Title
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Journal
Ethnicity & Disease, 30(1)

ISSN
1049-510X

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Publication Date
2020

DOI
10.18865/ed.30.1.5

Peer reviewed

Original Report: High School Programming to Promote Careers in STEM

The NIDDK High School Short-Term Research Experience for Underrepresented Persons

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Background: Increasing the pipeline of aspiring minority biomedical/health professionals is a crucial component to diversifying the health science workforce. The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) created the High School Short-Term Research Experience for Underrepresented Persons (HS-STEP-UP) to provide introductory biomedical/biobehavioral research experiences to promising high school students, who are traditionally underrepresented in the biomedical/biobehavioral sciences. The program reaches out to African American and Lationo/Hispanic students, as well as Native American students and students from the United States Territories.

Methods: HS-STEP-UP provides a stimulating, rigorous 8- to 10-week summer research experience for a national cohort of ~100 high school students each year; the experience is organized through four National Institutes of Health (NIH)-funded coordinating centers. Typically, the program receives about 300 applications a year and about 100 students are accepted. Applicants are reviewed and selected based upon their online application that includes: a high school transcript, list of classes and extracurricular activities, two recommendation letters and a personal statement. The program culminates with a symposium at the NIH where students present their research and attend workshops and seminars.

Results: For the 2017 and 2018 HS-STEP-UP programs, the classes included 193 students; 67% were females and 82% were underrepresented minorities. Forty eight percent of students reported a family income <$37,000/year, and 23% were from first generation college families. Ninety percent were very satisfied or satisfied with their research topic and 94% rated the end of the year symposium at NIH as excellent or very good. Only 65% were very satisfied or satisfied with their mentor matching, and 21% stated they were dissatisfied or very dissatisfied with their mentor. All the students successfully completed their summer research projects and presented their research abstracts at the symposium. All participating seniors reported attending college.

Conclusion: HS-STEP-UP has been highly successful in recruiting traditionally underrepresented students and supporting underrepresented HS students with a rewarding introductory experience to research. Students are overall satisfied with the program, but mentor matching needs more attention. Longer-term follow-up is needed to determine how participating in STEP UP impacts their decisions to participate in the biomedical workforce in the future.
*Ethn Dis.*2020;30(1):5-14; doi:10.18865/ed.30.1.5

Keywords: Diversity; Biomedical Research; Workforce Training; Underrepresented; High School

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Introduction

There is a critical shortage of underrepresented racial/ethnic minorities (Latino/Hispanic, African Americans, Asian Pacific Islanders, and American Indians/Alaska Natives), individuals with disabilities, and those from low income or educationally disadvantaged backgrounds in biomedical research and the health professions.[1] Diversity in research and education can have a positive impact, especially when it comes to developing new approaches and methods.[2,3] As a result of these shortages, unique and vital insights and perspectives from these historically underrepresented groups are lacking in the development, implementation, and evaluation of the growing and important fields of biomedical research and health science.

Without an investment in the training and mentoring of early career underrepresented minority trainees, the United States is unlikely to achieve the national goal of increasing a high-quality, diverse biomedical and health professional workforce as a key strategy for improving the health of the nation.[3-7] Increasing workforce diversity is one of the major goals of the 2016-2020 NIH-wide Strategic Plan.[8] While much focus has been dedicated to junior faculty, graduate and even undergraduate students, few studies have focused on the high school-to-undergraduate transition,[9] and few biomedical/health professional research programs exist to capture and inspire talented underrepresented high school students.[10-17]

The Case for Increasing Diversity

A wide range of skill sets and viewpoints borne of diverse backgrounds highlights the value of diversity in both life experience and education.[2,18,19] Moreover, the recognition that a randomly selected team of intelligent, diverse problem-solvers can outperform a team composed of homogeneous best-performing problem-solvers[20] reveals ideas whose scope is constrained by limited approaches and tightly defined paradigms that can converge quickly on common and incomplete conclusions and thereby limit opportunities for innovation. This reinforces the power of diversity in perspectives. In addition, it is critical for young underrepresented minorities to see role models that can encourage and inspire them to see themselves as a biomedical researchers.[21]

Developing and capturing the best talent in rapidly growing and relatively untapped underrepresented groups, which will soon represent 50% of our nation's population,[22] can help to generate the best science and accelerate innovative approaches to existing and new health-related problems.

Critical Barriers to Progress

The contextual disadvantages faced by underrepresented persons (underrepresented minorities, first generation college, disabled individuals, and women at higher levels of the education pathway) interested in pursuing biomedical sciences are many and usually begin with being more likely to be relegated to poor pre-K through 12 educational systems or to lower quality programs in higher preforming schools. This is mainly due to persistent socioeconomic and educational injustices, under employment and other structural disparities that were originally designed to disproportionately affect predominantly Black neighborhoods, in part, by exclusion of Blacks from the Homeowners' Loan Act of 1933 and the Servicemen's Readjustment Act of 1944 (GI Bill) primarily through a system known as "redlining" thereby magnifying residential segregation and its harmful effects.[23,24] Unfortunately, despite civil rights legislation these exclusionary policies and/or practices have continued to perpetuate a high level of segregation with associated economic and educational inequity.[23] These structural inequities created an easy way to bypass the intent of "Brown vs Board of Education" to eliminate the educational inequities, through policies to fund public education based on local taxes (creating educational inequities that follow economic inequities) rather than having all public schools receive equal support.

A major focus of disparities in the biomedical/health professional pipeline has been undergraduate/graduate students,[3,25-28] with less emphasis on high school students. The high school to undergraduate transition is less well studied, and has most commonly been examined retrospectively from the college level.[9] Key barriers to progress for underrepresented high school students include: 1) limited data collection and evaluation to accurately assess the infrastructure, environment, and sociocultural aspects of career development at the high school level[29]; and 2) paucity of exploration of non-traditional success factors on biomedical science careers such as precollege academic achievement, social support, peer racial dynamics (eg, racial climate), institutional characteristics (eg, scope of courses, advising), and others.[9]

As the number of individuals from underrepresented minority groups interested in pursuing science remains low, it is vital to provide programs and other opportunities that recruit and retain talented underrepresented minorities into the science and health-related fields.[30] Providing opportunities for underrepresented groups of talented youth to enter the science and higher education pipelines will not only increase the number of youth from diverse backgrounds entering biomedical and health sciences, but will increase the number of diverse health care professions and scientists overall. While increasing the numbers of under-

represented youth entering biomedical research, it is equally important that there are an increasing number of examples of highly successful scientists and health care professions to continue to motivate and inspire future generations to seek biomedical research as a career. Improving education and career opportunities can occur in different ways, including providing career information and counseling, as well as supporting individual career aspirations, individual academic achievement, science education, and general school reform.[31,32]

To provide the requisite early education opportunities and support, the NIH-NIDDK initiated a pilot high school student summer research program in 1995 (known as the National High School Student Summer Research Program) to provide a stimulating, rigorous 8- to 10-week summer research experience to a national cohort of 35 traditionally underrepresented high school juniors and seniors. In 2000 the program expanded to 75 students[33] and in 2003 NIDDK launched the formal HS-STEP-UP that included funding awards for both high school and undergraduate students programs.[34] The over-arching goal of the NIH-NIDDK HS-STEP-UP High School program is to provide a rewarding 8- to 10-week mentored summer research experience to ~100 underrepresented high school students annually. The program objectives include: 1) exposure and education in research principles, research conduct, and the presentation of science; 2) intensive mentoring of each student by active research faculty; 3) participation in the annual HS-STEP-UP symposium at NIH/NIDDK, where the students make oral and/or poster presentations to peers and established researchers using the standard presentation format of national scientific meetings; and 4) evaluation of the impact of HS-STEP-UP on key early hallmarks of success that predict the students' ability to persist and excel in the biomedical and health professional sciences.

Here, we describe the key elements of student recruitment and characteristics of the 2017 and 2018 HS-STEP-UP classes.

Methods

The NIH-NIDDK HS-STEP-UP supports underrepresented students who are aged ≥16 years and either in the 11th or 12th grades at the time of application (Tables 1-3). Four Coordinating Centers (CC) work collaboratively to recruit, place, mentor and follow-up students in disparate locations across the United States and its territories. The Stanford University and University of California Los Angeles (UCLA) Coordinating Centers are responsible for recruiting and following students from the 48 contiguous United States (excluding American Indian students). The University of Nevada Las Vegas (UNLV) Coordinating Center is responsible for recruiting American Indian and Alaska Native students, and students from Puerto Rico and the Virgin Islands. The University of Hawaii Coordinating Center is responsible for recruitment of students from Hawaii and US territories in the Pacific Islands (including American Samoa, the Marshall Islands and Palau). Each Coordinating Center identifies and matches students with NIH-funded researchers at colleges and universities in locations geographically near the student's home residence for their summer placements. The Centers also facilitate follow-up and/or ongoing mentorship for students following the completion of their summer research experience when possible. They utilize web-based interactive technology, social media and other dissemination methods for students and mentors in providing outreach and follow-up, student educational and professional development sessions, and to build a community among HS-STEP-UP participants. The NIDDK program office is in the process of identifying the status of program graduates to determine student outcomes.

The over-arching goal of the NIH-NIDDK HS-STEP-UP High School program is to provide a rewarding 8- to 10-week mentored summer research experience to ~100 underrepresented high school students annually.

The program provides financial support for high school students to participate in 8 to 10 consecutive

weeks of research training over the summer in NIDDK-related mission areas. At the end of the summer, the students are required to attend a scientific symposium to present results from their research experience on the NIH campus in Bethesda, Maryland. All students are required to present an 8-minute presentation summarizing their summer research projects; 12th graders are also required to design and present a scientific poster. HS STEP UP alumni and other biomedical graduate students are recruited as chaperones to provide additional oversight and guidance to students during the several days they attend the scientific symposium on the NIH campus.

Core Curriculum

The HS-STEP-UP orientation includes, but is not limited to, exposure to the responsible conduct of research such as animal research, human research, hazardous materials, medical ethics, regulations, best practices, conflicts of interests and effective functioning in a research team environment. These courses are provided through online modules with certification of completion to ensure each student has a solid foundation before initiating their research experience, which is then reinforced locally depending on their research topic.

Students participate in one webinar with their Coordinating Center prior to the start of the summer program; the webinar provides an

Table 1. The High School Short-Term Research Experience for Underrepresented Persons (HS-STEP-UP) application process

Eligibility	Be a US citizen, non-citizen national, or legal permanent resident Be aged ≥16 years and in their junior or senior year of high school, during the application period
How to apply	If a student is eligible to participate in the HS-STEP-UP program, the student creates an account through the Student Portal.
Submit an application	Students read the application instructions prior to submitting an application. They check the Eligibility Requirements if they are unsure of their eligibility. All applications must be submitted through the Student Portal prior to the submission deadline. The application process typically opens in October before the summer session.
Required documents	Students view the Required Documents Check List for a list of documents to be submitted in order to complete their application
Application deadlines	Applications and supporting documents must be received by 11:59 p.m. EST on the last day, usually in mid-February.
Status and review process	Application status can be found online when the student logs into the Student Portal. HS-STEP-UP program staff review only complete applications. If an application is incomplete, the student receives an email instructing them to check the application in the Student Portal to find out which components are missing so that they can submit the necessary documents to complete their application prior to the deadline. While staff are reviewing applications, status shows 'review in progress.' Once the review is complete, the status changes to 'reviewed.'
Notification of Acceptance	Notifications of acceptance into HS-STEP-UP begin via email in March prior to the summer research period and continue until all available spots are filled.
Acceptance of award	If offered a HS-STEP-UP award, the student must confirm their acceptance and participation within one week of notification. They will also be required to provide proof of existing medical insurance or to obtain medical insurance prior to the start of the program. Furthermore, students are required to submit a copy of their US passport, US birth certificate, or a government-issued photo identification document.
Required documents for a complete application	All applicants must submit: A completed online application A personal statement of no more than 600 words 2 letters of recommendation Contact information for two academic references. (Instructions to submit online letters of recommendation are provided in the Student Portal website.) Past HS-STEP-UP participants must have at least one letter from their most recent HS-STEP-UP Research Mentor. The letters of recommendation must be uploaded to the Student Portal by the deadline. Paper copies will not be accepted An academic transcript, which reflects all earned credits and most recent grades. Transcripts are to be uploaded to their application; however exceptions can be made, especially for students in the territories.

overview of the program and offers an opportunity for students to receive answers to any questions and assistance in completing biosafety and Collaborative Institutional Training Initiative - commonly known as CITI training. Mentors also participate in a webinar to answer any questions and provide them with information on best practices in mentoring high school students.

During the summer program, students work with their research mentors on a designated research project. They also participate in weekly webinars on basic statistics and research methodology, writing scientific abstracts, creating research presentations, and/or other topics. During the week-long conference at the NIH, students present their research during oral (all students) and poster presentations (seniors), and attend workshops on getting into college, transitioning to college, and research careers and opportunities. Further, students' presentations are critiqued, and constructive feedback is given by NIH scientists, to assist the students in improving presentation skills and development of research ideas. Chaperones and program staff are also available to provide mentorship during the entire week.

Results

For the 2017 HS-STEP-UP program, 99 students participated and 94 participated in the 2018 program; of the 193 students, 82% self-identified as being an underrepresented minority and 23% were from first generation college families. Sixty seven percent were females; 29% self-identified as Latino/Hispanic, 8% as Native American, 24% as Hawaiian/Pacific Islander, 30% as African American/Black, 8% as White and 10% as Asian. Of the students that reported family income, 48% reported <$37,000/year. All seniors reported attending college.

Analysis of the HS-STEP-UP program evaluation revealed that 90% were very satisfied or satisfied with their research topic and 94% rated the year end program at NIH as excellent or very good. However, only 65% were very satisfied or satisfied with their mentor matching and 21% were dissatisfied or very dissatisfied. Less than 10% reported being dissatisfied or very dissatisfied for issues such as research instruction and guidance or communica-

Table 2. Student expectations if accepted into the High School Short-Term Research Experience for Underrepresented Persons (HS-STEP-UP) Program

If accepted a student is assigned to a STEP-UP Coordinating Center (CC)	Students are assigned to a CC after they are accepted into the program. The CC serves as the HS-STEP-UP student's primary contact for any administrative or programmatic needs during the summer research experience. The CC provides direct oversight for all student activities. Once assigned to a CC, students are asked to provide proof of health insurance (exceptions will be granted for students living in the Pacific Islands) and a copy of a US passport, US birth certificate, or government-issued photo identification document
Each student works with their assigned CC to select a research location and mentor	Students DO NOT have to conduct their research at a coordinating center. Instead, students can work with their CC to identify and secure a research institution and research mentor closer to their home. Research can be conducted at colleges or universities, hospitals, departments of public health, private research institutions, etc. We highly recommend that students conduct research at institutions within commuting distances of their homes, because housing or funds to be housed elsewhere are not provided by HS-STEP-UP.
Students complete the required trainings and begin summer research	The start dates for the HS-STEP-UP program are determined by the CC and research mentor and may vary based on the student's school year. All students are expected to have a minimum of eight weeks of research experience during their HS-STEP-UP experience. Students are assigned research that may not necessarily match their research interests; however, the program does its best to match students with a great research experience. If there is a research mentor and/or institution that a student is interested in, we attempt to make that connection. The program encourages, but does not require, that students pursue research within the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) mission areas of diabetes, endocrinology and metabolic diseases; digestive diseases and nutrition; or kidney, urologic and hematologic diseases. Staff at CCs attempt to match students with research mentors within NIDDK core mission areas before matching students with research mentors outside of the NIDDK core mission areas.
Students attend the annual summer research symposium	Students are required to attend the annual research symposium to present their research project. The symposium is held on the NIH campus in Bethesda, MD in early August. Transportation and hotel accommodations are provided. Students are required to attend all of the activities of the symposium, which includes a variety of career development workshops; students deliver both poster and oral presentations of their summer research projects.

tion with lab, mentor or coordinating center. Finally, a list of student research topics (Table 4) highlights the diversity of research topics and activities experienced by the students.

Table 3. Description of 2017/2018 HS-STEP-UP high school student characteristics

Characteristics	2017 STEP-UP students, N=99	2018 STEP-UP students, N=94
Female, %	69	64
Race		
African American/Black, %	31	29
American Indian/Alaskan Native, %	8	7
Asian, %	4	16
Native Hawaiian/Pacific Islander, %	28	19
White, %	1	15
Ethnicity		
Latino/Hispanic, %	27	30
First generation college, %	30	15
Low family SES (<$33,000/yr), %[a]	65	31

a. About only half of the students each year report family income.
HS-STEP-UP, High School Short-Term Research Experience for Underrepresented Persons; SES, socioeconomic status.

Discussion

The HS-STEP-UP program captures a diverse group of students recognized as underrepresented in the biomedical/health professional workforce, including Latino/Hispanic, Native American, Hawaiian/Pacific Islander, African American/Black, and low-income White and Asian students from across the 50 US states and the US territories.[35] Many HS-STEP-UP students are the first in their family to attend college, which, compared with their peers, means they will likely have lesser high school academic preparation, lower educational degree expectations and come from a lower level of family income and support.[36]

The persistently low numbers of underrepresented persons pursuing biomedical science and health-related fields reinforces the need to provide targeted programs and other opportunities to inspire traditionally marginalized students to pursue such opportunities.[30] The NIH-NIDDK HS STEP-UP is one example of a replicable and successful program providing research experiences, supplemented with college preparedness, to help increase the number of diverse health care professions and scientists. The HS STEP-UP shares many similarities with other local high school biomedical research,[11,12] health professions[13-15], and/or summer science, technology, engineering and mathematics (STEM) enrichment programs[16] by offering a highly stimulating and in-depth learning environment that includes, but is not limited to, providing direct interaction with biomedical and health science researchers as role models, imparting scientific and health career knowledge, college admissions preparation and career counseling.

The HS STEP-UP program evaluation revealed that most students rated most of the program elements highly, except for mentor matching. Mentor matching and research placements are driven in part by mentor proximity and availability and may not match students' area of interest. This may be the reason behind these dissatisfaction ratings. It may also be that students find out research is not what they envisioned and that can be equally important to understand, especially with many being pushed to enter STEM careers. Although mentors volunteer to serve in this capacity, we cannot exclude a potential lack of mentor commitment/interest in the student as another reason for these ratings. We acknowledge the importance of finding dedicated mentors with experience and/or commitment to work with underrepresented students and advancing diversity in the biomedical workforce, as poor mentoring matching or negative experiences may turn students away from the field in the future.

Having interested high school students participate in research activities can help them better understand if a biomedical research career truly resonates with them or not. For the majority who are excited and stimulated being involved in research, the HS-STEP-UP, the experience can nurture and solidify their interest in science-related professions.[37] The HS-STEP-UP Program goals are consistent with a growing body

Table 4. Select High School Short-Term Research Experience for Underrepresented Persons 2017 Summer Projects

Coordinating Center: University of Hawai'i at Manoa
One-Year Mortality Comparison between Chamorros and the other Ethnic Groups with End Stage Renal Disease
Observation of the Productivity of *Isochrysis galbana* Cultures with Exposure to Different Light Intensities
Testing Recruitment Strategies to Improve Enrollment in a Cardiometabolic Study in Guam
The Effect of Trash and Piggeries on the Health of Mangrove Forests in American Samoa
Children's Food Knowledge and Preferences and their Effect on Early Childhood Obesity
Investigation of Hypothalamic Selenoprotein M in Energy Metabolism
Determination of Antigenotoxicity in Guam's Noni Fruit (Morinda citrifolia) and Avocado Seed (Persea americana)
Effectiveness of Compost Application on Growing Spoon Cabbage (Brassica rapa) in Salt-Treated Soil
Invertebrate Biodiversity In Palau
Beta-Cell Lines and Insulin Stimulation of Local Palauan Tea
Culturing Brachionus rotundiformis with Different Treatments of Microalga to Determine the Best Feed Combination
Exosomes: A Potential Flavivirus Vaccine
Natural and Artificial Rehabilitation of Degraded Soils (Mal) of Pohnpei island, FSM
Coordinating Center: University of California Los Angeles
Generalizability of Clinical Trials on Hypertension to the American Population
Effect of Ayurvedic Remedy on PAFR-dependent Pathways
Are the Outcomes of The Diabetes Prevention Program (DPP) for Different Race and Gender Groups the Same?
What Is the Burden of 30-Day Hospital Readmission Among US Peritoneal Dialysis Patients, and What Are the Correlates of These Readmissions?
Organ Specific Insulin Resistance in Diet-induced Obesity
Transforming the Intestine: Deletion of GATA 4 in Duodenal Enteroids Leads to Expression of Ileal Genes
Intracellular Fibroblast Growth Factors and the Modeling of Cardiac Excitability
Role of FGF Signaling in Kidney Structure, Function, and Mineralization
The Effect of Saturated Fatty Acid on the Expression of Apoptotic and Fibrotic Proteins in Renal Tubular Epithelial Cells
Coordinating Center: Stanford University
Effects of Epac1 on Diabetic Retinal Inflammation
Sex Differences in Two Strains of Mice Fed a Methionine Restricted High Fat Diet
The Effect of Dietary Fructose on Triple Negative Breast Cancer (TNBC) in Transgenic Mice
Anatomical Structure of Primitive Kidney in Triops *cancriformis*
The Effects of Obesity and Bariatric Surgery on the Expression of Genes in the Akt Insulin Signaling Pathway in Human Adipose Tissue
Engineering a C. Elegans Model of INF2-associated Kidney Disease
What Are Normal Cortisol Values for Young Children?
Epigenetic Factors Impacting Type 2 Diabetes in American Indians
ApoL6 in Lipolysis
Coordinating Center: University of Nevada, Las Vegas
Diabetes and Processed Foods Across the Belt
Structural Characterization of Cytochrome *c* A44C Mutant
Assessing the Nutritional Environment in Kewa Pueblo
Interaction and dynamics of Cytochrome c protein encapsulated in nanoparticles
pH and How it Affects the Physical World
Electrospun Cellulose Acetate-Nanodiamond Scaffolds for Bone Tissue Regeneration
Effect of Morphine on Cilia in Rat Adrenal Glands
Mapping the Prevalence of Prediabetes and Diabetes among Obese Latino Youth in Maricopa County
Water Quality on the Kickapoo Reservation

of evidence that suggests that participation in out-of-school programs can make a positive difference in the lives of young people.[38] Patterson and Carline suggested program strategies aimed at increasing minority representation in science and health careers should include such elements as increasing career awareness and motivation, and youth mentoring through long-term relationships between pre-college students and older

students or professionals in science fields, research apprenticeships to develop research knowledge, and reward incentives for successful program participation and other achievements.[31]

The NIH-NIDDK HS STEP-UP is one example of a replicable and successful program providing research experiences, supplemented with college preparedness, to help increase the number of diverse health care professions and scientists.

Of importance for the program is providing adolescents opportunities for exposure to scientific research environments and direct apprenticeship with scientist mentors who encourage passion for, and sustained pursuit of, education overall, and the sciences in particular. The HS STEP-UP summer research experience is grounded in pairing students with experienced researchers and mentors. The inclusion of mentors in the development of young professionals is a longstanding practice.[39] Mentoring of youth is often defined as a sustained relationship between a young person and an adult in which the adult provides the young person with support, guidance, and assistance.[40] Mentoring has been shown to be specifically effective in three major areas that are critical to young people's success in life: educational achievement, health and safety, and social and emotional development.[40] Many mentoring programs emphasize improving the academic and cognitive skills of youth because academic achievement is a key predictor of socioeconomic status.[40] In addition, programs that focus on all aspects of healthy youth development, such as adding social and motivational components (eg, Health Professions Partnership Initiative 2004), are also important elements in maintaining the lasting positive effects of mentoring.

Through role modeling and the provision of emotional support and positive reinforcement, mentoring is also expected to influence adolescents' perceptions of self-worth and their beliefs about their competence as learners and their valuing of school based education.[41] By conveying messages regarding the value of school and serving as tangible models of success, mentors stimulate improved attitudes toward school achievement, perceived academic competence and school performance,[42,43] as well as strengthen adolescents' beliefs about the relationship between educational attainment and future occupational opportunities.[44]

There are several key characteristics of successful youth mentoring relationships. Youth are more likely to benefit if mentors maintain frequent contact with them, know their families, and if they perceive high-quality relationships with their mentors.[40] Additional program practices that enhance quality mentoring include being well-structured, facilitating high levels of interaction between young people and their mentors, and being driven more by the needs and interests of youth than the expectations of the adults.[40] Appropriate matches between mentor and youth, the development of trust, and utilizing the help and advice of program staff also contribute to effective mentoring relationships.[39]

In addition to providing mentored research experiences, the HS STEP-UP offers a variety of enrichment programs and initiatives. Such enrichment programs and initiatives have been identified to enhance the science achievement and attitudes of both girls and boys. These programs have emphasized the importance of inquiry-based learning, in which students participate in the process of scientific discovery.[45-47] A large longitudinal study revealed that students who actively performed their own science experiments learned more than those who did not.[47,48] Other comparisons of hands-on vs more passive learning paradigms also support the value of active learning for enhancing science achievement.[49,50] Girls may benefit in particular from opportunities to use science tools and equipment because they often have less experience than boys with science-related activities outside the classroom.[46,48,51,52] Educators have stressed that girls in particular learn best through an "engaged pedagogy" that promotes student participation in a supportive environment.[53] Provision of science career information has

also been identified as important for the promotion of science interest and achievement. Educators have suggested that these advantages are especially important for girls because girls are less likely to have access to them in traditional educational settings.[51,54,55]

Conclusion

In conclusion, the HS-STEP-UP program has been highly successful in recruiting traditionally underrepresented students into participating in summer research. Longer-term follow-up on student's career progress including choice of college major, continuation to a graduate school biomedical science program as well as an ascertainment of other chosen career paths is needed to determine its ultimate impact on increasing diversity in the biomedical workforce. Additional program improvement efforts including exit interviews or focus groups will need to be taken to ensure a better understanding of how to facilitate positive research placements and to optimize mentor matching for students.

Acknowledgments

This project was conducted with support from NIH-NIDDK grants 1R25DK113659 (KCN), 5R25DK078386 (GH), 5R25DK078382 (BH-F) and 5R25DK098067(CD-F).

Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Rivers, Norris, Hui, Guerrero, Halpern-Felsher, Dodge Francis, Golshan, McLaughlin, Antolin, Caffey-Fleming, Agodoa; Acquisition of data: Norris, Hui, Guerrero, Halpern-Felsher, Dodge Francis, Golshan, Tran, McLaughlin, Antolin, Yoshida, Caffey-Fleming; Data analysis and interpretation: Rivers, Norris, Guerrero; Manuscript draft: Rivers, Norris, Hui, Guerrero, Halpern-Felsher, Dodge Francis, Golshan, Brinkley, Tran, McLaughlin, Antolin, Yoshida, Caffey-Fleming, Agodoa; Statistical expertise: Rivers, Norris, Guerrero; Acquisition of funding: Rivers, Norris, Hui, Guerrero, Halpern-Felsher, Dodge Francis, Agodoa; Administrative: Rivers, Norris, Hui, Guerrero, Halpern-Felsher, Dodge Francis, Golshan, Brinkley, Tran, McLaughlin, Antolin, Yoshida, Caffey-Fleming, Agodoa; Supervision: Rivers, Norris, Hui, Guerrero, Halpern-Felsher, Dodge Francis, Agodoa

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