Original Report:
Training the Next Generation
of Health Equity Researchers

Baseline Characteristics of the 2015-2019 First Year Student Cohorts of the NIH Building Infrastructure Leading to Diversity (BUILD) Program

Keith C. Norris, MD, PhD[1]; Heather E. McCreath, PhD[1]; Karsten Hueffer PhD, FHEA[2]; Stephen B. Aley, PhD[3]; Gabriela Chavira, PhD[4]; Christina A. Christie, PhD[1]; Catherine M. Crespi, PhD[1]; Carlos Crespo, PhD[5]; Gene D'Amour, PhD[6]; Kevin Eagan, PhD[1]; Lourdes E. Echegoyen, PhD[3]; Andrew Feig, PhD[7]; Maryam Foroozesh, PhD[6]; Lourdes R. Guerrero, EdD[1]; Kelly Johanson, PhD[6]; Farin Kamangar, PhD[8]; Laura Kingsford, PhD[9]; William LaCourse, PhD[10]; Nicole Marie-Gerardi Maccalla, PhD[1]; Leticia Márquez-Magaña, PhD[11]; Ambika Mathur, PhD[12]; Kenneth Maton, PhD[10]; Shiva Mehravaran, MD, MIH[8]; Danielle X. Morales, PhD[3]; Terry Nakazono[1]; Elizabeth Ofili, MD, MPH[13]; Kolawole Okuyemi, MD, MPH[14]; Laura Ott, PhD[10]; Audrey Parangan-Smith, PhD[11]; Christine Pfund, PhD[15]; Dawn Purnell[1]; Arleigh Reynolds, DVM, PhD[2]; Phillip J. Rous, PhD[10]; Carrie Saetermoe, PhD[4]; Katherine Snyder, PhD[16]; Jamboor K. Vishwanatha, PhD[17]; Amy Wagler, PhD[3]; Steven P. Wallace, PhD[18]; Teresa Seeman, PhD[1]

Objective: The biomedical/behavioral sciences lag in the recruitment and advancement of students from historically underrepresented backgrounds. In 2014 the NIH created the Diversity Program Consortium (DPC), a prospective, multi-site study comprising 10 Building Infrastructure Leading to Diversity (BUILD) institutional grantees, the National Research Mentoring Network (NRMN) and a Coordination and Evaluation Center (CEC). This article describes baseline characteristics of four incoming, first-year student cohorts at the primary BUILD institutions who completed the Higher Education Research Institute, The Freshmen Survey between 2015-2019. These freshmen are the primary student cohorts for longitudinal analyses comparing outcomes of BUILD program participants and non-participants.

Design: Baseline description of first-year students entering college at BUILD institutions during 2015-2019.

Setting: Ten colleges/universities that each received <$7.5mil/yr in NIH Research Project Grants and have high proportions of low-income students.

Participants: First-year undergraduate students who participated in BUILD-sponsored activities and a sample of non-BUILD students at the same BUILD institutions. A total of 32,963 first-year students were enrolled in the project; 64% were female, 18% Hispanic/Latinx, 19% African American/Black, 2% American Indian/Alaska Native and Native Hawaiian/Pacific Islander, 17% Asian, and 29% White. Twenty-seven percent were from families with an income <$30,000/yr and 25% were their family's first generation in college.

Planned Outcomes: Primary student outcomes to be evaluated over time include undergraduate biomedical degree completion, entry into/completion of a graduate biomedical degree program, and evidence of excelling in biomedical research and scholarship.

Conclusions: The DPC national evaluation has identified a large, longitudinal cohort of students with many from groups historically underrepresented in the biomedical sciences that will inform institutional/national policy level initiatives to help

Introduction

Despite the increasing evidence of the benefits of diversity in multiple disciplines, including science and health care,[1-9] a 2019 National Science Foundation (NSF) report noted that persons with disabilities, African Americans, Hispanic/Latinx, American Indians/Alaskan Natives, and Native Hawaiians/Pacific Islanders continue to receive doctoral degrees and/or academic appointments in the areas of science, technology, engineering and math (STEM) at rates substantially lower than their representation in society.[10,11] Notwithstanding multiple efforts, there remains a paucity of individuals from traditionally underrepresented groups (URG) pursuing

academic research careers within the biomedical/behavioral sciences (herein referred to as biomedical sciences). This participation gap is evident for disabled and underrepresented minority groups at all stages from completion of undergraduate degrees, acceptance into and completion of graduate degrees, participation in and completion of competitive post-doctoral programs, through to entry into tenure-track academic positions, promotion in rank, receipt of grant support from various funding mechanisms, and service in senior leadership positions.[11] While women now are better represented in STEM education, they continue to have low levels of representation at higher levels of faculty appointment and leadership positions.[11]

Of note, despite prior efforts, disparities in National Institutes of Health (NIH) R01 funding awards made to doctoral-trained underrepresented minority biomedical scientists persist, even after adjustment for educational background, country of origin, training, previous research awards, publication record, and employer characteristics.[12] Indeed, the low rate of R01 grants awarded to African Americans still persisted after adjusting for smaller professional networks and lower rates of grant application resubmission,[12] spurring a 2012 Report from the Advisory Committee to the Director of the Working Group on Diversity in the Biomedical Research Workforce. The report recommended that the NIH pursue evidence-based and/or theory-informed strategies to increase diversity in the biomedical/health professional workforce.[11] A more recent report suggests lower NIH funding award rates for minorities persist and the need to pursue the Working Group recommendations still remains.[13]

In order to develop a richer evidence base of research to engage a more diverse field of individuals in biomedical research careers, the NIH created the Diversity Program Consortium (DPC), a prospective initiative to implement and evaluate several novel interventions at a variety of academic institutions across the country and their key research and pipeline partner institutions. The DPC comprises: 1) 10 Building Infrastructure Leading to Diversity (BUILD) programs that are implementing student, faculty, and institutional-level interventions (Table 1); 2) the National Research Mentoring Network (NRMN),[14,15] which is focusing on interventions related to professional development and mentoring at all stages of the biomedical research career development pathway[7]; and 3) the Coordination and Evaluation Center (CEC), which serves to externally evaluate the impact of the various interventions related to the DPC's overarching objectives in the Enhance Diversity Study.[16] The DPC has a major focus on examining transition points along the trajectory from an undergraduate student to an independently funded investigator.[17] These multi-site interventions will be subject to consortium-level analyses using quasi-experimental designs.[16]

The BUILD initiative was fund-

diversify the biomedical workforce. *Ethn Dis*. 2020;30(4):681-692; doi:10.18865/ed.30.4.681

Keywords: Diversity; Biomedical Research; Workforce Training; Underrepresented Students

[1] BUILD Coordination & Evaluation Center, David Geffen School of Medicine at UCLA, Los Angeles, CA
[2] BUILD BLaST, University of Alaska, Fairbanks, AK
[3] BUILDing SCHOLARS, University of Texas at El Paso, TX
[4] BUILD PODER, California State University, Northridge, CA
[5] BUILD EXITO, Portland State University, OR
[6] Project Pathways, Xavier University of Louisiana, New Orleans, LA
[7] ReBUILD Detroit, Wayne State University, Detroit, MI
[8] BUILD ASCEND, Morgan State University, MD
[9] CSULB BUILD, California State University, Long Beach, CA
[10] STEM BUILD at UMBC, University of Maryland, Baltimore County, MD
[11] SF BUILD, San Francisco State University, San Francisco, CA
[12] University of Texas, San Antonio, TX
[13] Clinical Research Center at Morehouse School of Medicine (NRMN U01), Atlanta, GA
[14] Department of Family and Preventive Medicine at the University of Utah School of Medicine (NRMN U01), Salt Lake City, UT
[15] NRMN CC, University of Wisconsin, Madison, WI
[16] ReBUILD Detroit, University of Detroit, Mercy, MI
[17] NRMN RC, University of North Texas Health Science Center, Fort Worth, TX
[18] Community Health Sciences, UCLA Fielding School of Public Health, Los Angeles, CA

Address correspondence to Keith C. Norris, MD, PhD; Geffen School of Medicine at UCLA, 1100 Glendon Ave #710, Los Angeles, CA 90024; kcnorris@mednet.ucla.edu

Table 1. Administration details for The Freshman Survey by BUILD institution and year

	The HERI Freshman Survey (TFS) administration year				
BUILD Institution	**2015**	**2016**	**2017**	**2018**	**2019**
California State University, Long Beach	Institution-wide, paper at orientation with cohort sampling from follow-up	Institution-wide, web at orientation with cohort sampling from follow-up	Sampled cohort, web after classes began	Institution-wide, web after classes began with cohort sampling from follow-up	Institution-wide, web after classes began with cohort sampling from follow-up
California State University, Northridge	Institution-wide, paper and web with cohort sampling from follow-up	Institution-wide, web after classes began with cohort sampling from follow-up	Institution-wide, web after classes began with cohort sampling from follow-up	Sampled cohort, web after classes began	Sampled cohort, web after classes began
Morgan State University	Institution-wide, paper and web after classes began and with targeted classes	Institution-wide, web after classes began and with targeted classes	Institution-wide, web after classes began and with targeted classes	Institution-wide, paper after classes began and with targeted classes	Institution-wide, paper after classes began and with targeted classes
Portland State University	Convenience sample with targeted classes, web after classes began	Institution-wide, web prior to classes began	Institution-wide, web prior to classes began	Institution-wide, web prior to classes began	Institution-wide, web prior to classes began
San Francisco State University	Institution-wide, web after classes began	Institution-wide, web after classes began	Institution-wide with limit to responses, web after classes began	Institution-wide with limit to responses, web after classes began	Institution-wide with limit to responses, web after classes began
University of Alaska Fairbanks	Institution-wide, paper during orientation	Institution-wide, web after classes began	Institution-wide, web after classes began	Institution-wide, web after classes began	Institution-wide, web after classes began
University of Detroit-Mercy	Institution-wide, paper during orientation	Institution-wide, paper during orientation	Institution-wide, paper during orientation	Institution-wide, paper during orientation	Institution-wide, paper during orientation
University of Maryland, Baltimore County	Institution-wide, paper and web after classes began and with targeted classes	Institution-wide, web during orientation	Institution-wide, web during orientation	Institution-wide, web during orientation	Institution-wide, web during orientation
University of Texas at El Paso	Institution-wide, paper and web after classes began and with targeted classes	Sampled cohort, web after classes began	Sampled cohort, web after classes began	Sampled cohort, web after classes began	Sampled cohort, web after classes began
Xavier University of Louisiana	Institution-wide, paper only during orientation	Institution-wide, paper and web during orientation	Institution-wide, web only after classes began	Institution-wide, web only after classes began	Institution-wide, web only after classes began

Note. Survey administration methods varied by institution and year based on institutional interest in surveying all incoming students and conducting the survey as part of new student orientation or after the academic term began. The survey is a central element of HERI's the Cooperative Institutional Research Program.
BUILD, Building Infrastructure Leading to Diversity Institutions; HERI, Higher Education Research Institute.

ed in 2014 for five years (Phase I of BUILD). Phase II of BUILD was funded for an additional five years, beginning in July 2019. First-year student participation in the initiative's programs began in 2015. BUILD institutions were required to be baccalaureate degree-granting colleges and universities that each received <$7.5mil annually in NIH Research Project Grant funding (total costs) and have relatively high proportions of students from low-income backgrounds as evidenced by at least 25% of the institution's students being supported by Pell grants.[18] This approach was used to focus eligibility on institutions likely to have many students who would be classified by NIH as underrepresented in biomedical research.[18]

BUILD is designed to provide evidence-based practices around several key predictors of biomedical student degree completion and transition to a biomedical career (termed hallmarks of success)[19] viewed as critical to increasing diversity in the biomedical research workforce.[17,19] The broad, external evaluation of the BUILD initiatives by the CEC uses a quasi-experimental longitudinal multi-methods design and will use

data collected from the beginning of the initiative (in 2015) through Phase II (ending in 2024) using a variety of approaches including surveys and case studies.[20] Final analyses and evaluation will be provided after the conclusion of funding in 2024.

The main aims of the longitudinal BUILD evaluation are to: 1) identify the hallmarks of a successful biomedical research career at each phase of the training process; 2) elucidate what motivates students to enter biomedical research career paths and what factors contribute to their sustained participation; 3) determine what factors influence emerging scientists, particularly those from underrepresented backgrounds, to enter, exit, or persist in a biomedical research career; 4) identify what must happen during different stages of training to ensure that trainees develop the skills, knowledge, and competencies essential to successful biomedical careers, including careers in the NIH-funded biomedical research workforce; 5) enhance faculty mentoring and research skills; and 6) determine how institutional structures and resources facilitate successful research training and professional development activities.[18]

As noted above, multiple sources are being used to evaluate BUILD student outcomes, including national Higher Education Research Institute (HERI) surveys and DPC-specific surveys. Students involved with the BUILD program are compared with students not in the program, both cross-sectionally and longitudinally.[20,21] These comparisons allow multiple ways of assessing the impact of the BUILD interventions.[20] Once enrolled in an evaluation cohort, students are surveyed annually for major predictors and outcomes.

Within this article, we describe the baseline characteristics of entering first-year students from the Phase I BUILD grantee institutions (academic years 2015-2016 through 2018-2019) enrolled in the Enhance Diversity Study. Students include those who have participated in BUILD interventions and similar students who have not participated in BUILD interventions at the same institution. While many of the BUILD programs actively engage with students and faculty at partner institutions, the consortium-wide evaluation focuses only on students at the primary BUILD institutions. Future data collection will include first-year students at matched non-BUILD institutions to conduct analyses that will control for potential spillover effect of BUILD activities on non-BUILD students within the same institution.

Methods

Design

Students were recruited into Phase I evaluation cohorts either through an invitation to participate as an incoming freshman/first year student or by participation in one or more of the BUILD activities offered at their institution. Incoming first-year students were asked to complete HERI's The Freshmen Survey (TFS) either in person or online (Table 1). Depending on the size of the campus, either all students were invited to the survey or the students were sampled for inclusion based on declared major (biomedical/non-biomedical) and

Table 2. Building Infrastructure Leading to Diversity (BUILD) institutional characteristics[a]

	Institutional characteristics	
BUILD Institution	**Institutional control, public/ private**	**Total full-time enrollment, median (range)[b]**
California State University, Long Beach	Public	27,870 (27,490 – 28,415)
California State University, Northridge	Public	29,411 (28,409 – 30,177)
Morgan State University	Private	5,992 (5,843 – 6,336)
Portland State University	Public	16,887 (16,604 – 17,155)
San Francisco State University	Public	23,090 (22,747 - 23,744)
University of Alaska Fairbanks	Public	4,850 (4,585 – 5,152)
University of Detroit-Mercy	Private	2,551 (2,526 – 2,727)
University of Maryland, Baltimore County	Public	9,920 (9,827 – 10,031)
University of Texas at El Paso	Public	16,818 (16,569 – 17,578)
Xavier University of Louisiana	Private	2,229 (2,173 – 2,247)

a. Classified by the US Department of Education as a minority-serving institution in February 2017.
b. Estimated full-time equivalent undergraduate enrollment, 2015-16 through 2017-18, Integrated Postsecondary Education Data System (IPEDS).

considering demographic factors in order to ensure adequate representation of these different groups within the cohorts being followed. Each year, the goal has been to recruit 5,000 incoming students across the DPC in order to have an adequate number of participants with longitudinal data.

Setting

Ten institutions serve as the primary awardees for BUILD programs, three in California, two in Maryland and one each in Texas, Alaska, Michigan, Louisiana, and Oregon. Eight are public and all ten are classified as minority-serving institutions (Table 2).

Data Collection

Incoming first-year students at the primary BUILD institutions were surveyed using HERI's The Freshmen Survey (TFS) each fall from 2015-2019. This annual national survey collects information about students' backgrounds, high school preparation for college, reasons for attending college, and expectations about the college experience, and has been taken by over 15 million students over 50 years as part of the HERI Cooperative Institutional Research Program.[5] The survey consists of 50 core questions and takes approximately 25 minutes to complete. Responses from the survey serve as a rich source of information for higher education institutions in general, as baseline data for the early hallmarks of success and as predictors of later-stage hallmarks for the DPC. At some institutions, students were offered small incentives for participating in the survey (eg, $5-10 gift card, entry into a raffle for campus bookstore gift card or tablet computer).

Data Analysis

Descriptive analyses were conducted of basic demographic characteristics at entry to college of the students enrolled in the national evaluation at BUILD institutions to date. Analyses presented here describe the cohorts of students who have been identified and who will be followed longitudinally. The analyses focus on the ability to assess major hallmarks and outcomes of interest such as graduation with an undergraduate degree, acceptance to graduate school, and pursuit of a biomedical research career among a national and diverse group of students.

We describe the baseline characteristics of entering first-year students from the Phase I BUILD grantee institutions (academic years 2015-2016 through 2018-2019) enrolled in the Enhance Diversity Study.

Results

The full-time enrollment at BUILD institutions as of fall 2017 was 12,389 (median) with a range of 2,229 – 29,411 students. Eight BUILD institutions are public and two are private; four are Hispanic-serving institutions, two are historically Black colleges/universities, and all 10 are classified as minority serving institutions (Table 2).

Survey response rates across the study period ranged from 25%-30%. The overall student characteristics are shown in Table 3. Of the student participants, 65% were female and the mean age was 18.5 + 1.9 years (range: 15-64). Of those who responded to the race/ethnicity question (n=29,872), the racial and ethnic composition of the cohort was 18% Hispanic/Latinx, 19% African American/Black, 2% Native Hawaiian/Pacific Islander or American Indian/Alaska Native, 17% Asian, 29% White, and 14% reported two or more races. Twenty-seven percent (27%) of the 26,174 who answered the income question were from families with an income < $30,000/yr, 25% (6,544 of 26,145 respondents) reported being first generation in college, and 28% of the 17,277 responding to the disability question reported at least one disability (the disability questions were not asked every year).

The characteristics of students stratified by race/ethnicity are described in Table 4. The percentages of female students who are also Hispanic/Latinx, African American/Black, and two or more races were greater than the cohort average, ranging from 68%-70%. Hispanic/Latinx, African American/Black and other single race groups of students were more likely to have a family income <$30,000/yr and to receive Pell grants, while Latinx were more likely than the other groups to be first generation in college. Table 5 describes the characteristics of students stratified by biomedical science majors (as either natural/life science or social/behavioral science majors), or non-biomedical science majors.

Table 3. Overall description of student characteristics at BUILD[a] institutions,[b] 2015-2019

Characteristics, n= respondents[c]	Student cohort
Total surveyed, N	32,963
	Mean (SD, range)
Age, yrs, n=26,642	18.5 (1.9, 15-64)
	N (%)[d]
Sex, n=31,448	
Female	20,211 (64)
Male	11,237 (36)
Race/ethnicity, n=29,872	
Hispanic/Latinx	5,460 (18)
African American/Black	5,535 (19)
Asian	5,179 (17)
White	8,762 (29)
American Indian/Alaskan Native, Native Hawaiian, or Pacific Islander	604 (2)
Two or more races (not incl. Latinos)	4,332 (14)
Family demographics	
First generation entry to college, n=26,145	6,544 (25)
Family SES/total income, n=26,174	
<$19,999	2,635 (10)
$20,000 - $29,999	4,348 (17)
$30,000 - $59,999	5,394 (21)
$60,000 or more	13,797 (53)
Pell grants, n=27,538	11,842 (43)
Family covers some expenses, n=27,322	19,504 (71)
Intended major, n=28,792	
Biomedical basic science	15,969 (55)
Biomedical social science	2,513 (9)
Non-biomed	10,310 (36)
At least one disability, n=17,277[c]	4,803 (28)

a. BUILD - Building Infrastructure Leading to Diversity Institutions.
b. Data from Higher Education Research Institute (HERI) The Freshman Survey respondents from 2015 – 2019.
c. HERI Freshman Survey - 2016 and 2018-2019 only. Sample sizes may differ within and across tables due to non-response for selected questions.
d. Percent responders for a given question.

Most biomedical science majors were enrolled in basic biomedical science majors. Relative to students enrolled in basic biomedical science majors, those in social/behavioral biomedical science majors were more likely to be female, Hispanic/Latinx, African American/Black, first generation in college, have a low family income, and/or to have a Pell grant. Overall, 36% of survey respondents were non-biomedical majors, consistent with the study plans to survey students in both biomedical and non-biomedical major disciplines who are not connected to the BUILD programs (Table 5).

Discussion

Consistent with recommendations from the 2012 Report from the Advisory Committee to the Director's Working Group on Diversity in the Biomedical Research Workforce,[11] the baseline sample of incoming freshmen at BUILD institutions reflects a large percentage of students recognized as underrepresented in the biomedical research workforce.[16] Many students at BUILD institutions come from groups that are recognized as underrepresented in the biomedical research workforce,[22] with nearly 40% from underrepresented racial/ethnic minority groups and more than 25% reporting at least one disability. Furthermore, the proportion of BUILD students with Pell grants is 43%, and 25% report being the first in their family to attend college. Compared with their peers, first generation college students have been reported to have a lower level of family income and support, lesser high school academic preparation, and lower educational degree expectations.[23] Thus, the BUILD student cohort represents a large proportion of students facing multiple challenges associated with a lack of achievement in the biomedical sciences.

Having many BUILD institutions recognized as a minority-serving institution may be fortuitous as they have been reported to be perhaps the most poised of any sector within American postsecondary education to encourage students from historically disadvantaged backgrounds to enter research careers.[18,24] In fact, they produce a disproportionately high number of STEM doctoral degree recipients.[5,25] For example, more than one third of Black STEM PhD recipients who earned their degrees between 2005 and 2010 earned their undergraduate degrees at a historically Black college or university.[25]

These baseline findings demonstrate that the DPC has been able to

Table 4. Description of student characteristics by race/ethnicity at BUILD institutions[a]

Characteristics	Race/Ethnicity[b]						
	Hispanic/ Latinx, n=5,460	African American/ Black, n=5,535	Asian, n=5,179	White, n=8,762	AI/AN, NH/ PI, n=604	≥2 Ethnicities, n=4,332	P[c]
Age, n=26,459, mean (SD, range)	18.5 (1.7, 16-54)	18.4 (1.8, 15-59)	18.5 (1.7, 15-59)	18.5 (2.1, 16-64)	18.6 (2.1, 16-38)	18.5 (2.0, 16-54)	<.0001
Sex, n=29,189							<.0001
Female	3,630 (68)	3,742 (70)	3,041 (60)	5,160 (60)	343 (58)	2,862 (68)	
Male	1,675 (32)	1,638 (30)	2,052 (40)	3,426 (40)	244 (42)	1,376 (32)	
Family demographics							
First generation college, n=26,043	2,756 (57)	742 (17)	1,116 (24)	1,056 (13)	154 (30)	687 (18)	<.0001
Family SES/ total income, n=26,058							<.0001
<$19,999	780 (16)	614 (13)	441 (10)	336 (4)	84 (17)	363 (10)	
$20,000 - $29,999	1,412 (28)	821 (17)	781 (17)	660 (9)	100 (20)	547 (14)	
$30,000 - $59,999	1,435 (29)	1,047 (22)	906 (20)	1,146 (15)	100 (20)	732 (19)	
$60,000 or more	1,373 (27)	2,223 (47)	2,421 (53)	5,370 (71)	218 (43)	2,148 (57)	
Pell grants, n=27,400	3,230 (63)	2,636 (53)	1,919 (40)	2,089 (26)	224 (43)	1,672 (42)	<.0001
Family covers some educational expenses, n=27,144	3,118 (61)	3,409 (71)	3,668 (78)	6,039 (76)	325 (62)	2,860 (72)	<.0001
Intended major, n=28,600							<.0001
Biomedical: basic science	2,580 (49)	3,126 (60)	3,265 (66)	4,490 (54)	306 (56)	2,112 (51)	
Biomedical: behavioral/ social Science	620 (12)	570 (11)	266 (5)	591 (7)	35 (6)	416 (10)	
Non-biomedical	2,107 (40)	1,544 (29)	1,443 (29)	3,273 (39)	210 (38)	1646 (39)	
At least one disability, n=17,220[d]	627 (21)	707 (23)	590 (20)	1,923 (36)	77 (24)	865 (36)	<.0001

Values are N (%) unless otherwise noted.
BUILD, Building Infrastructure Leading to Diversity Institutions; AI/AN, NH/PI, American Indian/Alaska Native, Native Hawaiian/Pacific Islander.
a. Data from Higher Education Research Institute (HERI) The Freshman Survey respondents from 2015 – 2019.
b. Percent responders for a given question.
c. Chi-square test except age, which uses ANOVA.
d. HERI Freshman Survey - 2016 and 2018-2019 only. Sample sizes may differ within and across tables due to non-response for selected questions.

identify a diverse cohort of students to enable long-term evaluation of the BUILD program impact. In addition, by utilizing an established survey with historical information about college students nationally, we will have the ability over time to assess the contribution of a range of characteristics and expectations on outcomes for the different BUILD student subgroups. More specifically, we will be able to assess whether and to what extent the BUILD program interventions may have had positive impacts on BUILD hallmarks of success such as undergraduate biomedical degree completion, entry into/completion of a graduate biomedical degree program, evidence of excelling in biomedical research and scholarship, and electing to pursue an academic or other career involving biomedical research. Determining the program impact at a national level will require administrative records (eg, NSF) and other sources of data in the future, beyond DPC-specific data collection efforts.

The need for NIH to continue to pursue these 2012 recommendations remains of great consequence, as Valantine et al recently reported the continued racial/ethnic funding gap for first-time NIH R01 applica-

Table 5. Description of student characteristics by intended major classification at BUILD Institutions[a]

Characteristics	Intended major classification			
	Natural/life science, n=15,969	Social/behavioral science, n=2,513	Non-biomed, n=10,310	
	Mean (SD, range)	Mean (SD, range)	Mean (SD, range)	P[b]
Age, n=25,783	18.4 (1.3, 15–51)	18.7 (2.7, 17-59)	18.7 (2.4, 16-64)	<.0001
	N (%)[c]	N (%)	N (%)	
Sex, n=28,147				<.0001
Female	9,612 (61)	2,109 (86)	6,436 (64)	
Male	6,052 (39)	334 (14)	3,604 (36)	
Non-response	305	70	270	
Race/ethnicity, n=28,600				<.0001
Hispanic/Latino	2,580 (16)	620 (25)	2,107 (21)	
African American/Black	3,126 (20)	570 (23)	1,544 (15)	
Asian	3,265 (21)	266 (11)	1,443 (14)	
White	4,490 (28)	591 (24)	3,273 (32)	
American Indian/Alaskan Native, Native Hawaiian, or Pacific Islander	306 (2)	35 (1)	210 (2)	
Two or more races (not incl. Latinos)	2,112 (13)	416 (17)	1,646 (16)	
Non-response	90	15	87	
Family demographics				
First generation college, n=25,616	3,322 (23)	663 (30)	2,432 (27)	<.0001
Family SES/total income, n=25,674				<.0001
<$19,999	1,345 (9)	265 (12)	975 (11)	
$20,000 - $29,999	2,229 (16)	438 (20)	1,600 (17)	
$30,000 - $59,999	2,863 (20)	510 (23)	1,915 (21)	
$60,000 or more	7,838 (55)	972 (45)	4,724 (51)	
Non-response	1694	328	1096	
Pell grants, n=27,025	6,250 (41)	1,195 (51)	4,200 (44)	<.0001
Family covers some expenses, n=26,796	10,862 (73)	1,598 (69)	6,692 (70)	<.0001
At least one disability, n=16,831[d]	2,184 (24)	565 (38)	1,951 (32)	<.0001

BUILD, Building Infrastructure Leading to Diversity Institutions.
a. Data from Higher Education Research Institute (HERI) The Freshman Survey respondents from 2015 – 2019.
b. Chi-square test except age, which uses ANOVA.
c. Percent responders for a given question.
d. HERI Freshman Survey - 2016 and 2018-2019 only.
Sample sizes may differ within and across tables due to non-response for selected questions.

tions.[26] As new policies and other diversity initiatives are implemented, close observation and understanding of the processes and pathways to these outcomes are required to ensure all groups benefit equally.[27] Hopefully, lessons learned from BUILD will not only be highly generalizable, but will include outcomes that will be useful to a wide array of students and faculty, as well as institutions, ranging from small to large and public to private.

Increasing diversity in the biomedical research workforce is more than an issue of equity; it is an issue of excellence and ensuring that the best biomedical science minds have the opportunity to contribute to advance the health of our nation. Having teams from diverse backgrounds can bring to bear a wide range of skill sets and viewpoints in both life experiences and education that can be of immense value.[4,28] A series of research findings from the last

two decades has identified the benefits provided by diverse learning environments for college student success.[4,29] Similarly, diverse work environments can enhance innovation, competitiveness, creativity, and performance.[30,31] Diverse teams working in collaboration to advance scientific inquiry resulted in higher impact publications, presumably due to improved research quality based on broader perspectives.[6] When compared with a team of homogeneous high-ability problem-solvers, a randomly selected team of intelligent, diverse problem-solvers outperformed the homogenous group in a computer model,[9] supporting the concept that diversity of perspectives can improve innovations and better solve complex problems. However, the types of diversity that benefit a given team may vary by discipline, projected outcomes and/or other factors.[32]

Developing and capturing the best talent in a growing population underrepresented in the biomedical sciences, which will soon represent 50% of our nation's population,[33] can help generate the best science and accelerate innovative approaches to solve existing and new problems. Nobel physicist Carl Wieman suggested that universities should move beyond just doing STEM talent selection and include STEM talent development, an approach that would change the nature of the present underrepresented persons pipeline conversation. This is consistent with the DPC approach[34] and the rigorous analyses of BUILD interventions, which are designed to distill the evidence to develop talent at the undergraduate level in promising underrepresented persons, increase diversity in the biomedical sciences and promulgate this evidence at a national level.[14,16,17,20]

The National Academies of Sciences, Engineering, and Medicine Committee on the Next Generation Initiative identified several impediments to progress in the biomedical research workforce over the next several years. These include constraints on resources, an absence of shared responsibility for the biomedical research system, a lack of comprehensive and accessible data about the biomedical research system, and rapid shifts in the biomedical research enterprise.[35] Identifying impediments led the committee to recommend several substantive and structural reforms for stakeholders across the research enterprise, including the creation of a biomedical research workforce that is competitive, rigorous, fair, dynamic, and able to attract the best minds from across the country. Recommendations also included having relevant institutions assume a substantive role for providing trainees and newly independent investigators accurate and timely information about stable and attractive career options. Further, the committee recommended that institutions develop and implement programs and policies that respond to investigators' needs at all stages of their careers.[35] To this end, the DPC interventions and evaluation are designed to bring additional evidence to the practices for preparing students to be successful along their path to graduate school.

Study Limitations

Study limitations include survey response rates, which have tended to be lower than desired, although consistent with contemporary trends in survey research (eg, averaging 25%-30% across the BUILD grantees).[36] We have found that the most effective method for obtaining high response rates with incoming freshmen was to schedule survey administration explicitly during orientation sessions. That approach, however, is not feasible at all institutions due to other institutional and/or state-mandated surveys or training sessions. Offering incentives or raffles for survey participation alleviates some of these factors,[37] as well as appealing to students' desires to contribute to science and the representation of their communities in such studies.[38] Going forward, the broad design of the evaluation will include acquiring and analyzing information from national databases such as IPEDS or the National Clearinghouse, which will allow us to assess potential bias in the survey sample. An addition-

Increasing diversity in the biomedical research workforce is more than an issue of equity; it is an issue of excellence and ensuring that the best biomedical science minds have the opportunity to contribute to advance the health of our nation.

al study limitation is the possibility of incomplete or inaccurate responses to survey items due to survey fatigue, as students in our study may be receiving surveys from other sources, and/or feel that the survey is too long.[36] Efforts to minimize such problems have and will continue to include avoiding overlaps of survey administrations whenever possible, careful evaluation of necessary content to minimize length, design of the survey with clear instructions on item response requirements, and use of skip patterns.

Conclusion

The DPC has established a large cohort of diverse undergraduate students historically underrepresented in the biomedical sciences with respect to race/ethnicity, income, family educational background and disabilities such that the potential benefits of the BUILD programs can be evaluated among many important undergraduate subgroups. The DPC will also evaluate mentoring and other faculty-level strategies, as well as novel institutional approaches to enhance student success. Thus, the DPC has created the requisite foundation to prepare, evaluate and track many talented trainees historically left behind, and to provide evidence-based practices that can be adapted for undergraduate institutions committed to increasing diversity in the biomedical/behavioral workforce across a range of institutional settings.

Acknowledgements

We would like to thank all members of the DPC for their steadfast contributions and all survey participants for willingness to contribute. A special thanks to Gerald Asare Bempong for his technical and administrative support and to Drs. Emerald Nguyen and Kenny Gibbs for the critical review and input.

Ethics Approval

The Diversity Program Consortium Initiative was conducted in full compliance with ethical standards and approved by the institutional review boards at all participating institutions.

Funding

Work reported in this publication was supported by the National Institutes of Health Common Fund and Office of Scientific Workforce Diversity (USA) and the National Institute of General Medical Sciences (NIGMS) through the following awards: ReBUILDing Detroit - 8UL1GM118982, 8TL4GM118983, 8RL5GM118981; MSU ASCEND - RL5GM118972, TL4GM118974, 5UL1GM118973; UAF BLaST - RL5GM118990, TL4 GM 118992, 1UL1GM118991; BUILD PODER - 5TL4GM118977, 5RL5GM118975, 8UL1GM118976; STEM BUILD at UMBC - TL4GM118989, UL1GM118988, RL5GM118987; SF BUILD - RL5GM118984, TL4GM118986, 1UL1GM118985; BUILDing SCHOLARS - RL5GM118969, TL4GM118971, UL1GM118970; Project Pathways - UL1GM118967 8TL4GM118968, RL5GM118966; BUILD EXITO - UL1GM118964, RL5GM118963, TL4GM118965; CSULB BUILD - UL1GM118979, TL4GM118980, RL5GM118978; NRMN U54GM119024 and U54GM119023 and the CEC at UCLA - U54GM119024 and U54GM119024–03:S1. The work was conducted by members of the Diversity Program Consortium of the Enhancing the Diversity of the NIH-funded Workforce Program. In addition, the CEC is supported by the following NIH offices, centers and institutes: Office of the Director (Common Fund and Office of Scientific Workforce Diversity), Fogarty International Center, NIH Office of Research Infrastructure Programs, NICHD, NCATS, NIGMS, NCI, NIDA, NCCIH, NLM, NINDS, NIEHS, NIDCR, NIDDK, NIAMS, NINR, NIDCD, NHGRI, NIMH, NEI, NHLBI, NIAID, NIMHD, NIBIB, NIA, and NIAAA. All CEC co-authors were supported by the above referenced funding. The work is solely the responsibility of the authors and does not necessarily represent the official view of the National Institutes of Health.

Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Norris, McCreath, Christie, Crespo, Eagan, Feig, Foroozesh, Guerrero, Johanson, Kamangar, Kingsford, Maccalla, Márquez-Magaña, Mathur, Maton, Ofili, Okuyemi, Parangan-Smith, Pfund, Reynolds, Rous, Saetermoe, Snyder, Vishwanatha, Wallace, Seeman; Acquisition of data: McCreath, Aley, Chavira, Christie, Crespo, Eagan, Echegoyen, Feig, Johanson, Kamangar, Kingsford, Maccalla, Márquez-Magaña, Mathur, Maton, Mehravaran, Ofili, Purnell, Saetermoe, Snyder, Vishwanatha, Wallace, Seeman; Data analysis and interpretation: Norris, McCreath, Hueffer, Crespi, Crespo, D'Amour, Eagan, LaCourse, Maccalla, Mathur, Maton, Mehravaran, Morales, Nakazono, Okuyemi, Ott, Pfund, Wallace, Seeman; Drafting of manuscript: Norris, McCreath, Hueffer, Chavira, Crespi, Echegoyen, Feig, Foroozesh, Guerrero, Kingsford, LaCourse, Maccalla, Mathur, Maton, Mehravaran, Morales, Okuyemi, Ott, Parangan-Smith, Purnell, Reynolds, Wagler, Seeman; Statistical expertise: McCreath, Crespi, Eagan, Guerrero, Maccalla, Maton, Nakazono, Seeman; Acquisition of funding: Norris, McCreath, Aley, Christie, Crespo, Echegoyen, Feig, Foroozesh, Johanson, Kamangar, Kingsford, Márquez-Magaña, Mathur, Maton, Morales, Ofili, Okuyemi, Pfund, Reynolds, Snyder, Vishwanatha, Wallace, Seeman; Administrative: Norris, McCreath, Hueffer, Chavira, Christie, D'Amour, Eagan, Echegoyen, Feig, LaCourse, Mathur, Mehravaran, Morales, Ofili, Ott, Parangan-Smith, Purnell, Reynolds, Rous, Saetermoe, Vishwanatha, Wagler, Wallace, Seeman; Supervision: Norris, McCreath, Christie, Saetermoe, Seeman.

References

1. European Commission, Directorate-General for Employment, Industrial Relations and Social Affairs. *The Costs and Benefits of Diversity: A Study on Methods and Indicators to Measure the Cost-Effectiveness of Diversity Policies in Enterprises*. 2003. Kent, UK: Centre for Strategy and Evaluation Services. Last accessed August 12, 2020 from https://bit.ly/2FgmbAn
2. Campbell LG, Mehtani S, Dozier ME, Rinehart J. Gender-heterogeneous working groups produce higher quality science. *PLoS One*.

2013;8(10):e79147. https://doi.org/10.1371/journal.pone.0079147 PMID:24205372
3. Cohen JJ, Gabriel BA, Terrell C. The case for diversity in the health care workforce. *Health Aff (Millwood)*. 2002;21(5):90-102. https://doi.org/10.1377/hlthaff.21.5.90 PMID:12224912
4. Denson N, Chang MJ. Racial diversity matters: the impact of diversity-related student engagement and institutional context. *Am Educ Res J*. 2009;46(2):322-353. https://doi.org/10.3102/0002831208323278
5. Eagan K. *The American Freshman: Fifty-year trends, 1966-2015*. Los Angeles, CA: Higher Education Research Institute, Graduate School of Education & Information Studies, UCLA; 2016.
6. Freeman RB, Huang W. Collaboration: strength in diversity. *Nature*. 2014;513(7518):305. https://doi.org/10.1038/513305a PMID:25230634
7. Gurin P, Dey E, Hurtado S, Gurin G. Diversity and higher education: theory and impact on educational outcomes. *Harv Educ Rev*. 2002;72(3):330-367. https://doi.org/10.17763/haer.72.3.01151786u134n051
8. US Department of Health and Human Services, Health Resources and Services Administration (HRSA). *The Rationale for Diversity in the Health Professions: A Review of the Evidence*. Washington, DC: HRSA, Bureau of Health Professions. 2006.Last accessed August 12, 2020 from https://bit.ly/3iCoGvn.
9. Hong L, Page SE. Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *Proc Natl Acad Sci USA*. 2004;101(46):16385-16389. https://doi.org/10.1073/pnas.0403723101 PMID:15534225
10. National Science Foundation (NSF), Center for Science and Engineering Statistics. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019.* Special Report NSF 19-304. Alexandria, VA: NSF. Last accessed August 12, 2020 from https://www.nsf.gov/statistics/wmpd.
11. National Institutes of Health. *Draft Report of the Advisory Committee to the Director's Working Group on Diversity in the Biomedical Research Workforce*. Bethesda, MD: The National Institutes of Health; 2012.
12. Ginther DK, Schaffer WT, Schnell J, et al. Race, ethnicity, and NIH research awards. *Science*. 2011;333(6045):1015-1019. https://doi.org/10.1126/science.1196783 PMID:21852498
13. Hoppe TA, Litovitz A, Willis KA, et al. Topic choice contributes to the lower rate of NIH awards to African-American/black scientists. *Sci Adv*. 2019;5(10):eaaw7238. https://doi.org/10.1126/sciadv.aaw7238 PMID:31633016
14. Guerrero LR, Ho J, Christie C, et al. Using collaborative approaches with a multi-method, multi-site, multi-target intervention: evaluating the National Research Mentoring Network. *BMC Proc*. 2017;11(S12)(suppl 12):14. https://doi.org/10.1186/s12919-017-0085-6 PMID:29375657
15. Sorkness CA, Pfund C, Ofili EO, et al; Duplicate Of Weber-Main; NRMN team. A new approach to mentoring for research careers: the National Research Mentoring Network. *BMC Proc*. 2017;11(S12)(suppl 12):22. https://doi.org/10.1186/s12919-017-0083-8 PMID:29375663
16. Hurtado S, White-Lewis D, Norris K. Advancing inclusive science and systemic change: the convergence of national aims and institutional goals in implementing and assessing biomedical science training. *BMC Proc*. 2017;11(12)(suppl 12):17. https://doi.org/10.1186/s12919-017-0086-5 PMID:31851727
17. McCreath HE, Norris KC, Calderón NE, Purnell DL, Maccalla NMG, Seeman TE. Evaluating efforts to diversify the biomedical workforce: the role and function of the Coordination and Evaluation Center of the Diversity Program Consortium. *BMC Proc*. 2017;11(S12)(suppl 12):27. https://doi.org/10.1186/s12919-017-0087-4 PMID:29375668
18. National Institutes of Health. RFA-RM-13-016: NIH Building Infrastructure Leading to Diversity (BUILD) Initiative. 2013. Last accessed August 12, 2020 from https://grants.nih.gov/grants/guide/rfa-files/RFA-RM-13-016.html.
19. National Institutes of Health. Enhancing the Diversity of the NIH-Funded Workforce - Hallmarks of Success. Last accessed August 12, 2020 from https://www.nigms.nih.gov/training/dpc/Pages/success.aspx.
20. Davidson PL, Maccalla NMG, Afifi AA, et al. A participatory approach to evaluating a national training and institutional change initiative: the BUILD longitudinal evaluation. *BMC Proc*. 2017;11(S12)(suppl 12):15. https://doi.org/10.1186/s12919-017-0082-9 PMID:29375658
21. Diversity Program Consortium, Coordination and Evaluation Center (CEC). *BUILD Program Evaluation: Identification of Comparator Institutions. Technical Report. 2019*. Los Angeles, LA: Coordination and Evaluation Center (CEC) of the Diversity Program Consortium at UCLA. Last accessed August 12, 2020 from https://www.diversityprogramconsortium.org/files/view/docs/TechnicalReport_Mar19_2019_v2.pdf.
22. National Institutes of Health. Updated Notice of NIH's Interest in Diversity. NOT-OD-18-210. July 2018. Last accessed August 12, 2020 from https://grants.nih.gov/grants/guide/notice-files/NOT-OD-18-210.html; Notice rescinded on November 2019 and replaced by NOT-OD-20-031 available at https://grants.nih.gov/grants/guide/notice-files/NOT-OD-20-031.html.
23. Pascarella ET, Pierson CT, Wolniak GC, Terenzini PT. First-generation college students: additional evidence on college experiences and outcomes. *J Higher Educ*. 2004;75(3):249-284. https://doi.org/10.1080/00221546.2004.11772256
24. National Academies of Sciences. *Medicine. Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce*. Washington, DC: National Academies Press; 2019.
25. Upton R, Tanenbaum C. *The Role of Historically Black Colleges and Universities as Pathway Providers: Institutional Pathways to the STEM PhD*. Washington, DC: American Institutes for Research; 2014.
26. Valantine HA, Serrano E. *Advisory Committee to the Director. Working Group on Diversity in the Biomedical Research Workforce. Report on the Progress of Activities*. Bethesda, MD: National Institutes of Health; 2017.
27. Myers SLJ Jr, Fealing KH. Changes in the representation of women and minorities in biomedical careers. *Acad Med*. 2012;87(11):1525-1529. https://doi.org/10.1097/ACM.0b013e31826d7189 PMID:23018333
28. Hofstra B, Kulkarni VV, Munoz-Najar Galvez S, He B, Jurafsky D, McFarland DA. The Diversity-Innovation Paradox in Science. *Proc Natl Acad Sci USA*. 2020;117(17):9284-9291. https://doi.org/10.1073/pnas.1915378117 PMID:32291335
29. Leung AK, Maddux WW, Galinsky AD, Chiu CY. Multicultural experience enhances creativity: the when and how. *Am Psychol*. 2008;63(3):169-181. https://doi.org/10.1037/0003-066X.63.3.169 PMID:18377107
30. Hurtado S, Alvarez CL, Guillermo-Wann C, Cuellar M, Arellano L. A model for diverse learning environments. In: Smart J., Paulsen M. (eds) *Higher Education: Handbook of Theory and Research. Higher Education: Handbook of Theory and Research.* 2012; 27. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-2950-6_2
31. Page S. *Diversity Powers Innovation*. Washington, DC: Center for American Progress. 2007. Last accessed August 12, 2020 from https://www.americanprogress.org/issues/economy/news/2007/01/26/2523/diversity-powers-innovation/
32. Bell ST, Villado AJ, Lukasik MA, Belau L, Briggs AL. Getting specific about demographic diversity variable and team performance relationships: a meta-analysis. *J of Management.* 2010;37(3):709-743. https://doi.org/10.1177/0149206310365001
33. Passel JS, Cohn DV, Agarwal S, et al. Trends in childhood cancer mortality--United States, 1990-2004. *MMWR Morb Mortal Wkly Rep*.

2007;56(48):1257-1261. PMID:18059256
34. Mervis J. Grand challenge: undergraduate teaching. Transformation is possible if a university really cares. *Science.* 2013;340(6130):292-296. https://doi.org/10.1126/science.340.6130.292
35. National Academies of Sciences. *The Next Generation of Biomedical and Behavioral Sciences Researchers: Breaking Through*. Washington, DC: National Academies Press; 2018.
36. Porter SR, Whitcomb ME, Weitzer WH. Multiple surveys of students and survey fatigue. *New Dir Institutional Res*. 2004;2004(121):63-73. https://doi.org/10.1002/ir.101
37. Laguilles JS, Williams EA, Saunders DB. Can lottery incentives boost web survey response rates? Findings from four experiments. *Res High Educ*. 2011;52(5):537-553. https://doi.org/10.1007/s11162-010-9203-2
38. Nair CS, Adams P, Mertova P. Student engagement: the key to improving survey response rates. *Qual High Educ*. 2008;14(3):225-232. https://doi.org/10.1080/13538320802507505