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"Anyone Can Be a Researcher": Findings from the MYHealth Virtual Summer Research Training Program for High School Students from Historically Marginalized Groups

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ABSTRACT: Despite ongoing efforts to increase diversity in science, technology, engineering, mathematics, and medicine (STEM) fields, disparities persist. MYHealth Summer Launch is a virtual, out-of-school STEM outreach program aiming to increase participation of historically marginalized students in health research to develop researcher identity and science motivation. Thirty 9th-12th grade students were enrolled in the 10-day virtual program, where they learned research methods and engaged with academic researchers. We conducted a mixed methods evaluation to assess the feasibility and acceptability of the program, and the influence on researcher identity and science motivation. The evaluation included: 1) pre- and post-surveys measuring researcher identity and science motivation; 2) program participation; and 3) semi-structured interviews exploring program successes and challenges. Thematic analysis findings were integrated with quantitative outcomes (e.g., paired t-tests, linear mixed models) to evaluate program implementation. Students completed an average of 45.75 hours (48.75 hours max) of activities. Mean scores showed a statistically significant increase in researcher identity, intrinsic motivation, and science self-efficacy subscales. Salient themes included: 1) building community in an online environment; 2) exploring what it means to be a researcher. Future program offerings will build on these findings to foster researcher identity and motivation in this population.

INTRODUCTION

There is persistent exclusion of individuals from some identities and backgrounds in science, technology, engineering, mathematics, and medicine (STEM) fields and careers, which has resulted in underrepresentation in the STEM workforce (National Science Foundation [NSF], 2023). In this article, we use the terms "historically underrepresented" and "marginalized" to represent the collective, yet varied, experiences of groups that have faced pervasive barriers to STEM opportunities, education, and careers. This includes racial and minoritized groups in the United States, such as Black and African American, Latino and Hispanic, Asian, American Indian, and/or multiracial groups; women and gender minorities; those from economically disadvantaged or low-income backgrounds; people with disabilities; and those who have been otherwise excluded from STEM fields and careers. Other terms may also describe the collective experience of these groups, such as "powerful groups targeted by oppression," to recognize both the assets of communities and the intentional, systematic marginalization faced.

Equity in the STEM workforce is important for ensuring the quality, innovation, and impact of research and promoting the health and well-being of communities (Cohen et al., 2002; Swartz et al., 2019). Yet, women and other minoritized groups remain underrepresented in STEM. In 2021 women made up 51% of the total U.S. population between the ages of 18 to 74, yet only 35% of those employed in STEM (NSF, 2023). Despite representing approximately 19% and 14% of the total U.S. population respectively, only 15% of the STEM workforce was Hispanic or Latino and 9% was Black or African American. Meanwhile, White and Asian individuals make up a higher proportion of the STEM workforce than the general population (NSF, 2023). In addition, these disparities obscure the heterogeneity within populations and the unique and cumulative barriers that individuals from different backgrounds may face when pursuing STEM careers.

Disparities are also evident in universities, where those earning advanced degrees are disproportionately White. For example, the U.S. college-aged population (18-34 years) is 54% White, 6% Asian, 22% Hispanic or Latino, and 14% Black or African American. Despite representing 14% of the U.S. college-aged population, Black or African American recipients received only 12% of all STEM degrees earned in 2020, including 9% of all bachelor's degrees and 11% of master's degrees and 7% of doctoral degrees. Hispanic and Latino individuals, who made up 22% of the U.S. college aged population, earned only 17% of bachelor's degrees, 13% of master's degrees, and 7% of doctoral degrees awarded in STEM fields in 2020 (NSF, 2023). Likewise, less than 1% of STEM degrees earned in 2020 were among American Indian or Alaska Native recipients, a figure that has been declining over the last decade (NSF, 2023). While students from marginalized populations are attending college and increasingly earning more STEM degrees as a whole, gains in STEM education are inconsistent among degrees, fields, and identities (NSF, 2023).

Similarly, disparities in representation in STEM degrees earned and the overall STEM workforce are mirrored in health and medicine, where physicians are predominantly White and male. In 2019, the Association of American Medical Colleges (AAMC) reported that only 5.0% of physicians were Black or African American, while 5.8% were Hispanic or Latino and 17.1% Asian. Approximately 36% of all physicians were female (AAMC, 2018). While the number of female students in medical school now surpasses the number of male students, disparities by gender and race/ethnicity persist among groups historically underrepresented in medicine (Morris et al., 2021). For example, Black men and women made up only 2.9% and 4.4% of medical students in 2018 (Morris et al., 2021). Medical and STEM graduate students are also being taught by predominantly White faculty—less than 10% of U.S. medical school faculty (AAMC, 2019), and less than 9% of all STEM faculty positions are held by Black, Hispanic, or American Indian individuals despite representing about one-third of the U.S. population (NSF, 2021). Importantly, enrolling in advanced STEM training does not ensure that students from historically underrepresented backgrounds will graduate and become physicians or contribute to biomedical research.

Recently, there have been calls for research, training opportunities, and resources focused on supporting historically excluded and underrepresented groups in the STEM and biomedical workforces to nurture their STEM interest and address inequities (Hurtado et al., 2017; Rocha et al., 2022; National Institute of General Medical Sciences [NIGMS], 2011). These programs and resources are particularly important in adolescence, when students are exploring their interests, values, and career goals and disparities in STEM interest are evident (Anderson and Ward, 2014). Out of school experiences present an opportunity to provide STEM experiences and nurture interest in STEM among high school students from historically marginalized communities. A meta-analysis of out of school time programs demonstrate that they can have a positive effect on STEM interest, particularly when incorporating social goals (e.g., leadership, collaboration, connection to communities) beyond academic training (Young, 2017). In addition, summer and university-led STEM outreach programs have demonstrated success at increasing STEM interest among high school students. For example, Kitchen and colleagues' analysis of 27 university programs showed that, when controlling for student background characteristics, high school students participating in a university-led summer program had 1.4 times the odds of STEM career aspirations by the end of the program and 1.8 times the odds when the program emphasized real-world STEM experiences (Kitchen et al., 2018).

STEM outreach programs for high school students have successfully targeted student interest, self-efficacy, and pursuit of biomedical research careers through exposure to biomedical research careers, research training, near peer mentoring, and youth development (Qua et al., 2020; Rocha et al., 2022; Salto et al., 2014). Many of these programs occur in-person and through ongoing partnership between an academic medical center or university and local high schools. While impactful, these place-based programs may be limited in their reach and consequentially exclude students who are not located near an academic institution or lack regular or reliable transportation (Wozniak et al., 2023). We expect that a virtual STEM outreach program can address some of these gaps by increasing availability and accessibility of the program to a wider geographic area, and thereby students who may not otherwise be able to participate. In addition, we anticipate that virtual programming can provide more flexible scheduling options for high school students with competing responsibilities and opportunities and reduce the reliance on transportation and potentially long commutes.

In addition to pragmatic advantages, there is growing evidence that STEM outreach programs for high school students can be successfully implemented online (Hurse et al., 2021; Ufnar et al. 2021; Watts-Taffe, et al., 2021). Several programs that were adapted to online environments due to the COVID-19 pandemic have reported high levels of acceptability among high school students and positive impacts on student outcomes, including scientific knowledge, scientific identity, and comfort with scientific tasks. (Qua et al., 2021; Wozniak et al., 2023). Qua and colleagues describe how their SEO/YES program, which was rapidly adapted to be online during the COVID-19 pandemic, demonstrated similar results in student engagement, learning, research, and mentoring during both in-person and virtual years. In their evaluation, high school students indicated that many of the program components, particularly those with an emphasis on interaction and discussion between students and mentors, could remain online in the future (Qua et al., 2021).

MYHealth was designed to fill an identified need for STEM outreach programs to provide authentic and relevant STEM research experiences to grow interest in biomedical research among youth from historically marginalized groups. The virtual delivery was planned before the COVID-19 pandemic to enable a broader reach than in-person programs and connect students across geographic areas. The first phase, the all-virtual Summer Launch, introduces high school students to health research and health research careers in an effort to build interest in future research and STEM opportunities. The purpose of this study was to 1) evaluate the feasibility and acceptability of the first-time implementation of a 10-day virtual STEM program (Summer Launch) using participation in program activities and perspectives on participant successes and challenges, and 2) evaluate if MYHealth Summer Launch can influence researcher identity and science motivation in youth by measuring changes in these outcomes.

METHODS

Overview. MYHealth is a research training program focused on developing interest and persistence toward research careers among high school students from historically marginalized groups. The program consists of three consecutive phases, the Summer Launch, Impact Projects, and Peer Leaders. The Summer Launch is a 10-day virtual research training program that introduces high school students to research through interactive activities, lectures, discussions, and networking opportunities with academic researchers. Students learn about health research (e.g., research ethics, methods, design) and how research can have an impact on them and their communities. The second phase, Impact Projects, is an applied research experience in adolescent health that takes place during the academic year. The third phase, Peer Leaders, engages returning high school students as peer mentors for the next cohort of Summer Launch and/or Impact Project students. High school student participants can complete one or all phases of MYHealth, and recruitment and enrollment for each phase occurs separately. Figure 1 depicts the three phases, objectives, and approximate timelines.

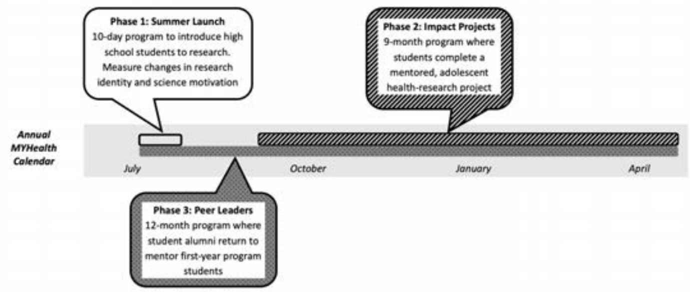

Figure 1. MYHealth program overview.

Here we focus on a mixed methods evaluation of the first year of the Summer Launch, which is described in more detail in the sections that follow and in the study protocol (Chuisano et al., 2023). We integrated quantitative (surveys at baseline and program completion; program engagement) and qualitative (interview) approaches to understand 1) the feasibility and acceptability of a 10-day virtual STEM outreach program and 2) how the Summer Launch impacted interest, motivation, and identity in research. The study was approved by the University of Michigan Medical School Institutional Review Board (HUM00213914).

Summer Launch Curriculum and Program Components. Each year, the Summer Launch lasts for 10 weekdays and focuses on building students' foundational knowledge in research, research ethics, and research methods. In addition, the Summer Launch program aims to build students' interests in STEM and research, their ability to see themselves as researchers (i.e., researcher identity), and their motivation towards science and research. Students learn about conducting ethical research and an introduction to qualitative, quantitative, participatory, and mixed methods research approaches.

In the 2022 offering of Summer Launch, 30 students met on Zoom daily for 4-5 hours each day alongside three program faculty (university faculty), program manager, one graduate and one undergraduate research assistant, and an external evaluator. In addition, all Zoom meetings were audio-video recorded. In most sessions, one or more additional research faculty or staff members from outside the MYHealth team joined for a "Researcher Chat," where they completed a Q&A with students on their path to research, their research interests, and a short presentation on a current research project. The Researcher Chats were designed to introduce students to researchers from diverse and historically marginalized groups, in addition to those with diverse training and contributions to research teams. For example, during the 2022 Summer Launch, nearly all researcher chats were led by women, people of color, first generation college students, children of immigrants to the United States, and/or members of other groups often excluded from research

Table 1. *MYHealth Summer Launch Sample Daily Agenda.*

Day 1	Day 2	Day 3	Day 4	Day 5
Introductions & Icebreakers - Live Poll & Discussion	"What Research Are You Interested In?" Collaborative Document	Researcher Chat (Social Work)	Researcher Chat (Family Medicine)	Researcher Chat (Nutrition)
"Introduction to MYHealth" Presentation	"Who Is A Researcher?" Myth vs. Fact Trivia Game	Ethical Treatment in Research Presentation & Trivia Game	Introduction to CBPR - Presentation & Discussion	Introduction to Qualitative Data - Presentation & Trivia Game
"What is Research?" Simulation with Text Messaging for Data Collection	Researcher Chat (Social Work)	Researcher Chat (Pediatrics)	Introduction to Data - Interactive Presentation	Introduction to CBPR (Part 2) - Presentation & Discussion
Shared Expectations Development - Collaborative Document	"Introduce Yourself" Presentation Party	Iterative Research Cycles - Presentation & Discussion	Researcher Chat (Informatics)	Researcher Chat (Surgery)

careers. Researcher Chats were led by researchers from a variety of disciplines and specialties including surgery, nursing, nutrition, pediatrics, endocrinology, biostatistics, family medicine, and social work. Researchers included physician scientists, social scientists, and other research team members (e.g., program manager, biostatistician, science communicator). In addition, students completed team building exercises and interactive activities to build community and learn about research in each session. A sample Summer Launch Agenda can be found in Table 1.

Participants and Recruitment. High school students were recruited in collaboration with community partners and youth-serving organizations to focus on enrollment of students from groups that have historically been excluded from research. We use a broad definition of underrepresentation and marginalization that includes race, ethnicity, gender, socioeconomic status, and disability. We also use an intersectional lens (Crenshaw, 1989; Velez and Spencer, 2018), to acknowledge the multiple, systemic ways that students may experience marginalization in STEM.

For the 2022 Summer Launch, we aimed to enroll 30 students. A recruitment flyer was distributed to local high schools through collaborations with school districts and individual emails to guidance counselors and science teachers. Interested students were asked to contact the research team to learn more about the study and provide informed consent. Participants under the age of 18 provided written agreement to participate and their parent or guardian provided written consent. To participate, students had to be a current or recent high school graduate (9th-12th grade in 2021-2022 academic year) in Southeast Michigan and able to join the program virtually. Students without access to a computer to join the program were provided with a laptop for the duration of the summer program.

Data Collection. At baseline and upon completion of the program, participants completed an online survey which included items on science interest, science motivation, and researcher identity (Aschbacher et al., 2009; Glynn et al., 2011; Wilson et al., 2022). Demographic information was also collected in the baseline survey. During the program, data on participation was collected. Upon program completion, a subset of participants was invited to participate in semi-structured interviews. Each of these methods are described in more detail below.

Program Participation. Program participation was evaluated using attendance at each activity throughout daily sessions as well as completion of independent online activities. Attendance was recorded every 30 to 60 minutes by reviewing who was logged into the Zoom meeting. For asynchronous activities, either 30 or 60 minutes of time, depending on the complexity of the task, was awarded for completion of the activity. Upon completion of the program, the total hours of potential activities were calculated.

Demographics, Science Participation and Aspirations. Information on grade, gender identity, racial and ethnic identity, and disability status were collected at baseline using multiple-selection questions (e.g., Which of the following best describes your gender identity? Please select all that apply.) Options for gender identity included female, male, transgender, genderqueer, agender, cisgender, or nonbinary. Participants could also indicate that they prefer not to answer or provide a gender identity not listed. Likewise, 17 racial and ethnic identities in addition to a self-describe option were provided in a similarly structured multi-select question. The MacArthur Scale of Subjective Social Status (where youth select what rung on a ladder they perceive themselves to be in) was used as a proxy for socioeconomic status (Goodman et al., 2001). Previous science participation and STEM interests were measured through self-report items in the Is Science Me? Questionnaire (Aschbacher et al., 2009). Items gauged participants' previous experiences with science-focused programming (e.g., "Have you ever attended a science camp or special science program?"), with college preparation ("Have you ever taken the ACT, PSAT, or SAT?", and with formal science education (e.g., "Have you ever had a science teacher who made it exciting to learn science?"). Students could select yes or no responses and for some items they could distinguish between a lack of interest versus a lack of availability to them. Additionally, students identified which STEM-related college majors they might be interested in majoring in on a defined three-point scale (very interested, somewhat interested, or not interested).

Researcher Identity. The Researcher Identity Scale measures students' agency, community, interest, aspiration, and self-perceptions as someone who can contribute to investigations about a topic (Koo et al., 2021), and has been validated for use with high school students as a Likert-scale and Guttman scale (Wilson et al., 2022). In this study, researcher identity was derived by averaging the Guttman scale answers to twelve questions (Wilson et al., 2022). When answering each question, respondents could choose from five text options, which translated to a numeric range from 1 to 5, where the first option (assigned the numerical value of 1 for analysis purposes) was the "lowest level" and the last option (assigned the numerical value of 5 for analysis purposes) was the "highest level". For example, "Which statement about being a researcher best captures your opinion of yourself? (1) I do not consider myself a researcher, (2) I probably do not consider myself a researcher, (3) I am beginning to consider myself a researcher, (4) I consider myself to be a student researcher, (5) I consider myself to be a professional researcher."

Science Motivation. Science motivation was assessed using the Science Motivation Questionnaire (SMQ-II) (Glynn et al., 2011), which measures components of students' motivation to learn science, and has been previously validated in several settings with youth (Bryan et al., 2011; Glynn et al., 2011). The SMQ-II consists of 25 items across 5 sub-scales: intrinsic motivation, self-efficacy, self-determination, grade motivation, and career motivation. Respondents rated the frequency with which they related to each item on a 5-point scale from never (1) to always (5). For example, items include "Science is interesting" or "I am sure I can understand science."

Semi-structured Qualitative Interviews. Upon completion of the program, we conducted follow-up qualitative interviews with a subset of program participants to understand their experience while participating in the program. The interview guide focused on identifying barriers and facilitators to participation and engagement, and opportunities for improvement in subsequent years of programming. Thirteen participants were invited to participate in the interview. Students were selected based on their interest in continuing into the next phase (Impact Projects) of the program so that a mix of students planning and not planning to continue in the program were included. Interviews were led by a member of our evaluation team (AA) and attended by one other member of the research team (SC, AA). Interviews were video-recorded and transcribed by Zoom, a HIPAA-compliant video conferencing platform. Transcripts were reviewed by the study team for accuracy.

DATA ANALYSIS

Quantitative Analysis. Selected participant sociodemographic and other background characteristics from the baseline survey were summarized using descriptive statistics (Table 2). Program participation is presented in Table 2 as the mean (SD) number of hours in in-session.

The variables "Interest in Physical & Applied Formal Sciences", "Interest in Life Sciences", "Interest in Social Sciences", and "Interest in Other STEM" were created by aggregating a list of STEM majors in the following way: chemistry, physics, earth sciences, engineering, computer science were categorized as physical and applied formal sciences; biology, pre-medicine, pre-veterinary, and nursing were categorized as life sciences; environmental studies and psychology were categorized as social sciences; and science education and other STEM were categorized as other STEM subjects. In addition, the three response categories were collapsed into two categories.

To test for differences in mean researcher identity and science motivation scores before and after the program, we used paired t-tests and Wilcoxon signed-rank tests. Due to the assumptions of the statistical tests used, the analysis is restricted to matched individuals who completed baseline and post-survey questionnaires (N=27).

To further investigate the statistically significant difference between pre- and post- survey mean researcher identity and science motivation scores, we used linear mixed models. The purpose of adopting this modeling approach was to observe whether there was a statistically significant increase or a decrease in the mean responses before and after the summer program. From a statistical modeling perspective, as opposed to using traditional linear regression, implementing a linear mixed model allowed us to incorporate random effects (RE), which can be used to account for a respondent or group-specific effect on the outcome. This approach can be used when the data have a nested structure (i.e., repeated observations nested within students or also, in this case, grades), which could result in the outcome being affected differently across individuals or groups, generating within and between individual/group variation. For each research and science indicator as an outcome variable, we ran three models: an individual random effect (RE) model, a grade RE model, and a model with both individual RE and grade as a fixed effect (FE). Each model included a binary pre/post-curriculum independent variable. In addition, linear mixed models have the advantage of dealing with missing at random data, thus allowing us to use the full sample of 57 observations, three observations more than the matched 54 pre-post responses.

Qualitative Analysis. Interviews were analyzed using an inductive, thematic approach (Braun and Clarke, 2006). Structural/domain codes were created in alignment with partici-

Table 2. *Pre-summer Program Sociodemographic and Background Statistics on Research and Science Indicators.*

Variable	Pre-program, N = 30[1]
Gender	
Female	24 (83%)
Male	4 (14%)
Cisgender	1 (3.3%)
Prefer not to respond	1 (3.3%)
Ethnic Background	
African American/Black	6 (20%)
American Arab/Arab American	15 (50%)
Other	4 (13%)
South Asian American	4 (13%)
White/Caucasian/European/European American & Japanese/Japanese American	1 (3.3%)
Grade	
9th grade	3 (10%)
10th grade	6 (20%)
11th grade	13 (43%)
12th grade	8 (27%)
Previous Exposure to a STEM Program	
Yes	10 (33%)
No	20 (67%)
Interest in Physical & Applied Formal Sciences[2]	
Not Interested	2 (6.7%)
Very/Somewhat Interested	28 (93%)
Interest in Life Sciences[3]	
Not Interested	1 (3.3%)
Very/Somewhat Interested	29 (97%)
Interest in Social Sciences[4]	
Not Interested	1 (3.3%)
Very/Somewhat Interested	29 (97%)
Interest in Other STEM[5]	
Not Interested	14 (47%)
Very/Somewhat Interested	16 (53%)
Interest in Medical Major[6]	
Yes	29 (97%)
No	1 (3%)
Interest in Medical Job[7]	
Yes	29 (97%)
No	1 (3%)
Family Member Went to College	
Yes	21 (70%)
No	9 (30%)
In-session Hours	
Mean (SD)	34.5 (7.2)

[1] n (%). [2]Physical and applied formal sciences include chemistry, physics, engineering (aeronautical, electrical, mechanical), computer science, earth and space science (geology, astronomy, etc.).
[3]Life sciences include biology (marine, plant, etc.), pre-medicine/pre-dentistry, pre-veterinary science, nursing.
[4]Social sciences include environmental studies, psychology.
[5]Other STEM include science education (teaching), other science-related major.
[6]Medical majors include biology, pre-medicine/pre-dentistry, nursing.
[7]Medical jobs include doctor/veterinarian/dentist, physical therapist, dental hygienist.

pant responses. Data were then categorized into structural/domain codes (e.g., "participation" and "challenges") in a spreadsheet. Four members of the research team (MD, SC, AA, AA) reviewed all the responses in each of the domains. Each team member took notes on preliminary themes that captured patterns across multiple codes. Themes were then discussed and finalized as a group. The themes are described below and paired with illustrative quotes to highlight shared experiences among participants. Quotes have been lightly edited for readability by removing filler words.

RESULTS

Participant Demographics. In 2022, 30 high school students completed the Summer Launch. Participant self-reported demographics are described in Table 2. Most participants were female (83%) and Arab/Arab American (50%), African American/Black (20%), or South Asian American (13%). The majority were in the 11th grade. Most participants (67%) indicated a lack of previous attendance in a science camp or club and an interest in a STEM or medical-related college major such as medicine (93%) or psychology (93%).

Program Participation. Thirty students enrolled in the Summer Launch program. Students attended a mean of 34.5 in-session hours (out of 40.75 hours total) with live facilitation of program activities. In addition, students completed an average of 45.75 out of 48.75 total possible hours of Summer Launch activities, which included the synchronous in-session and asynchronous post-session activities through our program website.

Pre- and Post-Surveys. Table 3 compares the responses to six subscales derived from a selection of pre- and post-summer program survey questions, showing means (SD), as well as the results of testing for statistically significant differences in the means using paired t-tests and Wilcoxon signed-rank tests. Both the paired t-tests and the Wilcoxon signed-rank test show statistical significance at least at the 5% significance level for researcher identity, intrinsic motivation, and science self-efficacy, while self-determination, grade motivation, and career motivation were not significant (Table 3).

Figure 2, below, depicts the change in participants observed via a linear mixed effects modeling approach. With respect to the Researcher Identity indicator, the results can be consistently interpreted as strongly statistically significant increases between 0.38 and 0.39 points in the post-curriculum mean scores. For the Intrinsic Motivation indicator, the results of the individual RE models can be consistently interpreted as statistically significant increases between 0.25 and 0.26 points in the post-curriculum mean scores. On the other hand, the results were not statistically significant in the

Table 3. *Pre- and Post-summer Program Summary Statistics and Tests of Mean Difference*

Variable	Pre-program, N = 27[1,2]	Post-program, N = 27[1]
Researcher Identity		
Mean (SD)	3.08 (0.53)	3.46 (0.67)
Paired t-test (95% CI)	*P*<0.001 (0.214, 0.570)	
Wilcoxon signed-rank test	*P*<0.001	
SMQ-II[3] Intrinsic Motivation		
Mean (SD)	3.89 (0.74)	4.18 (0.65)
Paired t-test (95% CI)	*P*=0.02 (0.049, 0.440)	
Wilcoxon signed-rank test	*P*=0.02	
SMQ-II Self-Efficacy		
Mean (SD)	4.01 (0.64)	4.29 (0.53)
Paired t-test (95% CI)	*P*=0.03 (0.031, 0.480)	
Wilcoxon signed-rank test	*P*= 0.02	
SMQ-II Self-Determination		
Mean (SD)	4.02 (0.71)	4.10 (0.67)
Paired t-test (95% CI)	*P*=0.77 (-0.194, 0.261)	
Wilcoxon signed-rank test	*P*=0.73	
SMQ-II Grade Motivation		
Mean (SD)	4.47 (0.81)	4.52 (0.70)
Paired t-test (95% CI)	*P*=0.57 (-0.129, 0.230)	
Wilcoxon signed-rank test	*P*=0.47	
SMQ-II Career Motivation		
Mean (SD)	4.44 (0.61)	4.45 (0.56)
Paired t-test (95% CI)	*P*=0.79 (-0.148, 0.193)	
Wilcoxon signed-rank test	*P*=0.47	

[1]n (%).
[2]The number of pre-program responses is 30. However, for paired t-tests, only the paired responses could be used, which was 27.
[3]SMQ-II: Science Motivation Questionnaire-II.
SD: standard deviation; CI: confidence interval.

model using a grade RE. The results for the Self-Efficacy indicator's individual RE models can be consistently interpreted as a statistically significant increase of 0.27 points in the post-curriculum mean scores. The grade RE model shows weaker significance, with a mean score increase of 0.29 points that was only significant at the 10% significance level. None of the model results for Self-Determination, Grade Motivation, and Career Motivation were statistically significant. Overall, the linear mixed models confirm the pattern of results of the pairwise t-tests and Wilcoxon signed-rank tests.

Interviews. Of the thirteen students invited, ten completed interviews. Six of the interview participants indicated an interest in continuing with the academic-year program, whereas four indicated that they were not. Overall, participants had a positive view of the Summer Launch program. Salient themes included: 1) building community in an online space; 2) exploring what it means to be a researcher.

Theme 1: Building Community in an Online Environment. Students described how participating in the program allowed them to be a part of a community over the summer. In this community, students interacted with new people (e.g., "...I really liked how we were able to meet with a lot of new people"), learned about research and research careers, and had a sense of purpose. Several participants described how the Summer Launch provided a unique opportunity to learn about research outside of school and over the summer break, when they would not otherwise. One participant explained:

> *I like participating in it, because it gives you something to do during the summer… I felt like instead of sitting at my house, instead of playing video games or watching YouTube on my phone, it's good to interact with other people, seeing other people's perspectives about work and college and stuff like that you know.*

As another participant summarized: "I really, really enjoyed it and I felt it was also very beneficial to me to keep my mind… active and challenged throughout summer break." For many, belonging to the community was in line with their educational and career interests (e.g., "stuff that might help me in the future") and they were able to meet other high schoolers with similar goals: "I believe I met some friends and some learned about topics and jobs I've been considered before, and especially in the research aspect of things."

Participants described how daily interactive activities and icebreakers helped them to feel comfortable with the group. For example:

> *I like…really interactive activities and how we would do an icebreaker in the beginning. And I also really like how even though it was really, I think, awkward at first, because none of us really knew each other. For the end, we all had these inside jokes and kind of felt like we've known each other for weeks and weeks and weeks. And I also feel like that's a really hard connection to have online, not even like in person it's hard to have, but the fact that we did it online in just two weeks is amazing.*

Also, "I feel like [the icebreakers] got me and more comfortable with unmuting my mic and talking to people and, building relationships with the faculty leaders and the other students with me." They described having a positive view of hands-on activities where they can contribute, discuss, and see others' opinions in real-time.

> *Also the slideshows that were prepared and that told us more about research like qualitative data versus quantitative data, and when we broke into different breakout rooms and we kind of designed our own things based on different types of data techniques.*

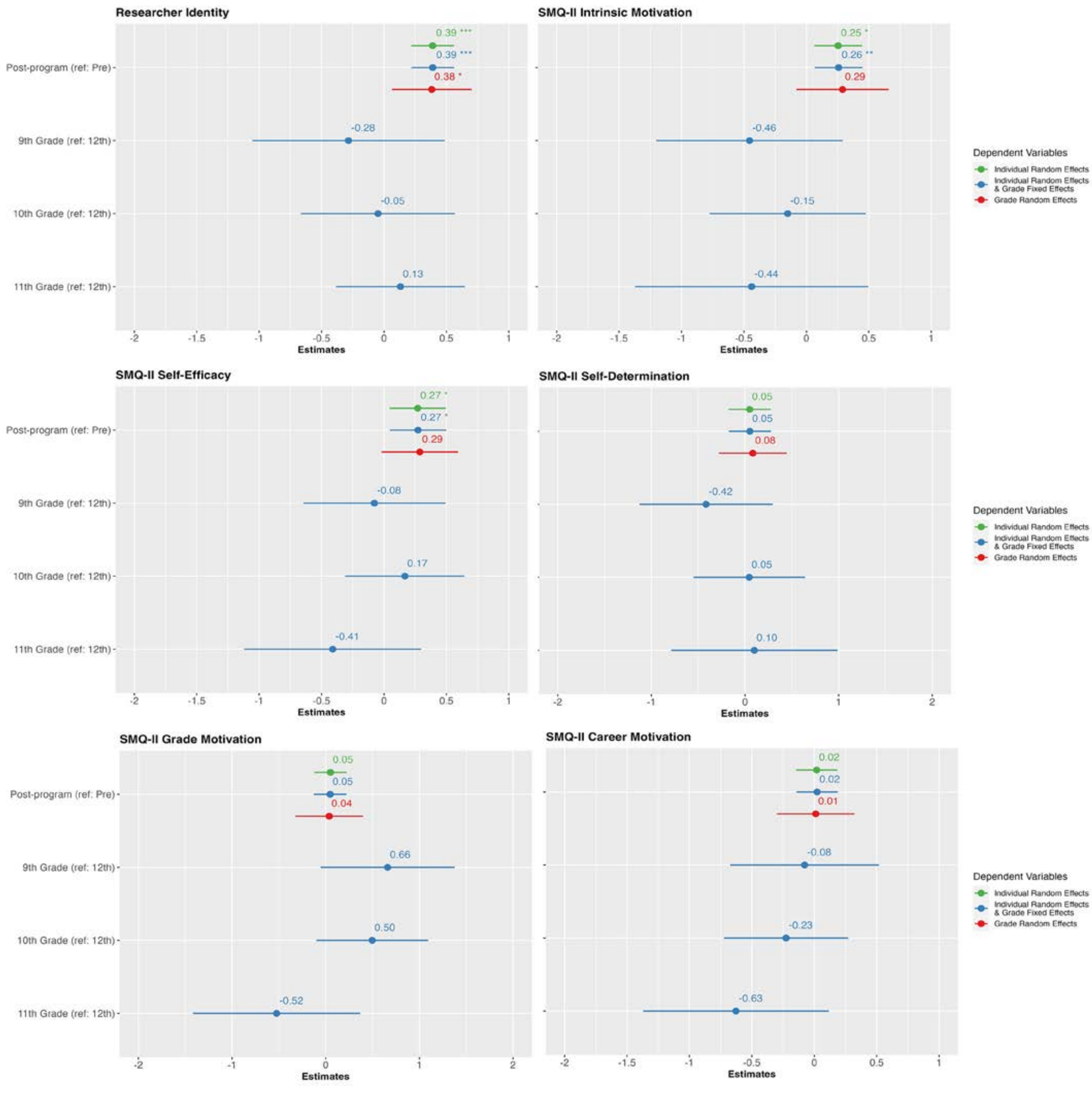

Figure 2. Linear mixed models for researcher identity and science motivation.

> *Like when we got to do stuff by ourselves in small groups, it was really cool because you get to use what you learned with the slideshows and then apply it yourself.*

Summer Launch participants largely advocated for diverse forms of communication (i.e., use of cameras, microphone, and chat) during norm setting sessions. Despite this, participants noted that there were still barriers to engagement in the online setting.

> ...[M]*aybe in the beginning with the ice breakers and more on our part, we were just very shy, the students in general, with the opening our cameras we didn't seem to open our cameras throughout the whole experience, but we did start unmuting our mics I just feel like there was a barrier, because we are on Zoom that was the only thing.*

During activities, small group breakout rooms were used to try to encourage participation among those who may have felt uncomfortable in the larger group. Still, some noticed limited engagement in the small groups as well.

Sometimes, like when nobody would speak, especially in the small group, it would be really awkward… It probably be me and one other person and we'd be like hey guys, what do you think about this and then we'd get no response and I'm going sometimes we get it in the chat but I wish there were more verbal or physical or more faces and more eye contact. So that's why I wish that we had all, including me, I wish I had turned on my camera more, and I wish other people had at us as well.

When we get separated into breakout rooms, sometimes I felt like there wasn't a lot of interaction between the other students because, like nobody, not nobody, was there, like it was rarely anybody pushing each other to do the activity.

One interview participant noted that gaining comfort speaking in group settings is a valuable skill that should be encouraged: "I think, maybe there are some things like again with, speaking out in front of everyone that could have made people nervous, but I think it's a good thing to kind of get used to that…"

To improve engagement in the virtual program, interviewed participants recommended including more interactive, hands-on activities and frequent breaks. Interactive activities included those where students were actively completing a task or participating in a group discussion, both in small and large group settings. During the Summer Launch, activities included brainstorming and discussion alongside use of online tools, such as Jamboard, Padlet, and Google Docs. One participant explained how they were pulled back into engagement through interactive activities: "I felt like during the times where I wasn't focused, the main thing that pulled me back in was the more hands on activities, like we respond to something or where we interact with the speaker…"

Theme 2: Exploring What It Means to Be a Researcher. The majority of interviewed youth were interested in research and/or careers in the medical field prior to their participation in the Summer Launch. Through the program, youth shared that they were at least the same if not more interested in those fields. One youth said,

I think honestly anything medical to me has always been interesting, so in the future, eventually, [I] *want to do something in the medical field, so I guess it hasn't really changed subject wise, but I'd say just my interest has grown more.*

Others shared that they would recommend the program because it opened their understanding of research. For example:

I definitely would to anyone who is interested in science, medical [research] *or anything along those lines. It really kind of opened my eyes to the importance of research and how it's not a certain person that can conduct research. Everyone can do* [research], *which was really eye opening for me.*

Another youth agreed that their conception of who could be a researcher expanded during the program:

We did an icebreaker in the beginning about what we thought research was and mine was very stereotypical like everyone else's, the lab coat with the glasses, older… it's one path as a career, but I learned that research was in any career, you could be a researcher, while being a doctor or being a scientist or anything and it's very helpful and it's not the one certain type of person that does it, anyone is able to do it.

For Summer Launch participants, Researcher Chats were a vehicle to learn about what researchers do and who can conduct research. Participants enjoyed the opportunity to build connection with academic researchers. They engaged in real, informal conversations with researchers, which enabled them to see each researcher's own path to their career. One participant described their impression of a Researcher Chat with a transplant surgeon: "He made it more personal. It wasn't just him giving information about just what he studies, but he kind of talked about what his own experience was which I really like to hear about." In addition, some participants described how they connected with the content areas that researchers studied: "One of the speakers that we had… she talked about social justice issues within the Black community and that was something I was very much interested in." Another participant noted how researchers were passionate about their research interests and their careers, which helped them to see research as a viable career path:

They were very enthusiastic and passionate about what they talked about which was really interesting… I really like to see that because I always hear how people say they hate their jobs or how they wake up in the morning, they don't want to go, but they all seem so passionate about their jobs and how much they love.

To prepare for the Researcher Chats, students were asked to spend time getting to know each presenter through their online profile. One participant explained:

We had these post activity sessions, where we would do a little research on them and ask and read about them before we got to know them, which was, I thought really smart I've never done anything like *that, before because I got to know the person before really talking to them like reading their page on machine the University of Michigan and just getting to know them.*

DISCUSSION

Thirty high school students participated in a 10-day virtual STEM outreach program during summer break. Despite being virtual, Summer Launch participants demonstrated a high level of participation across the duration of the program, with students attending an average of 85% of the program activities. Compared to before Summer Launch, students reported an increase in researcher identity and aspects of science motivation, including science self-efficacy and intrinsic motivation. Increases in researcher identity and science self-efficacy were supported by qualitative findings that showed the development of a community of peers and increased understanding of research and who can participate in research. Taken together, our findings show that high school students from historically underrepresented communities increased their interest in STEM through the 10-day virtual program.

A growing field of research has investigated the role of identity in STEM—or the ability to see oneself as capable of and belonging in STEM—in ongoing disparities in STEM educational outcomes, college matriculation, and careers (Chemers et al., 2011; Simpson and Bouhafa, 2020; Syed et al., 2019). Relatedly, researcher identity, or the ability to see oneself as conducting and contributing to research, has been posited as a potential mechanism contributing to interest and persistence toward STEM careers. Research has found that girls, young women, and youth of color are less likely to see themselves and their future selves as compatible with STEM, despite having the same skills and propensity for science as their peers (Calabrese Barton et al., 2008; Hill et al., 2017; Kalendar et al., 2019; Kang et al., 2019). STEM outreach programs for high school students from underrepresented groups have the potential to positively impact students' researcher identities by providing meaningful, authentic, and positive research experiences and mentorship (Basu and Calabrese Barton, 2006). For example, one such program, San Francisco Health Investigators, demonstrated an increase in researcher identity among high school students through a year-long community-based participatory research project that emphasized belonging in peer relationships and the larger research community (Koo et al., 2021). Their findings also support the importance of building community among students who are marginalized in STEM outreach programming (Koo et al., 2021). Using a similar model of research training and mentorship alongside a community of peers, students in MYHealth also increased their sense of belonging and identity in research.

We also found that a virtual research training program can increase aspects of science motivation, specifically science self-efficacy and intrinsic motivation, which is consistent with meta-analyses of STEM outreach programs (Young et al., 2017). While other aspects of science motivation were measured, only self-efficacy and intrinsic motivation were statistically significant. Introductory training and applied activities in health research concepts, including research methods, research ethics, and study design, may explain improvement in science self-efficacy. In the qualitative interviews, participants described their understanding of study design, including how researchers develop research questions, collect data, and analyze their findings.

Qualitative findings also suggest that the curriculum's focus on engagement and networking with a community of peers (through icebreakers and group activities) and academic researchers (through facilitation by faculty leaders and presentations during Researcher Chats) may have positively contributed to researcher identity, science self-efficacy, and intrinsic motivation in science among participants. This finding is not surprising, as Summer Launch aims to leverage supportive peer and mentoring relationships to engage and motivate students in the program. Existing literature has described the importance of peer relationships and community support in STEM self-efficacy, motivation, and researcher identity (Jacquez et al., 2020; Koo et al., 2021; Trujillo and Tanner, 2014; Usher et al., 2019). Research suggests that youth of color, and those from low-income or other marginalized backgrounds may have fewer opportunities to participate in formal science experiences and receive STEM mentorship. In outreach programs focused on STEM outreach opportunities for marginalized youth, relational components may be particularly important in helping youth to feel connection and belonging in research (Basu and Calabrese Barton, 2006; Rocha et al., 2022). By promoting community-building alongside authentic research experiences, youth can practice research learning and see themselves as capable of research. Additional research is needed to examine the impact of specific Summer Launch program components on aspects of science motivation.

Future phases of the overall MYHealth program include an academic year program ("Impact Projects") that students can participate in following completion of the Summer Launch. The Impact Projects phase is designed to directly build upon emergent interest in health research and support students to be co-researchers in a real-world, ongoing study of adolescent perspectives on health-related topics (DeJonckheere et al., 2017). Grounded in participatory research principles, the Impact Projects will scaffold students through an applied research experience, including survey design, qualitative data analysis, and academic dissemination. As a result, students will have future opportunities to nurture their interest in health research, build self-efficacy through applied and authentic research experiences, and receive additional mentorship and guidance from research team members. Following the academic year phase, alumni will be invited back to participate in a second year of STEM outreach programming—this time as peer leaders who engage the next cohort of high school students in research training and activities, with emphasis on near peer mentoring, research training and facilitation, leadership, teamwork, and building a community of researchers.

Limitations. Participants who enrolled in Summer Launch chose to participate in an out-of-school, virtual opportunity focused on health research during their summer break. Not surprisingly, participants reported a high level of interest in STEM careers upon enrollment. Previous research on informal STEM programs has demonstrated similar self-selection biases (Vallett et al., 2018). However, this may also underscore our quantitative findings as conservative estimates of impact, in that Summer Launch fostered significant change along several dimensions, despite attendees beginning the program with a high level of STEM interest. Future research should investigate whether out-of-school STEM outreach programs can grow interest among those who may have lower STEM interest upon enrollment; such programs may also demonstrate even stronger impacts on STEM interest, given more "room to grow" among a more normative population.

Our purposive sampling strategy for the qualitative interviews was to recruit two groups of Summer Launch participants: those who intended to continue with the MYHealth program during the upcoming academic year and those who did not. Most of the participants who were eligible to participate (i.e., high school students during the upcoming academic year) indicated an interest in continuing. Still, it is possible that the participants we spoke to had experiences in the Summer Launch that were different from those who did not complete an interview.

Our quantitative analyses included the 30 students who participated in the first-year implementation of the Summer Launch and allowed us to evaluate changes in mean scores on study outcomes. The sample size in this study is comparable to or higher than similar evaluations of out-of-school STEM outreach programs for high school students (e.g., Nation and Muller, 2023; Wozniak et al., 2023). Thematic findings further elaborated our quantitative results, highlighting that high school students found community and an emerging understanding of the diverse ways that they could contribute to research. After multiple years of programming, we will also be able to compare mean differences in program outcomes across participant characteristics, by pooling data from multiple cohorts of participants.

MYHealth Summer Launch took place over 10-days, and post-program data was collected during the last hour of programming with very limited capacity to collect any long-term follow up data. As a result, we are unable to detect the long-term impact of this STEM outreach program. Future iterations of our program will benefit from longitudinal data collection to examine the impact of health research training over time.

CONCLUSION

In MYHealth Summer Launch's first year, participants from historically underrepresented groups were engaged with and experienced benefits from the out-of-school program, including an increase in researcher identity. Students demonstrated increases in researcher identity and aspects of science motivation, including science self-efficacy and intrinsic motivation, which were triangulated by our qualitative findings - which also underscored the importance of a community of peers in STEM outreach programming for students who are marginalized. Notably, these changes were observed despite a relatively short program duration and despite participants entering the program with initially high levels of STEM interest. Future program offerings will integrate insights from our initial cohort of co-researchers and continue partnerships to foster researcher identity in this population

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ABBREVIATIONS

AAMC: Association of American Medical Colleges; FE: Fixed Effect; NIGMS: National Institute of General Medical Sciences; NSF: National Science Foundation; RE: Random Effect; SMQ: Science Motivation Questionnaire; STEM: Science, Technology, Engineering, Mathematics, and Medicine

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