Racial and Gender Diversity Among Students and Faculty in EHAC-Accredited Environmental Health Sciences Programs: Trend Analysis from 2009 to 2021

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ABSTRACT: Diversity in the environmental health sciences (EHS) workforce is crucial in providing culturally sensitive services to diverse communities. This may be influenced by academic faculty training a diverse student body in the field of environmental health. This study aimed to characterize the diversity of students and faculty in EHS programs accredited by the National Environmental Health Science and Protection Accreditation Council (EHAC). A retrospective analysis was conducted on secondary data obtained from annual surveys administered to program directors in EHAC-accredited academic programs that included both undergraduate and graduate EHS degrees. The database covered surveys on gender and race that were conducted by EHAC for 12 academic years spanning 2009-2010 to 2020-2021. Results show most students (undergraduate and graduate) were female (54.4% and 52.1%, respectively) and white (61.0% and 50.7%, respectively). Increasing trends were observed over the last 12 years (2009-2021) in female undergraduate (from 53.7% to 59.8%) and graduate (from 47.1% to 60.3%) students and in non-white undergraduate students (from 40.0% to 48.2%). Most faculty (teaching in undergraduate and graduate programs) were male (64.4% and 64.3%, respectively) and white (77.9% and 92.1%, respectively). Increasing trends were observed from 2009 to 2021 in female faculty teaching undergraduate (from 27.7% to 42.2%) and graduate (from 31.3% to 42.1%) students. Native American, Alaska Native, Native Hawaiian, and Pacific Islander are consistently the most underrepresented racial groups in both undergraduate and graduate students and faculty. This study provides baseline data on the diversity of students and faculty in EHAC-accredited programs, which is important in informing future research and efforts to increase such diversity. Gender and racial disparity in EHS students and faculty needs to be addressed to provide necessary support to women and non-White constituents by institutional change in culture through active recruitment and by stronger collaboration between professional organizations and minority groups.

KEYWORDS: Gender diversity, racial diversity, disparity, environmental health, student diversity, faculty diversity, EHAC

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Introduction

Diversity, equity, and inclusion (DEI) has increasingly become an important topic in several fields and organizations. Diversity refers to real or perceived physical or socio-cultural differences attributed to people; equity refers to fairness in the treatment of people in terms of outcome and opportunity; inclusion refers to creating a culture that incorporates diverse groups and fosters belonging.[1] Diversity within the environmental health science (EHS) workforce is crucial in providing valuable environmental health services to diverse communities and populations,[2] particularly in a way that is culturally sensitive. Culturally sensitive services are interventions that are implemented while striving to acknowledge, understand and respect the diversity of cultures (including race, ethnicity, gender, religion and sexual orientation)[3] and that enable recipients of such services to feel comfortable and respected.[4] In health care, culturally sensitive services are expected to enhance the patient-provider relationship and communication and to improve patient health outcomes. This is accomplished, for example, by incorporating necessary variations in assessment and care plans, carefully prescribing medications considering racial characteristics, knowing differences in health conditions by cultural groups, and understanding cultural practices and beliefs that may affect diagnostic procedures and prescribed treatments.[5] In environmental health practice, culturally sensitive services are expected to improve communication, understanding, community engagement in planning and community acceptance of interventions to eliminate or mitigate environmental impacts, particularly in minority and low-income communities where environmental health issues are prominent.[2]

A study by Gerding et al[6] found that EHS professionals working in state, tribal, local, and territorial (STLT) health departments across the United States (US) are predominantly White (86%) with relatively even gender distribution (ie, 51% male and 49% female), which indicates low racial diversity in the EHS workforce. For decades, the importance of a diverse workforce among health care and research institutions has been recognized, considering the established relationship between

systems of bias and human health, health care access and utilization.[7] Similarly, the importance of a diverse EHS workforce has been recognized, considering that environmental health practice is a community-based discipline and the EHS workforce should reflect the diverse communities that it supports.[2,8] Health disparities in underserved communities caused by environmental health conditions can be addressed, in part, by overcoming cultural and language barriers through a diverse EHS workforce.[8] The National Center for Environmental Health (NCEH) of the US Centers for Disease Control and Prevention (CDC) has supported a number of projects to increase diversity in the EHS workforce, in collaboration with environmental health entities.[8] The Respect, Integrity, Service and Equality (RISE) Task Force was also recently formed by the American Academy of Sanitarians (AAS) to assess the state of diversity and inclusion in AAS, to recommend approaches to promote and increase diversity, and to create and implement diversity and inclusion policies and statements for the benefit of the AAS and the EHS profession.[9]

A diverse workforce in EHS starts with having a diverse student body in EHS academic programs, eventually earning their degrees and working as EHS professionals. The diversity of a student body may be influenced and improved by a diverse pool of faculty in EHS programs, who may serve as role models needed by students to emulate and increase their self-worth.[10] Student perceptions that minority faculty are not hired or retained may discourage minority students from entering or staying in the discipline.[11] The United Nations Educational, Scientific and Cultural Organization (UNESCO) recognizes that promoting more female role models in STEM (science, technology, engineering, and mathematics) fields, specifically female faculty in higher education, is an important strategy to attract women into STEM fields.[12] The importance of understanding student diversity has been recognized as they will become the future workforce and will serve as same-gender and same-race role models and mentors.[13] In the US Southwest, BUILDing SCHOLARS, a regional undergraduate training approach through multi-institution consortium, was implemented to help increase the diversity of the biomedical research workforce in 7 research fields, including environmental health.[14] Recognition of the importance of promoting diversity of environmental health students and faculty has led to the development of the National Council on Diversity in Environmental Health (N-CODE Health) and its concepts related to a diverse EHS workforce.[2,8,10] Four of the concepts included in the platform for N-CODE Health are: (1) "Diverse student bodies and faculties must be created in educational institutions to produce a diverse workforce."; (2) "A diverse workforce in environmental health is essential to bring 'emerging professionals' into the field."; (3) "Effectiveness in resolving environmental health concerns in a community is related to the degree that the environmental health workforce is representative of the population it serves."; and (4) "Solutions and innovations to enhance diversity must be incorporated in all sectors of the environmental health workforce within local, state, and federal programs."[2]

Multiple studies on gender and racial diversity of faculty in different specialties in academic medicine, such as neuroradiology,[15] family medicine,[16] pediatric radiology,[17] ophthalmology,[18] internal medicine,[19] emergency medicine,[20] general surgery,[21,22] chest radiology,[23] plastic surgery,[24] anesthesiology,[25] neurology,[26] dermatology[27] and gastroenterology,[28] have been published and demonstrated that faculty in medical programs were predominantly male and White. For example, 69% of chest radiology faculty[23] and 59% of family medicine faculty[16] in North America, and 71% of ophthalmology faculty[18] and 67% of emergency medicine faculty[20] in the US were male. Moreover, 78% of emergency medicine faculty,[20] 70% of surgery faculty[22] and 60% to 85% of neurology faculty (from instructor to full professor)[26] were White. Only 35% of US medical school faculty were women and 62% were White, making White male full professors the largest group in the study population.[29] Fewer studies on gender and racial diversity of both students and faculty in STEM disciplines have been conducted.[11,13,30,31] These STEM studies showed underrepresentation of Black, Latinx and/or Native American students and faculty in science and engineering programs in general[11,13] and in environmental engineering programs specifically.[30,31] This underrepresentation needs to be addressed through effective recruiting, retaining, and supporting strategies.[32] However, no published gender or racial diversity studies on students and faculty specifically in the field of environmental health currently exist, which would be beneficial in determining the extent to which efforts and resources to increase diversity among EHS students and faculty are needed.

The National Environmental Health Science and Protection Accreditation Council (EHAC) is a non-profit US organization that accredits stand-alone Environmental Health Academic Programs that provide applied, STEM-based professional degree programs.[33] The mission of EHAC is to enhance the education and training of students in EHS and protection by requiring a robust educational foundation in the natural sciences (biology, chemistry, physics, geology) and the completion of a practical, hands-on internship.[33] Accreditation guidelines are developed and applied by the EHAC Council for institutions of higher education that aim to provide quality education and training of environmental health practitioners.[33] The purpose of this study is to characterize the diversity of students and faculty in EHAC-accredited EHS programs by gender and race and provide recommendations that may inform future educational recruitment policies.

Materials and Methods

Source of data

This study retrospectively analyzed secondary data obtained from surveys conducted annually by EHAC as part of the Council's regular activities, with the purpose of obtaining baseline

Figure 1. United States Map showing the location of current (2022; 28 undergraduate and 9 graduate) EHAC-Accredited Environmental Health Sciences degree programs.

information on the demographics of students and faculty in EHAC-accredited EHS programs and, consequently, identifying the health of and challenges facing accredited degree programs. This information helps EHAC measure progress and provides useful information to partner organizations and government agencies that rely on the exceptional students graduating from EHAC-accredited degree programs. Figure 1 indicates the locations of EHAC-accredited degree programs (28 undergraduate and 9 graduate) in 2022.

To characterize gender distribution, the outcome variable used was the number of students and faculty identified as male, female, or other in undergraduate and graduate EHAC-accredited EHS programs in each academic year. To characterize racial distribution, the outcome variable used was the number of students and faculty identified in specific racial groups in undergraduate and graduate EHAC-accredited EHS programs in each academic year. All outcome variables were based on self-identification of students and faculty from institutional records. Brief surveys (Momentive [formerly Survey Monkey], San Mateo, CA) were sent annually to program directors of EHAC-accredited Environmental Health programs through email and were required to be completed by March 15 of each year. Gender and racial data were retrieved by EHS program directors using university-provided analytical software that gathers information on a variety of topics provided by academic programs through interactive dashboards (eg, Institutional Planning, Assessment and Research Business Intelligence software) and from their first-hand knowledge. The survey data collected were not further evaluated for reliability beyond what was provided by the program directors. Survey data from 12 academic years (AY) 2009-2010 to 2020-2021 were provided by EHAC. Given that the data used in this study did not include identifying information, the study is not considered as human subject research and does not require approval from the Institutional Review Board (IRB).

The survey was completed separately for undergraduate and graduate programs, and was comprised of 4 inquiry items about student and faculty gender and race: (1) Please indicate the number of degree program faculty that identify with each category of race/ethnicity; (2) Please indicate the number of degree program faculty that identify with each gender identity; (3) Please indicate the number of students that identify with each category of race/ethnicity; and (4) Please indicate the number of students that identify with each gender identity in your program. Survey response options for gender of students and faculty are as follows: male; female; transgender: female-to-male; transgender: male-to-female; genderqueer/gender conforming/neither exclusive male nor female; and other, which were based on suggested gender questions and definitions by the CDC.[34] Survey response options for race of students are as follows: Alaska Native or Native American; Asian; Black or African American; Hispanic or Latino; Native Hawaiian or Other Pacific Islander; non-Hispanic White; Other/Not available; and More than 2 races, which were based on race classification and definitions by the US Census Bureau.[35] The option "More than two races," defined as "multiracial," was recently added in the AY 2020 to 2021 survey. Survey response options for race of faculty differed slightly from students: 8 options for undergraduate faculty (Alaska Native; Asian; Black or African American; Hispanic or Latino; Native American; Pacific Islander; non-Hispanic White; and Other) and 7 options for graduate faculty (Alaska Native; Asian; Black or African American; Hispanic or Latino; Native American; non-Hispanic White; and Other/More than 2

races). For each academic year, the total number of students and faculty identified in different gender and racial categories was determined by adding the number of students and faculty from each EHAC-accredited EHS program, separated into undergraduate and graduate categories.

Data analysis

The total number and percentage of students and faculty per gender and racial categories in each academic year were calculated in Survey Monkey and then downloaded into a Microsoft Excel spreadsheet. Baseline data on gender and race were reported using descriptive statistics (ie, frequencies, percentages). Frequency tables were created for survey responses on race for students and faculty, which are subcategorized into "undergraduate" and "graduate." Faculty can be counted for both undergraduate and graduate categories. Bar graphs were created to visualize responses for both gender and race for students and faculty. Annual percentages by gender and race were analyzed for linear trends for the entire 12-year study period (2009-2021) by fitting linear regression models for each gender/racial category. A similar analysis was conducted in a trend analysis study by Hwang et al[36] Microsoft® Excel® for Microsoft 365 MSO (version 2202, Microsoft, Redmond, WA) was used to analyze the data and create graphs for data presentation.

Results

All EHAC-accredited degree programs completed the required annual surveys, ranging from 28 to 30 undergraduate and 7 to 9 graduate programs each year. Completing the annual report is mandated by EHAC policy to maintain accreditation, as stated in Policy 4.4 in the EHAC Policy and Procedures Manual.[37] Thus, there is a 100% response rate from currently accredited degree programs at the time of each annual survey.

Gender diversity of undergraduate and graduate students

Gender data on a total of 16 497 undergraduate and 3622 graduate students were received during the entire study period. Most undergraduate students were female (54.4%; n = 8976). In every surveyed year, there were consistently more female (51.9%-59.8%) than male (40.0%-48.1%) undergraduate students (Figures 2A and 3A), with yearly gender differences ranging from 3.8 to 19.8%. A slight increasing trend in the percentage of female undergraduate students was observed through the study period, from 53.7% in AY 2009-2010 to 59.8% in AY 2020-2021 (Figure 3A). Academic year (AY) 2020 to 2021 had the highest percentage (59.8%) of female undergraduate students (Figure 3A).

Similarly, most graduate students were female (52.1%; n = 1888) for the entire 12-year study period. Figures 2B and 3B show that the earlier years of the study period had more male graduate students (eg, 51.8%-53.5% for the first 3 years), while the last 4 years had more female graduate students (54.8%-60.4%). AY 2020 to 2021 had the highest percentage of male graduate students (58.1%), while AY 2019 to 2020 had the highest percentage of female graduate students (60.4%) (Figure 3B). An increasing trend in the percentage of female graduate students was observed throughout the study, from 47.1% to 60.3% (Figure 3B). AY 2015 to 2016 had the highest number of graduate students (n = 466, 52.4% male, 47.9% female), while AY 2012 to 2013 had the lowest (n = 231, 48.5% male, 51.5% female) (Figures 2B and 3B).

Racial diversity of undergraduate and graduate students

Racial data for a total of 16 294 undergraduate and 2702 graduate students were received during the study period (Table 1). Most undergraduate students were White (n = 9942; 61.0%), followed by Black (n = 1974; 12.1%) and Hispanic/Latino (n = 1839; 11.3%) (Table 1). Excluding "More than two races" (0.1%; n = 16), Alaska Native or Native American had the smallest overall percentage (1.0%; n = 157), followed by Native Hawaiian or Other Pacific Islander (1.1%; n = 173) and Other/Not Available (4.6%; n = 742) (Table 1).

Every year, the White race categorized most undergraduate students (51.8%-68.8%) (Figures 4A and 5A). From AY 2009-2010 to 2014-2015, the second largest percentage of undergraduate students was Black (11.7%-14.1%) (Figure 5C), although a much smaller percentage than White students (Figure 4A). Interestingly, from AY 2015-2016 to 2020-2021, Hispanic/Latino overtook the Black students as the second largest racial group (11.3%-20.1%), reaching 20.1% in AY 2019 to 2020 (Figure 5C). From AY 2009-2010 to 2012-2013, Asian undergraduate students had the third largest percentage (7.9%-12.2%) but numbers fell below Black or Hispanic/Latino students from AY 2013 to 2014 onward (Figure 5C). In all years surveyed, Native Hawaiian/Other Pacific Islanders generally had the smallest percentages from 0.3% to 1.5% (except AY 2018-2019 with 7.0%), followed by Alaska Native/Native American from 0.4% to 1.5% (Figure 5C). Although the percentage of White undergraduate students was consistently higher than that of the other races/ethnicities combined (ie, non-White), an increasing trend in the percentage of non-White undergraduate students was observed through the study period, from 40.0% to 48.2% (Figure 5A).

Most graduate students were White (n = 1370; 50.7%), followed by Black (n = 547; 20.2%), Other/Not Available (n = 288; 10.7%), and Asian (n = 263; 9.7%) (Table 1). Excluding "More than two races" (0.7%; n = 19), Native Hawaiian or other Pacific Islander had the smallest overall percentage (0.5%; n = 14) of graduate students, followed by Alaska Native or Native American (0.6%; n = 16) and Hispanic/Latino (6.8%; n = 185) (Table 1). White comprised most graduate students (42.2%-77.4%) every year (Figures 4B and 5B), except AY 2015 to 2016 when Black graduate students were the majority (41.6%; n = 117) (Figure 4B). Every year, the second largest percentage was generally among Black graduate students (9.5%-41.6%) but usually much lower

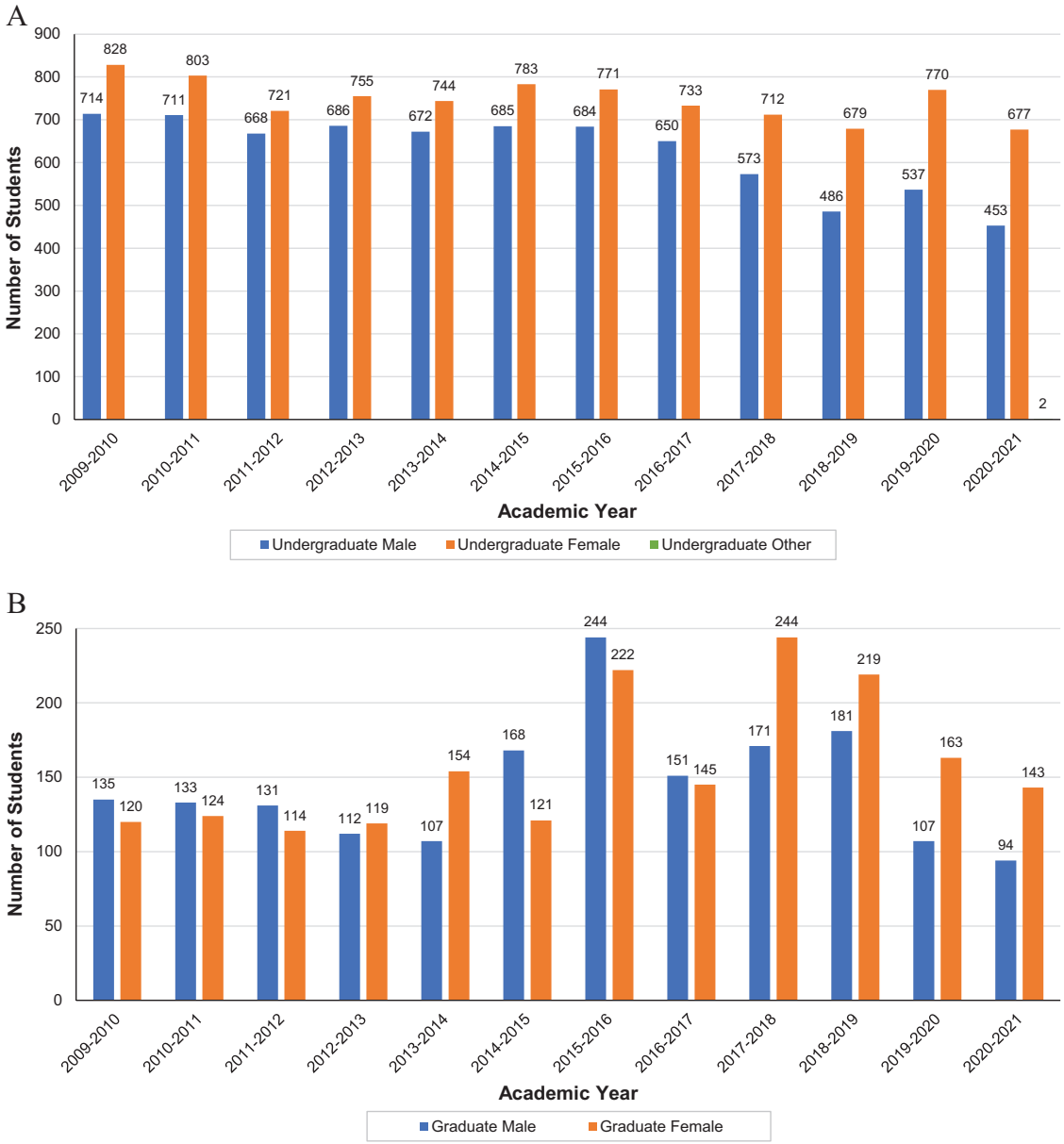

Figure 2. Number of (A) undergraduate and (B) graduate students in EHAC-Accredited Environmental Health Sciences programs by gender from academic year 2009-2010 to 2020-2021, United States of America.

than the percentage of White students (Figure 4B). Asian graduate students had the third largest percentage (6.0%-19.1%) from AY 2009-2010 to 2016-2017 but were surpassed by Hispanic/Latino graduate students (6.8%-10.5%) from AY 2017 to 2018 onward (Figure 5D). In all years surveyed, Native Hawaiian/Other Pacific Islanders generally had the smallest percentages from 0.0% to 0.4% (except AY 2010-2011 with 5.4%), followed by Alaska Native/Native American from 0.0% to 2.1% (Figure 5D). Although the annual percentage of non-White graduate students was not consistently lower compared to that of the White students, a decreasing trend in the percentage of non-White graduate students was observed through the study period (Figure 5B), which was the opposite of the non-White undergraduate student trends (Figure 5A). However, increasing percentages of non-White graduate students were observed from 2016-2017 to 2020-2021 from 22.6% to 57.0% (Figure 5B).

Incomplete data on race was received during 2 academic years (2016-2017 and 2017-2018). For 2016 to 2017, 1 undergraduate and 3 graduate programs did not report racial data. For 2017 to 2018, three undergraduate and 2 graduate programs did not report racial data.

Gender Diversity of Undergraduate and Graduate Faculty

Gender data on a total of 3572 undergraduate and 845 graduate faculty were received during the study period. Most undergraduate (64.4%; n = 2302) and graduate (64.3%;

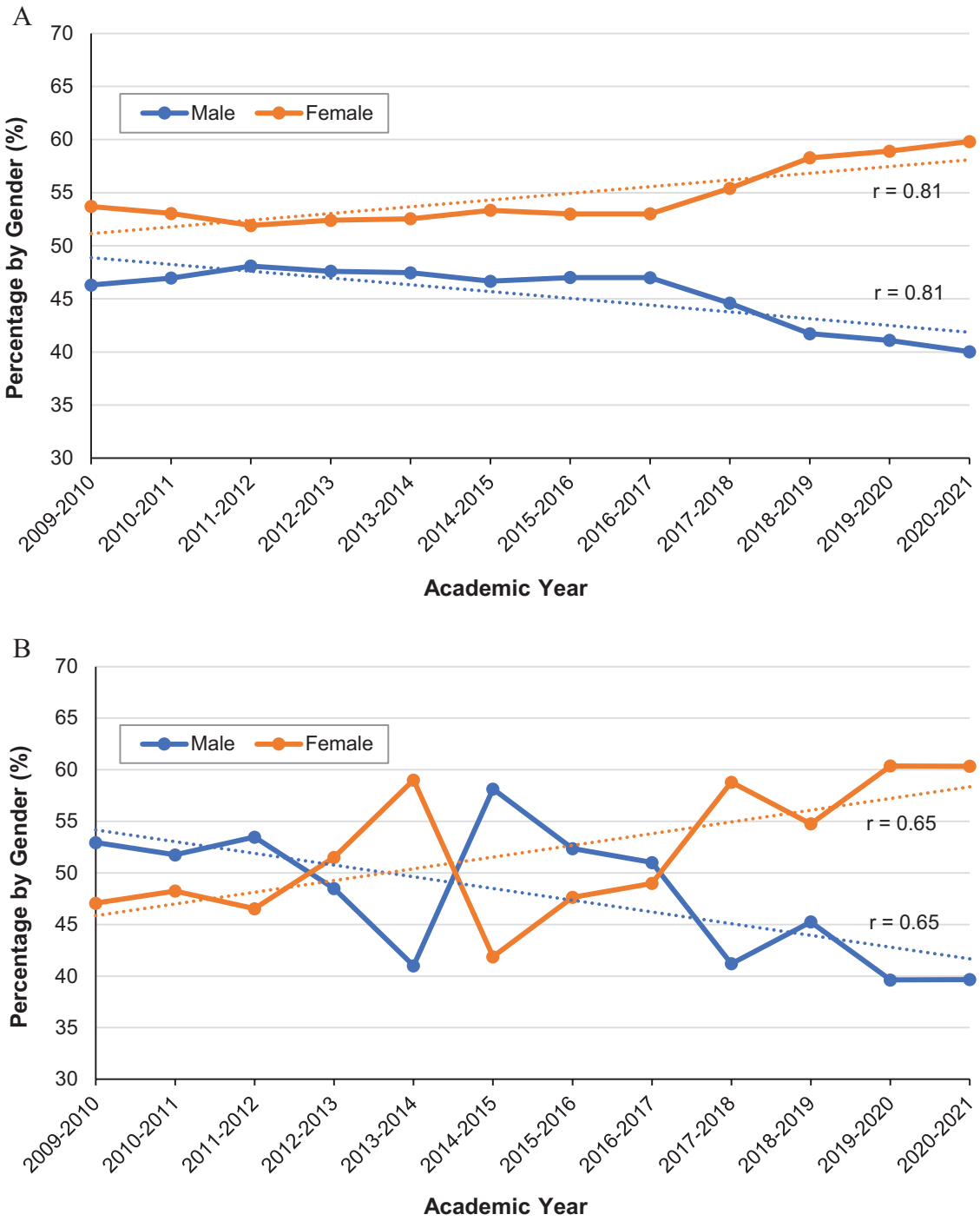

Figure 3. Percentage of (A) undergraduate and (B) graduate students in EHAC-Accredited Environmental Health Sciences programs by gender from academic year 2009-2010 to 2020-2021, United States of America. Dotted lines represent linear trendlines per gender category.

n = 543) faculty were male. In each surveyed year, there were more male faculty in both undergraduate (57.2%-72.3%) and graduate (57.9%-75.0%) programs (Figures 6 and 7). Throughout the study period, a slight increasing trend in the percentage of female faculty for both undergraduate (from 27.7% to 42.2%) and graduate (from 31.3% to 42.1%) programs was observed (Figure 7). The highest percentage of male faculty was found in AY 2009 to 2010 for undergraduate programs (72.3%) (Figure 7A) and in AY 2010 to 2011 for graduate programs (75.0%) (Figure 7B).

Racial Diversity of Undergraduate and Graduate Faculty

Racial data for a total of 3247 undergraduate and 2745 graduate faculty were received during the study period (Table 2).

Table 1. Racial distribution of undergraduate and graduate students in EHAC-Accredited Environmental Health Sciences program by number and percentage from academic year 2009-2010 to 2020-2021, United States of America.

ACADEMIC YEAR	ALASKA NATIVE OR NATIVE AMERICAN		ASIAN		BLACK OR AFRICAN AMERICAN		HISPANIC OR LATINO		NATIVE HAWAIIAN OR OTHER PACIFIC ISLANDER		WHITE (NON-HISPANIC/ LATINO)		OTHER/NOT AVAILABLE		MORE THAN 2 RACES*		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Undergraduate students																		
2009-2010	23	1.5	188	12.2	206	13.4	153	9.9	5	0.3	924	60.0	42	2.7	-	-	1541	100
2010-2011	13	0.9	168	11.1	186	12.3	121	8.0	14	0.9	949	62.7	63	4.2	-	-	1514	100
2011-2012	14	1.0	117	8.7	157	11.7	103	7.6	4	0.3	927	68.8	25	1.9	-	-	1347	100
2012-2013	19	1.3	114	7.9	189	13.1	99	6.8	6	0.4	954	65.9	66	4.6	-	-	1447	100
2013-2014	17	1.2	109	7.7	185	13.1	123	8.7	6	0.4	870	61.4	106	7.5	-	-	1416	100
2014-2015	8	0.6	113	8.4	190	14.1	133	9.9	7	0.5	827	61.6	65	4.8	-	-	1343	100
2015-2016	8	0.5	116	7.8	146	9.8	168	11.3	9	0.6	980	65.8	62	4.2	-	-	1489	100
2016-2017	11	0.8	108	7.5	158	11.0	173	12.0	5	0.3	901	62.6	84	5.8	-	-	1440	100
2017-2018	14	1.1	112	8.8	150	11.7	157	12.3	5	0.4	757	59.3	82	6.4	-	-	1277	100
2018-2019	11	0.9	99	7.8	155	12.1	192	15.0	89	7.0	683	53.5	48	3.8	-	-	1277	100
2019-2020	4	0.4	93	8.4	130	11.8	222	20.1	7	0.6	602	54.4	48	4.3	-	-	1106	100
2020-2021	15	1.4	114	10.4	122	11.1	195	17.8	16	1.5	568	51.8	51	4.6	16	1.5	1097	100
Overall	157	1.0	1451	8.9	1974	12.1	1839	11.3	173	1.1	9942	61.0	742	4.6	16	0.1	16 294	100
Graduate students																		
2009-2010	1	0.4	41	16.1	45	17.6	34	13.%	0	0.0	131	51.4	3	1.2	-	-	255	100
2010-2011	2	1.0	39	19.1	41	20.1	12	5.9	11	5.4	90	44.1	9	4.4	-	-	204	100
2011-2012	2	0.9	35	15.1	35	15.1	14	6.0	0	0.0	144	62.1	2	0.9	-	-	232	100
2012-2013	2	0.9	35	15.2	43	18.6	10	4.3	1	0.4	102	44.2	38	16.5	-	-	231	100
2013-2014	1	0.4	20	7.7	38	14.6	8	3.1	0	0.0	119	45.8	74	28.5	-	-	260	100
2014-2015	0	0.0	21	9.1	45	19.4	11	4.7	0	0.0	98	42.2	57	24.6	-	-	232	100
2015-2016	6	2.1	22	7.8	117	41.6	11	3.9	1	0.4	101	35.9	23	8.2	-	-	281	100
2016-2017	1	1.2	5	6.0	8	9.5	3	3.6	0	0.0	65	77.4	2	2.4	-	-	84	100
2017-2018	0	0.0	15	6.3	32	13.4	25	10.5	0	0.0	153	64.3	13	5.5	-	-	238	100
2018-2019	1	0.4	8	3.0	39	14.8	26	9.9	0	0.0	158	60.1	31	11.8	-	-	263	100
2019-2020	0	0.0	7	4.0	24	13.9	14	8.1	0	0.0	102	59.0	26	15.0	-	-	173	100
2020-2021	0	0.0	15	6.0	80	32.1	17	6.8	1	0.4	107	43.0	10	4.0	19	7.6	249	100
Overall	16	0.6	263	9.7	547	20.2	185	6.8	14	0.5	1370	50.7	288	10.7	19	0.7	2702	100

*Added in AY 2020 to 2021.

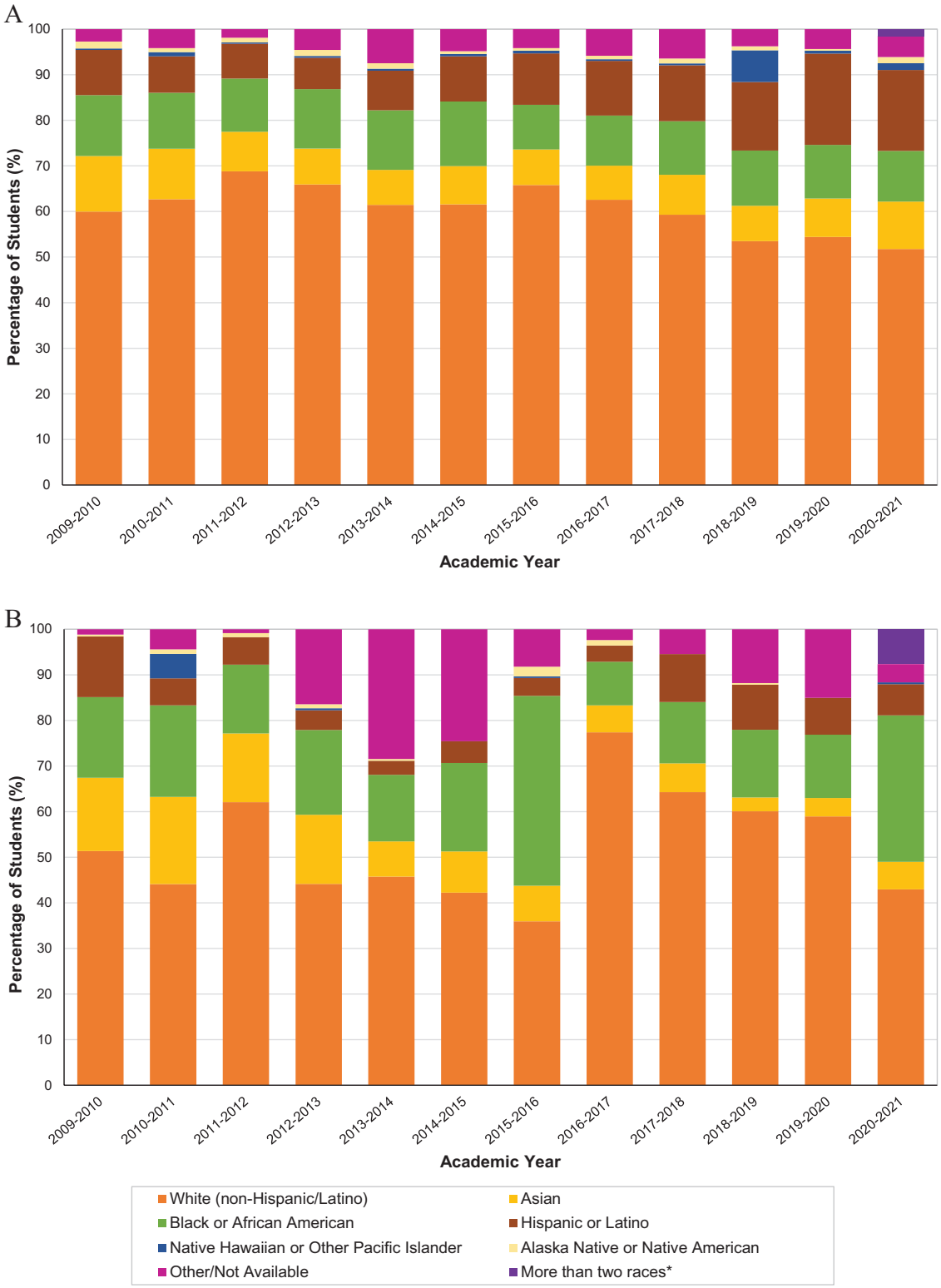

Figure 4. Racial distribution of (A) undergraduate and (B) graduate students in EHAC-Accredited Environmental Health Sciences programs by percentage from academic year 2009-2010 to 2020-2021, United States of America.

Most undergraduate faculty were White (77.9%; n = 2529), followed by Black (8.3%; n = 268) and Asian (7.5%; n = 245). Pacific Islander had the smallest overall percentage (0.03%; n = 1), followed by Native American (0.3%; n = 9) and Alaska Native (0.7%; n = 23) (Table 2).

In each surveyed year, White consistently categorized most undergraduate faculty (69.5%-81.7%), with the highest percentage found in AY 2016 to 2017 (Figures 8A and 9A). From AY 2009-2010 to 2014-2015, the second largest percentage was among Black undergraduate faculty (8.0%-12.1%)

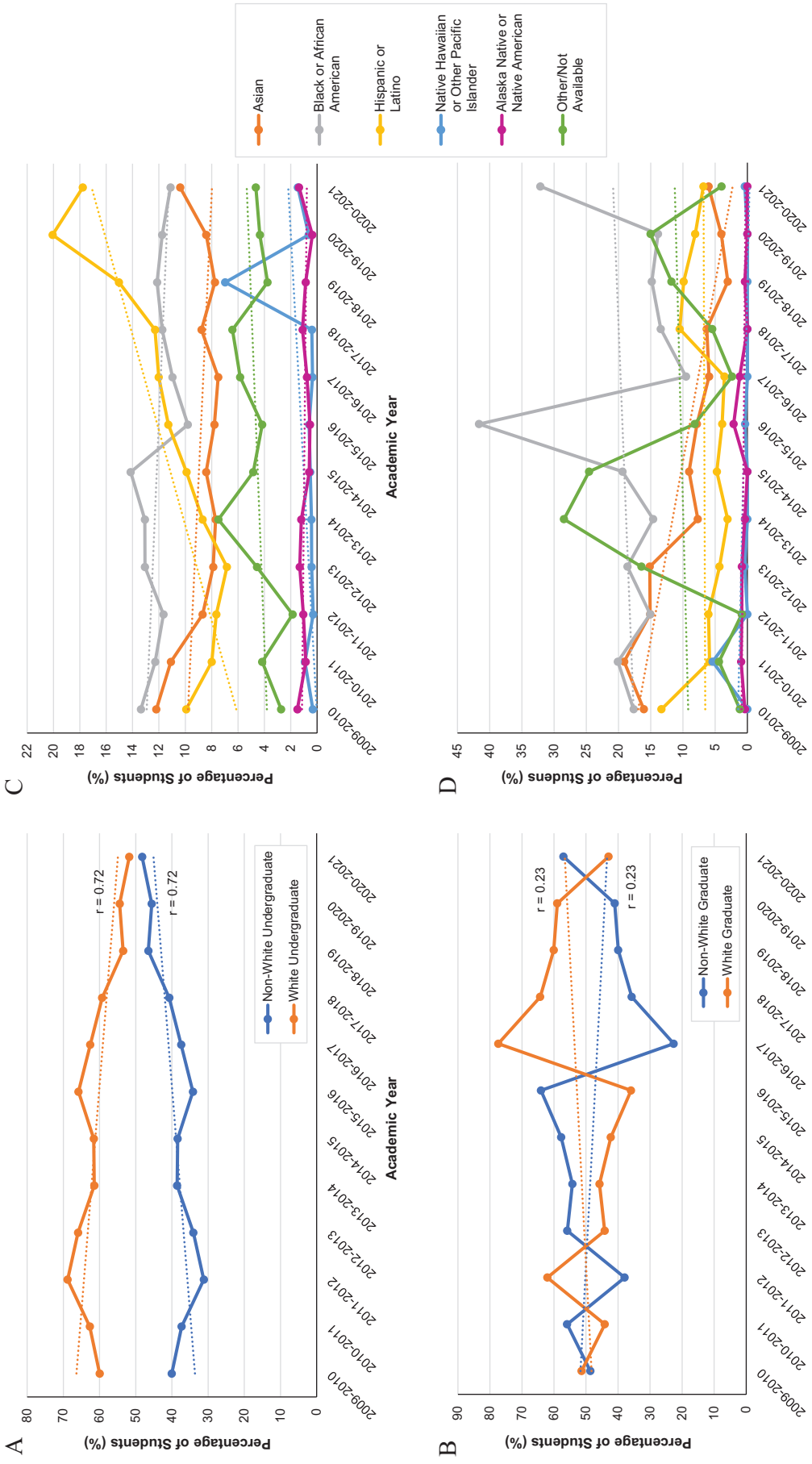

Figure 5. Percentage of White and Non-White (A) undergraduate and (B) graduate students and percentage of non-White (C) undergraduate and (D) graduate student by race (other than White) in EHAC-Accredited Environmental Health Sciences programs from academic year 2009-2010 to 2020-2021, United States of America. Dotted lines represent linear trendlines per racial category.

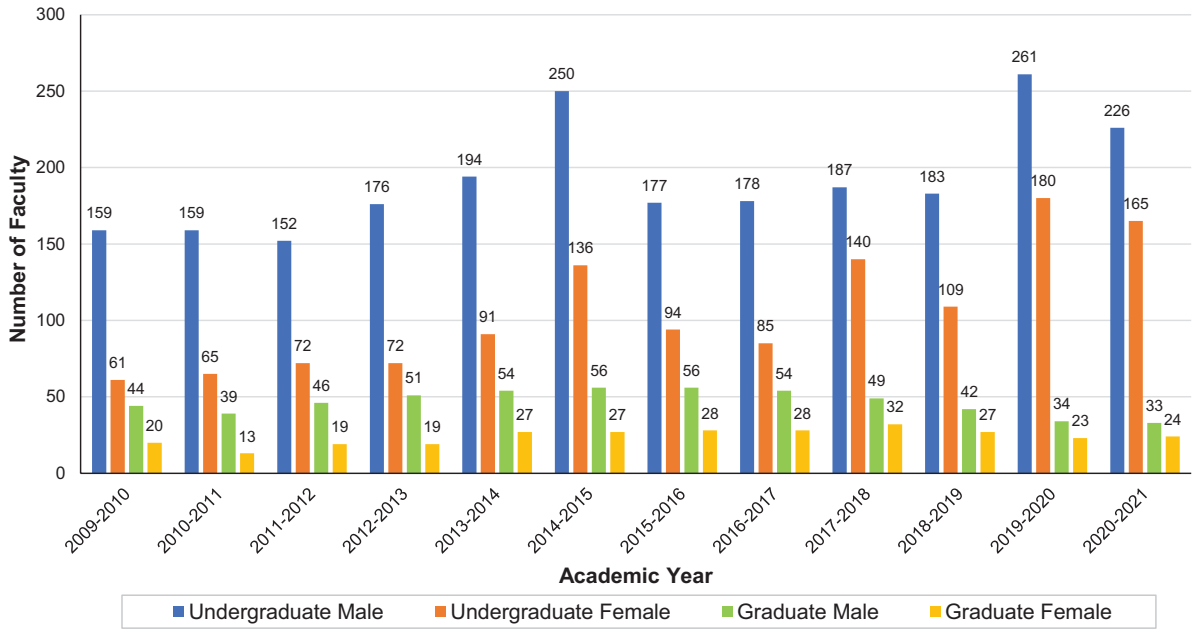

Figure 6. Number of undergraduate and graduate faculty in EHAC-Accredited Environmental Health Sciences programs by gender from academic year 2009-2010 to 2020-2021, United States of America. Faculty can be counted for both undergraduate and graduate categories.

(Figure 9C), although much smaller than the percentage of White faculty (Figure 8A). However, from AY 2015-2016 to 2020-2021, Asian surpassed Black as the second largest racial group (8.0%-10.1%) among undergraduate faculty, reaching 10.1% in AY 2017 to 2018 (Figure 9C). Throughout the study period, Hispanic undergraduate faculty generally had the fourth largest percentage (0.0%-4.4%), with none identified in AY 2010 to 2011. In all years surveyed, no Pacific Islanders were identified except in AY 2020 to 2021 when 1 (0.4%) was identified. Moreover, no Native Americans were identified in 6 (ie, half) of the years surveyed and no Alaska Natives were identified in 2 of the years surveyed (AY 2009-2010 and 2011-2012). Pacific Islander and Native American had the smallest annual percentages, less than 1.0% (ie, 0.0%-0.7%) (Figure 9C). While the percentage of White undergraduate faculty was consistently higher than non-White, an increasing trend in the percentage of non-White undergraduate faculty was observed throughout the study period (Figure 9A).

Overall, most graduate faculty were White (92.1%; n = 2529), followed by Black (3.2%; n = 88) and Asian (2.0%; n = 56) (Table 2). Native American had the smallest overall percentage (0.1%; n = 2), followed by Alaska Native (0.6%; n = 17) and Hispanic (0.7%; n = 19) (Table 2). Similar to undergraduate faculty, the White racial category consistently comprised a big majority of the graduate faculty (88.3%-94.2%) every year, with the highest percentage found in AY 2014 to 2015 (Figures 8B and 9B). The second largest percentage each year was among Black graduate faculty (3.1%-4.1%), except in AY 2018-2019 and 2019-2020 when Asian (3.0% and 3.5%, respectively) surpassed Black faculty (Figure 9D), but such percentages were still much smaller than those of White faculty (Figure 8B). Throughout the study period, Hispanic undergraduate faculty consistently had the fourth largest percentage (0.4%-1.3%), with the highest percentage found in AY 2015 to 2016. No Native American was identified in 9 of the years surveyed and no Alaska Native was identified in 3 of the years surveyed (AY 2017-2018, 2019-2020, and 2020-2021). Native Americans and Alaska Natives had the smallest annual percentages, ranging from 0.0% to 2.3% (Figure 9D). As the annual percentage of White graduate faculty remained consistently and substantially higher compared to that of non-White, an increasing trend in the non-White graduate faculty is almost non-existent but relatively steady throughout the study period (Figure 9B).

Discussion

Undergraduate and graduate EHS students were comprised of more females than males for the duration of the study period. The annual percentages similarly show more female undergraduate students throughout the study period and more female graduate students compared to males in the most recently surveyed years. Moreover, increasing trends in both female undergraduate and graduate students were observed, from 53.7% in AY 2009-2010 to 59.8% in 2020-2021 and from 47.1% to 60.3%, respectively. From 1966 to 2012, the percentage of women receiving science and engineering degrees increased from 24.8% to 50.5% for bachelor's, from 13.3% to 45.6% for master's, and from 8.0% to 40.6% for doctorate degrees.[38] For health-related degrees, the percentage of women receiving them increased from 63.5% to 82.6% for bachelor's, from 43.6% to 81.3% for master's, and from 10.9% to 70.2% for doctorate degrees.[38]

However, despite having more female students in both undergraduate and graduate EHAC-accredited EHS programs, there are more male than female faculty in both undergraduate and graduate programs, with 28.9% and 32.1% overall

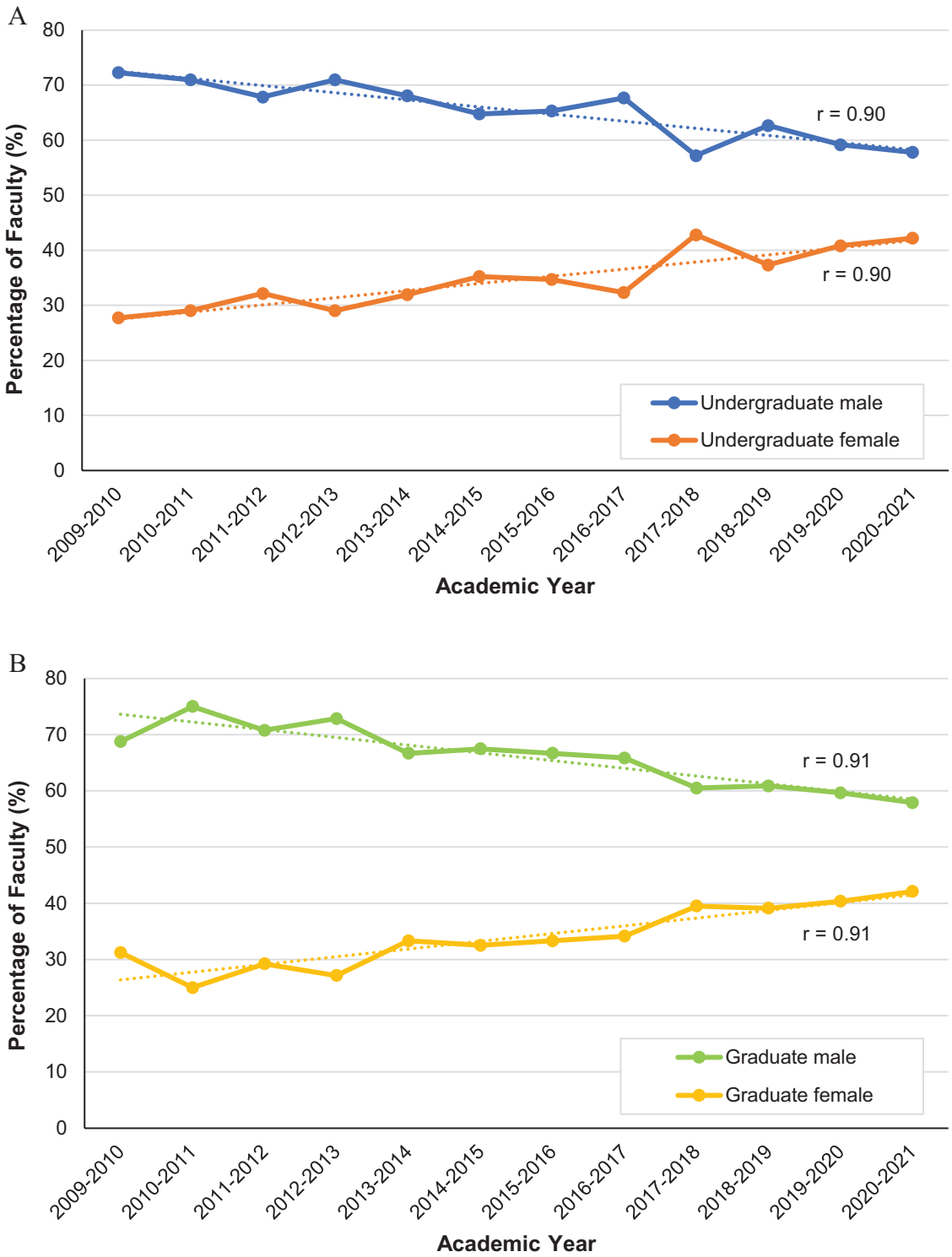

Figure 7. Gender distribution of (A) undergraduate and (B) graduate faculty in EHAC-Accredited Environmental Health Sciences programs by percentage from academic year 2009-2010 to 2020-2021, United States of America. Dotted lines represent linear trendlines per gender category. Faculty can be counted for both undergraduate and graduate categories.

difference between the genders, respectively. Annual assessed differences between numbers of male and female faculty in undergraduate and graduate EHS programs reached up to 45.5% and 50.0%, respectively. Similarly, faculty members in several specialties in medicine (eg, neuroradiology,[15] family medicine,[16] pediatric radiology,[17] ophthalmology,[18] internal medicine,[19] emergency medicine,[20] general surgery,[21,22] chest radiology,[23] plastic surgery,[24] anesthesiology,[25] dermatology,[27] gastroenterology[28]), public health,[40] and STEM disciplines[11,41] were found to be predominantly males.

Although an increasing trend in female EHS undergraduate and graduate faculty was observed, the gender disparity remains

Table 2. Racial distribution of undergraduate and graduate faculty in EHAC-Accredited Environmental Health Sciences program by number and percentage from academic year 2009-2010 to 2020-2021, United States of America.

ACADEMIC YEAR	ALASKA NATIVE		ASIAN		BLACK OR AFRICAN AMERICAN		HISPANIC OR LATINO		NATIVE AMERICAN		PACIFIC ISLANDER		WHITE		OTHER/MORE THAN 2 RACES		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Undergraduate faculty																		
2009-2010	0	0.0	15	7.1	24	11.3	2	0.9	1	0.5	0	0.0	169	79.7	1	0.5	212	100
2010-2011	1	0.5	16	7.3	23	10.6	0	0.0	0	0.0	0	0.0	168	77.1	10	4.6	218	100
2011-2012	0	0.0	10	4.5	27	12.1	5	2.2	0	0.0	0	0.0	179	79.9	3	1.3	224	100
2012-2013	2	0.9	16	6.8	24	10.3	7	3.0	0	0.0	0	0.0	185	79.1	0	0.0	234	100
2013-2014	1	0.4	17	6.0	26	9.2	8	2.8	1	0.4	0	0.0	229	80.6	2	0.7	284	100
2014-2015	1	0.3	23	6.0	31	8.0	17	4.4	0	0.0	0	0.0	306	79.3	8	2.1	386	100
2015-2016	2	0.7	24	8.9	11	4.1	11	4.1	2	0.7	0	0.0	216	79.7	5	1.8	271	100
2016-2017	1	0.4	21	8.0	12	4.6	11	4.2	0	0.0	0	0.0	215	81.7	3	1.1	263	100
2017-2018	7	2.1	33	10.1	30	9.2	13	4.0	2	0.6	0	0.0	231	70.6	11	3.4	327	100
2018-2019	4	1.4	25	8.5	19	6.5	7	2.4	2	0.7	0	0.0	235	79.9	2	0.7	294	100
2019-2020	2	0.7	25	8.3	22	7.3	11	3.6	1	0.3	0	0.0	210	69.5	31	10.3	302	100
2020-2021	2	0.9	20	8.6	19	8.2	3	1.3	0	0.0	1	0.4	186	80.2	1	0.4	232	100
Overall	23	0.7	245	7.5	268	8.3	95	2.9	9	0.3	1	0.03	2529	77.9	77	2.4	3247	100
Graduate faculty																		
2009-2010	2	1.0	2	1.0	7	3.7	2	1.0	0	0.0	-	-	169	88.5	9	4.7	191	100
2010-2011	1	0.6	3	1.7	6	3.3	1	0.6	0	0.0	-	-	168	93.3	1	0.6	180	100
2011-2012	1	0.5	2	1.0	8	4.1	1	0.5	0	0.0	-	-	179	92.3	3	1.5	194	100
2012-2013	3	1.5	7	3.4	7	3.4	1	0.5	0	0.0	-	-	185	90.7	1	0.5	204	100
2013-2014	1	0.4	3	1.2	10	4.0	1	0.4	0	0.0	-	-	229	92.7	3	1.2	247	100
2014-2015	2	0.6	4	1.2	10	3.1	3	0.9	0	0.0	-	-	306	94.2	0	0.0	325	100
2015-2016	1	0.4	5	2.1	8	3.4	3	1.3	0	0.0	-	-	216	91.9	2	0.9	235	100
2016-2017*	-	-	-	-	-	-	-	-	-	-	-	-	215	100.0	-	-	215	100
2017-2018	0	0.0	9	3.5	10	3.9	1	0.4	1	0.4	-	-	231	90.9	2	0.8	254	100
2018-2019	6	2.3	8	3.0	7	2.6	2	0.8	1	0.4	-	-	235	88.3	7	2.6	266	100
2019-2020	0	0.0	8	3.5	7	3.1	2	0.9	0	0.0	-	-	210	92.5	0	0.0	227	100
2020-2021	0	0.0	5	2.4	8	3.9	2	1.0	0	0.0	-	-	186	89.9	6	2.9	207	100
Overall	17	0.6	56	2.0	88	3.2	19	0.7	2	0.1	-	-	2529	92.1	34	1.2	2745	100

*No data for non-White races in AY 2016 to 2027.

Figure 8. Racial distribution of (A) undergraduate and (B) graduate faculty in EHAC-Accredited Environmental Health Sciences programs by percentage from academic year 2009-2010 to 2020-2021, United States of America.
*AY 2016 to 2017 excluded due to lack of data for non-White graduate faculty.

large. Similar findings showed a steady increase in female faculty in specific medical (eg, physical medicine and rehabilitation,[36] surgery[22]) and science and engineering fields[11] across academic ranks but gender disparity continues to exist overall, particularly at higher ranking faculty positions.[11,22,23,36] The proportion of females in higher faculty ranks (ie, associate professor, full professor) was lower than those of males[15-17,27,39] and shown to decrease as the academic ranking increases.[20,23,26,40,41] For example, comparing women versus men, gender differences for the ranks of instructor, assistant professor, associate professor, and full professor in academic neurology were 51.9% and 48.1%, 43.2% and 56.8%, 32.9% and 67.1%, and 16.9% and 83.1%, respectively.[26] Similar results in gender disparity by rank were also found among faculty in emergency medicine wherein lower percentage of women compared to men were associate or full professors[20] and in chest radiology wherein 29% and 19% of associate and full professors, respectively, were women.[9,23]

Several reasons have been suggested for the underrepresentation of women faculty in academia despite the increasing number of female students and degree recipients, which may

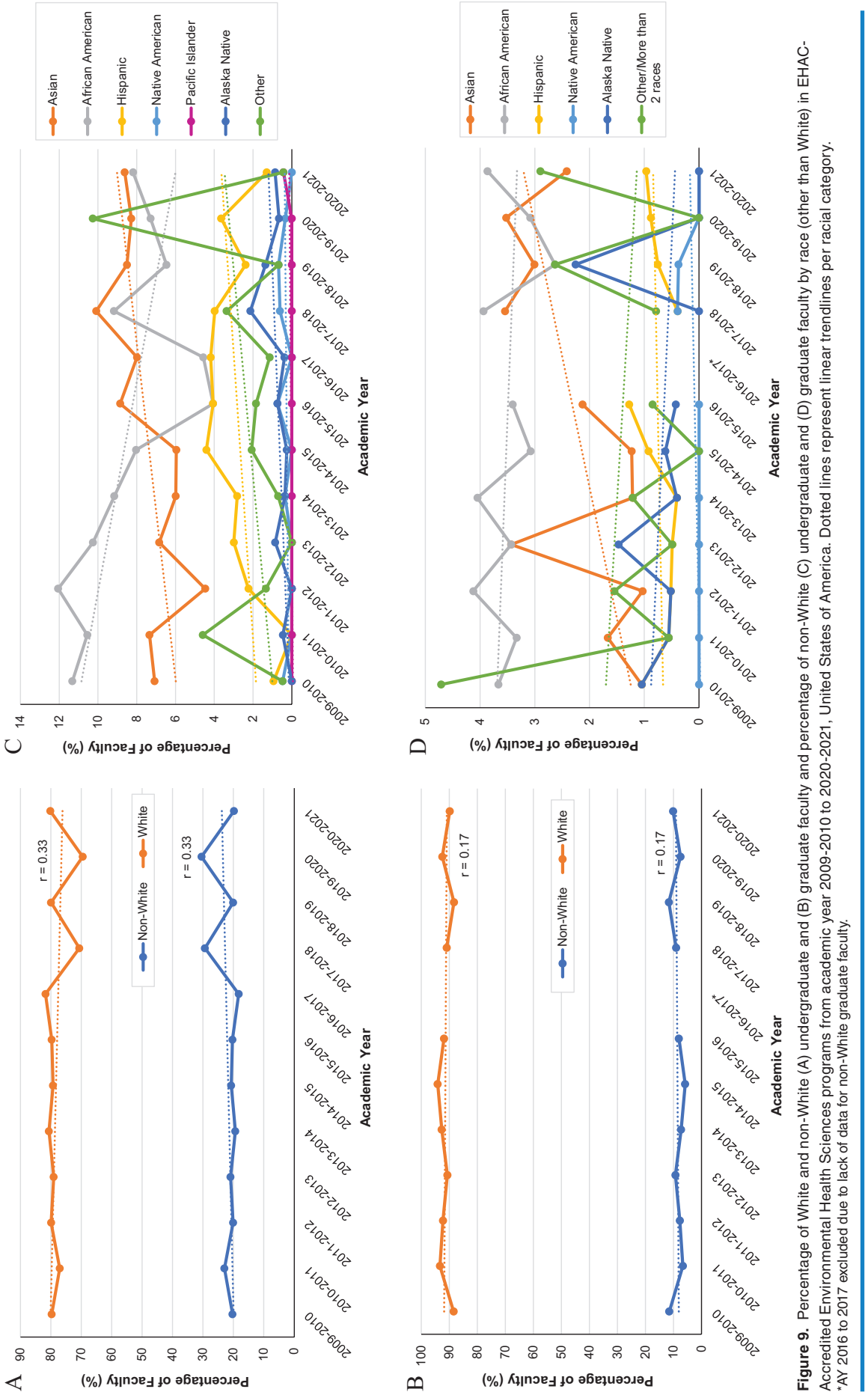

Figure 9. Percentage of White and non-White (A) undergraduate and (B) graduate faculty and percentage of non-White (C) undergraduate and (D) graduate faculty by race (other than White) in EHAC-Accredited Environmental Health Sciences programs from academic year 2009-2010 to 2020-2021, United States of America. Dotted lines represent linear trendlines per racial category.
*AY 2016 to 2017 excluded due to lack of data for non-White graduate faculty.

also be applicable to EHS students and faculty. First, there may be fewer female EHS faculty because they do not remain in academia or advance in their academic career. Carr et al[42] found that female faculty were less likely to stay in academic medicine positions compared to male faculty. This has been attributed to the greater burden of domestic responsibilities (eg, caregiving)[43] and more pressures related to balancing multiple roles both at home and work[44,45] experienced by women as compared to their male counterparts. However, others suggest that the underrepresentation of women faculty is more strongly explained by an academic culture that provides limited institutional support (eg, internal grant funding, administrative assistance) and fewer opportunities to women as they begin their academic careers, rather than gender-based differences in domestic responsibilities.[41-46] Changes in the organizational culture in academia are needed to narrow the current gender disparity by providing equivalent research support and advancement opportunities to female and male faculty, particularly those in the early phase of their academic careers.[41]

Another possible reason for gender disparities in EHS faculty may be the preferential hiring of male EHS graduates into EHS faculty positions. Several studies showed related evidence of gender bias in academia. Sheltzer and Smith[47] found that male faculty who run elite biology laboratories employ fewer female graduate students and postdocs and that "feeder" laboratories (ie, laboratories that produce assistant professors) employ more male postdocs, likely making male graduate students and postdocs more competitive in the faculty selection process. Given the increasing number of female degree recipients, a study by Xu[41] suggested that the major "leakage" in the supply line is likely due to the disproportionately small number of women hired into faculty positions. This gender disparity may be a consequence of failure to meet criteria for diversity and equity in the selection of faculty candidates. Thus, an improved effort to ensure equal opportunity for female applicants at hiring is essential to increase the presence of female faculty, which may include better advertisement of position openings to promising female candidates and gender-balanced search committees to avoid gender-related biases and/or discrimination.[41]

Having females in leadership positions was associated with a higher proportion of female faculty and may consequently encourage women joining these academic faculty departments/groups.[27] However, women in various disciplines (eg, medicine, public health) are underrepresented in academic leadership positions.[15,16,19,20,23,27,40,42] For example, only 15% of chairs/vice chairs in academic emergency medicine[20] and 23% of department chiefs in academic chest radiology[23] are women. Ahmadi et al[15] also found gender disparity to be highly significant ($P < .01$) for leadership positions in academic neuroradiology. Carr et al[42] suggests that women may not be getting equal opportunity or support to achieve leadership positions and that culture change is necessary to attain equitable career advancement of women across professions. Given that a small proportion of faculty leaders are women, efforts should be made to recruit women in leadership positions to help reduce gender disparity among faculty. The underrepresentation of women in academia may slow the progress of discovery due to the exclusion of female individuals who can make significant scientific contributions.[47]

Most undergraduate (61.0%) and graduate (50.7%) EHS students were White. Annual reported percentages similarly show more White undergraduate students throughout the study period and more White graduate students in most of the surveyed years compared to other racial groups. However, an increasing trend in underrepresented minorities combined among undergraduate students was observed, from 40.0% to 48.2%. Although the percentage of underrepresented minority graduate students has an overall decreasing trend for the entire study period, increasing percentages were observed in the last 5 years from 22.6% to 57.0%. Similarly, from 2008 to 2018, the percentage of underrepresented minorities receiving science and engineering degrees increased from 17.8% to 24.1% for bachelor's, from 16.6% to 22.1% for master's, and from 11.1% to 13.6% for doctorate degrees.[48] However, these groups remain underrepresented relative to their representation in the overall US population.[48]

Here, a large majority of both undergraduate and graduate EHS faculty from EHAC-accredited (US) programs were White (77.9% and 92.1%, respectively), followed by Black and Asian. Among undergraduate faculty, the overall difference in percentage between the biggest (77.9% for White) and the second biggest (8.3% for Black) racial groups was substantially large (69.6% difference). Moreover, such overall percentage differences between the biggest (92.1% for White) and the second biggest (3.2% for Black) racial groups among graduate faculty was even larger (88.9% difference). Comparing the largest with the smallest racial group, the overall difference in percentage between White and Native American graduate faculty was 92.0%. A slight increasing trend in the percentage of non-White underrepresented minority undergraduate faculty was observed throughout the study period but the percentage of non-White underrepresented minority graduate faculty remained stagnant. Over the past 12 years in academic neurology, White people were predominant in all faculty positions followed by Asians, Hispanics, and Black, with the least representation among Native Hawaiians and Native Americans.[26] Moreover, significantly more White faculty (69.8%), compared to other races, exist in academic surgery.[22] In science and engineering fields, underrepresented minority faculty in tenure-track and tenured positions were relatively few, despite the increasing number of PhD recipients in the same field.[11] When categorized according to academic ranks, the proportion of White et al faculty in higher ranks (ie, associate professor, full professor) was higher than those of underrepresented minority faculty in various disciplines, such as medicine[20,22,36,39] and science and engineering.[11] Such proportion of White faculty increases as the academic ranks increase.[11,22] Non-White

faculty were also underrepresented in academic leadership positions, such as department chair and vice chair, in different medical disciplines (eg, emergency medicine,[20] surgery,[22] neurology,[26] dermatology,[27] gastroenterology[28]).

The racial disparity found within EHS faculty has relevant implications that can adversely affect the EHS student body, EHS faculty responsibilities, EHS research, and potentially EHS practitioners. With the increasing percentage of minority undergraduate students in EHS, it is crucial for them to have mentors among the minority EHS faculty for improved recruitment, student experience, and retention. Similarly, although the percentage of underrepresented minorities receiving bachelor's degree in science and engineering continues to increase, they are likely to have few minority faculty as role models and mentors because the percentage of underrepresented minority faculty is lower than that of minority PhD recipients, and even much lower than that of minority bachelor's degree recipients.[11] Minority students may not be encouraged to persist in a discipline if they perceive that minority professors are not hired, retained, and/or treated fairly.[11] This underrepresentation also places the burden of extra responsibilities on minority faculty for the sake of achieving diversity, which may involve mentoring minority students and staff, working in minority community efforts, and/or taking on committee work on diversity.[49]

Additionally, racial disparity is an important issue that needs to be addressed to improve research on underrepresented minority groups since many graduate faculty (ie, tenure-track and tenured) also have institutional responsibilities of conducting research, in addition to teaching and service. A diverse set of researchers are likely to focus environmental health research efforts on advocating for the health of diverse communities,[11,50,51] which are likely understudied. Either as researchers or practitioners working in communities, minority EHS professionals of a particular racial group may have a better understanding of that group's culture, thus enhancing rapport when working in diverse communities.[52]

Native Americans are consistently among the most underrepresented racial groups in both undergraduate and graduate students and faculty of EHAC-accredited EHS academic programs, both in overall and annual trends. Similarly, Native Americans were the most underrepresented among Ph.D. recipients in science and engineering disciplines, compared to Black, Hispanic, and Asian racial groups.[11] Native American representation among science and engineering students is lower than their overall US population (~1.2%).[13] Moreover, Saleem et al[26] found that American Indian or Alaskan Native had the smallest percentage among neurology faculty, regardless of the academic rank. In a 2012 survey of top 50 science and engineering departments, Native Americans (including Alaskan Natives, Native Hawaiians, and Pacific Islanders) had the lowest faculty representation compared to all other races, with no representation at all faculty ranks in certain disciplines (eg, math, mechanical engineering, economics, political science, sociology).[11] Such extreme underrepresentation of Native American faculty may be perceived by Native American students and graduates as academia being unwelcoming to them.[11] Having more Native American EHS faculty may help in recruiting and retaining more Native American EHS students and consequently in producing more Native American EHS practitioners and researchers. This is essential in addressing the unique environmental health problems and issues that affect the health of Native American populations, who are served by environmental health specialists and officers through the Indian Health Service as the federal health program for American Indians and Alaskan Natives.[53] Some of the most prevalent environmental health issues affecting tribal communities include indoor air pollution, mining, sludge sites, food contamination and poor housing conditions, leading to chronic hazard exposures and diseases.[54,55] Dietary exposure to polycyclic aromatic hydrocarbons (PAHs) due to traditional fish smoking methods was found to increase cancer risks.[56] Cadmium exposure among American Indians due to diet, smoking and living near industrial and mining sites was associated with total and specific cancer mortality[57] while chronic arsenic exposure from contaminated food and water was associated with increased risk of diabetes,[58] carotid arterial disease[59] and chronic kidney disease.[60] Indoor fine particulate matter ($PM_{2.5}$) levels in Native American homes practicing solid fuel burning exceeded airborne exposure limits, leading to increased risk of acute and chronic diseases.[61] Hence, the need for the development of tribal research capacity has been recognized to ensure the conduct of research studies that are respectful of tribal culture and policies.[62]

The primary limitation of this study is related to data analysis, wherein the comparison of racial distribution for certain racial groups (eg, students versus faculty; undergraduate faculty versus graduate faculty) is limited due to the differences in survey response options. For example, the response options "Alaska Native" and "Native American" are separate in the undergraduate faculty survey but are combined as "Alaska Native or Native American" in the student survey. In addition, the response option "Pacific Islander" is included in the undergraduate faculty survey but not in the graduate faculty survey. Also, survey data for AY 2016 to 2017 was incomplete and thus excluded from the analysis. Despite these limitations, to the authors' knowledge, this study is the first to characterize the gender and racial diversity among EHS undergraduate and graduate students and faculty and may serve as baseline information for related future studies.

Conclusion

This study shows that gender and racial disparities exist among students and faculty in EHAC-accredited EHS undergraduate and graduate programs. Increasing trends were observed over the last 12 years in female undergraduate (from 53.7% to

59.8%) and graduate (from 47.1% to 60.3%) students, in non-White undergraduate students (from 40.0% to 48.2%) and in female undergraduate (from 27.7% to 42.2%), and graduate (from 31.3% to 42.1%) faculty. Although the majority of undergraduate (54.4%) and graduate (52.1%) EHS students were female, percentages of female undergraduate (35.6%) and graduate (35.7%) EHS faculty were lower than those of the male faculty. Most EHS students (>50%) and faculty (>77%) were White in both undergraduate and graduate programs. Native American, Alaska Native, Native Hawaiian, and Pacific Islander are consistently the most underrepresented racial groups in both undergraduate and graduate EHS students (⩽5.4%) and faculty (⩽2.3%).

Efforts to promote diversity of EHS students and faculty were initiated more than a decade ago by the N-CODE Health, which developed platform concepts related to a diverse EHS workforce.[2] In more recent years, EHAC and the Association of Environmental Health Academic Programs (AEHAP) actively explored their collaborative role in addressing environmental and public health issues in marginalized communities, promoting cultural competency among EHS practitioners, and increasing diversity of students and graduates of EHAC-accredited EHS programs.[63] However, these efforts need to be further strengthened through more active participation of EHAC-accredited EHS programs, EHS professional organizations and other stakeholders. Gender and racial disparities in EHS programs, particularly the underrepresentation of female and non-White EHS faculty, should be investigated further and addressed by institutional change in culture, efforts and policies to provide necessary support to women and non-White constituents. For example, institutions should actively recruit non-White students by strengthening communication/marketing and partnerships within their own university and/or other institutions that serve minority populations (eg, historically Black and American Indian colleges and universities) to bring students on campus (or virtually) for tours, career fairs, and other student events. Pathways can be developed for undergraduate students to encourage applications/admissions to EHAC-accredited graduate programs (eg, funded on campus or virtual summer research programs for undergraduates to establish potential graduate mentor connections and work with EHS professors). Moreover, professional organizations and societies should work together to develop ideas to increase diversity of faculty and students within environmental health programs. For example, the American Indian Science and Engineering Society is partnering with the Entomological Society of America, Ecological Society of America, and Botanical Society of America on a 5-year project titled "*Culture Change for Inclusion of Indigenous Voices in Biology*," which is supported by a $1.5 million grant from the National Science Foundation.[64] This collaboration aims to address the underrepresentation of Native Americans in STEM disciplines and could be used as a model in the EHS field through collaboration between EHS professional organizations (eg, National Environmental Health Association [NEHA], AEHAP) and other organizations/societies that advocate for underrepresented minority groups.

This study provides baseline information on the diversity of students and faculty in EHS programs. Findings may assist in identifying specific issues on gender and racial disparities that could be addressed in future research. Further investigation on gender and racial disparities of EHS faculty by academic rank is warranted to determine the specific needs of the faculty at different stages of their academic careers. Future research should be encouraged on underrepresented minority EHS students and practitioners to investigate their reasons for pursuing an environmental health career, their challenges (if any) related to enrollment, retention and graduating from an EHS program (undergraduate or graduate), their potential and/or current work challenges, and their unique needs as a minority in the EHS discipline. Similar studies (eg, diversity assessment and challenges/opportunities resulting from EHS work in minority and other communities) should also be conducted on EHS practitioners working in county, state, federal, and private areas of the environmental health field. Findings from these diversity studies may eventually be translated into supporting ideas and policies that could be implemented in various institutional, governmental, and professional settings.

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