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In-Person to Online Transition Increased Access and Geographical Diversity in Oakland University William Beaumont School of Medicine High School Outreach Program

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ABSTRACT: Encouraging underrepresented minority and economically disadvantaged students to pursue medical and biomedical sciences careers is crucial, and it is important to engage them early on. However, limited access to learning resources, students' responsibilities toward their family and community, and biases in admission selection processes can challenge student engagement. The Oakland University William Beaumont School of Medicine (OUWB) has provided outreach programs since 2012 to encourage students to enter medical and biomedical sciences pathways. Recently, we developed an online enrichment program to help address the aforementioned issues. The program was evaluated through a retrospective study design. The analysis found that the online program significantly increased the geographical diversity of participants, increasing those from less wealthy areas ($p<0.001$) compared to the in-person program ($p=0.013$). Additionally, there was a significant increase in the percentage of students matriculating from public schools, with high percentages of economically disadvantaged (14% vs. 28%, $p<0.001$) and underrepresented minority students (7% vs. 36%, $p=0.028$). Completion rates for students who participated online were high (89%), and they reported high levels of satisfaction. These findings suggest that the online program helped overcome barriers to participation and engagement, increased diversity, and maintained program rigor while introducing students to medical and science careers.

INTRODUCTION

The racial and ethnic diversity of the United States of America is changing. By 2060, the white non-Hispanic population will no longer be the majority (Cilluffo and Ruiz, 2019; Vespa et al., 2018); however, this trend is not reflected in predictions for the medical field (*2021 State Physician Workforce Data Report*, 2021). The American Association of Medical Colleges recognizes the need for diversity and defines ethnic and racial populations that are underrepresented in the medical profession relative to their numbers in the general population as underrepresented in medicine (AAMC, 2004; Clay et al., 2021). While efforts to address disparities over the last 20 years have resulted in increases in Hispanic (12.1% in 2022) and African-Americans (10% in 2022) that are enrolled in medical school (Colleges, 2019), these individuals are still underrepresented compared to the U.S. population, especially when considering the racial and ethnic demographics of individuals under the age of 40 (Colleges, 2021). Not only is racial and ethnic diversity lagging but there is also a deficit regarding socio-economic diversity. The majority of U.S. medical students come from the upper quintiles of parental income, with only 5% from the lowest quintile (Youngclaus and Roskovensky, 2018). Physicians with social and cultural backgrounds that mirror patients in underserved communities are more likely to serve in similar communities ("The Decline in Rural Medical Students: A Growing Gap In Geographic Diversity Threatens The Rural Physician Workforce," 2019; Labbe et al., 2018; Lun et al., 2022; Poole et al., 2021; Salhi et al., 2022). The lack of clinicians with these backgrounds contributes to the continuing shortage of medical professionals practicing in underserved communities.

Medical institutions and professional organizations recognizing the value of diversity have increased their outreach efforts. Pathway programs are widely accepted strategies to address physician workforce disparities for underrepresented minorities (URM; African American, Native American/American Indian, Native Hawaiian/Pacific Islander, and Hispanic/Latino) and students from families with limited economic resources (EDS). Pathway programs enhance the matriculation of diverse youth into the medical profession. These programs promote the reduction of physician workforce disparities as they afford students unique opportunities (Garcia et al., 2021; Smith et al., 2009).

Students' opportunities to participate in pathway programs can be limited as some programs have admission and participation requirements that can be a barrier for URM and EDS individuals. For example, URM and EDS individuals are more likely to experience lower academic preparation (Ghazzawi et al., 2021; Rivera et al., 2019; Rozek et al., 2019; Salehi et al., 2020; Strayhorn, 2010), making them less likely to apply or to be selected for these programs. In addition to reduced academic preparation, commitments outside of the program, such as employment, family and/or community obligations, and lack of transportation to programs may make it difficult for some students to engage fully (Kana et al., 2020). Asynchronous online programs may remove or reduce some of these barriers, as they do not require students to commute and provide flexibility in scheduling to allow time for other commitments (Fung et al., 2021).

Several approaches may be used during pathway programs to support students from URM and EDS populations, including the use of role models, mentoring, ensuring community involvement in recruitment, and facilitating access to health-related work experience (Braithwaite et al., 2020; Crews et al., 2020; Matthews et al., 2020). This experience is essential for URM students and students whose families have economic disadvantages in order to promote their entry into the STEMM pathway (Fester, 2010; Hypolite et al., 2022; Matthews et al., 2020; Roche et al., 2020; Strayhorn, 2010).

The barriers that EDS and URM students face must be considered in the design of pathway programs. Programs should consider features such as transportation, costs to participants, scheduling, and admission policies. There is a wealth of literature in the area of holistic admissions (Ballejos et al., 2015; Coleman-Salgado, 2021; Coplan et al., 2021; Scott and Zerwic, 2015). Holistic admissions processes contextualize multiple applicant dimensions, helping improve STEMM diversity by reducing selection bias (Wilson et al., 2019). Pathway programs may be well-served to mirror this type of selection process or to remove barriers altogether by eliminating the selective process.

A unique opportunity arose during the early stages of the COVID-19 pandemic to evaluate the change of an in-person pathways program to an online format with a less restrictive and less selective admission process. The following questions were asked to consider the impact of this change to the program:

Question 1: How does removing the selective admissions process and changing the learning modality for a medical-focused high school outreach program impact participation of students from schools reporting high enrollment of EDS or URM students?

Question 2: How do changes in the learning modality for a medical-focused high school outreach program impact completion rates and participant satisfaction?

METHODS

Institutional Review Board Approval. This evaluation was identified as no human subjects research following review by the Institutional Review Board at Oakland University (IRB-FY2021-388) and performed in accordance with designated guidance. Due to the nature of data collection by program staff, our study design was retrospective, incorporating data specific to the high schools that students attended.

Setting and Program. OUWB hosted high school outreach programs in-person (2017-2019) and online (2020-2021) (Table 1). The programs were developed in a partnership between the program administrators in The Office of Diversity and Inclusion and faculty in the Department of Foundational Medical Studies at OUWB, with the aims of supporting the institution's goals to increase diversity and inclusion in medicine, serving the needs of the community, and facilitating students entering the medical and biomedical sciences pathways. The program administration staff led the marketing and student recruitment efforts by sharing information about the program through mass email distributions to schools throughout southeast Michigan, website announcements, communications with several community-based organizations, and professional and personal network outreach. The Office of Diversity and Inclusion staff were responsible for communicating all of the program requirements and expectations with student participants. The faculty designed the curriculum and structure of the program sessions and answered student queries regarding content (Kemp et al., 2021). Several faculty members, students from the university and medical school, and clinicians from the affiliated hospital system Corewell Health volunteered their time to participate in the programs.

In-Person Version of the Program. The in-person program described here was hosted on-site at the Oakland University campus and Corewell Health hospital system for two weeks in the summers of 2017, 2018, and 2019 for eight hours each

Table 1. *Summarized description of the in-person vs. online programs.*

Program Type	In-Person			Online		
Percent Synchronous Engagement	100%			≤30%		
Program Date	SU - 2017	SU - 2018	SU - 2019	SU - 2020	SP - 2021	SU - 2021
Students (#)	29	29	40	26	43	29
Faculty (#)	16	16	18	10	13	10
D & I Staff (#)	3	3	2	3	3	3
Program Length (days)	8	9	10	4	4	5
EDS HS (%)*	15	8	3	25	43	35
Activities	Lectures, small group discussion, large group discussion, group research project and poster presentation, videos, peer assessment of research project, lab exercises, campus tour, and expert panel			Lectures, case studies, small group discussion, large group discussion, games, comics, review articles, videos, group research project and creation of informative slides**, peer assessment of research project**, and expert panel		
Disciplines Incorporated	Anatomy, Physiology, Microbiology, Cell Biology, Biochemistry, Genetics, Ethics, and Public Health			Anatomy, Physiology, Microbiology, Cell Biology, Biochemistry, Genetics, Ethics, Public Health, and Behavioral Science**		

* *EDS: High schools (HS) that have more than 45% of students receiving free or reduced lunch (see text for details).*
** *Indicates this occurs in summer 2021 only.*

day. Each summer had a theme, and the students attended a mixture of lectures, laboratories, and related activities exploring topics in medicine, basic science, social determinants of health, ethics, and clinical perspectives of medical practice. The program also contained a student-driven research component. A detailed description of the program has been previously published (Kemp et al., 2021).

Online Version of the Program. The online program was hosted using Google Classroom and its suite of tools in the summer of 2020 and the summer and spring of 2021. The program in summer of 2020 and spring 2021 was ~20% synchronous and 80% asynchronous, held over four days, and focused on medical microbiology, antimicrobials, and clinical perspectives (Hurse et al., 2021). The program in summer 2021 was ~30% synchronous and 70% asynchronous, held over five days, and focused on the nervous system and its integration with the other organ systems, the role of the environment, social determinants of health, behavioral health, neurodiversity, and neuroethics.

Students typically were expected to spend six to seven hours a day on the program, with five hours a day dedicated to asynchronous learning of materials organized in short modules along with formative assessments. The assessment served to allow students to test their knowledge and gain feedback and allow faculty to track participation and student content mastery. Students were given a suggested schedule but told that they could proceed with modules in whatever manner best fit their needs (Appendix A). This allowed students time to explore their interests around the topics and attend to responsibilities outside of the program. In order to promote further exploration, students were asked what they wanted to learn more about at the completion of each module. Faculty regularly reviewed student feedback and attempted to expeditiously provide resources for students to explore topics further through a class discussion board. Students were alerted to the synchronous sessions in advance with a schedule posted online. In the summer of 2020 and spring of 2021, synchronous sessions were held for one hour each morning and one hour in the afternoon of the fourth day. In the summer of 2021, the synchronous sessions were hosted for one hour each morning, one hour in the afternoon of the first day, and three hours in the afternoon of the fifth day. In addition, the group research project component was added back in the summer of 2021. Students worked with groups of four to five to further explore a topic of their choosing related to the theme of the nervous system and the brain. Students created a short informative slide deck (3-5 slides) regarding the topic instead of a poster. In lieu of presentations, students were expected to view and comment on the slides of at least one other group. A summary of the programs can be found in Table 1.

Participants. Recruitment of students in Michigan for both the online and in-person programs was through descriptive e-brochures sent to local schools and community organizations, as well as personal networks (Kemp et al., 2021). The admissions process differed for the two modalities. For the in-person program, participation was limited to rising sophomores, juniors, seniors, and recent graduates, and students submitted an application and two letters of recommendation. Participants were selected by a committee composed of faculty and staff from the medical school and Oakland University (Kemp et al., 2021). For the online program, interested participants were directed to a link that allowed them to input contact information and school information; once this was reviewed, participants were required to have their parents submit authorization paperwork and then sent a link to access the online classroom. Current freshmen, sophomores, juniors, and seniors were invited to participate in the spring program, while students that were entering high school in the subsequent fall, recent graduates, or currently in high school were invited to participate in the summer program.

Data Collection and Analysis.

Demographic Information. Students self-reported information regarding race/ethnicity, gender, high school, and current school grade for all years included in the study, with the exception of summer 2020, when gender and race/ethnicity were not collected (Appendix B - Tables 1 and 2).

While the US government identifies individuals of Middle Eastern, North African, and Arab backgrounds as white, research indicates that these individuals do not perceive themselves this way, and their lived experiences and the perceptions of others do not align with the designation of white (Awad et al., 2021; Maghbouleh et al., 2022). Therefore, those who identified themselves as a member of this group are reported separately from white individuals. Direct identifiers were removed from the data prior to analysis. The data were filtered by: (1) high school, (2) race/ethnicity, (3) gender, and (4) program completion. All data points were obtained from the registration form except the program completion, which was determined by comparing student attendance and assignment submissions (online component only). Students were expected to attend all synchronous sessions and complete all assignments unless given an excused absence. This information was provided by the administrators of the program. Schools attended were mapped based on geographical location.

End-of-Program Evaluation for Online Students. End-of-program evaluations were administered to students to solicit feedback on the appropriateness of the program, the quality of the modules, and participant interest and satisfaction. Data on satisfaction were reported regarding whether or not students believed the program to be beneficial for their future career path and if they found it to be interactive and engaging.

Publicly Available Information Utilized. The number of EDS, based on usage of free or reduced lunch, and URM in the state of Michigan for grades 9-12 were collected from the Michigan "School Enrollment Count Report" for the year 2019-2020 (*MI School Data Student Enrollment Counts Report*, 2022), the most recent year on record when this study was initiated.

The socioeconomic information for cities and counties where students attended school and the state of Michigan were collected from "The U.S. Census Bureau Quick Facts" website (last accessed December 2021), as these data were available and complete for the population (QuickFacts United States, 2020). Two researchers confirmed all information accessed from the websites.

Socioeconomic Scores (SES). SES for areas (city/town and county) surrounding the school of the participants who attended public schools were calculated using data acquired from the U.S. Census (*QuickFacts United States*, 2020): per capita (PC), percent of individuals with a bachelor's degree or above (BD), owner-occupied housing (OO), median house cost (MH), and percent of individuals 16 or older in the workforce (Work). Per capita was chosen instead of household income to capture the fact that individuals in large households could have their true available income per family member masked. Each was normalized to the state of Michigan data and then summed.

For comparison, each measure for the state of Michigan was normalized to a score of 1, resulting in a composite score of 5. The decision to calculate SES using these measures was made after reviewing recommendations by the National Center for Education Statistics that in addition to education level, work status, and income, a factor for owned wealth should be included (*Improving the Measurement of Socioeconomic Status for the National Assessment of Educational Progress: A Theoretical Foundation,* 2012). There was one town in the in-person cohort data for which the SES score was not available due to the low population. Analyses were not performed for the cities where private schools are hosted. Students can live in a number of areas outside of the cities where the private schools are located, and it was decided that this would not allow for an accurate representation of the student's environment.

URM and EDS Determination for Public Schools. School information related to race/ethnicity (African-American/Black, Hispanic, Native American, and Native Hawaiian/Pacific Islander), free or reduced lunch, and the total number of students was collected from the National Center for Education Survey (*Common Core of Data [CCD] America's Public Schools*, 2019). Free or reduced lunch information is not available for private schools, and therefore, these were not included in this analysis. Public schools were determined to have a high percentage of URM or EDS if the total percentage of students attending the schools exceeded the state percentages of 25% for URM students in 9th-12th grade, and 45% for students receiving free or reduced lunch in 9th-12th grade as reported from the Michigan School Data Student Enrollment Count year 2019-2020 (*MI School Data Student Enrollment Counts Report*, 2022), respectively. Based on these cutoffs, the data were converted to categorical (yes or no).

Statistical Analysis. The three cohorts of in-person students and the three cohorts of online participants were combined into two respective combined data sets. The total number for each data set was 98; however, some of the variables were missing for participants in the data set. Seven of the online students did not report their school, while one attended an online academy. These individuals were not included in the analysis. In addition, three of the public schools did not have publicly available information in the NCES database, and private school attendees were not included in much of the analysis. The sample for each test run is noted in the data tables found in the supplemental materials.

A Fisher's Exact test was used to determine if the variables tested were dependent on each other. A *chi-squared* test was run to determine if there was a difference in the distribution of the categorical values for two variables. The strength of association was calculated using Cramer's V for all analyses where a *chi-square* or Fisher's Exact test was run to measure the strength of association between variables. See Appendix B - Table 3 for test run and variables tested. A Kolmogorov-Smirnov test of normality was run to determine the distribution of the SES data for the cities of the public-school participants' high schools in-person and online. A Mann-Whitney U test was then run to determine if the SES scores of the cities varied when the program ran in-person and online. Test statistics and effect sizes can be found in the supplemental materials (Appendix B - Tables 4-7).

The alpha was set at 0.05 for each test performed with a confidence interval of 95%, two-tailed analysis for all tests. Two members of the research team independently ran all analyses. All analyses were performed using Microsoft Office Excel, online calculators hosted by Social Science Statistics (https://www.socscistatistics.com/) and Math Crackers (https://mathcracker.com/), and through SPSS Statistics software ("IBM SPSS Statistics for macOS,").

RESULTS

Changes in Geographical Diversity and Populations Occur upon Switching to Online. There were a total of 32 schools that we drew participants from when the program ran online and 33 schools when the program ran in-person. This led us to recruit a number of students from the same high schools in a given cohort. The participants' high school demographics were compared between the in-person and online cohorts. There was a shift in the geographical location of the participants' schools when the program switched to online (Table 2 and Figure 1). There was a statistically significant association between the counties where students attended school and whether or not the students attended the online or in-person program (p= 0.013). The online program allowed for an increase in students attending schools in Wayne County, a less affluent county with an SES score of 4.5, and decreased the percentage of students attending schools in Oakland County, a more affluent county with an SES score of 7.2 (Table 2). For reference, 5.0 was the composite average SES score for high schools in the state of Michigan (see Methods). The percentage of students from Macomb County (SES score of 5.3) was similar between the online and in-person cohorts.

Table 2. *The counties where students attend school change when switching from in-person to online.*

Counties	In-person n (%)	Online n (%)	p
Oakland	74 (76%)	56 (62%)	
Macomb	8 (8%)	7 (8%)	0.013
Wayne	8 (8%)	23 (26%)	
Other*	8 (8%)	4 (4%)	

* *The students attending schools located in counties outside of Southeast Michigan were combined into the "Other" category. Seven of the online students did not report their school, while one attended an online academy. These individuals were not included in the analysis. The percent shown is the number of individuals in each subcategory out of the number of students that participated online with data available(n=98) and in-person (n=90). Total percent may be over 100% due to rounding.*

CITY	SES	I-P	Online	CITY	SES	I-P	Online
Detroit	3.14	--	3	Auburn Hills	5.86	3	--
Pontiac	3.20	1	1	Grand Blanc	6.24	2	--
Center Line	3.69	--	1	Shelby	6.50	3	2
Harper Woods	4.17	--	2	Ferndale	6.89	--	2
Lansing	4.25	1	--	Macomb	6.95	1	--
Monroe	4.36	1	--	Oxford	6.95	5	3
Dearborn Heights	4.42	2	3	Washington	7.12	--	2
Madison Heights	4.77	--	1	Clarkston	7.44	1	--
Dearborn	4.87	1	15	Canton	7.48	3	0
Fraser	5.10	1	--	Farmington Hills	7.52	1	3
Flushing	5.18	--	2	Orion	7.59	1	--
White Lake	5.24	--	2	Rochester Hills	8.11	6	9
Marysville	5.27	--	1	Troy	8.30	13	6
Walled Lake	5.29	--	1	Novi	8.51	1	1
Southfield	5.44	--	3	West Bloomfield	8.62	5	6
Sterling Heights	5.48	2	1	Beverly Hills	10.25	2	--
Milan	5.50	1	--	Bloomfield	10.73	20	10
Lapeer	5.60	1	--	Birmingham	11.88	7	2
Norton Shores	5.60	1	--				

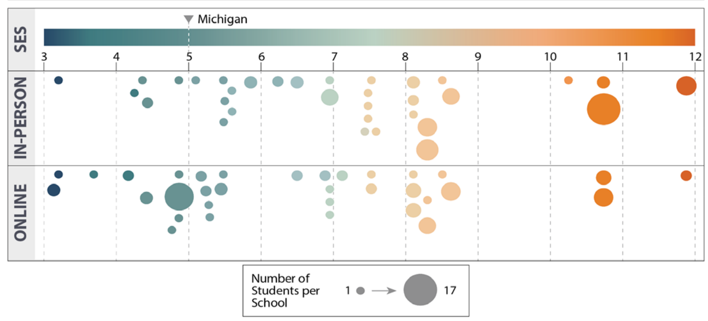

Figure 1. Online and in-person enrollment. Location of the public high schools and the SES scores of the cities in which they reside. The public high schools attended by students in-person (left) and online (right) are mapped. The SES score for each city where the high school is present is indicated by color, with orange representing a higher SES score or more affluent and green shades of color representing lower SES scores (see the key at the lower center of the figure).

The SES scores were determined for the cities/towns where the students' public schools were located. The locations of the participants' schools shifted from high SES areas to lower SES areas when moving online from in-person (median= in-person 8.3, median= online 7.0; p <0.001; Figure 1 and Table 3). Moreover, there was a shift in students attending the program from public schools located in cities with lower SES scores when comparing online and in-person within Oakland (median= in-person, 8.6 median= online 8.2; p= 0.018) and Wayne County median= in-person 6.2, median= online 4.9; p= 0.013) Interestingly, the population of individual cities within the counties was similar between the in-person and online cohorts, but the number of participants within the cities shifted (Figure 1). For example, 20 students attended from a school located in Bloomfield Hills Charter

Table 3. *The median SES scores for students attending public schools' changes when moving from in-person to online.*

	n	% of Total Enrollment	Median	IQR	*p*
All public school students					
in-person	82	84%	8.3	10.7-7.0	<0.001
online	87	89%	7.0	8.3-4.9	
Public school students within Oakland County					
in-person	68	69%	8.6	10.7-8.1	0.018
online	50	51%	8.2	8.6-7.1	
Public school students within Wayne County					
in-person	6	6%	6.2	7.5-4.9	0.013
online	23	23%	4.9	4.9-4.4	

Total percent may be over 100% due to rounding.

Township when in person, but this number decreased to ten when online. However, the number of students that attended a school in Dearborn, a less affluent area, in-person was one and increased to 15 when online.

High school students from all grade levels participated online, while when in-person, freshmen were excluded from participation, and most students were sophomores or juniors (Appendix B - Table 8). The percent of students attending public schools was similar between the online and in-person cohorts (90% vs. 84%, respectively); however, the number of students attending public schools with high percentages of URM or EDS students was higher in the online group (high online URM 28% vs. in-person URM 14%; high online EDS 36% vs. in-person EDS 8%), and the difference was statistically significant (p_{EDS}<0.001; p_{URM}=0.028; Table 4 and Appendix B - Figure 1). In addition, there was a slight decrease in the number of students attending advanced or accelerated (AA) programs (selected, magnet schools, international baccalaureate, or dual enrollment/early college schools) in the online cohort compared to the in-person cohort (Appendix A). Gender and race data were not collected in the summer of 2020, making it difficult to compare these metrics between the in-person and online cohorts. However, this data is reported in Appendix B - Tables 1 and 2.

School Type and Composition of the Student Body Did Not Affect the Completion Rate in the Online Program. The second question regarding the completion rate was answered using the existing convenience sample for the online cohort. Students attending a public school with high numbers of EDS or URM students completed the program at rates similar to those who attended schools with lower numbers of EDS (Table 5). Moreover, attending an AA program did not have a statistically significant impact on completion for public school students (Table 5).

Table 4. *There is an increase in participants who attend schools with high numbers of URM and EDS when moving from In-person to online.*

	In-person n (%)	Online n (%)	*p*
High URM	12 (14%)	22 (28%)	0.028
Low URM	75 (86%)	58 (73%)	
High EDS	7 (8%)	29 (36%)	<0.001
Low EDS	80 (92%)	51 (64%)	

Ten of the in-person students attended private school and one of the public high schools did not have data available in the NCES database. Seven of the 98 students that participated online did not report their high school, eight attended a private school, one was homeschooled, and two of the public high schools did not have data available in the NCES database. Total percent may be over 100% due to rounding.

Table 5. *Students had similar completion rates when participating online regardless of school type.*

	Completed n (%)	Incomplete n (%)	*p*
High URM	17 (77%)	5 (23%)	0.1053
Low URM	54 (93%)	4 (7%)	
High EDS	26 (90%)	3 (10%)	1
Low EDS	45 (88%)	6 (12%)	
AA	17 (89%)	2 (11%)	1
Standard	56 (89%)	7 (11%)	

There were 82 students that attended public schools, but data for two of the schools were not reported in the NCES database. Total percent may be over 100% due to rounding.

Participants that Complete the Online Program Have a High Degree of Interest in Medicine and Science. All participants were encouraged to take an end-of-program evaluation. Sixty-four students completed the end-of-program survey (response rate of 65%), and the demographics for those participants are in Table 6. Individuals were asked to report on their motivation for participating in the program, and 89% of participants indicated that they engaged in the program due to an interest in a science or health-related field. The remaining individuals participated because their parents encouraged them (5%), they wanted to review material or increase their knowledge (3%), or a teacher/counselor suggested they register (3%). Moreover, over 90% of students

Table 6. *Demographics of participants that completed the end of program evaluation for the online programs.*

Race/Ethnicity	n	Percent
Asian	18	28%
Black/African American	7	11%
Hispanic/Latinx	2	3 %
Middle Eastern/North African/Arab	15	23 %
White	15	23%
Multiple Identities Asian/Black-1 Asian/White-2 Black/Hispanic-3 Black/White-1	7	11%
Gender Identity	**n**	**Percent**
Female	47	73%
Male	12	19%
Prefer not to answer	5	8%

For Race/Ethnicity, participants were presented with the options in rows 1-5 and told to choose all options to which they identified. For gender identity, students were given the choice of female, male, and non-binary. Students also had the option of choosing other or prefer not to answer for both of these categories. Total percent may be over 100% due to rounding.

indicated a preferred career in a STEMM field after participating in the program, with 3% reporting a non-STEMM career (other). In addition, over half indicate physician (53% physician and 3% physician-scientist), as shown in Figure 2.

Participants that Complete the Online Program Have High Rates of Satisfaction. The end-of-program survey was used to assess participants' perceptions of the program. The program was well-received by the participants, reflecting previously published findings for the in-person program (Kemp et al., 2021). Ninety-four percent of participants strongly agreed or agreed with the statement, "I believe that participating in this program will be useful for my future career choice," median (IQR)= 5 (5-4). In addition, 89% of participants strongly agreed or agreed with the statement, "I found the program interactive and engaging," median (IQR)= 5 (5-4). Student responses to prompts on the end-of-program survey can be found in Appendix B.

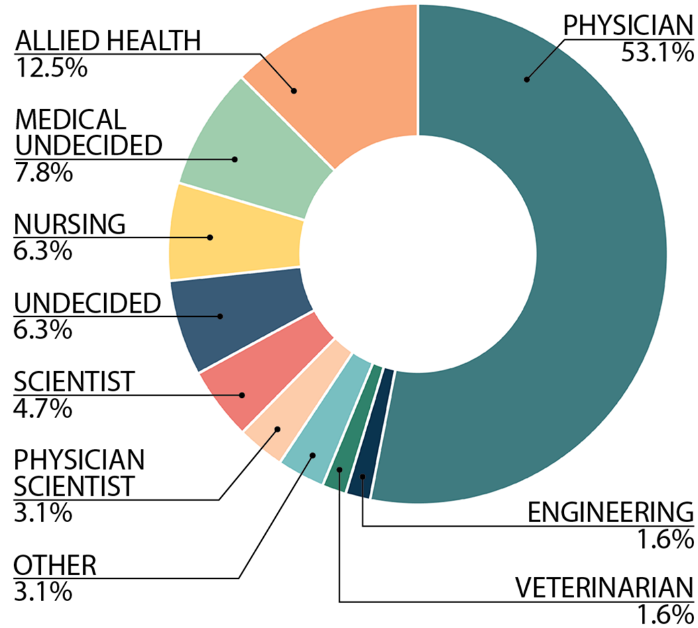

Figure 2. Potential careers of students that participated online and completed the end-of-program evaluation. Sixty-four students indicated their preferred careers. "Medical undecided" indicated that they mentioned multiple possible clinical paths (physician, PA, nursing, etc.) or indicated that their career would be clinically related, but they were unsure which field. The category "Undecided" refers to a similar response but without a medical focus. Those that indicated dentistry, physical therapy, optometry, occupational therapy, behavioral therapy, etc., were placed in the allied health profession.

DISCUSSION

Barriers to Engagement Remain. While there has been a concerted national effort to expose URM and EDS students to opportunities in biomedicine and medicine, numerous barriers remain. These barriers include, but are not limited to, lack of access to information about careers or advanced courses, program admission policies, transportation issues, and insufficient resources (Abdulrazzak et al., 2021; Estrada et al., 2016; Johansson et al., 2020; Kerr et al., 2018). A number of publications exploring barriers have focused on access to college. However, barriers to participation in supplemental educational programs or outreach programs may also contribute to this lack of matriculation into STEMM. Early exposure to medical and biomedical careers via outreach programs increases interest in these fields, sense of belonging, aspirations, and likelihood of entering degree programs that lead to careers in medicine and biomedical sciences. Moreover, participation in these programs provides opportunities for networking and mentorship that contribute to future success (Forrest et al., 2022; Fritz et al., 2016; Hollow et al., 2006; Patel et al., 2015). Such programs can also establish an early record of student interest in a health professional career.

During the seven years of in-person outreach programming, we identified potential barriers to participation. These barriers included the admissions process, capacity, and transportation, all of which limit the access of students with fewer resources. In addition, we identified the low socioeconomic and geographic diversity of participants as areas for improvement (Kemp et al., 2021).

In the summer of 2020, OUWB moved the summer outreach program online in response to the COVID-19 pandemic. A program evaluation after the third iteration revealed that moving online resulted in changes in geographical diversity and populations served (see Figure 1 and Tables 2-4). There was greater interest in participation from schools found in lower SES areas and a shift in the school type of the public-school students that attended (14% high URM in-person vs. 28% online; 7% high EDS in-person vs. 36 % online). Due to the program attendance policy, the completion rate of the in-person program was 100% (summer 2017-2019), as students were required to commit to attending every component of the program prior to completion. This is higher than when held online (88%); however, reported completion rates for online educational programs are notoriously low, unlike what is observed with the online program discussed here (Bawa, 2016; Jordan, 2015; Reich and Ruipérez-Valiente, 2019). While there was a moderate effect size regarding URM status of a school and completion rate (Appendix B - Table 7), there was no statistically significant difference in completion rate (URM p= 0.105; EDS p= 1). This indicates that students were able to successfully complete the program regardless of school type in the absence of a selective admission process. The end-of-program evaluation (response rate 65%) indicated there was a non-majority population regarding race/ethnicity, 22% of individuals reported a URM ancestry, and the majority of participants were female (see Table 6). This continues a historical trend for programming at OUWB where female participation is 70-80%. Gender-based differences in participation in pathway programs is an area in which future evaluation would be informative.

The researchers cannot definitively answer why there was a significant shift in participant geographical diversity. While the total number and population of schools recruited from were similar, the number of students from the individual schools varied between the in-person and online programs. There was no difference in recruitment strategy when switching from in-person to online. Moreover, any student that expressed interest was admitted to the online program. This is different from the in-person program where students had to apply and were selected by a panel. Seniors, juniors, and students who indicated that they were attending college were preferentially selected. Moving to an open acceptance policy may have helped contribute to increasing diversity as those with less impressive pedigrees were empowered to participate. This also may have led to a shift in who applied, as the change to remove the selection process may have lowered the value of the program to some individuals. It is also possible that individuals from schools that have high URM or EDS became inspired to enroll because they became more aware of health professions careers due to the COVID-19 Pandemic or that they felt inspired to participate due to increased time availability during the "shutdown." The majority of answers from participants on the end-of-the-program evaluation regarding why they chose to participate indicated that most participants enrolled due to an interest in health-related fields, and over 90% of students indicated a preferred career in a STEMM field. In addition, the comments of the participants on the end-of-program survey indicate that moving online may also help reduce barriers to participation.

How Moving Online May Address Barriers to Participation in Outreach Programming. The online format allowed us to address a number of limitations and previously identified barriers (Scott and Zerwic, 2015). Moving online led to an increase in the number of participants from geographical areas with lower SES scores. The majority of the in-person students attended schools in Oakland County, a relatively wealthy area with an SES score of 7.2, and many of the students attended public schools within this county, as shown in Table 2. After moving online, there was an observed increase in the participation of students attending schools in Wayne County (SES score of 4.5). This may be due to an increase in the accessibility of remote learning. Previously, students were required to provide transportation. This was a barrier for some students from areas with lower SES scores, leading them to decline invitations. Due to the COVID-19 pandemic, the State of Michigan and local school districts made it a priority to provide internet access and devices to students to promote hybrid or fully online learning in compliance with Michigan legislation (The State School Aid Act 94 of 1979). Thus, in the online format, all students who had internet access and devices were able to engage with the program. It is unknown at this time if districts will continue to support access to the internet and devices following the loss of emergency COVID-19 pandemic funds, which may affect future outcomes regarding online outreach programs. Census data prior to the start of the pandemic indicated that 89.2% of Oakland County residents have access to high-speed internet compared to 75.5% of those in Wayne County. Electronic access becomes even more disparate when we analyze city data. Only 64.4% of individuals residing in Detroit, the city with the largest population in Wayne County, have internet access, vs. 93.2% in Troy, the city with the largest population in Oakland County (*QuickFacts United States*, 2020). In the future, mobile hotspots or devices may need to be provided if public support of high-speed access wanes.

Modifications in the program's admission process may also have contributed to a reduction of barriers. The application process for the in-person outreach program required students to complete an online application that included two 500-word essays, an extra-curricular academic resume, an official transcript, and two letters of recommendation. In addition, students were required to have a minimum grade point average of 2.5 on a 4.0 scale, and there was also a non-refundable application fee of $25 for each student. This process previously favored students that were able to overcome these barriers.

At the beginning of the pandemic, the Diversity and Inclusion Office needed to rapidly adjust outreach programming efforts by moving them to an online format. In response, the admission process for the online program was modified; the application essays, recommendation letters, and fees were eliminated. Such changes may have reduced barriers to allow students from underserved schools and those of low SES to feel more empowered to participate, similar to the findings of Cheng et al. (2023). Moreover, a recent publication exploring barriers to STEM for Hispanic/Latinx youth reported that high school students identified fears regarding academic preparation and grades, financial issues, lack of mentoring, and lack of exposure as barriers (Johansson et al., 2020). Changing the selection process to be more equitable by not favoring students with more impressive academic and extracurricular profiles, may have contributed to the shifting demographics observed when the program moved online.

Finally, changes in the structure of the program may also have contributed to the shifting demographics. The structure of the program moved from two-week, eight-hour day synchronous sessions to a one-week program that consisted of a mixture of synchronous and asynchronous sessions (20-30% synchronous to 70-80% asynchronous). Details about the program structure can be found in a previous publication (Hurse et al., 2021) and Table 1. This allowed students with employment or other daytime commitments outside of the program to participate. Moreover, students were able to learn at their own pace as opposed to that of the group, and time was allotted during the assigned hours of the program for students to explore topics independently.

Students' Satisfaction with the Online Program. Similar to findings from Fung et al. (Fung et al., 2021) student comments and evaluations of the program indicated that the overwhelming majority of students found the online program engaging (89%) and useful (94%). It is clear from students' comments found in Appendix B that the guided self-paced learning approach and multiple learning modalities employed in the program were beneficial for students. Furthermore, because students were given time in the schedule to reflect and explore the topics further, students had the opportunity to engage in aspects of self-regulated learning related to goal setting, resource gathering, self-reflection, and evaluating their knowledge and limitations (Greene et al., 2015; Kesuma et al., 2021; Robinson and Persky, 2020).

Additional Challenges and Benefits Associated with Moving the Program Online. Transitioning from in-person to online learning can present some challenges, such as limited peer-to-peer interactions, reduced opportunities for faculty to observe student behavior during learning modules, and fewer hands-on experiences. To overcome these challenges, we introduced various methods for students to interact with each other, such as synchronous morning meeting sessions, asynchronous discussion boards, and group projects. We also engaged medical students as near-peer mentors to facilitate group discussions and provide resources for research projects. We monitored student engagement in Google Classroom through progress checks, quizzes, and interactive assignments to track their involvement and understanding of the material. We utilized learning analytics and data-driven insights to identify areas for improvement and provided timely support to struggling students. While online learning does not allow for in-person campus and lab tours, program experiences can be supplemented with virtual tours. Based on feedback, we recently developed programming that includes lab activities with guided videos and online repositories for data sharing, which we hope will increase peer-to-peer interactions. The asynchronous format allowed students to meet program requirements on their own schedules and increased diversity and flexibility for enrollees. Other observed benefits to the online format included things such as reduced costs, faculty contact time, and physical space requirements.

Limitations. Relating to the first question about the impact of program changes on the participation of EDS and URM students, one limitation resulted from the demographic data available. This data was self-reported and did not include race/ethnicity, home zip code, or gender identity. In addition, because the online program participants' home addresses were not collected, we relied on school demographic data as the best remaining indicator of demographic changes. We evaluated the differences in the SES scores of the city and counties of the school locations. This decision was made because school district populations were better represented by a wider regional demographic than the focused areas represented by school address zip codes. Ideally, each student's home zip code would have been the best indicator linked to SES. It is our current intention that this information will be obtained for future prospective studies of online program participation. An additional limitation of this analysis is that multiple students are enrolled in the program from the same school, and we do not account for the interdependence of student characteristics when multiple students are enrolled. Last, information regarding the school of origin was not available for seven of the online program participants, which reduced the statistical basis (n=90) for demographic comparisons. Our current intention is that this information will be obtained for future prospective studies of online program participation. Also, information regarding school of origin was not available for seven of the online program participants, which reduced the statistical basis (n=90) for demographic comparisons.

It is also possible that public school students could have been attending a school out of their assigned home district due to school-of-choice policies. Many public-school districts in Michigan allow school choice. This policy varies from allowing students to choose the school of their choice within the district to opening seats to children in adjacent cities or within the same intermediate school district if there is room available (Singer and Lenhoff, 2022). Data from a 2015 study exploring school-of-choice in Michigan indicated that roughly 13% of students participated in school-of-choice (DeGrow, 2017), with the majority of participants including students from low-income areas attending schools in high-income areas. This could result in a school having higher numbers of EDS students than the city where the school is located. In addition, one of the schools in the study has three campuses in Oakland County but reports the data as one school, and four high schools draw students from adjacent cities or townships in Oakland County with similar SES scores.

Regarding completion rate and satisfaction outcomes there was an unavoidable limitation resulting from the need to aggregate students by school type. Additional data will be instructive to link unique student characteristics to known completion rates and program satisfaction as a follow-up to aggregated outcomes by schools, as reported in this study.

Implications. There are numerous barriers to participation in supplemental educational programming. Offering an online high school outreach program with a modified admission process increased the number of students that participated from URM and EDS high schools when compared to historical data from in-person offerings. Student participants find the program to be useful and enjoyable. This work may benefit others engaged in outreach that seeks to increase participation from individuals in these demographics. The online outreach model may serve as an additional tool for ensuring the recruitment of EDS and URM students onto the STEMM pathway.

ASSOCIATED CONTENT

Supplemental material mentioned in this manuscript can be found uploaded to the same webpage as this manuscript.

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Author Contributions

DH, TT, and KK conceived of the project. DH performed data analysis and data interpretation and contributed towards the methods and results write-up; JG contributed to the figure design and writing the figure legends and methods, reviewed data extracted from public sites, and helped de-identify the data set; SKE contributed to the literature review and contributed to the introduction, results, and discussion write-up; TT contributed to the literature review and contributed to the introduction and data interpretation; TW helped clean and de-identify the data set and contributed to writing the methods, discussion, and results section; AF helped clean and de-identify the data set and contributed to writing the methods section; and KK developed the data analysis strategy, performed data analysis and interpretation, contributed towards writing the methods, results, discussion, and figure design, and wrote up the supplemental data. All authors were involved in editing the paper and approval of the final manuscript.

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ABBREVIATIONS

AA: Advanced or Accelerated; BD: percent of individuals with a Bachelor's Degree or above; D&I: Diversity and Inclusion; EDS: Economically Disadvantaged Students; HS: High School; MH: Median House Cost; NCES: National Center for Education Survey; OO: Owner-Occupied Housing; OUWB: Oakland University William Beaumont School of Medicine; PA: Physician Assistant; PC: Per Capita; SES: Socioeconomic Scores; STEMM: Science, Technology, Engineering, Math, and Medicine; URM: Underrepresented Minority; Work: percent of adults in the Workforce

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