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## Academic Success in Medical School for Prematriculation Program Students—a Retrospective Analysis of Year 1 Course Exams at Boonshoft School of Medicine at Wright State University

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**Academic success in medical school for prematriculation program students—A retrospective analysis of year 1 course exams at Boonshoft School of Medicine at Wright State University**

**Abstract**

As medical schools are striving to enroll the most diverse candidates to their schools, the medical schools have developed enriching prematriculation programs to their diverse candidates to ensure that all students are prepared for the first year of medical school. The prematriculation programs attempt to build in academic content with study techniques to help students become confident in their learning in the first weeks of school but also in the last months of their first year when they can still employ various study tools learned in the summer from the prematriculation program. However, with the implementation of these programs, there is scant evidence to support the need for these programs and justification of allocating funds towards these programs. Analyzing the success of those who attended prematriculation programs is imperative to understanding the impact of these programs and can help in decision making of expanding these programs and altering the curriculum if needed.

A data set from the two consecutive years of prematriculation program, Class of 2021 and 2022, from Boonshoft School of Medicine at Wright State University (BSOMWSU) was used to determine the effectiveness of the program by measuring academic success of those who attended the program on midcourse exams and course final exams compared to those who qualified to attend the program but did not attend as well as those who did not qualify. To test this hypothesis, we used the individual exam scores from the respective three groups and used analysis of covariance test. SPSS was used to carry out descriptive and analytic statistics<sup>1</sup>

Analysis showed those who did not qualify for the program scored higher on all Year 1 exams. Additionally, those who qualified and enrolled in the prematriculation program scored lower on all Year 1 course exams than their counterparts the program. These results may suggest that the prematriculation program is ineffective in any one of various ways. Since the program is still in its infancy with new curricula, the results may indicate that curricula may need better alignment to the school year curricula or instructors may need to go through more training on how to better approach this demographic of students and teaching the content. While the program does not appear to demonstrate an academic boost to these students, there may be social and emotional benefits to attending these programs that can be apart of a future study.

## Background

Medical schools' first-year curricula are notorious for overwhelming students with copious amounts of academic content and new vocabulary as well as social-emotional pressures of limited time with friends and families and new college settings. The increasing demands on students to perform due to the insurmountable amount of loans taken out, at a mean debt of \$196,520 and 3% increase from the Class of 2017 to the Class of 2018 and a 284% increase from 1995 to 2018 <sup>2,3</sup> as well as schools' pressures to increase medical rankings; prematriculation programs have sought to bridge the gap from undergraduate programs or other work careers into medical school to help ensure student success and near 100% graduation and residency match rates for universities.

With over 41 of 83 responding U.S. medical schools having a prematriculation program since 1994<sup>4</sup>, there is a wide variation in the curricula of the program, the target population for

the program and the pedagogy used to teach the students. While ultimately every program's purpose is to retain and successfully graduate all students through medical school, there has been little evaluation of the students after they have matriculated into medical school. There is both a university responsibility for program effectiveness evaluation as well as a fiscal responsibility on part of the medical schools to ensure that the prematriculation programs are successful academically and social-emotionally for the enrolled students.

Prior studies have looked at mainly at online prematriculation courses<sup>5</sup> due to financial restrictions where the content is provided openly to any enrolled student to look at and use the academic content to their discretion and measured their performance on the first-year science courses<sup>6</sup>. The study analyzed those who accessed the online content to those who did not, and the program showed "significantly higher exam scores in early basic science courses"<sup>6</sup>, however, the study failed to control for selection bias. There may have been other factors associated with those who accessed the online material and those who scored better on the year-one exams, mainly academic motivation. Others studied an online prematriculation course and its successfulness independent of medical school performance, assessing students by pre and post-tests which examined student's ability to perform in both cooperative and self-directed learning, how to use the internet as part of studying and project management skills among other skills<sup>7</sup>. However, the prematriculation program's success was determined without evaluation of student success **within** medical school and only in the prematriculation program<sup>7</sup>. Perhaps the most robust study to date studied the University of California, San Diego's Core Topics in Biomedical Sciences (CTBS) prematriculation program, a 7-week course on-campus, which showed that "overall performance...correlated significantly with Year 1 performance and

was found to be a strong indicator of Year 1 performance”<sup>8</sup>. They were able to show that the material taught in the program was directly linked to an improved exam score compared to the average student. Yet, there was no analyzing of cohorts within the school, so it was again hard to compare groups that were evenly distributed<sup>8</sup>.

The Boonshoft School of Medicine at Wright State University (BSOMWSU) hosts a four week optional prematriculation program open to all enrolling students with a targeted focus on students who are career changer, who have been out of school for more than one year, who come from a disadvantaged background, who are underrepresented in medicine or have a non-science undergraduate major of which some of these variables have been correlated with “suboptimal outcomes”<sup>9</sup>. Over the course of four weeks, students are taught selected material in biochemistry that directly relates to their Origins course, physiology that corresponds to Staying Alive as well as clinical medicine skills. Overlaying each of these academic content areas, the instructors, whom are rising second-year medical students teach them how to study for each type of material, note-taking skills, and test-taking strategies. In addition, part of the hidden curriculum is to help the students build relationships with each other, second year students and the faculty and administration to facilitate a smooth transition once school begins. Unlike many programs, this program is an on-campus program by which students learn the content first at home through assigned readings and then again in a classroom through a series of twenty to twenty-five mock exam questions that simulate their school year exams through a pedagogy called peer instruction. The students will take two exams; biochemistry and physiology respectively, and a final exam at the end of the four weeks. The students’ academic successes within the program are not recorded or used for any purpose during the school year

This study will analyze the effectiveness of the prematriculation program for two cohorts of Class of 2021 and 2022 in relationship to students' academic success on Year 1 exams by comparing students who qualified based on one of the five aforementioned criteria and enrolled in the program to two other populations; students who qualified for the program and did not attend and students who did not qualify for the program. The study will measure academic success by using mid-course and final exam grades

## Methods

### **Study Design: Retrospective Study**

This retrospective study on the effectiveness of the prematriculation program of the classes of 2021 and 2022 at BSOMWSU and was conducted using data collected from the Association of American Medical Colleges medical student application, secondary application from BSOMWSU, mid-course exam scores from Origins 1 and 2 and a combined final exam and final exams from Human Architecture, Host and Defense and Staying Alive. The students' data were deidentified and the data were held by Adrienne Stolfi, assistant professor at BSOMWSU. Institutional Review Board reviewed this research was determined to be exempt.

### **Study Population: BSOMWSU Class of 2022, 2023**

The study was conducted at the Boonshoft School of Medicine at Wright State University, a mid-western US medical school. The data analyzed were from the class of 2021 and 2022 medical students. Medical students who did not complete the first-year medical. The resulting analytic sample included 233 students.

### **Exposure: prematriculation program**

Students who enrolled in the prematriculation program and completed the four-week program for either the matriculating year of 2017-2018 or 2018-2019 school year. Students qualified for the prematriculation by meeting one of the following five criteria 1) students with a non-science undergraduate major, 2) those who have been out of school for a substantial period defined by three or more years since undergraduate degree, 3) students who are changing professions, however, since it was hard to determine intent of career, substantial out of school time will serve as a proxy, 4) students who have educational backgrounds that put them at a disadvantage, 5) members of groups underrepresented in medicine. All data for exposures were self-reported on either AMCAS primary application or BSOMWSU secondary application. Students were stratified into three categories; those who qualified for the prematriculation program AND attended the program, those who qualified but DID NOT attend the program, those who did not qualify for the program. Those who did not complete or participate in all four-weeks of the program were excluded from the analysis.

**Outcome: Scores of Origins 1 and 2 Multiple Choice Quizzes (MCQ) 1-3, Origins 1/2 Final, Human Architecture Final Exam, Host and Defense Final Exam, Staying Alive Final**

The primary outcome is the raw, unscaled individual scores of Year 1 medical school exams including the following: Origins 1 and 2 MCQ 1-3, Origins 1/2 Final, and final exams for Human Architecture, Host and Defense and Staying Alive (See Appendix A for course descriptions). If students had to retake the exam, only the first score was used in the analysis.

**Covariates**

Covariates included in the analysis were age at matriculation into medical school and MCAT percentile scores. Note that raw scores for MCAT were not used due to scores transitioning from a score out of 45 to 528.

### **Analysis Plan**

Descriptive characteristics of participants in each category were compared using chi-square tests for categorical variables and presented in Table 1. We used a one-way ANOVA test to determine if there were statistical differences between the means of the three categories of students for each of the exam scores. We tested for confounding with MCAT scores by running a one-way ANOVA test to see if there was statistical difference between the three categories of students as well as ran a linear regression between MCAT scores and exam scores to check if there was any correlation. It was determined that MCAT scores were in fact a confounder and therefore it was controlled for during analysis. Missing data on outcome variables was not a factor since all students enrolled must complete each courses' exam to complete the first year of medical school. However, one student does not have complete exam data due to leaving the school prior to the end of the school year. The student's scores for the portion of the year that they were enrolled will be included in the data analysis. If a student had any missing data on the five criteria for enrolling in the prematriculation program, it was assumed to be a non-qualifying answer. This was not a major factor in the analysis since students needed just one qualifying answer (of five) to qualify for the prematriculation program. SPSS was used to carry out descriptive and analytic statistics<sup>1</sup>



## Results

During the study of two years of BSOMWSU's Class of 2021 and 2022, 233 students were analyzed. Descriptive characteristics of the study population are displayed in Table 1 by qualification and enrollment in the prematriculation program. The criteria to qualify for the prematriculation program are outlined in Table 2. Students who are underrepresented in medicine was the most frequent qualifier for students but was not the main driver for attending the program. Students with non-science degrees or who self-reported having an educational background that put them at a disadvantage were more likely to attend the program. Overall, those who did not qualify for the program scored higher on all Y1 exams. Additionally, those who qualified and enrolled in the prematriculation program scored lower on all Year 1 course exams than their counterparts as shown in Table 3. However, there was only a statistical difference on four of the ten exams. Students who qualified and enrolled scored lower with statistical significance compared to those who did not qualify on Origins 1 MCQ2 (67.6% vs 77.8%,  $p=0.015$ ), Origins 2 MCQ2 (70.8% vs 80.8%,  $p<0.001$ ), Host and Defense exam (71.7% vs 75.3%,  $p=0.001$ ) as well as scoring lower with statistical significance compared to those who did qualify and did not attend on Human Architecture practical exam (74.0% vs 82.9%,  $p=0.006$ ). All analysis of mean comparisons controlled for age and MCAT percentile.

## Discussion

The prematriculation program at the Boonshoft School of Medicine at Wright State University is a significant four week time commitment for incoming students and in order to understand its impact and value to the student and school, academic success of these students must be measured in comparison to those who did not attend. This study found that of the ten

Year 1 exams analyzed, only three showed statistical differences between those who qualified and attended compared to those who did not qualify and one exam between those who qualified and attended and those who qualified but did not attend. Contrary to my hypothesis, I found that participants in the program scored lower on the exams compared to their counterparts. This result appears to be in direct contrast to other schools' prematriculation programs<sup>8</sup>. While the three lower scores against those who do not qualify may attest to the inability of four weeks of a program to equalize the academic success, it is of concern that there was a statistically lower score compared to the group who qualified and did not attend as well as showing a non-statistical trend of averaging the lowest on all exams analyzed. While it is not statistically different, it is still a trend worth noting as shown in Figure 1.

What could possibly be explaining these results? First, it should be noted that this is a small data set with only two years of new curricula. Therefore, because it is only in its second year as a revised program, there is still room for more curricula development. While the first two years consisted mainly of a biochemistry focused prematriculation program, it would be expected to see an early bump in the scores during Origins 1 course exams yet those who attended the program are still underperforming. Additionally, there may be a social component that is creating negative synergistic effect once the school year begins. If those who attended the program form a strong social relationship that leads to study groups during the school year, they may not be receiving the same study benefits of studying with those who are more academically successful. Conversely, which still leads to the same exclusivity, there may be a lingering social stigma for those who attended the program and therefore others may

not want to study with them. Lastly, there could be some unknown qualifier that is playing a much larger role in academic success that the school is not targeting.

While the program is not demonstrating academic success as desired by showing similar mean scores to the two comparison groups, there may be an unmeasured social and mental success tied to the program. Students have four additional weeks to familiarize themselves with the school, the textbooks, the administration, their colleagues and the area surrounding the campus. These unmeasured variables would be of great interest in further studies with the prematriculation program.

## Limitations

Future studies should include a larger data set with more years of prematriculation program. Unfortunately, since the new curriculum was only two years old, the data set was limited and presented small cell sizes making the use of Fisher's Exact Test necessary. Additionally, identifying students who were "career changers" was difficult since there was not a direct question on either application to identify them, but rather a multitude questions that had to be synthesized together. However, the students' intent of shifting careers or improving their resume for medical school applications was hard to determine; therefore, a proxy variable of years since undergraduate degree was used. Furthermore, all variables on demographics and qualifiers for the prematriculation program were self-reported which may result in reporting errors although it is not believed that the reporting bias skewed answers in a particular direction.

## Strengths

This is the first study done on Boonshoft School of Medicine at Wright State University's prematriculation program and may serve as a foundation for revised curricula designing and target population for the program. Additionally, by using two comparison groups, the study was able to measure effectiveness against a comparable group based on demographic responses (those who qualified but did not attend) and against a non-comparable group who historically score higher on exams which provided a measurable target for ideal success of the program.

## Conclusion

The prematriculation program at the Boonshoft School of Medicine at Wright State University may serve the students beyond academic material, including both social and emotional relief. Medical school can be difficult or students beyond grappling with the academic material and programs such as these may provide early social networks and relieve students by exposing them to tough material in a very low stakes setting. To increase academic success of prematriculation program students, there may be a need for extended days and hours to the program as well as curricula revisions.

## Tables and Figures

Table 1. Demographics of the Class of 2021 and 2022

	Class of 2021 and 2021 prematriculation program				p-value
	Total n=233 <sup>^</sup>	Did not qualify n =141	Qualified, did not attend n=68	Qualified and attended n =24	
Age, mean (SD)	24.4 (3.0)	23.2 (1.1)	26.2 (4.4)	25.9 (2.6)	<b>&lt;0.001</b>
Race* n (%)					<b>&lt;0.001</b>
White	142	111 (78.2)	23 (16.2)	9 (6.3)	
Black	28	0 (0)	15 (53.6)	13 (46.4)	
Asian/Indian	34	25 (73.5)	7 (20.6)	1 (2.9)	
Biracial/other	19	0 (0)	18 (94.7)	1 (5.3)	
Sex n (%)					0.51
Female	130	76 (58.5)	38 (29.2)	16 (12.3)	
Male	103	65 (63.1)	28 (27.2)	9 (8.7)	
Graduate Degree n (%)	38	17 (44.7)	14 (36.8)	7 (18.4)	0.06
MCAT Percentile	69.2	74.1	64.0	54.6	<b>&lt;0.001</b>

<sup>^</sup>n=233, one person was removed who did not qualify but attended the program  
\*n=224

Table 2. Criteria to qualify for prematriculation program

	Qualifications for prematriculation program		
	Total n	Qualified, did not attend n(%)	Qualified and attended n(%)
Students with a non-science undergraduate major	14	8 (57.1)	6 (42.9)
Those who have been out of school for a substantial period	39	28 (71.8)	11 (28.2)
Students who are changing professions**	--	--	--
Students who have educational backgrounds that put them at a disadvantage	37	23 (62.2)	14 (37.8)
Members of groups underrepresented in medicine	47	33 (70.2)	14 (29.8)

\*\*out of school for substantial period served as proxy

Table 3. Prematriculation program compared to other groups by exam scores (Controlled for MCAT and AGE)

	Class of 2021 and 2021 Prematriculation Program				p-value
	Total	Did not qualify	Qualified, did not attend	Qualified and attended	
	n=233 <sup>^</sup>	n =141	n=68	n =24	
	$\mu$ (SD)	$\mu$ (SD)	$\mu$ (SD)	$\mu$ (SD)	
O1 MCQ1	83.5 (7.2)	84.8 (6.8)	82.4 (7.4)	79.5 (7.2)	0.472
O1 MCQ2	75.0 (10.7)	77.8 (9.2)	71.9 (11.7)	67.6 (10.3) <sup>1</sup>	<b>1: 0.015</b>
O1 MCQ3	84.4 (8.4)	86.2 (7.8)	82.6 (8.7)	79.3 (8.4)	0.073
O2 MCQ1	82.7 (9.3)	83.5 (9.1)	82.5 (9.6)	78.6 (9.1)	0.568
O2 MCQ2	78.0 (9.7)	80.8 (8.6)	74.7 <sup>1</sup> (9.0)	70.8 <sup>1*</sup> (11.4)	<b>1: &lt;0.001</b> <b>1*: 0.002</b>
O2 MCQ3	76.8 (10.1)	78.0 (9.9)	76.7 (10.2)	70.6 (9.7)	0.222
O1/2 Final	81.4 (7.7)	82.5 (7.3)	81.2 (7.6)	75.8 (7.7)	0.107
HA Practical Exam	82.5 (11.5)	83.8 (10.6)	82.9 (10.6)	74.0 <sup>2</sup> (15.8)	<b>2: 0.006</b>
HD Final	80.3 (11.2)	82.7 (10.2)	78.1 (11.3)	71.7 <sup>1</sup> (11.0)	<b>1: 0.001</b>
SA Final	73.7 (9.2)	75.3 (8.7)	71.7 (9.5)	69.9 (9.6)	0.127

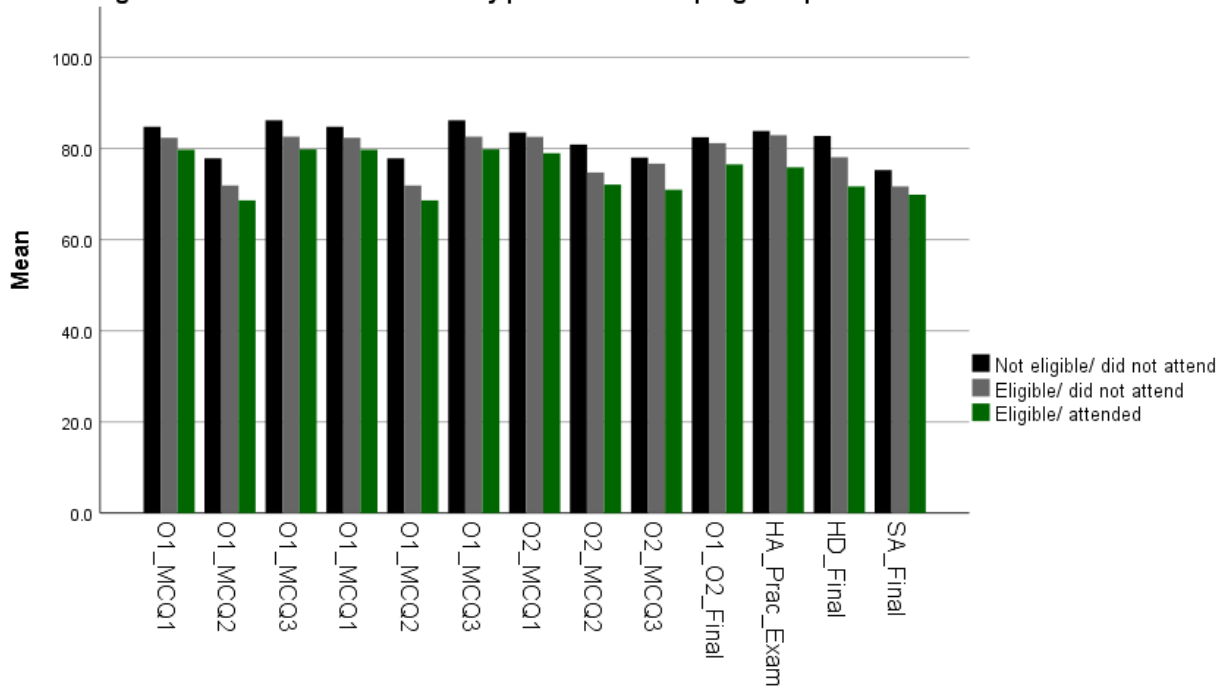
<sup>1</sup>: statistically significant difference as compared to “Did not qualify”

<sup>2</sup>: statistically significant difference as compared to “Qualified and did not attend”

Table 4. Prematriculation Program Qualifiers and Academic Outcomes

	Class of 2021 and 2021 Prematriculation Program				
	Total	Non-Science Degree	Out of school/changing professions	Disadvantaged background	Underrepresented in Medicine
	$\mu$ (SD)	$\mu$ (SD)	$\mu$ (SD)	$\mu$ (SD)	$\mu$ (SD)
O1 MCQ1	83.5 (7.2)	82.6 (7.8)	81.0 (7.1)	<b>78.7 (7.9)</b>	79.8 (7.9)
O1 MCQ2	75.0 (10.7)	70.7 (13.0)	70.1 (12.6)	<b>68.1 (9.9)</b>	69.8 (11.7)
O1 MCQ3	84.4 (8.4)	81.0 (8.8)	81.9 (8.7)	<b>79.6 (9.3)</b>	80.7 (8.7)
O2 MCQ1	82.7 (9.3)	82.4 (9.3)	80.0 (9.6)	<b>77.5 (10.2)</b>	81.0 (9.4)
O2 MCQ2	78.0 (9.7)	<b>71.4 (11.2)</b>	73.4 (9.6)	72.2 (10.4)	72.7 (9.2)
O2 MCQ3	76.8 (10.1)	77.6 (9.8)	74.4 (10.7)	72.9 (10.5)	<b>72.3 (10.1)</b>
O1/2 Final	81.4 (7.7)	79.2 (8.3)	79.3 (8.0)	<b>76.6 (8.6)</b>	78.3 (8.4)
HA Practical Exam	82.5 (11.5)	79.4 (12.7)	81.1 (13.1)	<b>77.1 (13.7)</b>	79.3 (12.5)
HD Final	80.3 (11.2)	<b>73.7 (12.3)</b>	74.7 (11.3)	75.3 (11.6)	75.4 (11.3)
SA Final	73.7 (9.2)	70.9 (8.9)	70.7 (9.1)	72.0 (9.6)	<b>69.4 (8.8)</b>

Figure 1. Mean score of Y1 exams by prematriculation program qualifications and enrollment



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## Appendix

### Appendix A: Course Descriptions

Origins 1	Molecular focus, introduction to pathology and pharmacology
Origins 2	Cellular focus, introduction to pathology and pharmacology
Human Architecture	Brief dissection immersion
Host and Defense	Immunology and Microbiology
Staying Alive	Cardiology, Nephrology and Pulmonology