%	38%	73%		

Another important criterion to evaluate the efficacy of the MAMS program is the performance of MAMS graduates in medical school. Since we can only obtain academic performance data on students who enroll in the BUSM MD program, we studied a larger cohort of MAMS graduates who attended the BUSM MD program and received their degree between 2006 and 2009. These students entered the BUSM MAMS program between 1999 and 2004 and approximately half of them had an undergraduate biology, chemistry, mathematics, and physics (BCMP) GPA below 3.0 (Figure 3). The average undergraduate BCMP GPA for all entering MAMS/MD students was 2.97; forty nine students had BCMP GPAs that were less than 3.00 while only 10 students had BCMP GPAs greater than 3.50. On other hand, the same entering MAMS/MD students had performed extremely well in the MAMS program with an average graduate GPA of 3.65 (Figure 3). Thus, a significant number of graduating MAMS/MD students in the years 2006 -2009, had undergraduate credentials that would have most likely kept them out of medical school had they not completed the MAMS program successfully.

To assess the broader impact of the BUSM MAMS program, we further analyzed the residency program matches of the BUSM MD graduates. Of the 610 BUSM MD graduates between 2006 and 2009, including those who received the combined MD/PhD, 417 (68.4%) entered as traditional 4-year students, 110 (18.0%) entered from the MAMS program, and 71 (11.6%) entered from joint undergraduate programs (Table 5). Interestingly, eighty-eight residency positions at Boston Medical Center (BMC, BUSM's primary teaching hospital), were offered to and accepted by the BUSM MD graduates over this period. Twenty-seven of these 88 positions (31%) were filled by MAMS/MD graduates, even though they represent only 18% of the graduating MD class.

As indicated in table 5, other prestigious residency programs accepted the MAMS/MD graduates. In fact, the 106 MAMS graduates (excluding MD/PhD) were distributed among 68 residency programs. Major hospital groupings (BMC, the New York City hospitals, the University of California hospitals, the "Ivy League" hospitals and the Johns Hopkins hospitals) provided residency training for nearly 75% of the BUSM MAMS/MD graduates during this period. The distribution of specialties chosen by the MAMS/MD and 4-year graduates was quite similar regardless of the institution they selected for their residency (Table 6).

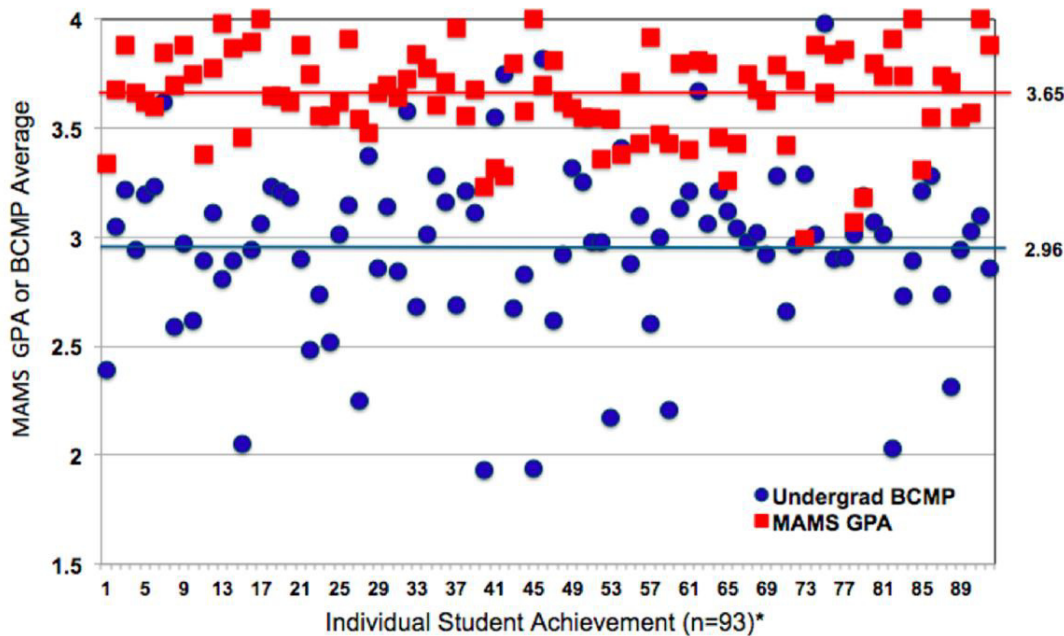


Figure 3. The MAMS GPA and undergraduate BCMP GPA of MAMS matriculants graduated from BUSM in 2006 – 2009.

Discussion

BUSM was among the first institutions in the U.S. to offer the MAMS degree with the primary objective to prepare students for admission to medical school. The medical school acceptance rate for these students has been extraordinary. In medical school, these students assimilate well, perform academically at a comparable level, and secure competitive residency placements when compared with their traditional 4-year counterparts. The success of the BUSM MAMS validates the role of this type of program in expanding the pool of qualified medical school applicants. The BUSM MAMS serves as a model for the development of Master's degree programs at medical schools that can successfully augment the physician workforce. This type of program may also be beneficial for individuals who are from backgrounds that are traditionally underrepresented in medicine or those who are economically/educationally disadvantaged.

Significant changes to the MAMS program have taken place in the last 10 years. First, MAMS class sizes have increased substantially (Table 1). In order to maintain the quality of the MAMS program with the increased enrollment, various medical school courses were offered twice per academic year by the same faculty. MAMS faculty members also organized an advising/mentoring program to provide academic and professional guidance to students, including assistance with applications and interviews. Each faculty member worked with 12-15 students from each entering class for the duration of the program. One faculty advisor with considerable experience in standardized testing in the biomedical sciences met with students individually to help them develop study strategies for coursework and the MCAT.

As discussed previously, MAMS students who were included in this analysis took classes with the BUSM first year medical school students, giving them an opportunity to demonstrate their academic competitiveness in a rigorous medical school environment. Shared classes with MD students were the signature strength of the MAMS program and contributed to its growth and the success of the students. More recently, there has been a national movement towards integrated medical school curricula that is not amenable to the semester-based course structure of U.S. Master's degree programs. BUSM has recently begun to integrate its basic science curriculum and this may preclude continued intercalation of MAMS and first year MD students in the same class. While there is a need to

modify the basic science medical school curriculum, we believe that it is essential that a mechanism be created to allow Master's degree candidates such as the MAMS students to enroll in the first year medical school classes.

Table 5. Analysis of residency placements of BUMC graduates at Boston Medical Center Hospital (BMC) and other key hospitals with emphasis on MAMS graduates.

BUSM Graduates	Total Number	Percent of Total	
Total Graduates	610	--	
Cohort Distribution			
Regular 4 Year	385	63%	
Regular 4 Year MD/PhD	32		
Total Regular 4 Year	417	68%	
MAMS	106	17%	
MAMS MD/PhD	4		
Total MAMS	110	18%	
Joint Undergrad Programs	83	14%	

Residency Data for BMC Hospital	Number of Places	Percent of Total Student Cohort	Percent of Total BMC Placements
Total Available	88		
Cohort Distribution			
Regular 4 Year Grads	47	12%	
Plus 4 Yr. MD/PhD	48	12%	55%
MAMS Grads	24	23%	
Plus MAMS MD/PhD	27	25%	31%
Joint Undergrad Programs	13	16%	14%

Other Residency Places of MAMS BUMC Grads	Placements	Percent of Total MAMS Grads
Harvard, Columbia, Brown, Yale Penn, Cornell, Dartmouth, J. Hopkins	26	24%
University of California UCLA, UCSD, UC Davis, UC Riverside UCSF, UC Irvine	15	14%
NY Hospitals SUNY, St Vincent, Mt Sinai, NYU, Einstein	13	12%
Plus BMC Hospital	27	25%
Total Residencies	81	74%

Our data challenge the dependence on undergraduate grades and MCAT scores as the key predictors of success in medical school (Julian 2005; Callahan et al., 2010; Gilbert et al. 2002). Grades in the sciences, notably organic chemistry, are not necessarily useful or valid predictors of success in medical school (Lambe & Bristow 2011). More consideration of the ramifications of our findings by medical school admissions committees is warranted.

Table 6. Comparison of residency programs pursued by BUSM MD graduates (2006 – 2009) from the MAMS and traditional 4-yr programs

	No of Placements	
	MAMS	Trad 4-Yr
Anesthesiology	7	21
Dermatology	1	5
Emergency Medicine	10	26
Family Medicine	9	25
Internal Medicine	28	125
Neurology	2	3
Ob/Gyn	6	10
Ophthalmology	5	9
Orthopedics	6	10
Otolaryngology	2	7
Pathology	3	7
Pediatrics	18	44
Psychiatry	2	14
Radiology	6	13
Surgery	8	20
Urology	3	9

The success of the BUSM MAMS program highlights a critical issue: there are far more qualified candidates who can succeed in medical school if given the chance to improve their academic credentials. The findings from this study support the need to reassess the criteria used for medical school admission (Bore et al., 2009) since the data suggest unequivocally that those students who pursued a MAMS degree at BUSM subsequently performed well in medical school and secured competitive residency placements. Students mature academically and professionally at different points in their lives. Very few, if any, of the MAMS graduates who are now productive practicing physicians would have been accepted to medical school had they not completed the MAMS program. Graduate programs similar to the BUSM MAMS are important mechanisms to prepare candidates for the academic and personal rigors of medical school. The data presented herein suggest that the criteria for medical school admission need to be reevaluated to ensure appropriate consideration for the increasing number of qualified candidates who otherwise will not have a chance to matriculate in medical school (Spooner 1990; Turner & Nicholson, 2011; Siu & Reiter, 2009).

We conclude from these analyses that the BUSM MAMS graduates who have completed medical school at BUSM or elsewhere now comprise a pool of successful practicing physicians who might never have gained admission to a medical school program if they did not have an opportunity to improve their qualifications through participation in the BUSM MAMS program.

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