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A Drug Discovery and Biomedical Research Training Program for Underserved Minority Youth

Adel Karara[1], Anjan Nan[1], Yen Dang[1], and Rekha Shukla[2]

[1]School of Pharmacy and Health Professions, University of Maryland Eastern Shore, Princess Anne, MD and [2]Barbara Goldberg & Associates, Wilmington, DE

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ABSTRACT: The Maryland Action for Drug Discovery and Pharmaceutical Research (MADDPR) Program provides hands-on lab experience and mentoring to underserved minority high school students. Over 4 years, 93 high school students and their science teachers participated in the two-week summer camp program which was led by 15 faculty from the School of Pharmacy. Graduate student mentors led small student mentor groups. The program offered labs with a diverse set of topics ranging from drug design to applied clinical pharmacy. Across study years, student data showed that Black/African American, Hispanic and "Two or more races" groups accounted for 40, 13 and 11% of students, respectively. Survey data from pre- and post-sessions show that the MADDPR program significantly influenced students' career choices with most opting to choose future careers in life sciences, pharmacy and pharmaceutical sciences. Data from a demographically matched comparison group showed that the MADDPR respondents reported statistically significant higher levels of agreement with the statements "I know I would like to pursue a STEM career" (p=0.00424) and "I know I would like to pursue a biomedical science career" (p=0.0004) compared to a comparison group. The MADDPR program is supporting the STEM career exploration by minority underserved high school students to ultimately enhance the diversity of the biomedical workforce.

INTRODUCTION

Despite efforts to increase diversity in the biomedical sciences, the underrepresentation of Black, Hispanic, and Native Americans in the biomedical career workforce remains evident. A recent cross-sectional study comparing the racial/ethnic diversity among 10 health care professions found that Black, Hispanic, and Native American people were underrepresented compared with their representation in the general population (Salsberg et al., 2021). Most Americans value workplace diversity (Horowitz, 2019) and there is evidence that diversity in the biomedical sciences increases workgroup/team innovation and creativity (Valantine and Collins, 2015). Also, data shows that underrepresented groups produce higher rates of scientific novelty (Hofstra et al., 2020). Hinton et al. (2020) recommended actions to curtail disparities that included: 1) early exposure, 2) access to resources, 3) supportive mentoring networks, and 4) comprehensive training programs. Data shows that research-based experiences for high school students outside the classroom setting may contribute to the increased recruitment of underrepresented students into biomedical and science related fields (Rohrbaugh and Corces, 2011; Patel et al., 2021; Witzel, et al., 2020). Students who develop an interest in STEM tend to be more engaged by extracurricular and hands-on laboratory experiences (Lemelson Foundation, 2010; Yonezawa et al., 2009). Data shows that these hands-on laboratory experiences results in the development of critical thinking and problem solving skills and, ultimately, enhanced students' interest in STEM education and careers (Alcéna-Stiner, 2020; Hernandez-Matias, 2020; Pender, 2010; Russell, 2007; VanMeter-Adams, et al., 2017).

In this paper we report on four years of collective data from a high school summer research training program at the University of Maryland Eastern Shore (UMES) School of Pharmacy. The Maryland Action for Drug Discovery and Pharmaceutical Research (MADDPR) is a partnership program between the UMES School of Pharmacy and high schools in Somerset County, MD. Somerset County is one of the most rural and underserved areas in Maryland. Ethnicity/race data shows that Black/African American, American Indian, Hispanic comprise 41%, 0.5 % and 4.1%, respectively

of the population (US Census Bureau, 2021). Nearly a quarter (24%) of county residents are in poverty per the most recent US Census data, as compared to 11% of the US population (US Census Bureau, 2021). Minority and underserved youth residing in rural areas and coming from families of low socioeconomic status have few, if any, opportunities to experience the research methodology and tools used in drug discovery and biomedical research. UMES is a historically black college or university (HBCU) founded in 1886 and is among the institutions of higher education in the United States established before the Civil Rights Act of 1964 whose purpose is to serve the African American community. UMES School of pharmacy is one of seven HBCUs in the country with a pharmacy doctoral program. (University of Maryland Eastern Shore, n.d.).

Our program was anchored on building a strong relationship with the Somerset County Public Schools District teachers and administrators. This started early on with the program investigators forging a working relationship with teachers. One of the program investigators had been a longtime volunteer with the Maryland Business Roundtable for Education Program (MBRT.org, 2023) at Washington Academy High School, Princess Anne, MD. The program investigator visited 9-10 grader classrooms and engaged students in participatory exercises intended to promote their interest in the pharmacy profession and to motivate the student to choose more rigorous coursework at their high school to succeed in college and the workplace. These early experiences with students and teachers resulted in the building of trust and credibility which are important qualities when needing to build a partnership. Another experience was important for setting up the current project. Prior to the start of the project, the UMES School of Pharmacy conducted a successful pharmacy boot camp for local high school students. The program investigators participated in that camp and offered a lab exercise in pharmaceutical compounding. The lab involved the students' compounding ingredients for salicylic acid capsules and conducting quality control testing on the final product. The students were so excited and proud of their final pharmaceutical product they wanted to take it home to show their parents, but that request could not be accommodated as that would be against regulations. Both program investigators were impressed with the level of enthusiasm and engagement of the students throughout the lab exercise. The students were focused and exhibited maturity levels quite like the professional Doctor of Pharmacy students who are given essentially the same lab exercise. It was that experience that convinced the program investigators and was the motivation behind forming a partnership with Somerset County Public Schools to bring drug discovery and biomedical research methodology training to the minority underserved youth in our area.

The MADDPR program's main objectives are: (1) to deliver, evaluate and disseminate a curriculum comprised of a series of interactive STEM modules providing hands-on training in research methodology in the areas of drug delivery and biomedical sciences to high school students; and, (2) to implement a mentoring program for the high school students to provide support during and after curriculum delivery (Karara et al., 2021). MADDPR seeks to train minority youth in research methods of drug discovery and biomedical sciences and to motivate them to pursue higher education and careers in applied healthcare fields and biomedical research, with the support of near-peer mentors who are graduate students in the UMES School of Pharmacy (Karara et al., 2021). Partnering with "Project Lead the Way (PLTW 2023)" science teachers, an integrated curriculum was developed that builds on Somerset County's high school biomedical program. PLTW comprises four fundamental courses offered to sophomore, junior and senior high school students: 1) Principles of Biomedical Science, 2) Human Body Systems, 3) Medical Interventions, and 4) Biomedical Innovation. MADDPR's two-year curriculum links the PLTW curriculum with hands-on training modules in drug discovery and biomedical research led by experienced pharmaceutical researchers. Over the course of the two-year program, participating students experience an array of hands-on lab modules designed with PLTW teacher input. MADDPR participants also receive ongoing support from near-peer mentors who are mostly minority graduate students in Pharmaceutical Sciences. Overall, the program outcome is a participatory research training program designed to stimulate the students' interest in and pursuit of pharmaceutical, health related and biomedical research careers, ultimately enhancing the diversity of the biomedical workforce.

METHODS

The MADDPR program is designed to offer hands-on training in research methodology and advanced tools used in drug discovery and biomedical research. The program is offered to high school students over the course of a 2-year span, where the students perform hands-on lab experiments covering a wide range of topics described in the schematic shown (Figure 1).

Setting and Program Transitions (Years 1-4). The inaugural program in 2019 was conducted at the School of Pharmacy on the UMES campus and included a 1-week summer camp and several half-day sessions in the Fall of 2019. With the outbreak of the COVID-19 pandemic, the program transitioned into an online offering for the Summer of 2020 (Karara et al., 2021). Because of disruptions in school schedules, the half-day sessions were folded into the one-week camp activities starting in 2020 and subsequent years. In 2021 the program resumed its hands-on and in person format, like the

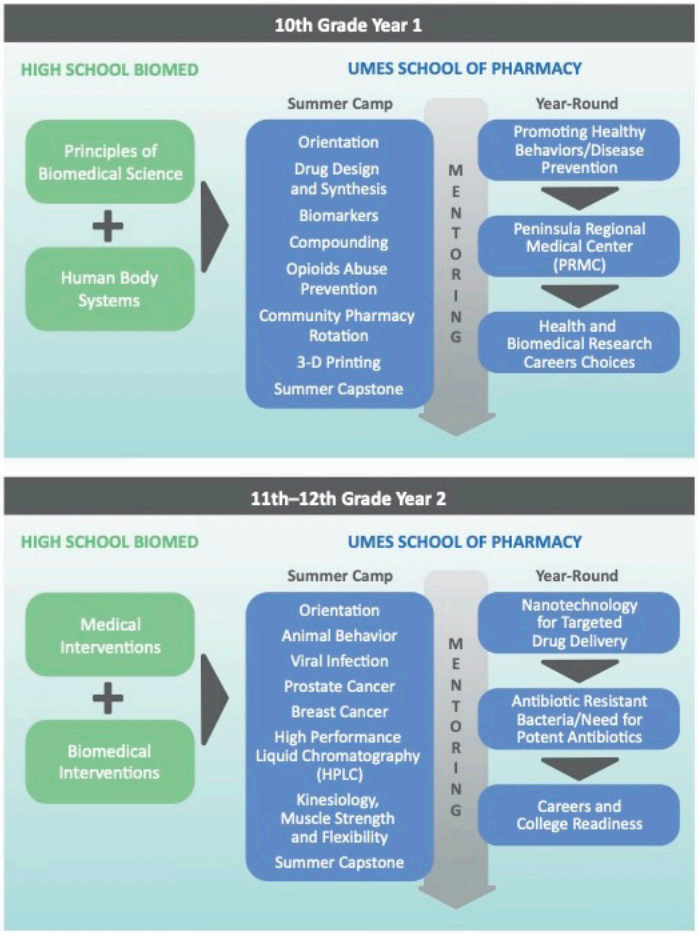

Figure 1. A Two-Year Curriculum for the MADDPR Program in Relationship with the PLTW Core Coursework. (Adapted from Karara et al., 2021 with permission from Journal).

first year of implementation.

Program Participants. Students are annually recruited from Somerset County's High School biomedical sciences program, (PLTW, 2023), through the support of the superintendent and teachers. A PLTW high school teacher is appointed as camp coordinator and helps with recruiting efforts including the distribution of camp flyers and application forms. Students are given a stipend for their participation in the program along with materials for the camp, office supplies, college-readiness material, and a personalized lab coat. Enrollment occurs when students are rising sophomores (10th grade) or juniors (11th grade) in high school. Consistent with the program goals, approximately 25 students are enrolled in each cohort during a weeklong summer camp. Due to the disruption of the pandemic, the MADDPR Program has offered (since 2020) the flexibility to students that allow them to participate in both years programming during a single summer and "catch up."

Program Elements. The progression of the program activities and expected outcomes are described in its logic model. (Figure 2). The components of the logic model were designed in accordance with the 2004 Logic Model Development Guide from the W.K. Kellogg Foundation (2023). The model components relate to the project's ultimate outcomes which are to ensure: 1) healthcare and biomedical research workforce encompasses diversity and inclusion and 2) area high schools support STEM careers. The program activities anticipate annual outputs of student participation (approximately 50 per year), enhanced skills and knowledge for high school teachers (approximately two to four), and graduate student mentorship (approximately three per year).

Collaborating Partners. The MADDPR Program has engaged with several collaborators for planning and implementing the program. A) Somerset County Public Schools: high school biomedical teachers have worked with program PIs to plan the summer camp, ensured, and coordinated student enrollment to the program, and attended all summer camp sessions. B) Faculty and Staff from UMES and neighboring institutions: UMES School of Pharmacy, Department of Kinesiology, and Salisbury University. Fifteen faculty members and staff present the diverse program sessions during the summer camp every year. C) UMES School of Pharmacy Graduate Students: students are selected every year to serve as near peer mentors for the high school participants. The mentoring experience provides them an opportunity to develop teaching and presenting skills. Participating high school student mentees are divided into groups of approximately eight and assigned a mentor each year. Mentors are involved in facilitation of sessions during the summer program and conduct breakout sessions to facilitate one-on-one interactions with their mentees. Mentors are trained to connect with their assigned student groups beyond the confines of the program to encourage their academic path and provide information on their prospective careers. The high school students had access to contact information from their graduate student mentor and were encouraged to contact them throughout the academic year. Several students shared their achievements/awards with their mentor, contacted their mentor for externship research opportunities at the University or guidance on college and financial aid/scholarship applications. We did not collect data on that aspect of the program. D) 4-H STEM Training: All involved with the MADDPR Summer Camp Program participate in a training program that concentrates on mentoring and delivering STEM concepts for high school students. Annually before the start of the Summer Camp, 4-H STEM Educators at UMES conduct a "Train-the-Trainers" session for faculty instructors and near-peer mentors to educate them in best practices and apply experiential learning strategies to their activities. The half-day training focuses on developing sessions appropriate for high school student learners and helps to establish learning objectives, including clear expectations and teacher presence, and brainstorm strategies for youth engagement in learning.

Description of Program Modules. The design of the offered modules is aligned with the PLTW Biomed Program

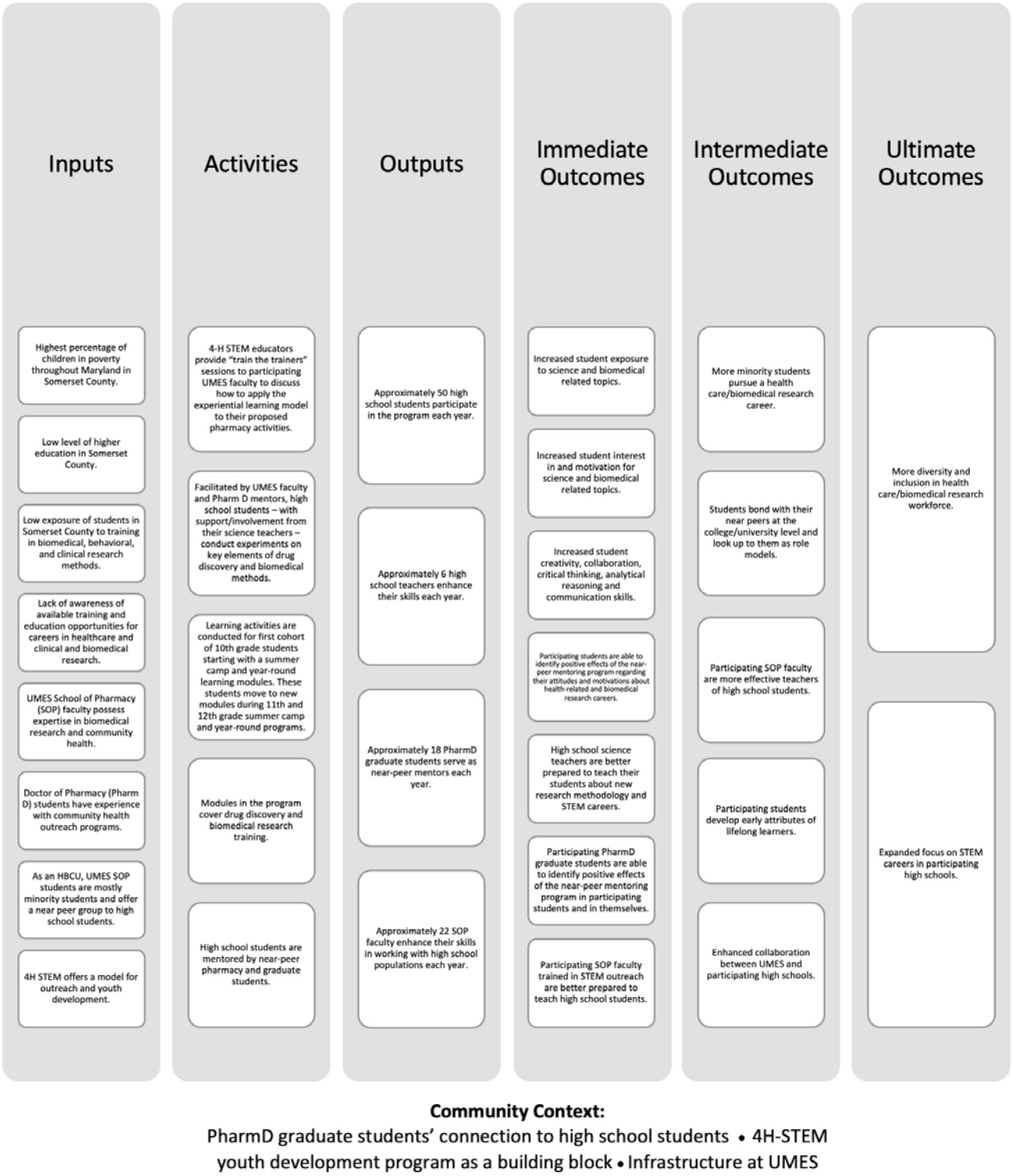

Figure 2. Logic Model for the MADDPR Program

and is based on teachers' recommendations and the students' level of advancement in the Biomed program such as more drug discovery and development topics for first year students and more advanced basic research techniques for returning students. Each module exposes students to cutting edge research methodologies, bioanalytical instruments, cell biology tools and pharmacy practice experiences. Figure 3 shows representative pictures from some of the offered lab modules. Brief descriptions of the core sessions are listed below:

Sessions Offered to First Year (new) Program Participants. ***Drug Discovery and Development Topics: Drug design, synthesis, and characterization.*** Students perform exper-

iments dealing with the design, synthesis, and analysis of physical properties of methyl salicylate as a natural product. Students determine the completion of the synthesis using the thin-layer chromatography technique. Following the session, students can understand the chemical synthesis process used for drug discovery and the purification and identification process using thin-layer chromatography. Students experience the steps for liquid-liquid extraction techniques to identify the active pharmaceutical ingredient in an over-the-counter medication using gas chromatography and mass spectrometry (GC/MS) (Figure 3A).

Learning Compounding Skills. Students learn the process of making capsules as a dosage form. Capsules, which account for about 20% of all prescriptions dispensed, are gelatin shells filled with the ingredients that make up an individual dose. This compounding exercise involves labeling and dispensing a prescription of extemporaneously compounded salicylic acid capsules. Participating students perform all necessary calculations, weigh, and mix ingredients using mortar and pestle, perform the filling operations, and engage in quality control testing of the finished capsules using disintegration and dissolution apparatus and UV spectrophotometry (Figure 3D and 3G).

Biomarkers. In this session, students explore and learn the basic science of biomarkers in disease diagnosis. Biomarkers, also referred to as molecular markers, are defined as a biological molecule found in blood, other body fluids, or tissues that can serve as an index for a normal or abnormal process in diseases. A biomarker may be used to see how well the body responds to a treatment for a disease or condition. This session has been modified in response to the pandemic since 2021 and adapted to learn about COVID-19 diagnosis and vaccines. The students learn the genomic features, mutations, infection mechanisms, and diagnosis of SARS-CoV-2 (COVID-19) wild type and variants. Students perform the rapid COVID-19 antigen tests and the antibody detection and PCR diagnosis of COVID-19 (Figure 3E).

Computer Aided Drug Design (CADD) - 3D Printing. In this session students explore medication administration devices through a critical thinking exercise developing a solution to an existing medication administration problem. As an example, intranasal administration of medications bypasses oral swallowing and avoids needles. It allows for administration to an individual who is not conscious without first achieving intravenous access. Students work in groups to create a device to help administer the medication considering important elements about nasal administration. After brainstorming, a draft diagram of the device is produced to clearly define the idea. Finally, students use design software to create and print a 3D image of the device (Figure 3 B).

Figure 3. Representative MADDPR Camp Lab sessions. **A:** Student Injecting Drug Sample in GC/MS. **B:** Students Designed Inhalation Devices by 3D-printing. **C:** Students Filling Prescriptions in a. Model Retail Pharmacy. **D:** Student using UV Spectrometer to Measure Drug Content in Capsules. **E:** Students Using the COVID-19 Rapid Antigen Test. **F:** Graduate Student Mentor Assists a Student Observing a Virus Particle Under the Fluorescence Microscope. **G:** MADDPR SEPA Students Worked Jointly with the CURE SEPA Students on Pharmaceutical Compounding of a Capsule Prescription. **H:** Nanomedicine Lab Session where Students Prepared Drug Dispersions and Learned the Use of Zetasizer Nano® for Particle Characterization.

Public Health Promotion Topics: Health Disparities and Promoting Healthy Behaviors. Given that the target student audience resides in rural Maryland, an area with significant health disparities, this activity focuses on dietary issues specific to the community. Students learn about the importance of diet for disease prevention; how to define carbohydrates, fats, and proteins; and about the recommendations by the

American Heart Association, the American College of Cardiology, and the US Department of Agriculture. Activities include interpreting food labels and considering the health implications of balanced consumption of calories, carbohydrates, proteins, and fats as well as the impact of physical activity on weight, cardiovascular health, and overall wellness. As part of the session, students experimentally measure out the nutrient content of the meals using standard cooking measuring cups and spoons. Students discuss how visuals of the fat and sugar content can help people conceptualize the unhealthy content of their diets.

Opioids Abuse and Prevention. Students learn that opioids are drugs that are derived from the opium poppy plant or are synthetic equivalents, such as methadone and fentanyl. Opioids are commonly prescribed in forms of medications to relieve pain and reduce the intensity of pain signals reaching the brain. Prescription opioid misuse is defined as the use of a medication without a prescription; it also can mean taking more than the prescribed amount for its effects. In this activity students are required to consider several facts vs. misconceptions, examine the adverse effects of opioids on the nervous system, and review different case studies that illuminate the science behind some of the signs and symptoms of opioid misuse.

Response to a Pandemic. The session was reoriented to provide students with an experience in COVID-19 testing and vaccination. The program consisted of discussions on what happens when COVID-19 infects the host and how the body reacts. Students experimented with models of coronavirus and how immune response works for future defense with the help of cytotoxic T cells, helper cells, and phagocytes. They discussed testing strategies that look for viral specific particles or antibodies in response to viral particles. Students learned about the transmission of disease and the use of personal protective equipment (PPE). Each student learned the correct order and manner of putting on the PPE. Students learned how to administer antigen tests and recognize a negative or positive test. In addition, the students learned about the importance of surveillance through quarantine, isolation, and contact tracing.

Pharmacy Practice. In this session, students experience ***Retail Pharmacy Operations*** in a simulated environment. This session is conducted at UMES's Next-level Educational Simulation Training (NEST) center — a simulated mock-pharmacy area where participants see the interworking of a community pharmacy. Participants learn about the workflow process for filling a prescription (Figure 3C). In this hands-on session students get to practice filling prescriptions and conduct mock patient counseling. To emphasize the importance of medication safety, students participate in a game where they learn to recognize real medication formulations from candy. Students also gain exposure on how pharmacists aid in preventive health. In the first year of the camp this activity was supplemented by a physical tour of a local hospital (Tidal Health) to learn about pharmacy operations in a clinical setting. Students had an interactive experience with an automated packaging system used to repackage medications from a bulk container to a unit-of-use format, which allows nurses to barcode scan at the patient's bedside during administration. Students learned how pharmacists are part of a multidisciplinary health care team in the hospital and experience the various technologies that are utilized to improve medication safety and efficiency. Subsequently this activity was offered as a virtual tour in 2020 and 2021 due to COVID-19 restrictions.

Sessions Offered to Second-Year (returning) Program Participants.

Drug Discovery and Development Topics: Understanding Animal Behavior. The session explored the principles of classical and operant conditioning to guide animal behavior. In this hands-on in-person session, each student had access to "Sniffy the Virtual Rat" software (Sniffy, 2023). The program is a learning tool to help students learn about psychological and behavioral phenomena. Students learned about operant conditioning and reinforcement and punishment.

Understanding Viral Infections: Characterization of Drug Effects on Viral Neuronal Infection. The topic was focused on the epidemiology and virology of the COVID-19 pandemic and fundamentals of molecular biology and cell culture techniques (Figure 3F).

Nanomedicine. The objectives of this module are to identify drug delivery challenges that exist for small and macromolecules to learn a) the state-of-the-art methods of nanoscale drug delivery systems characterization, and b) the effects of physicochemical properties of nanomaterials on their biological disposition. Students synthesize microparticles and entrap model drug molecules (Figure 3 H). Using a Zetasizer® Nano equipment they measure the hydrodynamic size and surface charge of the nanoparticles. Post-activity, students discuss the impact of nanoparticle characteristics on biological effects in vivo such as efficacy, toxicity, and stability.

Breast Cancer Research. Hormone responsive breast cancer cell proliferation is increased with exposure to estrogens. Receptor antagonists are utilized clinically to reduce hormone-driven cancer growth. The exercise uses virtual simulation (Labster®) to perform mock cell proliferation assays and understand the significance of cancer cell growth inhibition.

Mechanisms in Prostate Cancer. Students explore cell culture of prostate cancer cells and assess changes in cell morphology resulting from cytokine-induced differentiation. Students learn to use fluorescence microscopy and assess changes in the pattern of staining of the cytoskeletal protein actin and tubulin. Changes in actin and tubulin expression are associated with the cellular differentiation of prostate cancer into neuron-like cells.

Antimicrobials. Students learn the concept of antimicrobial drug therapy, antibiotic resistance, the approach of antibiotic discovery, and microbial applications, particularly as probiotics. Students also learn about the current trend of growing incidences of multi-antibiotic-resistant bacteria, and how antibiotic resistance has become a major health threat all over the world. In this session students are provided dozens of antimicrobial activity assay plates to investigate how naturally occurring soil microbes produce potentially clinically significant antibiotics. Students observe and analyze growth inhibition of non-pathogenic model organisms. Students also perform colorimetric assays to understand how to assess the viability of bacterial test organisms.

Pharmaceutical Laboratory Skills. Students performed High Performance Liquid Chromatography-Mass Spectrometry (HPLC-MS) for drug analysis to determine the stability of compounds at different temperatures and the medical application of nanotechnology. As an example, students learned about gamma hydroxybutyrate (GHB), one of the drugs of abuse by athletes. The drug can be detected in hair samples. Students were given data generated from a Waters QDA HPLC/MS instrument for the analysis of GHB from hair samples. Students used the data to estimate the concentration of GHB detected in the hair sample to determine if the athlete did use GHB.

Public Health Promotion Topics: Kinesiology and Physical Fitness. The specific objective of this session is to provide a kinesiological approach to communicate to the students the scientific knowledge about health benefits of physical activity. The activity aims to increase students' understanding of the body system and how it responds to physical activity. Students gain an understanding of two of the health-related components of physical fitness, in particular muscular strength, and flexibility, which have a strong relationship with overall health and are an indication of an individual's ability to perform activities of daily living. Students interact with anatomical models of the arm and leg. Students also participate in a running activity to test their aerobic capacity and perform calculations to estimate the rate of oxygen consumption.

Topics Offered to Both New and Returning Participants.

Orientation. The PIs and mentors' welcome students and introduce them to the MADDPR Program. Students have an opportunity to connect or reconnect with their assigned mentors and share their current educational and career goals. In this session students are provided basic lab safety training, RCR training, and provided an overview of camp activities expectations and daily schedule.

Capstone. Students have an opportunity to connect with their mentors and reflect on their education and career pathways. Each student prepares a PowerPoint presentation and shares with the group their experience and main takeaways from the camp. At the end of the session, there was an opportunity for a campus tour and students received a certificate and a book on college admissions.

College Readiness. Career options, financial aid, and college advice are provided by UMES counselor. During the session, students participate in discussions led by UMES faculty and administrators on topics such as academic advising, mentorship, admissions, education and career paths and financial aid. Tours of the UMES campus, health professions classrooms are provided to introduce students to the life of a college student. During the weeklong summer camp, students dine with their peers and mentors daily at the University cafeteria, take walks across campus, tour several campus buildings and recreational facilities.

Supplemental MADDPR Program to Address COVID-19 Vaccine Hesitancy. In 2021, supplemental funding allowed a cohort of 45 high school students from Somerset County to participate in a program focused on addressing COVID-19 vaccine hesitancy. During this time, Somerset County had a rapidly growing COVID-19 prevalence rate coupled with the lowest COVID-19 vaccine uptake rates in the State of Maryland. Background knowledge was covered in a jeopardy game format about COVID-19 based on current scientific evidence regarding vaccine types, indications, side effects, and the development process by a pharmacist. A counselor discussed how to make rational decisions, how to control emotions and biases, and methods to examine evidence to discover reputable sources of information. Afterwards, a multi-disciplinary panel of influential leaders in Somerset County including physician assistants, pastors, teachers, public health officials, and students discussed common excuses for vaccine refusal and common misconceptions. Students then went to an independent pharmacy to observe patients receiving the COVID-19 vaccine and COVID-19 testing. Students also performed intramuscular vaccine injections in a fat pad to simulate the COVID-19 vaccine administration process. Finally, students created two public service announcements about the importance of getting

COVID-19 vaccinated in the community and spoke about their own reasons for wanting to get vaccinated. The videos in which the students ultimately became ambassadors for the COVID-19 vaccine were disseminated on social media for the public to view. Data from this program will be published under a separate cover.

MADDPR Program Evaluation. A mixed-method evaluation design is utilized that includes both quantitative and qualitative methods of gathering data (Karara et al., 2021). Student participants are asked to complete a pre-and post-test survey on the first and last day of their camp week and matched responses are identified. Post-program surveys are also collected from participating faculty members, school teachers and graduate student mentors. Additional sources of data utilized in the evaluation include program records, materials, statistics, and reports, survey observations, informal reports, and anecdotal materials. The evaluation methodology and data sources were published earlier (Karara et al., 2021). The study protocol was approved by the UMES Institutional Review Board.

Comparison Study Analysis. A comparison group study was implemented as part of the evaluation design supporting the MADDPR program to assess the effectiveness of the program in creating intended outcomes. The comparison group study is intended to compare the outcomes of MADDPR participants to the outcomes of similarly attributed non-participating students. Both participants and comparison groups — comprising students who are in the biomedical science track at the Somerset County Technical High School, but have not yet participated in the MADDPR Program — were surveyed during the academic school year, with the assistance of the biomedical sciences program teacher. Using this group of eligible students from which the program would soon draw its participants has expected to increase the likelihood of an objectively similar group of students in each comparison group. Both participant and comparison group respondents were largely female (74% and 84% respectively). Participants self-identified as "Black or African American" (28%), "Hispanic of any race" (20%), "Two or more" (12%), or "Asian" (8%). Comparison group respondents self-identified as "Black or African American" (32%), "Hispanic of any race" (9%), "Two or more" (4%), or "Asian" (1%). The majority of participants were first generation college prospects (55%); nearly half (48%) of the comparison group respondents were first generation college prospects. The outcomes are measured using survey findings about knowledge, interest in specific careers, role models, and peers. Best efforts have been made to ensure that the group of participants and members of the comparison group are statistically similar on measurable demographic, socioeconomic, and educational characteristics.

Data Analysis. The pre- and post-survey data evaluated the potential impact of the MADDPR program on participant's interest for opting for a career in a specific field of study that included: pharmacy, life sciences, earth sciences, environmental sciences, physical sciences, biomedical sciences, behavioral sciences, nursing, physician, physician assistant, physical therapist, rehabilitation therapist and respiratory therapist. Students had the option to check multiple career choices and indicate their level of interest. Survey data analyses were grouped into various years in which the survey instruments were administered (2019-2022). Additionally, statistical analyses were performed on select data on career aspirations to compare whether student responses differed between years and between camp participants and control groups (non-participants). Empirical estimates presented in this paper are all based on McNemar's Chi-Square goodness of fit test (Adedokun et al., 2012) for equality of proportion of matched group data in pre and post estimation analysis. Responses were considered statistically significant from pre- to post- surveys where p-values were less than 5% alpha levels, $p \leq .05$); an indication that analyses are based on 95% confidence level.

RESULTS

The structure of the MADDPR program allowed students to begin learning about the basics of drug discovery, biomedical research, public health, as well as college readiness, and healthcare careers in the first year. According to the program model, after the first-year camp, students are expected to return for one week in the second year to further develop their exposure in the biomedical sciences through expanded laboratory experiences, additional health promotion topics, and increase their knowledge in research. The topics are typically split into 3-hr modules led by faculty from pharmacy, pharmaceutical sciences, and kinesiology. Near-peer mentoring is a core component of the program and occurred throughout with UMES graduate student mentors. The mentors offered camp students instructions during lab experiments, career guidance, and served as positive role models for the high school students. At the end of each year, participating students conducted program review surveys to evaluate program success and metrics.

MADDPR Student Participants. The program's goal has been to include 25 students in each cohort (each week of the camp). Over the four program years to date, the program has taught an average of 21 participants in each session offered to first- and second-year participants, even as the program adjusted to pandemic conditions moving from in-person instruction at the UMES campus to online instruction in 2020 (Year 2) and to the Somerset County Technical High School in 2021 (Year 3) when the UMES campus was closed

Table 1. *Demographics of MADDPR Program evaluation group, as reported in pre/post program surveys.*

Demographic Category	2019 (First Year, n=23)	2020 (First Year n=18)	2020 (Second Year n=15)	2021 (First Year n=23)	2021 (Second Year n=19)	2022 (First Year n=19)	2022 (Second Year n=26)	Total (Unduplicated Count, n=93)
Gender								
Male	8 (35%)	5 (28%)	4 (27%)	7 (30%)	6 (32%)	2 (11%)	6 (23%)	24 (26%)
Female	14 (61%)	13 (72%)	11 (73%)	16 (70%)	12 (63%)	17 (89%)	20 (77%)	67 (72%)
Non-binary	-	-	-	-		-	-	-
No response	1 (4%)	-	-	-	1 (5%)	-	-	2 (2%)
Age (Average, SD)	15.8, 0.6	16.6, 0.8	16.8, 0.6	15.8, 0.7	17.5, 1.0	16.4, 1.0	16.6, 0.6	16.3, 0.9
Race/Ethnicity								
American Indian or Alaska Native	-	-	-	-	-	-	-	-
Asian	1 (4%)	-	-	3 (13%)	1 (5%)	-	-	5 (5%)
Black or African American	11 (48%)	5 (28%)	7 (44%)	5 (22%)	8 (42%)	14 (74%)	11 (42%)	37 (40%)
Native Hawaiian or Other Pacific Islander	-	-	-	-	-	-	-	-
Hispanic of any race	2 (9%)	4 (22%)	-	3 (12%)	3 (16%)	2 (11%)	6 (23%)	12 (13%)
Two or more	2 (9%)	1 (6%)	1 (7%)	5 (22%)	2 (11%)	1 (5%)	3 (12%)	10 (11%)
White	11 (48%)	9 (50%)	7 (44%)	9 (39%)	8 (42%)	6 (32%)	10 (38%)	40 (43%)
Prefer not to answer	-	-	-	1 (4%)	1 (5%)	1 (5%)	1 (4%)	4 (4%)
First Generation Status								
First Generation (no parent or guardian completed a four-year degree)	13 (57%)	8 (44%)	9 (60%)	9 (39%)	8 (42%)	8 (42%)	17 (65%)	43 (46%)

to non-UMES students. The program has successfully targeted students who are considered racially and ethnically underrepresented in biomedical sciences by the NIH note 2019, 40% of the participants to date are "Black or African American," and 13% are Hispanic of any race. A significant number of program participants (72%) are female. Nearly half (46%) of the participating students in self-reported data noted that they are first-generation college prospects (Table 1). The program draws students from a largely rural community. All (100%) of students participate in free/reduced lunch programs in the Somerset County School District per district policy. The 2021 US Census data had the median household income in the county of $48,661, well below the US median in the same year of $70,784 (Smega and Kollar, 2022).

Student Response to the Program Sessions. In post camp surveys for each of the four years, student response to the program sessions have been strong (Table 2). In post-camp surveys, respondents are asked to grade each session on a traditional grading scale (A, B, C, D). Year after year, responses have ranged between "B" and high "A" scores. Some of the core module topics that were most highly rated consistently over the years include: Community Pharmacy Rotation (Avg. 3.8 GPA), Capsule Compounding (Avg. 3.6 GPA), Opioid Abuse and Prevention (Avg. 3.6 GPA), Promoting Healthy Behaviors (Avg. 3.6 GPA) and Kinesiology (Avg. 3.5 GPA). In response to the pandemic, some content for sessions were changed to offer additional real-world examples for students to investigate the way that public health officials approached the issues of the pandemic or how their skills and knowledge could be applied to COVID-19 testing. Sessions included COVID-19 diagnosis and response to a pandemic. In 2021 a NIH SEPA supplement was funded to additionally bring students to participate in three sessions that addressed vaccine hesitancy. As one student said at the time (in summer 2020), "*I feel that the class was very informative, and I loved how the topic is related to a real- world problem that is relevant. I learned a lot about COVID-19 testing, and a lot about the virus itself too.*"

Graduate student mentors are an integral part of the MADDPR program. To date, six UMES pharmaceutical sciences Ph.D. graduate students have served in the role,

Table 2. *Participant grades of the MADDPR program overall, Years 1-4.*

Respondents	A	B	C	D	F	"GPA"
2022 (First Year n=19)	13 (68%)	6 (32%)	-	-	-	3.68
2022 (Second Year n=25)	16 (64%)	4 (16%)	4 (16%)	-	1 (4%)	3.36
2021[1] (First Year n=26)	18 (69%)	8 (31%)	-	-	-	3.69
2021 (Second Year n=18)	14 (78%)	3 (17%)	1 (6%)	-	-	3.72
2020 (First Year n=13)	10 (77%)	2 (15%)	1 (8%)	-	-	3.69
2020 (Second Year n=13)	10 (77%)	3 (23%)	-	-	-	3.77
2019[2] (First Year n=23)	12 (52%)	10 (43%)	1 (4%)	-	-	3.48

[1]*Rounding error. Percentages exceed 100%.*
[2]*Rounding error. Percentages do not total 100%.*

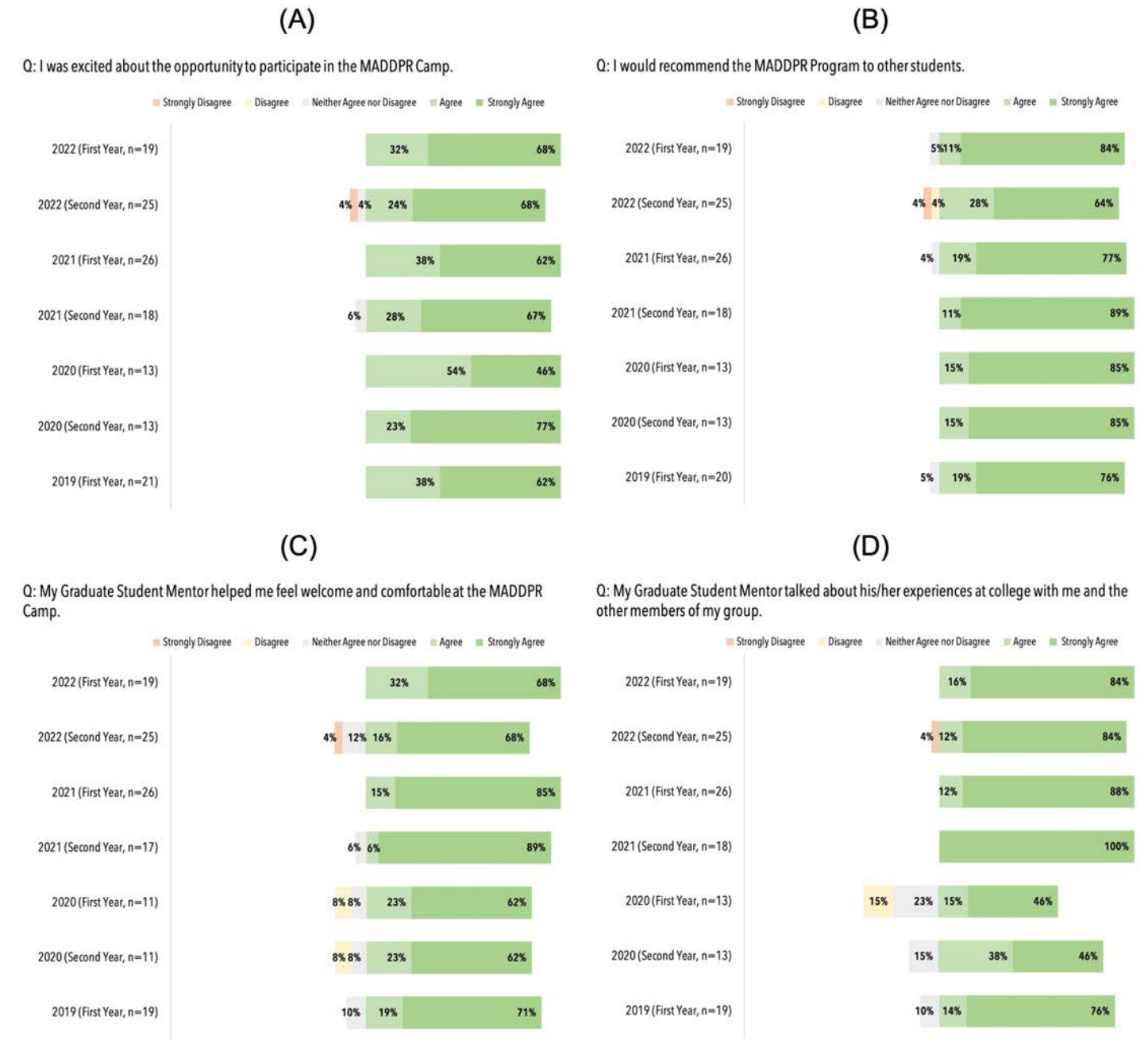

Figure 4. MADDPR Participants Responses to Statements Regarding the Summer Camp (A and B) and the Graduate Student Mentors (C and D).

providing guidance to the MADDPR participants during the two-week camp. In post-camp surveys over the past four years, participants have consistently reported that they agree their mentors help them "feel welcome and comfortable" at the camp, "talk about their own experience" with the participants, and make participants feel that mentors have a vested interest in their reaching their educational goals (Figure 4). It is important to note that in 2020 first year students engaged with their mentors during the height of the pandemic in a solely online environment; in 2021 those students who returned to the program for the second year, were able to meet and engage with their mentors in-person.

In survey comments, participants have specifically mentioned their mentors and the UMES faculty, thanking them for their guidance and support. As one student said after the 2021 program "*I just wanted to thank the professors, mentors and teachers who took their time and organized a camp with the wonderful intention of introducing us to the medical field*."

When asked about the MADDPR program overall, nearly all respondents agreed they were "excited about the opportunity to participate," that it was worth their "time and effort to participate," and that they "would recommend the MADDPR program other students." (Figure 4). As one second-year student commented following the program in Year 4, "*It was both entertaining and educational and helped me*

with my career choices." Additional questions added to the post-camp survey in 2022 honed in on the respondents' attitudes regarding the program's influence on their attainment of new skills and their career decisions. Nearly ninety-five percent (94%) of first-year respondents "strongly agreed" (68%) or "agreed" (26%) that they "gained new skills as a result of attending the MADDPR Camp". More than three-quarters (76%) of second-year respondents "strongly agreed" (52%) or "agreed" (24%) with the same statement; Nearly nine in 10 (89%) of first-year respondents ``strongly agreed" (42%) or "agreed" (47%) that "the MADDPR Camp helped me make a career decision;". Less than seven in 10 (68%) of second-year respondents ``strongly agreed" (32%) or "agreed" (36%) that the camp helps with career decisions. In survey comments, students explained their responses further. During 2022, a second-year student said, "*I'm still not 100% sure of a direct career path but I truly did enjoy most of the labs this week that made me consider going down a STEM career path.*" Another student in their first year said, "*I was already thinking about pursuing a career in STEM, but this program helped me make my final decision.*" In post-camp surveys, respondents were asked, "What overall grade would you give the MADDPR Camp?" and offered the traditional grading scale. Respondents over the years have offered grades with an average "GPA" of between 3.36 and 3.77 (Table 2). When asked to provide reasons for the grade they offered, student responses mentioned how much they learned, the careers they were exposed to, and the hands-on nature of the activities. As one second-year student during 2021 said, "[The camp] *opened my eyes to so many things and the hands-on activities helped a lot.*" Students who offered lower grades spoke of wanting more challenging material or that they found they were not interested in pharmacy as a career.

Teachers involved with the program have consistently rated it highly. During years when more than one teacher was involved (2019 and 2022) all (100%) survey respondents gave the program overall a grade of "A" on a traditional grading scale and commented on how informative and interactive it was for participating students. Importantly, teachers have found they use elements of the curricula and methods in their classrooms during the academic year. In 2019 (Year 1) both (100%) teachers involved with the program confirmed they would use concepts presented at the camp in their classrooms. As one stated at the time, "I learned so much about what I should be emphasizing to my students for their success in the medical field and college in general." During 2020, a teacher stated,

> *I realized this year that the more we involve students in college experience prior to them actually attending college, the more comfortable and confident they are when they actually get there. … And then, I personally have a better grasp of what students need to be successful in college in the science field. I have a better idea of the equipment that they use, the scope of what they'll cover.*

In 2022, three teachers attended sessions with their students. In surveys, they commented, "*I, personally, learned a great deal from the camp. I will implement some of what I learned in my own curriculum.* [The camp] *was energizing for me and I can't wait to implement what I learned in my own teaching!*" Another respondent noted that the camp was, "*…a great way for me to stay current in the health field*."

A summary of the impact of the MADDRP program on the student's decision on future career choices is displayed in Table 3, only career choices that reached statistical significance in accordance with the Chi-Square McNamar's test are displayed in the Table. Careers in the areas of life sciences, pharmacy and pharmaceutical sciences were among the careers consistently chosen by the students across study years.

The Comparison Study. The comparison group intended to include students in their sophomore year (10th grade) in the PLTW Biomedical Sciences Track at Somerset County Technical High School. In practice, it has included any Biomedical Science Track students who have not participated in the MADDPR Program and ranged in age from 10th to 12th grade, more than initially expected. Students from both Washington High School and Academy and Crisfield High School and Academy participated in the program. MADDPR participants are drawn from PLTW students in Somerset County. Students are self-selected and enter the program in their junior year (11th grade). The first participant group included in the comparison group study consists of students who started as PLTW students in their sophomore (or junior) year during 2019-2020 and entered the MADDPR program in summer 2020. As anticipated, comparison study group students were younger than participant students, but were not exclusively in the 10th grade (Table 4). Three sets of participant and comparison group respondents were given the same survey over three successive academic years after the program was complete and survey completions were facilitated by the biomedical sciences track program teacher at the high school. Students who responded to the comparison survey and later entered the MADDPR Program were removed from the comparison study for the purpose of analysis. The statistical analysis of a comparison of means does not include any redundant individuals either within or between the two samples, pooled over the two-year period. On average, MADDPR participants were more likely to agree than disagree than the comparison group respondents for all eight of the survey statements; for two of those statements the findings were statistically significant (Figure 5).

Table 3. *Impact of the MADDPR Program on the Student's decision on future career choices.*

2019* Year 1 students	2020**	2021 Year 1 students	2021 Year 2 students	2022 Year 1 students	2022 Year 2 students
Life Sciences $\chi2(1,N=16)=8$ Prob > $\chi2=0.0047$	Life Sciences $\chi2(1,N=10)=5.0$ Prob > $\chi2=0.0253$	Physical Therapy $\chi2(1,N=23)=6.0$ Prob > $\chi2=0.0143$	Life Science $\chi2(1,N=15)=5.0$ Prob > $\chi2=0.0253$	Life Sciences $\chi2(1,N=14)=5$ Prob > $\chi2=0.0253$	Life Sciences $\chi2(1,N=20)=5.4$ Prob > $\chi2=0.0196$
Pharmacy $\chi2(1,N=23)=16.0$ Prob > $\chi2=0.0001$	Physical Therapist $\chi2(1,N=8)=4.00$ Prob > $\chi2=0.0455$	Pharmacy $\chi2(1,N=16)=4.0$ Prob > $\chi2=0.0455$	Pharmaceutical Sciences $\chi2(1,N=15)=4.0$ Prob > $\chi2=0.0455$	Pharmaceutical Sciences $\chi2(1,N=9)=4.00$ Prob > $\chi2=0.0455$	Pharmacy $\chi2(1,N=18)=6.0$ Prob > $\chi2=0.0143$
Biomedical Science $\chi2(1,N=20)=5.00$ Prob > $\chi2=0.0253$	Nursing $\chi2(1,N=8)=4.00$ Prob > $\chi2=0.0455$		Behavioral Science $\chi2(1,N=16)=7.0$ Prob > $\chi2=0.0082$	Biomedical Science $\chi2(1,N=14)=5.0$ Prob > $\chi2=0.0253$	Pharmaceutical Sciences $\chi2(1,N=18)=5.4$ Prob > $\chi2=0.0196$
Environmental Science $\chi2(1,N=13)=4.50$ Prob > $\chi2=0.0339$	Physician Assistant $\chi2(1,N=9)=4.00$ Prob > $\chi2=0.0455$		Respiratory Therapist $\chi2(1,N=20)=5.0$ Prob > $\chi2=0.0253$	Respiratory Therapist $\chi2(1,N=15)=5.0$ Prob > $\chi2=0.0253$	Behavioral Science $\chi2(1,N=16)=5.0$ Prob > $\chi2=0.0253$
Earth Sciences $\chi2(1,N=12)=4.00$ Prob > $\chi2=0.0455$				Behavioral Science $\chi2(1,N=14)=6.0$ Prob > $\chi2=0.0143$	Physical Therapy $\chi2(1,N=14)=5.0$ Prob > $\chi2=0.0253$
				Physician Assistant $\chi2(1,N=14)=4.0$ Prob > $\chi2=0.0455$	
				Rehabilitation Therapist $\chi2(1,N=17)=4.0$ Prob > $\chi2=0.0455$	

Note: Chi-Square McNamar's test applied on pre- and post camp survey data considered statistically significant where p-values were less than 5% alpha levels ($p \leq 0.05$).
**The Inaugural year camp had only year 1 students.*
***Year 2020 summer camp was conducted virtually during the COVID-19 pandemic and both Year 1 and Year 2 data were combined. Starting in 2021, Year 1 and Year 2 student data were analyzed separately.*

- The 50 MADDPR follow-up survey respondents reported higher levels of agreement with the statement, "I know I would like to pursue a STEM career" (M = 3.90, SD = 1.65) compared with the 44 respondents in the comparison group (M = 3.20, SD = 1.47), t(92) = 3.0470, p = .0030.
- The 50 MADDPR follow-up survey respondents reported higher levels of agreement with the statement, "I know I would like to pursue a biomedical sciences career." (M = 3.88, SD = 1.003) compared with the 44 respondents in the comparison group (M = 3.39, SD = 1.104), t(92) = 2.2546, p = .0265.

For the remaining statements, findings were not statistically significant (Figure 5).

DISCUSSION

The MADDPR Scholars Program emphasizes experiential learning in diverse areas ranging from translational research to applied clinical pharmacy. Based on participants feedback, the diversity of the MADDPR topics is one of the main strengths of the program. Over the course of four years, the one-week summer camps included different daily research topics for each morning and afternoon session. Each lab session was led by a different program faculty in addition to an orientation and capstone sessions for each camp. A student commented "*I liked how we had new doctors and topics every day, but they were all related.*" That contrasts

Table 4. *Demographic characteristics of MADDPR Program participant groups and comparison study groups, pooled over three years.*

Demographic Category	Pooled Participant Respondents 2020-2021, 2021-2022, and 2022-2023* (n=50)	Pooled Comparison Group A (2020-2021), Group B (2021-2022), and Group C (2022-2023)* (n=44)
Gender		
Male	12 (24%)	7 (16%)
Female	37 (74%)	37 (84%)
Non-binary	-	-
No response	1 (2%)	-
Grade		
10th	5 (10%)	8 (18%)
11th	16 (32%)	23 (52%)
12th	29 (58%)	13 (30%)
Race/Ethnicity		
American Indian or Alaska Native	-	-
Asian	4 (8%)	1 (2%)
Black or African American	14 (28%)	14 (32%)
Native Hawaiian or Other Pacific Islander	-	-
Hispanic of any race	10 (20%)	4 (9%)
Two or more	6 (12%)	2 (4%)
White	19 (38%)	25 (57%)
Prefer not to answer	5 (10%)	2 (5%)
First Generation (no parent or guardian completed a four-year degree)	27 (55%)	21 (48%)

**Surveys for the comparison group study were completed by participant and comparison group during the academic year following each summer of MADDPR programming.*

with other programs that tend to have a focus on a specific research area for certain faculty or certain areas such as cancer research (Patel et al., 2021; Lessard et al., 2021; Marriott et. al., 2022). This structuring of the program was responsible for keeping a high level of interest and engagement as evidenced by the high GPA ratings of the program sessions (Table 2). Literature data shows that these types of diverse immersive research experiences result in increased students' motivation and have a positive impact on students' perception of science and affirmation to pursue a science career (Chittum et al., 2017; Salto et al., 2014; McLaughlin et al., 2020). Another measure of the strength of the program is the building of a strong partnership with the Somerset County Public School District teachers and administrators. One of the PLTW teachers took on the responsibility of recruiting for the program from their biomed program. The inaugural camp in 2019 was organized and hosted with 23 participant students that represented cohort 1 which had a target of 25 students. Following a successful year 1 cohort 1 experience, recruitment for the camp continued to progress smoothly. The PLTW teacher told us

> *My students are so excited that they have recruited* [next year's MADDPR program participants] *for us. We have more students than we can find a place for, for the next cohort, and I have not done anything. My students have gone out and talked to the other students in my program and they have come to me to get on the list. It's kinda like they have this little club within my classroom.*

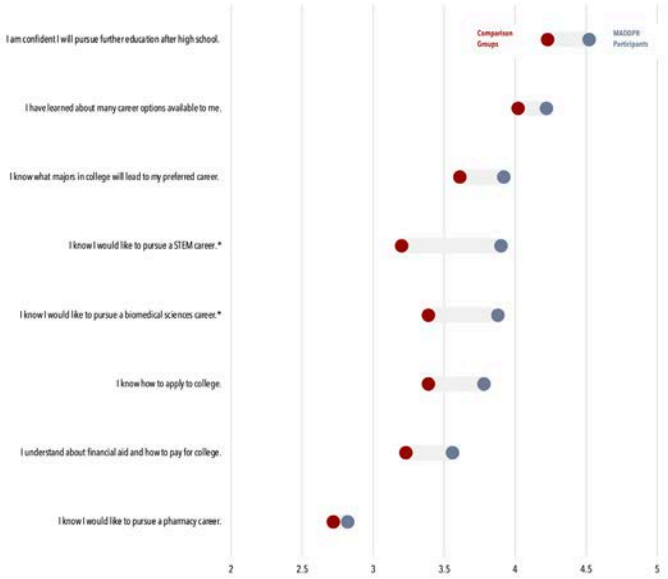

Figure 5. Comparison Study Assessing the Effectiveness of MADDPR Program in Creating the Intended Outcomes. MADDPR participants (gray) reported greater agreement for all eight statements that they and the comparison group (red) were asked about during three consecutive surveys in 2021 and 2022. *Statistically significant finding $p < .05$. 1=Strongly Disagree and 5=Strongly Agree.

There was true appreciation of the 4-year partnership of UMES with the school district evidenced by the following statement from Dr. John B. Gaddis, Superintendent of Somerset County Public Schools (October 10, 2022):

> *UMES' Summer Pharmacy Program has provided our high school students in the Academy of Health Sciences with rich, hands-on experiences in the medical research field and expert guidance from UMES Pharmacy Graduate Student Mentors on college readiness and career choices. The program instills confidence in our students and exposes them to potential career paths, with many of our graduates' pursuing degrees in Pre-Pharmacy, Biomedical Engineering, Pre-Occupational Therapy, Chemical Dependency, Biochemistry and Health Care Administration at higher educational institutions, today. We are extremely appreciative of the collaboration with UMES' Pharmacy Department for inspiring our students and providing invaluable exposure and real-life learning opportunities in the medical field.*

The program was able to reach the target student population and was representative of the majority minority local community in which a significant percentage of the county residents are of lower socioeconomic status. About 46 % of our program participants were first-generation students. Recently, Pena et al., 2022 outlined the support strategies that are needed to ensure the success of first-generation students allowing the creation of an inclusive research environment and increasing the diversity in STEM fields. One characteristic finding in the demographic data was the significantly high enrollment of female participants (72%) in the MADDPR program. We have also noted a similar observation with the pharmacy summer boot camp conducted with other local high school students. This finding is in close agreement with 69% female participants reported in the Health Sciences and Technology Academy (HSTA) program providing academic and social support to Appalachian youth in rural West Virginia (Chester et al., 2020). Also, Witzel et al. (2020) reported a 65% female participation in high school students participating in the Science and Health Education Partnership at the University of California San Francisco Intern Program. This trend speaks well for the future of women in the STEM workforce. Indeed, data are showing that women, while still underrepresented accounting for only 27% of the STEM workforce, are achieving significant gains in STEM fields (Martinez and Christnacht, 2021; Kantrowitz, 2022; Wang and Degol 2017).

Over the course of four years, the MADDPR scholars consistently rated the program sessions highly, mostly As and Bs. The following are comments from students' impressions at the conclusion of one of the summer camps: "*I feel*

though that the camp has already prepared me and gave a nice little boost in the right direction for college" (Cohort 2 [second year] Participant). It is worth noting that in the summer of 2022, our SEPA UMES MADDPR students experienced an enriching interaction with another SEPA program from the University of Maryland Baltimore CURE Scholars which was hosted during the summer on the UMES campus. The CURE Scholars attended several of the MADDPR Lab sessions in which students from both camps were paired together (Figure 3G). Both SEPA student teams had interacted virtually in prior years. The following comment from one of the PLTW teachers illustrates her impressions at the conclusion of one of the summer camps:

> *I have never been involved with a camp in which ALL the students attended EVERY day. This is a testament to their interest and engagement with a well-organized camp. The camp directors were so focused on every detail. They blended just the right amount of academia and fun to keep my students interested and engaged. Amazing!!! I have been involved with many camps over my long teaching career and I feel that MADDPR has been one of the best.*

In addition to rating the program highly, teachers indicated that the program helped them in integrating some elements into their own curricula and methods in their classrooms during the academic year.

Year 2 of the project coincided with the COVID-19 pandemic outbreak in 2020 which necessitated the transitioning to an online program. How do you transition from a hands-on laboratory-based program to a virtual program? A proactive, deliberate approach to program planning, implementation and evaluation enabled the MADDPR program to offer a valuable virtual experience to the student participants. Fortunately, all faculty in the School of Pharmacy have been trained on using online learning tools. For the summer camp 2020, the program depended heavily on a number of existing lab simulation software. Remarkably, student ratings of the virtual sessions compared favorably with in- person sessions (Karara et al., 2021). It should be noted that the program responded to pandemic conditions resulting in differing modes of program delivery for each of the four years of operation thus far. However, core elements of the program have remained intact. Clearly, one of the main challenges to the program was the continuous adjustment of the program as the COVID-19 realities affected every aspect of operations at both the high schools district and the University. Near peer mentoring by the graduate students was also a challenge at the outset and during the exclusively online environment. With increased training and experience of the graduate students, better outcomes were achieved as evident from high school students' evaluations and comments.

Pre-and post-camp analysis of survey data shows that the MADDPR program significantly influenced students' career choices with most opting to choose careers in the life sciences, pharmacy and pharmaceutical sciences (Table 3). Given that the main theme of the camp is pharmacy, it is reasonable that most students' future career interests were in the areas of pharmacy and pharmaceutical sciences. This agrees with similar programs in biomedical research experiences for URM high school students that serve as a launching point for many careers in the biomedical workforce (Witzel et al., 2020; Marriott et al., 2022; Stray et al., 2020). Data from our comparison study shows that the MADDPR students have a significantly higher level of career interest in becoming a biomedical scientist compared to the comparison group. The same study also showed that the MADDPR students reported significantly higher levels of agreement with the statement "I know I would like to pursue a STEM career" compared to the comparison group. A randomized controlled study showed that students attending summer STEM programs including 1-week programs are more likely to enroll in, persist through, graduate from college and attain STEM degrees (Cohodes et al., 2022).

A limitation of the study has emerged since the design was intended to a closely approximated program participants and non-participants as possible, drawing the comparison group from the pool of biomed track students who would then enter the program. As it has unfolded—of necessity– the pandemic had led to some flexibility in when and how students entered and participated in the program. Some students have completed the program in a single summer as opposed to over the course of two summers. And the teachers have allowed any student who hadn't yet entered the program to respond to the comparison group surveys. As the program continues, further analysis will continue, including plans to procure National Student Clearinghouse data examine the college pathways of MADDPR program participants.

CONCLUSIONS

Our data indicates that the UMES MADDPR Program has had a beneficial impact on participating high school students and teachers. The following quote from one of the students regarding the capstone project really captures what we had hoped the MADDPR project will achieve: "*With the help of the capstone project, I was able to analyze all that we did this week and find out what module interested me the most. This helped with my career decision options.*" A student commented on the campus tour "*I am planning to attend UMES for 4 years and this tour gave me lots of insights to what is on campus as well as what opportunities are available for me.*" A High School Teacher reflected on the camp "*I found this camp to be extremely valuable to my*

students. It is structured to introduce many of the topics that we cover in class that I can expound upon later. My students absolutely love it as do I." Building a trusting relationship between PIs, school teachers and administrators is essential for the success of the partnership. The high level of interest and engagement of the students in our program was a result of having a diverse set of hands-on research topics in a non-formal educational setting. There is evidence that points to the success of the interprofessional nonformal education structures in supporting biomedical research training for historically underrepresented undergraduates (Marriott et al., 2021). When URM students are given the opportunity to experience a variety of in-person lab experiences in biomedical research areas combined with mentoring support there is a greater chance that they would be motivated to pursue college and career choices in STEM.

AUTHOR INFORMATION

Corresponding Author

Adel H. Karara, Department of Pharmaceutical Sciences, School of Pharmacy, University of Maryland Eastern Shore, 11868 Academic Oval, Princess Anne, MD 21853. (410) 651-6186. ahkarara@umes.edu

Author Contributions

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ABBREVIATIONS

HBCU: Historically Black College or University; IRB: Institutional Review Board; MADDPR: Maryland Action for Drug Discovery and Pharmaceutical Research; NIGMS: National Institute of General Medical Sciences; NIH: National Institutes of Health; NSC: National Student Clearinghouse; PI: Principal Investigator; PLTW: Project Lead the Way; RCR: Responsible Conduct of Research; SEPA: Science Education Partnership Award; STEM: Science Technology, Engineering, and Mathematics; UMES: University of Maryland Eastern Shore; URM: Underrepresented Minority

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