What are the features of targeted or system-wide initiatives that affect diversity in health professions trainees? A BEME systematic review: BEME Guide No. 50

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What are the features of targeted or system-wide initiatives that affect diversity in health professions trainees? A BEME systematic review: BEME Guide No. 50

Kristen Simone[a], Rabia A. Ahmed[b], Jill Konkin[c], Sandra Campbell[d], Lisa Hartling[e] and Anna E. Oswald[f]

[a]Department of Medicine, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, Canada; [b]Division of Infectious Diseases, University of Alberta, Edmonton, Canada; [c]Department of Family Medicine, Division of Community Engagement, University of Alberta, Edmonton, Canada; [d]John W. Scott Health Sciences Library, University of Alberta, Edmonton, Canada; [e]Department of Pediatrics, University of Alberta, Edmonton, Canada; [f]Department of Medicine, Division of Rheumatology, University of Alberta, Edmonton, Canada

ABSTRACT

Background/purpose: There is interest to increase diversity among health professions trainees. This study aims to determine the features/effects of interventions to promote recruitment/admission of under-represented minority (URM) students to health professions programs.

Methodology: This registered BEME review applied systematic methods to: title/full-text inclusion review, data extraction, and quality assessment (QA). Included studies reported outcomes for interventions designed to increase diversity of health professions education (HPE) programs' recruitment and admissions.

Results: Of 7225 studies identified 86 met inclusion criteria. Interventions addressed: admissions (34%), enrichment (19%), outreach (15%), curriculum (3%), and mixed (29%). They were mostly single center (76%), from the United States (81%), in medicine (45%) or dentistry (22%). URM definition was stated in only 24%. The dimension most commonly considered was ethnicity/race (88%). The majority of studies (81%) found positive effects. Heterogeneity precluded meta-analysis. Qualitative analysis identified key features: admissions studies points systems and altered weightings; enrichment studies highlighted academic, application and exam preparation, and workplace exposure.

Discussion/conclusions: Several intervention types may increase diversity. Limited applicant pools were a rate-limiting feature, suggesting efforts earlier in the continuum are needed to broaden applicant pools. There is a need to examine underlying cultural and external pressures that limit programs' acceptance of initiatives to increase diversity.

Background

Diversity and the health professions

Disparities in access to healthcare persist despite efforts to improve care for underserved patients. This group includes but is not limited to those who are racial/ethnic minorities, are of low socio-economic status, lack healthcare insurance, and are recent immigrants. A shortage of health care professionals practicing in communities with populations experiencing health inequities is a major contributor and has led to calls for increased social accountability by the health professions education (HPE) community (Calkins 1978; AAMC 1996; Bediako et al. 1996; Cantor et al. 1998; Blakely and Broussard 2003). The World Health Organization (WHO) defines social accountability of health professions schools as "the obligation to direct their education, research and service activities toward addressing the priority health concerns of the community, region and/or nation that they have a mandate to serve. The priority health concerns are to be identified jointly by governments, health care organizations, health professionals and public" (Brody and Alexander 2000). By identifying and responding to the needs of the community, health professions training programs play a major role influencing the changes in the health care system that are necessary to ensure not only an effective and efficient system, but equally as important one

Practice points

- This literature is heterogeneous in regards to intervention type, study design, and study outcomes. Most studies addressed narrow URM definitions (ethnicity, race, and to a lesser extent SES), focused on medicine and dentistry and were conducted in the USA. Admissions and enrichment interventions were supported by the highest number of included studies and had the most studies with independent comparators. Admissions studies highlighted key features related to points systems and altered weightings. Enrichment studies highlighted key features related to academic, application and exam preparation and workplace exposure.

- Many authors identified limited applicant pools as a rate-limiting feature, suggesting that efforts earlier in the continuum than the admissions process itself are needed to broaden applicant pools.

- Most studies report positive results suggesting that any intervention type is likely to increase intended diversity dimensions over status quo; although there was a wide range of study quality when subjected to quality assessment (QA) analysis.

that is accessible and equitable to all. The call for greater social accountability within medical education has led to the development of new medical schools with this focus (e.g. Northern Ontario School of Medicine in Canada and James Cook University in Australia). There have also been attempts at restructuring established health professions schools worldwide (Andersen, Davidson et al. 2009).

One such response has been to increase diversity among the health professions student body and workforce. In a broad sense, diversity within the institution of health care refers to ensure greater inclusion of those populations that are under-represented in the health professions relative to their numbers in the general population. Little systematic documentation regarding what actually defines a diverse population is available. In many instances, demographic data from health trainees identifying markers of diversity in these populations is likewise not available. Dimensions of diversity have traditionally focused on gender, socioeconomic status (SES), urban/rural status, and ethnicity or race. There is a paucity of data regarding other dimensions such as disability, gender identity, and sexual orientation (Clewell and Keyser-Smith 1983). It has been proposed that in order to serve the complex health care needs of a diverse population and meet social accountability objectives, the health workforce must also be diverse (Bediako et al. 1996). Diversity conscious policies and programs have been implemented to achieve this goal and yet still lag behind population demographic shifts and changes.

The evidence to date suggests that achieving greater diversity has led to some of its intended benefits of improving health access. Several studies, including a systematic review of the patient care related benefits of a diverse health professions work force, found that health professionals (particularly physicians) from populations that experience health inequity are more likely to work in underserved areas and are more likely to treat patients experiencing health inequities (Armendariz 1973; AAMC 1996; Cliffordson and Askling 2006; Atchison, Friedman et al. 2009; Arnett and Forde 2012). Patients from under-represented populations tend to receive better interpersonal care from health professionals from the same racial or ethnic background and also report greater satisfaction when they receive care from these physicians (Cliffordson and Askling 2006; Atchison, Hewlett et al. 2009; Awe and Bauman 2010; Bailey 2013). Medical students from under-represented backgrounds report increased desire to work in underserved areas and with patients from under-represented populations or who have health inequities (Bruhn 1978). The benefits of a diverse medical class are not just limited to workforce considerations or patient satisfaction. A large survey of American medical students concluded that student body racial/ethnic diversity within American medical schools is associated with outcomes consistent with the goal of preparing students to meet the needs of a diverse population (Baker and Lyons 1989).

Conceptual underpinnings

The basis of this review is underpinned in Bandura's self-efficacy learning theory. This conceptual framework purports that the key elements essential for learning are: (1) experience; (2) modeling; (3) social persuasion; and (4) physiological factors (Bare 2007). In relation to this project, the first three elements are key to the diffusion of positive change through increasing diversity in health professions training programs. For example, in regards to experience and modeling in one large American study, students attending more racially diverse medical schools rated themselves as better prepared to meet the needs of a diverse population compared to those who attended less diverse schools (Baker and Lyons 1989). Expanding on this, we also draw on the concepts of "critical mass" and "social networks." Critical mass, as it pertains to health professions school diversity, has been defined as the minimum number of under-represented population students that are needed to produce a change in the group interaction and educational experience. However, as Elam et al. (2009) argue, the concept of critical mass alone conceptualizes a quantitative threshold in order to elucidate a qualitative change. Instead, Elam et al. suggest that achieving the goals of a critical mass of diverse students is linked to a critical mass of their social networks. Within this framework, critical mass is "conditional on the underlying meanings and self-perceptions individuals assign *via* the social roles they occupy, the social groups to which they belong" and reasonably the subsequent interactions among these groups.

It is also important to consider HPE diversity policies within the context of critical race theory (CRT) discourse. CRT (Ford and Airhihenbuwa 2010) is an emerging trans-disciplinary, race-equity methodology grounded in social justice. CRT consists of four basic features: "race consciousness," "contemporary orientation" (aspects of racialization that are contemporarily salient), "centering in the margins" (shifting perspective from that of the majority to that of the minority), and "praxis" (theory-informed action). CRT raises the concern that the concept of diversity may not in fact result in its intended inclusiveness that ultimately promotes social change and justice. Instead, a CRT discourse suggests that diversity policies may in fact normalize the power and privilege of the dominant group. For example, Iverson (2007) analyzed diversity action plans regarding race across 21 universities and found that these policies placed individuals of the non-dominant race as outsiders to the institution, at risk before and during participation in education and dependent on the university for success in higher education.

Approach to health professions diversity literature

While there are many ways to approach this literature, we categorized interventions aimed at increasing diversity into the following groups: (1) those intended to promote recruitment for application by a more diverse population (2) those intended to support success in admission by a more diverse population (3) those intended to support retention and completion of programs by a more diverse population, and (4) those intended to recruit and retain health professionals to work with more diverse populations. The present review focuses on the first two of these groups as interventions at these early stages may have the greatest impact on diversity as they represent the critical rate-limiting steps for entry into health professions programs.

While the evidence base demonstrating the benefits of interventions to increase diversity in the health professions

is encouraging, syntheses of primary research evaluating strategies aimed at promoting the recruitment and admission of students from traditionally identified under-represented groups is limited to date. Loftin et al. (2012) provided a synthesis of interventions used to facilitate the recruitment, retention, and program completion of under-represented nursing students. This review included studies that report on the implementation and evaluation of interventions designed to increase academic success and program completion of under-represented nursing students in the United States. Building on this review, our review sought to include a broader spectrum of HPE programs, a wider definition of diversity, and to include studies conducted outside of the United States. We also focus our review on the recruitment and admission of under-represented students whereas the previous review was more focused on retention of already admitted students. To date, such a comprehensive review of interventions has not been performed.

In conceptualizing our review, we recognize that other professions such as teaching, engineering, and the criminal justice system may also desire increased diversity in their training programs. However, health professions program and policy planners do not have a resource that evaluates such interventions that may be specific to their own context and needs. For example, applicants for many health professions programs require preparation for highly competitive admissions processes that focus on academic performance and suitability for the subsequent high stakes patient care and workplace-based learning (Claycomb et al. 1980). These processes provide different and significant barriers and challenges to potential applicants from under-represented groups in health professions than those in other non-healthcare related professions. In addition, the WHO recommendations regarding social accountability within health care clearly recognize healthcare as a unique and opportune setting to improve health inequity through workforce diversity (Brody and Alexander 2000).

Although it is clear that interventions to enhance diversity are increasing, it is not clear whether these efforts are translating into a more diverse student body (Bauman 1992; Atchison, Hewlett et al. 2009). For this reason, we sought to determine which interventions aimed at increasing under-represented populations are associated with meeting the desired outcomes of increasing the representation of these populations within the health professions student body. Such a review may enable policy makers and funders to aim future efforts toward those interventions with outcomes that successfully result in increased under-represented student recruitment and admission into health professions programs. Further, as we intend this review to inform and be used by policy makers at various health profession programs and schools, we will focus this review on interventions that schools administer or influence rather than those under the remit of higher levels of government or external organizations.

Objectives of the review

We conducted a systematic review of the literature to determine the features of recruitment and admissions interventions that affect diversity within HPE programs' student bodies.

Methods

Definitions

For the purpose of this review, diversity was defined within health care systems and educational programs as ensuring greater inclusion of those populations that are under-represented in the health professions relative to their numbers in the general population and included such dimensions as race/ethnicity, religion, gender, sexual orientation, geographic origin and SES (Bediako et al. 1996). Under-represented minority (URM) was defined as any recognized minority group whose representation in healthcare is disproportionately lower when compared to the group's proportion in the general population (Bediako et al. 1996). Minorities are often defined using categories of ethnicity/race but can also include other categories such as gender, geographic location, and socio-economic status. A complete glossary of terms is available at the end of the article.

Inclusion and exclusion criteria

As outlined in Table 1, we focused our review on students who are at the initial point of entry into a health professions program. We excluded trainees who are in later stages of training (e.g. post-graduate medical trainees, nurse practitioner trainees, etc.), and practicing health professionals as they are chosen exclusively from the already narrowed initial pool; where the ultimate goal is to maximally broaden diversity in the professions.

The initiatives included were targeted at recruitment and admissions of a diverse population of health professions trainees and some examples are listed under initiatives in Table 1. We have included both quantitative and qualitative study designs to ensure that we captured a broad range of initiatives and their outcomes (see Table 1). The same inclusion criteria were used for both quantitative and qualitative studies. Studies were only included if they reported data on one of the outcomes listed in Table 1.

Search strategy

A search was executed by an expert searcher/librarian (SC) on the following databases:

OVID Medline, OVID EMBASE, OVID Psycinfo, OVID ERIC, OVID EBM Reviews – Cochrane Database of Systematic Reviews, EBM Reviews – ACP Journal Club, EBM Reviews – Database of Abstracts of Reviews of Effects, EBM Reviews – Cochrane Central Register of Controlled Trials, EBM Reviews – Cochrane Methodology Register, EBM Reviews – Health Technology Assessment, EBM Reviews – NHS Economic Evaluation Database, OVID Global Health, EBSCO CINAHL, SCOPUS, Proquest Dissertations and Theses, PROSPERO, using controlled vocabulary (e.g. MeSH, Emtree, etc.). Publications relating only to residency or post-graduate studies or post-doctoral studies were excluded. No limits were applied. Results were exported to RefWorks citation management system. A sample search is available in Supplementary Appendix 1.

Table 1. Inclusion and exclusion criteria.

	Inclusion criteria	Exclusion criteria
Target participants	High school students Students not already in a health professions program Potential health professions applicants	Students applying for Non-Health professions programs Practicing health professionals
Target programs	Medicine Nursing Physician assistant Pharmacy Dentistry Dietetics/nutrition Physiotherapy Occupational therapy Dental hygiene Social work Speech and language pathology Clinical psychology Other health professions	Non-health professions programs
Initiatives	Awareness campaigns Career and health fairs Pipeline programs Pre-matriculation programs Targeted admissions quotas Facilitated admissions criteria Scholarships, bursaries, and financial aid Mentoring and support programs Other relevant initiatives	Studies without a specific intervention aimed at increasing diversity Studies that do not provide enough information about the initiative to allow replication by another group Initiatives aimed at retaining students already in health professions programs
Outcomes	Application rates Admission population profiles Program completion rates Impacts on knowledge, attitudes, and skills of the entire trainee population Maintenance in practice Diversity of practice population Leadership in diversity Under-represented population satisfaction Under-represented population outcomes Career choice Practice location Other relevant outcomes	Studies without reported outcome data Studies reporting only learner reaction or satisfaction
Study type	Studies which provide primary data for any of the outcomes listed above, including (but not limited to) the following designs: Randomized controlled trials Non-randomized control trials Before and after studies Interrupted time series Qualitative or mixed method	Studies reporting on needs assessments for diversity Studies reporting the physician workforce or patient outcomes related to diversity without specific interventions Studies reporting quantitative post-test only results where change cannot be determined Opinion papers, editorials, or commentaries

Searches were conducted using both the above-controlled vocabulary (MeSH, EMTREE, etc.) and text words representing the concepts described in more detail in Table 2. Keywords representing the concepts "health professions schools" and "recruitment and initiatives," and "under-represented groups" were included. In order to feel confident that we did not miss key studies or initiatives and because this area does not use many standard MeSH headings, we chose to use a broad search. The search was initially conducted in June 2014 and updated in February 2017.

In addition, we had screened the reference lists of all included studies and relevant reviews. We conducted a separate search on SCOPUS looking forward for studies that cite any of the included articles. We contacted authors of relevant studies to determine if they know of any unpublished, recently published, or ongoing studies relevant to the review. We also hand-searched conference proceedings for the Association of American Medical Colleges, the Association of Medical Education in Europe, and the Canadian Conference of Medical Education from 2013 to 2016. Further, we reviewed gray literature in the field of health education to identify any relevant studies using Google Scholar.

Screening and study selection process

The titles and abstracts of the studies obtained following our search were collated into a RefWorks reference management database and duplicates were removed. Title and abstracts were independently screened by two reviewers (KS and RA or AO) to exclude those that obviously did not meet the inclusion criteria or address the study question.

The full texts of all remaining studies identified by either reviewer were retrieved. A previously piloted study inclusion form (O'Dunn-Orto et al. 2012) derived from the BEME coding template was applied to all of these studies by two independent reviewers (KS and RA or AO) to filter for relevant studies. The decisions made by the two reviewers were then compared and any discrepancy that arose was resolved through discussion or with the aid of the third reviewer (AO) as required.

Data extraction

Data extraction was completed on the resulting eligible papers using a previously piloted refined electronic BEME coding sheet for data extraction (O'Dunn-Orto et al. 2012). The data extraction included the following information:

Table 2. Sample search terms.

Health professions schools		Recruitment and initiatives		Under-represented groups		Excluded concepts
exp Schools, health occupations/ or ((dental or dentistry or pharmac* or dietitian* or dietetic* or nutritionist* or sonograph* or radiation therap* or audiolog* or music therap* or respiratory therap* or physician* assistant* or phlebotom* or orthoptis* or Orthotis* or medical technol* or social worker* or massage therap* or podiatrist* or prosthetist* or chiropract* or kinesiolog* or medical or medicine or psycholog* or nursing or physical therap* or physiotherap* or occupational therap* or public health or speech therap*) adj2 (school* or program* or training or education)).mp.	AND	(recruit* or admit* or encourage* or entrance* or pipeline program* or rural pipeline* or bursar* or scholarships or affirmative action*).mp. or (admission adj2 (quota* or facilitat* or assist* or support*)).mp. or (entrance* adj2 (quota* or facilitat* or assist* or support*)).mp. or exp "Fellowships and Scholarships"/or exp School admission criteria/	AND	Transsexualism/or exp Sexuality/ or exp Ethnic Groups/ or bisexuality/ or exp homosexuality/ or exp socioeconomic factors/ or exp cultural diversity/ or exp disabled persons/ or transgendered persons/ or "transients and migrants"/ or women/ or Jehovah's witnesses/ or African continental ancestry group/ or American native continental ancestry group/ or (Anabaptist* or Apostolic* or Bahai* or Buddhis* or Confucianism or Hindu* or Islam* or Jehovah's Witness* or Judaism* or Latter-day Saint* or Mennonite* or Hutterite* or Mormon* or Muslim or Mysticism* or Pentecostal* or Shinto* or Sikh* or ((mature or disabled or transgendered or blind or deaf or amputat* or minorit* or diversity or wheelchair* or paraplegic* or immigrant* or ethnic*) adj3 student) or ((remote or rural) adj2 (student)) or poverty or impoverished or low social status or Metis or Indigenous* or Aboriginal* or Amerindian* or Autochtone* or First Nations or First Nation or tribal or Inuit* or aborigine* or torres strait islander* or maori* or sami or underprivileged or underrepresented or disadvantaged or inner city or downtown core or city core or skid row slum or slums or barrio or barrios or shanty town* or tenement housing).mp.	NOT	exp "Internship and Residency"/ or medical resident* or patient recruitment.mp. or postgraduate or postdoctoral or tertiary education or exp Patient Selection/

author's objective(s), structured intervention or initiative, comparator, outcomes, study design, characteristics of the study population, and key features that led to success or failure of the initiative. This form is available in Supplementary Appendix 2.

The data extraction process was discussed by both reviewers (KS and RA) to establish a consistent approach and any questions that arose were addressed at regular meetings. All studies underwent data extraction by one reviewer (KS or MT). To ensure accuracy and consistency of data extraction, a sample of 20% of the articles was randomly selected for checking by a second reviewer (LA or SC). Descriptive data are reported as absolute numbers and percentages (with percentages rounded to the nearest whole number).

Quality assessment

Methodological quality assessment (QA) of eligible studies was evaluated using tools devised by The Cochrane Effective Practice and Organization of Care (EPOC) Group (Effective Practice and Organisation of Care (EPOC) 2015) as well as the Critical Appraisal Skills Program Qualitative Checklist (CASP 2013) and mixed methods tools developed by Pace et al. (2012), Pluye et al. (2009), and others to determine the risk of bias and strength of study findings. Potential sources of bias were identified wherever individual studies were not awarded a point based on the QA tools for their respective study designs. QA of all eligible articles was performed independently by two reviewers (KS and either AC, SD, or MT).

Resolution of discrepancies

All data inclusion forms, 20% of data extraction forms and all QAs were completed by two independent reviewers.

These were compared at the end of each of the study selection, data extraction, and QA stages. Any discrepancies between the two reviewers were resolved through discussion and if needed with the input of a third party.

Data synthesis and analysis

Based on our group's previous experience conducting systematic reviews of the HPE literature, we anticipated that the data obtained might be too heterogeneous to be combined for quantitative statistical meta-analysis and this was confirmed. We approached our analysis in an iterative and responsive fashion as we extracted data and mapped the relevant studies. Due to heterogeneity in intervention types, outcomes and study designs, we conducted a qualitative synthesis of the evidence using procedures such as those outlined by Ogawa and Malen (1991) for synthesizing multi-vocal bodies of literature. Briefly, these approaches treat individual articles like cases in a case study, and they are then analyzed using methods common to thematic analysis. We conducted a qualitative review of the evidence, grouping, and reporting studies by intervention type. Two study team members (KS and RA) reviewed the results section of the data extraction forms line by line, and categorized the results into initial themes. These themes were then verified through regular meetings with co-investigators and ambiguities were resolved through discussion. Categories were reduced to major themes through ongoing discussion between study team members and the re-reading of the results section of the data extraction forms. These themes and key features are described by intervention in the results section. A focused qualitative analysis of the studies with independent comparators and a
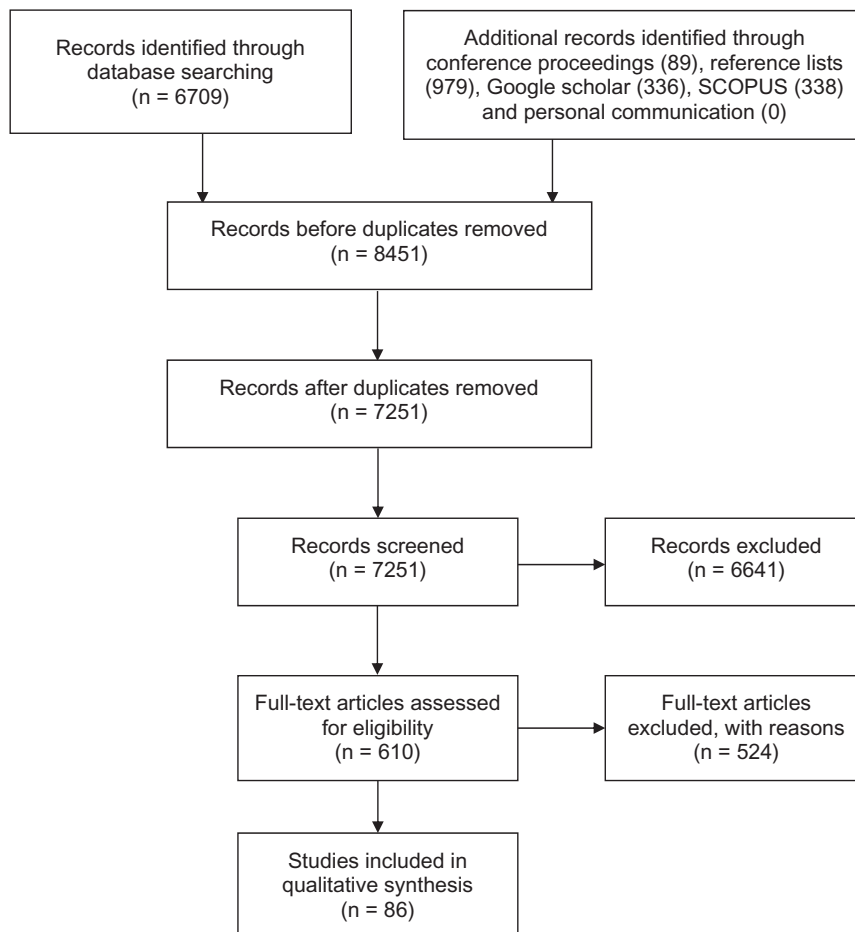
Figure 1. Flow diagram of included studies.

descriptive synthesis of the remaining studies was performed to identify key features.

Thirty-eight (44%) of all the included studies had independent comparators and thus were included in the focused qualitative analysis and are summarized in Supplementary Table 4. The following features were considered in this focused qualitative analysis: description of the interventions, dimensions of diversity, type of study designs, effect of the intervention on diversity, author's conclusions, and study limitations (Supplementary Table 4).

As there is a range of accepted outcomes as outlined in Table 1, we categorized outcomes with positive, negative, or neutral effects as described in each study. We did not feel it was appropriate to have preset criteria for effectiveness given the varied nature of the possible outcomes. We identified where studies reported statistical significance.

Results

Of the 7242 studies identified by the search process, 86 (1%) studies met the inclusion criteria. The study selection process is outlined in Figure 1.

Included studies are summarized in Supplementary Table 3 and a glossary of terms is available at the end of the article. Studies were published between 1972 and 2016 with 60 (70%) studies published since 2000. The majority of the studies (70 [81%]) were conducted in the United States, with the remainder performed in the United Kingdom (7 [8%]), Australia (2 [2%]), Canada (2 [2%]), South Africa (2 [2%]), Denmark (1 [1%]), Sweden (1 [1%]), and 1 (1%) multi-national study. There were 65 (76%) single-center studies

and 21 (24%) multi-center studies. Study designs included: 48 (56%) before–after studies, 10 (12%) retrospective cohort studies, 10 (12%) cross-sectional studies, 8 (9%) non-concurrent cohort studies, 4 (5%) prospective cohort studies, 3 (3%) mixed methods studies, 1 (1%) randomized controlled trial, 1 (1%) case-control study, and 1 (1%) interrupted time series.

Studies were categorized based on the authors' descriptions of the interventions, including 29 (34%) interventions in the admissions process, 16 (19%) enrichment programs, 13 (15%) outreach programs, 3 (3%) curriculum interventions, and 25 (29%) studies described as mixed interventions. The majority of the studies were conducted in medicine (39 [45%]) and dentistry (19 [22%]). Other health professions represented included pharmacy (4 [5%]), physical therapy (3 [3%]), nursing (3 [3%]), osteopathic medicine (2 [2%]), physician assistant (2 [2%]), clinical psychology (1 [1%]), dental hygiene (1 [1%]), social work (1 [1%]), and 11 (13%)) studies included mixed health professions.

Of these studies, 58 (67%) studies provided definitions for the term URM that considered the following dimensions: racial/ethnic background (51 [88%]), socioeconomic or educational disadvantage (1 [2%]), rural origins (1 [2%]) or a combination thereof (9 [16%]). The URM definition was explicitly stated in 21 (24%) studies and implied in 37 (43%) studies. Twenty-eight (33%) studies did not include a definition of the term URM. Seventy-eight (91%) studies included participants that were defined as racial/ethnic minorities (38 [44%]), socioeconomically or educationally disadvantaged (8 [9%]), or considered multiple dimensions of diversity (32 [37%]). The remaining studies used health

professions programs (4 [5%]), admissions committee members (2 [2%]), applications to health professions school (1 [1%]), and undergraduate institutions (1 [1%]) as participant groups. Fifty-four (63%) studies described participants' education level, including 18 (21%) studies with participants from an education level of high school or less, 11 (13%) studies included undergraduate students, 6 (7%) studies included post-baccalaureate students, 1 (1%) study with participants in the first year of medical school, and 19 (22%) studies included students from a combination of education levels. Participants' education level was not described in 32 (37%) studies.

Thirty-eight (44%) studies used an independent comparison group in their analyses, including 18 studies in the admissions group, 10 studies in the enrichment group, 3 studies in the outreach group, 3 studies in the curriculum group, and 4 mixed interventions. Of these, 2 (3%) studies (Helm et al. 2003; Vela et al. 2010) used a non-URM comparison group, 8 (9%) studies used a hypothetical class derived from admissions data (Mitchell et al. 1988; Cornely et al. 1998; Edwards et al. 1999; Raghavan et al. 2011; Reiter et al. 2012; Ballejos et al. 2015; Lievens et al. 2016) and 28 (33%) studies used a comparison group that was not exposed to the intervention. Of the 48 (56%) remaining studies, 4 (5%) made comparisons to national statistics (Carmichael et al. 1988; Bediako et al. 1996; Cantor et al. 1998; Watson et al. 2005; Larkins et al. 2015), and 44 (51%) used pre–post comparisons.

Several primary outcomes were reported including: application, acceptance/admission, or matriculation/enrollment rates (42 [49%]), breakdown of the diversity of applicants, accepted students or matriculants (14 [16%]), interest in health professions (10 [12%]), academic performance (6 [7%]), knowledge of health professions (4 [5%]), probability of acceptance (3 [3%]), knowledge of how to review students' applications (2 [2%]), application scores (1 [1%]), effectiveness of recruitment strategies (1 [1%]), employment in health professions (1 [1%]), presence of a preadmissions program (1 [1%]), and combined short-, mid-, and long-term outcomes (1 [1%]). Seventy (81%) studies reported positive effects of the intervention; 4 (5%) studies reported negative effects; (Lumb and Vail 2000; Cliffordson and Askling 2006; Andersen, Davidson et al. 2009; Hewlett, Andersen, Atchison, Bird 2009) and 12 (14%) studies described neutral effects (Yens 1986; DeBoer and Nyssen 1994; Strayhorn 1999; Strayhorn and Demby 1999; Turnbull et al. 2003; Crall, Friedman et al. 2009; Hewlett, Andersen, Atchison, Strauss 2009; Rashied-Henry et al. 2012; Reiter et al. 2012; O'Neill et al. 2013; Mathers et al. 2016). Forty-seven (55%) studies reported the statistical significance of their primary outcome, with 35 (41%) studies reporting statistically significant positive results, 1 (1%) study reporting statistically significant negative results, 8 (9%) studies reporting no statistically significant difference in their comparisons, and 3 (3%) studies reporting mixed results. Of the studies, 30 (79%) included in the focused qualitative analysis reported the statistical significance of their results.

Admissions

Of the 29 studies, 18 (62%) evaluating interventions within the admissions process were included in the focused

qualitative analysis (Supplementary Table 4). Interventions included points systems, altered weighting of existing admissions criteria, holistic admissions processes, the use of a standardized test, a graduate entry program, and application assistance. Seven (39%) of these studies (Cummings 1999; Kamali et al. 2005; Davidson, Andersen et al. 2009; Puddey et al. 2011; Tiffin et al. 2012; O'Neill et al. 2013; Larkins et al. 2015) reported on the statistical significance of their results.

Non-concurrent cohort (Puddey et al. 2011; Felix et al. 2012), retrospective cohort (Colborn et al. 1995; Davidson, Thind et al. 2009) before–after (Cornely et al. 1998; Raghavan et al. 2011), and cross-sectional (Cummings 1999; Larkins et al. 2015) studies were used to assess the effect of awarding points to URM students in the admission process. Dimensions of diversity considered in these studies included racial/ethnic minorities, gender, rural origin, age, SES, and military experience. All eight of these studies found that URM admission or enrollment increased and in fact, several authors concluded that URM enrollment would have decreased if points were not allocated for URM status. Noted limitations included limited generalizability (Cornely et al. 1998; Cummings 1999; Felix et al. 2012), missing data (Cummings 1999; Puddey et al. 2011), restricted URM definition (Davidson, Andersen, et al. 2009), lack of good quality comparison data (Larkins et al. 2015), and retrospective application of SES status back to 1985 based on 2010 postal code scoring data (Puddey et al. 2011).

Edwards et al. (1999), Mitchell et al. (1988) and Reiter et al. (2012) used before–after designs with hypothetical comparators to evaluate altered weighting of academic performance and either interview scores or nonacademic attributes on the enrollment of URM students, defined by race/ethnicity, gender, age, rural origin, or SES. Edwards and Mitchell reported a small increase in URM acceptance or enrollment while Reiter reported a neutral effect on the diversity of accepted students. All three authors concluded that their intervention was not sufficient to have a significant effect on diversity. Reiter described limitations including the data on race/ethnicity being limited to self-reported Aboriginal status, determination of SES using postal codes, and only being able to use data from one school for their analyses.

Others used non-concurrent cohort (Puddey et al. 2011; Felix et al. 2012), retrospective cohort (O'Neill et al. 2013), before–after (Helm et al. 2003), and cross-sectional design (Larkins et al. 2015; Mitchell et al. 1988) to assess multidimensional interventions on the admission process that resulted in a more holistic evaluation of the candidates' applications, with greater consideration of nonacademic components and personal attributes of URM students. Dimensions of diversity considered included race/ethnicity, gender, age, SES, educational disadvantage, rural origin, or work experience. Five of the six studies (Mitchell et al. 1988; Helm et al. 2003; Puddey et al. 2011; Felix et al. 2012; Larkins et al. 2015) reported increased diversity and one (O'Neill et al. 2013) reported a neutral effect. Two (Puddey et al. 2011; O'Neill et al. 2013) studies concluded that their interventions were insufficient to achieve their diversity goals. Helm et al. (2003) found that non-URM students had stronger academic performance and that URM and non-URM students had similar performance on nonacademic admissions criteria and in contrast concluded that

nonacademic criteria could be used to assess applicants more equitably. The limitations described by the authors included limited generalizability (Felix et al. 2012; O'Neill et al. 2013), missing data, lack of good quality comparison data (Larkins et al. 2015), and retrospectively determined SES (Puddey et al. 2011).

Cliffordson and Askling (2006), Tiffin et al. (2012), and Turnbull et al. (2003) used cohort studies to compare diversity outcomes (SES, age, race/ethnicity, gender, educational disadvantage, English as a second language (ELS), and/or rural origin) based on different uses of standardized tests. All three studies reported mixed results. Cliffordson reported greater diversity of accepted students with admissions based on grades, Turnbull reported a neutral effect on enrollment of students with low SES or rural origins, and Tiffin reported increased probability of acceptance to medical school with use of the UK Clinical Aptitude Test (UKCAT) (2017), especially when a threshold score was used to determine interview offers. Limitations noted included missing data (Cliffordson and Askling 2006; Tiffin et al. 2012), few applicants from low SES backgrounds (Tiffin et al. 2012), potential bias whereby schools who used a standardized test may have had a greater focus on diversity (Tiffin et al. 2012), and the use of statistical models that simplify the admissions process (Tiffin et al. 2012).

James et al. (2008) used a non-concurrent cohort study to compare a four-year graduate entry medicine program with the standard European five-year program with entry out of high school. The study found increased gender and socioeconomic diversity with the four-year program, but there were few applicants from racial/ethnic minorities. It was concluded that the intervention improved academic, socioeconomic, and gender diversity with limited impact on racial/ethnic diversity. Study limitations included missing data and the determination of SES using the postal code of the parental home.

Kamali et al. (2005) used a non-concurrent cohort study to compare students who received advice and assistance in organizing extra-curricular activities with students who only received advice. Both groups received assistance throughout the application process including information on the application process, advice on content of their personal statements, and interview preparation, including mock interviews. Both groups had increased acceptance rates following the intervention, with a greater increase in the group that received advice and assistance. Limitations included small sample size, the assumption of low SES based on school location and potentially limited generalizability.

Eleven studies not included in the focused qualitative analysis used pre–post intervention comparisons or used national statistics as a comparator. Fenton et al. (2016) and Shanks (2003) reported positive results of points-based interventions. Shanks (2003) implemented an affirmative action program and supported use of affirmative action to increase diversity in health professions programs. Fenton et al. (2016) found that adjusting the GPA and Medical College Admission Test (MCAT) scores of students from socioeconomically disadvantaged communities reduced the disparity that socioeconomically disadvantaged and ethnic minority applicants face in the admissions process. Ballejos et al. (2015) and Terregino et al. (2015) reported increased URM enrollment when the weighting of nonacademic

admissions criteria was increased relative to academic criteria. Lievens et al. (2016) and Mathers et al. (2016) evaluated interventions involving standardized tests. Lievens et al. (2016) found that complementing cognitive tests with a situational judgment test may increase the acceptance of female students and students from lower socioeconomic groups. Mathers et al. (2016) expanded on the work of Tiffin et al. (2012) and found that the use of a threshold UKCAT score reduced the advantage of being female but had a neutral effect on the acceptance of students from ethnic minority and low socioeconomic groups. Scott and Zerwic (2015) reported increased acceptance and matriculation of URM students following implementation of a holistic admissions process, including an interview, which considered applicants' experiences, attributes, and academic performance. Lumb and Vail (2000) found the deletion of all references to applicants' names and ethnicity in medical school applications to be time-consuming and ineffective as there was no difference between scores of blinded and non-blinded applications. Price, Crout, et al. (2008) and Price, Wells, et al. (2011) found that education of admission committee members to effectively assess URM applicants led to increased knowledge of how to assess URM applicants' files and increased URM acceptance rates. Watson et al. (2005) assessed cadet programs to provide students that did not meet admission criteria with supervised work experience with a goal of increasing the likelihood of gaining admission to nursing school, and found greater diversity amongst those who completed the cadet program than the general student nurse population.

Enrichment programs

Ten (63%) of the 16 studies evaluating the effect of enrichment programs used an independent comparator group to describe three categories of interventions: summer programs, post-baccalaureate programs, and pre-admissions programs (Supplementary Table 4). One study (Moreland 1981) did not include the statistical significance of its results.

Hall and Allard (2009), Jackson (1972), Moreland (1981), Philips et al. (1981), and Russell (1988) used a variety of study designs to compare the application and admission rates to health professions programs by racial/ethnic minorities or low SES participants in summer enrichment programs with non-participants. Four of the five studies reported an increase in the application or admission rate of participants and supported the use of multifaceted summer enrichment programs to increase the diversity of health professions students. Limitations included small sample size (Hall), limited generalizability (Hall), difficulty comparing the outcome between groups (Moreland), and limitations of the data provided by the source (Russell).

Giordani et al. (2001), Grumbach and Chen (2006), and Stagar (1998) used retrospective and case-control studies to evaluate 1-year post-baccalaureate programs for racial/ethnic minority and socioeconomically disadvantaged students who had previously failed to gain admission to medical school. Giordani and Stagar found that post-baccalaureate program students had comparable academic performance to their classmates in medical school despite having lower grade point averages (GPAs) and MCAT scores at admission

and Grumbach found that these students had a higher probability of matriculation than applicants who applied but did not participate in these programs. All three studies recommended post-baccalaureate programs as a means to increase diversity. Limitations included small sample size (Stagar 1998; Giordani et al. 2001), limited generalizability (Stagar 1998; Grumbach and Chen 2006), a narrow definition of a successful outcome (Grumbach and Chen 2006), lack of systematic outcome measurement (Grumbach and Chen 2006), and possible confounding variables (Grumbach and Chen 2006).

Strayhorn (1999) and Strayhorn and Demby (1999) used two cross-sectional studies to assess the effect of preadmissions programs at Liaison Committee on Medical Education (LCME) accredited medical schools on URM enrollment. Medical schools with a positive percent change in URM enrollment during the study period were more likely to have a preadmissions program. Similarly, medical schools with higher URM enrollment were also more likely to have a pre-admission program. Limitations of these studies included inability to determine cause and effect of the intervention due to the cross-sectional study design, use of programs as the unit of analysis, and possible differences between programs and their published descriptions.

Six studies not included in the focused qualitative analysis described academic enrichment programs (Bediako et al. 1996; Cantor et al. 1998; Markel et al. 2008) or post-baccalaureate programs (Lipscomb et al. 1993; Judd et al. 2007; Wides et al. 2013) and reported positive effects on the targeted dimensions of diversity. URM students had improved academic performance after completion of a six-week academic enrichment program (Cantor et al. 1998; Markel et al. 2008) or a post-baccalaureate program (Lipscomb et al. 1993). Wides et al. (2013) reported improved Dental Aptitude Test (DAT) scores as a short-term outcome of a post-baccalaureate program and provided non-comparative data describing the acceptance and graduation rates of participants from their dental school. Bediako et al. (1996) and Judd et al. (2007) reported increased application and/or acceptance rates following an academic enrichment (Bediako et al. 1996) or post-baccalaureate program (Judd et al. 2007).

Outreach programs

Three (23%) of the 13 studies assessing outreach programs were included in the focused qualitative analysis and described interventions such as targeted recruitment strategies and experiential programs (Supplementary Table 4). All three studies included the statistical significance of their results.

Yens (1986) considered ethnic and gender diversity as well as non-science majors and used a prospective cohort study to compare the effect of a targeted recruitment strategy. The recruitment effort did not affect URM application rates in the short-term and authors concluded that a longer, more intensive intervention may be needed to see effect.

Vergano and Lee (2013) used a retrospective cohort study with a post-intervention survey and Walker (1988) used a before–after study to assess experiential programs aimed at ethnic minorities and low SES students to expose

grade eight (Vergano and Lee 2013) or undergraduate students (Walker 1988) to the health professions. The programs featured "observerships" with a preceptor, discussions of HPE, interactions with health professions students, a career panel, and research experience. Both studies yielded positive results, with Walker finding a significant increase in knowledge of health professions careers and Vergano reporting a significant increase in interest in medicine. Both studies supported the use of multi-faceted experiential programs and Vergano suggested that collaboration between health professions schools and community organizations can increase interest in health professions. Vergano reported the nonrandomized design and outcome assessment based on participants' intentions to pursue a medical degree as limitations.

Ten studies not included in the focused qualitative analysis that reported on outreach programs targeted at URM middle or high school students described interventions ranging from 3 d to five years, with six interventions lasting one year or less, and most studies having short follow-up periods, ranging from no follow-up period (Thomson et al. 1992; Fleming et al. 2005; Wadenya and Lopez 2008; Nair et al. 2011; Butler et al. 2013; Katz et al. 2016) to one year (Pollard et al. 2010). Patel et al. (2015) performed a follow-up survey between two and three years after completion of the mentorship program and found that the 12 (75%) respondents were attending college and university and planning to pursue careers in the health professions. The interventions included summer programs or camps (Sherrod 1995; Thomson et al. 2003; Pollard et al. 2010; Butler et al. 2013; Katz et al. 2016) and other experiential programs or internships that provided exposure and opportunities to learn about health professions careers (Wadenya and Lopez 2008; Nair et al. 2011; Rashied-Henry et al. 2012). All of these studies reported that students had increased knowledge of, or interest in, a health professions career. Wadenya and Lopez (2008) encouraged involvement of parents and families and found that students in pre-dental or dental programs had a 96% rate of parental participation, compared to 44% parental participation for students who enrolled in other post-secondary or vocational training programs. Further, 100% of students in pre-dental or dental programs discussed their careers and education with their parents compared with 51% of students enrolled in other programs.

HPE curriculum components

All three studies evaluating curriculum changes aimed at attracting URM students were included in the qualitative synthesis and reported the statistical significance of their results (Supplementary Table 4). Bailey and Willies-Jacobo (2012) and Bailey (2013) evaluated a combined Doctor of Medicine/Master of Science (MD-MSc) program designed to train medical students to work in underserved communities and Vela et al. (2010) assessed the effect of a mandatory health disparities course in the first year of medical school. All three studies considered ethnic minorities. Bailey and Willies-Jacobo (2012) also considered SES, gender and educational, or cultural disadvantage. Bailey (2013) used an interrupted time series, Bailey and Willies-Jacobo (2012) a cross-sectional study to assess application and matriculation

rates of URM students, and Vela et al. (2010) a retrospective cohort design to compare URM enrollment to that of non-URM students. Bailey and Willies-Jacobo (2012) found that a greater proportion of URM and disadvantaged students applied to the MD-MSc program as compared to non-URM students and that there was a significant increase in the number of URM students matriculating but no significant change in application rates over a period of five-years. These studies concluded that URM students have greater interest in a program that addresses health disparities or includes training to work in underserved communities and that such programs can change application and matriculation rates of URM students. Limitations of these studies included small sample size (Bailey and Willies-Jacobo 2012; Bailey 2013) and possible confounding by simultaneous initiatives targeted at URM students (Vela et al. 2010).

Mixed interventions

Four (16%) of the 25 studies assessing mixed interventions were included in the focused qualitative analysis and included the statistical significance of their results (Supplementary Table 4). DeBoer and Nyssen (1994) and Haskins and Rose-St. Prix (1994) performed cross-sectional studies using a validated survey of physical therapy programs to identify interventions that increase diversity. DeBoer and Nyssen found no difference between programs with URM recruitment efforts and those without and that despite reviewing over 30 variables, only the use of athletic programs and alumni in the recruitment process were associated with increased URM enrollment. Haskins and Rose-St. Prix found the inclusion of parent groups, communication with minority students, assistance with admissions applications, flexible admissions processes, pre-professional enrichment programs, setting targets for URM enrollment, dissemination of financial aid information, and external funding to be positively associated with URM enrollment. Fritz et al. (2016) used a controlled before–after study to compare URM undergraduate students who participated in a pipeline program that focused on socialization, science study skills, financial literacy, mentorship, and resiliency training with students participating in an existing research focused premedical pipeline program. Upon completion of the pipeline program, the study participants had greater interest in a career in medicine and higher personal statement scores than participants in the research program. Thomson used a retrospective cohort study to compare URM students who applied for and matriculated into a combined BSc-MD program with interviewees who did not join the program. The program offered conditional acceptance to medical school and offered enrichment and support to students from ethnic minorities, medically underserved areas or a low SES background. The program was found to increase the odds of matriculation 7-fold and increased access to medical school for URM students. Stated limitations included the use of program-level data (DeBoer and Nyssen 1994; Haskins and Rose-St. Prix 1994), small sample size (Fritz et al. 2016; Haskins and Rose-St. Prix 1994), selection bias (Haskins and Rose-St. Prix 1994), and the lack of long-term follow-up (Thomson et al. 2003).

The majority of the mixed interventions that were not included in the focused qualitative analysis used pre–post analyses that evaluated multi-faceted interventions targeting more than one stage of the health professions "pipeline." Of the studies, 14 reported on the implementation of programs developed at dental schools in California as a component of the "Pipeline, Profession and Practice: Community-Based Dental Education" program. Different interventions were used at each site and included revised admissions processes, summer enrichment programs, standardized test preparation, post-baccalaureate programs, pre-matriculation programs, targeted recruitment, mentoring or academic advising, outreach programs involving middle school, high school and/or undergraduate students, career fairs, and financial aid. Ten (71%) of these studies reported positive results, two (14%) reported negative results, and two (14%) reported neutral effects on URM application and enrollment rates. Overall, URM applications increased by 77% and URM enrollment increased by 27% across the 14 sites, despite a decline in URM enrollment during the last year of the program (Andersen, Atchison, et al. 2009). This was reflected as an increase in the proportion of URM students from 14.9% in 2003 to 19.6% in 2006 and 18.4% in 2007 (Andersen, Atchison, et al. 2009).

Quality assessment/risk of bias

Two groups of studies in particular had significant potential sources of bias: before–after studies describing outreach studies (Walker 1988; Sherrod 1995; Thomson et al. 2003; Fleming et al. 2005; Wadenya and Lopez 2008; Pollard et al. 2010; Nair et al. 2011, 2011; Rashied-Henry et al. 2012; Butler et al. 2013; Patel et al. 2015; Katz et al. 2016) and the before–after studies describing mixed interventions (Armendariz 1973; Taylor et al. 1990; Andersen, Davidson et al. 2009; Atchison, Hewlett et al. 2009; Atchison, Friedman et al. 2009; Crall, Friedman et al. 2009; Crall, Hewlett et al. 2009; Davidson, Thind et al. 2009; Davidson, Andersen et al. 2009; Friedman, Hewlett et al. 2009; Friedman, Thind et al. 2009; Gift et al. 2009; Hewlett, Andersen, Atchison, Bird 2009; Hewlett, Andersen, Atchison, Strauss 2009; Thind, Hewlett et al. 2009; Thind, Andersen et al. 2009; White et al. 2013; Mains et al. 2016). All 11 outreach studies that used a before–after design had potential selection bias of the pre and post-intervention groups; ten of these (91%) (Walker 1988; Thomson et al. 2003; Wadenya and Lopez 2008; Pollard et al. 2010; Nair et al. 2011; Rashied-Henry et al. 2012; Butler et al. 2013; Patel et al. 2015; Katz et al. 2016) did not describe the validity of the outcome assessment; all 11 studies (100%) did not describe the reliability of the outcome data. All of the 19 before–after studies describing mixed interventions had significant potential sources of bias. Of these studies 18 (95%) did not describe the derivation of the pre and post-intervention samples, all 19 (100%) did not control for differences between groups or describe the reliability of outcome data, and 15 (79%) did not clearly define the time point when the intervention occurred.

Other sources of bias noted across all included studies were: failure to control for differences between groups (20 [69%] studies in the admissions group, 11 [69%] studies in the enrichment group, 1 [9%] study in the outreach group,

2 [67%] in the curriculum group, and 21 [84%] in the mixed interventions group), potential selection bias (5 [17%] in the admissions group, 5 [40%] in the enrichment group, and 12 [92%] in the outreach group), no or poor description of the validity of outcome data (4 [14%] of the admissions group) and no description of the reliability of outcome data (13 [(45%] studies in the admission group, and 4 [25%] before–after studies in the enrichment group).

Discussion

Summary of key study features

This review included 86 studies of recruitment and admission interventions aimed at increasing diversity of URM students in HPE. These studies represent a heterogeneous group of interventions and outcomes. This heterogeneity most likely resulted from regional variations in the characteristics and needs of health professions training programs. The wide-range of interventions, study types, and outcomes precluded meta-analysis and made it more difficult to determine types, or even features, of interventions that were clearly superior. We, therefore, included 38 (44%) studies with an independent comparator in a more detailed focused qualitative analysis. All intervention types were represented amongst this subgroup of studies making it possible to conduct a deeper qualitative analysis and draw inferences regarding key features that may affect diversity within HPE.

The included studies in our review were mostly single-center studies (76%) that were published in or after the year 2000 (70%) and were conducted in the United States (81%) within either medicine (45%) or dentistry (22%). This is despite the fact that our search strategy was rigorous and inclusive. The volume and strength of evidence in our review were most abundant for interventions targeting the admissions process, which comprised 34% of all included studies and 47% of studies considered in the focused qualitative analysis. In keeping with this, the most common outcomes measured amongst all studies were application, acceptance or matriculation rates (42 (49%)) of URM students. Importantly, the definition of URM was explicitly stated in only 27 (31%) of included studies. Further dimensions of diversity considered remained relatively restricted, with the greatest number of studies reporting ethnicity/race (44%) and few reporting SES, educational disadvantage, or rural background. The majority of studies 70 (81%) found a positive effect of the intervention on the intended diversity outcome, with only 12 (14%) showing neutral and 4 (5%) showing negative results.

Implications for policy development

The majority of the studies included in this systematic review described a positive effect on dimensions of diversity. This suggests that an intervention, whether related to admissions processes, enrichment programs, curricular components, outreach, or a combination thereof, likely resulted in a positive effect on diversity compared to no intervention at all or status quo. However, as each intervention type targeted a different aspect of recruitment and admission, a combination of interventions may be necessary to impart the critical mass, and social networks of desired dimensions of diversity within HPE. Thus, it may be more important for policy developers to focus on including at least one or more intervention type that has been shown to be effective rather than focusing on a single "most effective" intervention. This aligns with the pipeline approach to help URM students overcome barriers they typically face when attempting to pursue careers in the health professions and encompasses many intervention types within one program.

A multi-faceted approach may also serve to address authors' concerns that interventions have increased the competitiveness of URM candidates but have not necessarily led to an increase in the URM applicant pool. Thus greater focus and resources are needed to expand the applicant pool further upstream from the admission process itself. This would allow for both short-term (increased admission of URM students to HPE programs) and longer-term (more diverse health professions work force) URM recruitment goals to be achieved. Achievement of these goals will require the development of partnerships between all stakeholders including community organizations, the education system (primary, secondary and post-secondary), youth, their parents, the health services system, and HPE programs. Obviously integral to this solution is the need for collaboration and commitment from both the majority and minority populations to meet the health care needs of the entire population. This type of inclusiveness is the first step to promoting discourse around the underlying power and privilege discrepancies.

Key features of the results that support policy development

Overall, evidence is most abundant for interventions targeting the admissions process with 18 out of 29 (62%) admission process studies meeting our criteria for focused analysis. These interventions include the following key features: points systems altered weighting of existing admissions criteria, holistic admissions processes, the use of standardized tests, graduate entry programs, and application assistance. Points systems appeared to have the greatest effect on the intended dimensions of diversity though these studies were not designed for head-to-head comparison. All eight studies (Colborn et al. 1995; Cornely et al. 1998; Cummings 1999; Davidson, Thind et al. 2009; Puddey et al. 2011; Raghavan et al. 2011; Felix et al. 2012; Larkins et al. 2015) in the qualitative synthesis noted a positive effect, with six studies (Colborn et al. 1995; Cornely et al. 1998; Puddey et al. 2011; Raghavan et al. 2011; Felix et al. 2012; Larkins et al. 2015) showing increased enrollment/matriculation, and three studies (Cummings 1999; Davidson, Thind et al. 2009; Felix et al. 2012) showing increases in acceptance/admission rates. Several authors concluded that diversity goals would not have been achieved without awarding points for URM status (Cornely et al. 1998; Cummings 1999; Raghavan et al. 2011). Altered weighting between academic performance and nonacademic attributes and/or interview scores, holistic admissions processes, and the use of standardized admissions tests resulted in a mix of positive (Mitchell et al. 1988; Edwards et al. 1999; Helm et al. 2003; Puddey et al. 2011; Felix et al. 2012; Tiffin et al. 2012; Larkins et al. 2015), neutral (Turnbull

et al. 2003; Reiter et al. 2012; O'Neill et al. 2013) and negative (Cliffordson and Askling 2006) effects, suggesting that these interventions alone may not be able to significantly affect diversity. Lastly, graduate entry programs (James et al. 2008) and application assistance (Kamali et al. 2005) interventions had a promising effect on diversity, however, the strength of these findings was limited by the small number of included studies in these categories.

Ten out of 16 (63%) enrichment program studies met criteria for focused analysis. These interventions varied in length and format, but were all focused on both increasing candidates' likelihood of achieving admission and of performing successfully within an HPE program. Outcomes included academic performance (Moreland 1981; Giordani et al. 2001), application/admission rates (Jackson 1972; Russell 1988; Hall and Allard 2009), and enrollment/matriculation rates (Moreland 1981; Grumbach and Chen 2006). Key features of these programs included: academic preparation (e.g. study skills or time management) and performance (e.g. basic sciences course work) combined with exposure to some of the following opportunities: clinical or research experience, mentoring, HPE application assistance, and/or standardized test preparation. Nine of the 10 studies (90%) with independent comparators (Jackson 1972; Moreland 1981; Philips et al. 1981; Stagar 1998; Strayhorn 1999; Strayhorn and Demby 1999; Giordani et al. 2001; Grumbach and Chen 2006; Hall and Allard 2009) and all six of the remaining studies (Lipscomb et al. 1993; Bediako et al. 1996; Cantor et al. 1998; Judd et al. 2007; Markel et al. 2008; Wides et al. 2013) found a positive effect on intended diversity outcomes from this approach. Russell (1988) is the only outlier within this group of interventions and this study was included in the focused qualitative analysis. While Russell did not find a difference in admission rates to medical school of participants vs. non-participants of the pre-medical summer enrichment program, the authors concluded that the program should continue regardless with better tracking of participants to determine if they were admitted to other HPE programs. Enrichment programs address educational disadvantage to a greater extent than interventions focused on admissions processes alone, suggesting that they may have a greater effect on fostering the critical mass required for more longstanding change in programs.

The remainder of the interventions described in this review is limited in their contribution due to either insufficient number of studies (HPE curricular component interventions), quality of studies (outreach interventions), or a combination thereof (mixed interventions). Policy makers may wish to advocate for further evaluative studies in these areas.

HPE curricular components targeting URM students is a promising intervention type with all three studies (Vela et al. 2010; Bailey and Willies-Jacobo 2012; Bailey 2013) included in the focused qualitative analysis. Key features of these curricula included training in health disparities (Vela et al. 2010) and preparation for working within underserved communities (Bailey and Willies-Jacobo 2012; Bailey 2013). Authors concluded that these curricular features contributed to increased application and enrollment/matriculation of URM students in their respective studies. HPE curriculum interventions may serve to increase the proportion of accepted URM applicants deciding to enroll/matriculate. It is possible that curricular interventions may influence the school that URM students choose to attend rather than increasing the number of URM students applying to HPE programs. In fact, according to the 2012 AAMC matriculating students questionnaire, curricula ranked amongst the top five factors in choosing a medical school, and URM students in particular valued programs geared toward minority or disadvantaged students (Zhang et al. 2015).

Outreach programs primarily used targeted recruitment or experiential programs for URM youth or undergraduate students to promote interest in pursuing an HPE program. The key features of outreach interventions were multifaceted experiential programs (e.g. observership, discussion about HPE, interaction with HPE students, research experience, and career panel) combined with participation from HPE programs and community organizations. These appear promising in that two out of three (67%) of the studies with independent comparators (Walker 1988; Vergano and Lee 2013) found positive effects on URM students with increased knowledge, interest or applications to HPE programs. However, these studies were subject to several biases as described in the results.

Mixed interventions may also be of interest to policy makers. These include a combination of features of other intervention types, such as enrichment programs, outreach programs, assistance with admission applications, flexible admissions criteria, and financial aid. While this category may be attractive in that these programs address multiple key steps leading up to URM enrollment/matriculation and thus may lead to long-term effects, their evaluations are limited. However, widespread evaluation of this intervention type is complex and only four studies (DeBoer and Nyssen 1994; Haskins and Rose-St. Prix 1994; Thomson et al. 2003; Fritz et al. 2016) were able to conduct evaluations with independent comparator groups. Further, it is very difficult for the authors of these studies to determine the effect of individual components of these programs. On the other hand, it might be argued that it does not necessarily matter whether we know exactly which parts are working if they are able to demonstrate sustained change. Two (DeBoer and Nyssen 1994; Haskins and Rose-St. Prix 1994) out of the four studies with independent comparators concluded that their current URM recruitment efforts may not be adequate. Yet, Thomson et al. (2003) found a positive effect with a seven-fold increase in the matriculation rates of URM students who completed a combined BSc-MD program. This intervention included a holistic admissions process with conditional acceptance to a MD program if the enrichment program including experiential components were completed and academic standards were achieved. Fritz et al. (2016) also reported positive results with URM participants in a pipeline program that targeted barriers faced by URM students, including a lack of empowerment, academic success in pre-requisite courses, and financial need, reporting greater interest in a career in medicine than participants in a research-based pipeline program.

While not included in the focused qualitative analysis of studies with independent comparator groups, it is important to highlight the 14 studies from the mixed intervention "Pipeline, Profession and Practice: Community-Based Dental Education" program considering the very broad implementation of this program and the extensive work toward

program evaluation. These studies included revised admissions processes, summer enrichment programs, standardized test preparation, post-baccalaureate programs, prematriculation programs, targeted recruitment, mentoring or academic advising, outreach programs involving middle school, high school and/or undergraduate students, career fairs, and/or financial aid. While URM enrollment rates fluctuated across the five years of the intervention and varied between dental schools, comparison of pipeline to non-pipeline program schools indicated pipeline schools had a greater increase in odds (OR = 1.81) that an incoming student would be from an URM background. Cited barriers to URM enrollment included lack of financial resources, school location, lack of staff, lack of a sufficient pool of qualified URM applicants, lack of sufficient role models in applicants' early years, a school's reputation of being unwelcoming to minorities, and sustainability of the program. Factors impacting sustainability included faculty and administrator buy-in, financial resources, and availability of a qualified applicant pool.

Understanding neutral and negative studies

Although the majority of included studies described positive outcomes, it is important to consider those that either described negative or neutral findings as they may present valuable insights. Four studies described negative outcomes including two admissions interventions (Lumb and Vail 2000; Cliffordson and Askling 2006) and two mixed intervention studies (Andersen, Davidson et al. 2009; Hewlett, Andersen, Atchison, Bird 2009). Lumb and Vail (2000) simply concluded that their intervention of anonymizing shortlisted applicants (removal of names and nationality) was ineffective. Andersen, Atchison, et al. (2009), Andersen, Davidson, et al. (2009), and Hewlett, Andersen, Atchison, Bird (2009) used mixed interventions in the dental pipeline program and evaluated the effect on both ethnicity/race and SES. Interestingly, these authors both concluded that their interventions resulted in increased application but not in increased enrollment in the final year of their respective four-year studies. The authors suggested several possible reasons for this including: that individual URM students were applying to more schools but there was no increase in the total number of URM students in this applicant pool, the possibility that the applicant pool was larger but less qualified and so less likely to achieve admission and the possibility that limited programmatic resources remained in the last year of the study. Thus, they concluded that greater emphasis on generating and expanding a more qualified URM applicant pool was required. Three of the four neutral studies addressing the admission process (Turnbull et al. 2003; Reiter et al. 2012; O'Neill et al. 2013) also concluded that an increased number of qualified applicants was required to increase targeted diversity dimensions.

Three enrichment intervention studies (Russell 1988; Strayhorn 1999; Strayhorn and Demby 1999) reported neutral outcomes. Russell (1988) has been discussed above. Strayhorn (1999) and Strayhorn and Demby (1999) examined the effect of preadmissions programs and found that schools with a positive increase in first year URM enrollment were significantly more likely to have a preadmissions

program. However, there was no association between total URM enrollment in all four years of the study and the presence of a preadmissions program. Despite this, both studies concluded that preadmissions programs were useful in promoting URM enrollment. Two studies (Yens 1986; Rashied-Henry et al. 2012) described outreach interventions with neutral results and concluded that the follow-up period may not have been long enough to observe the desired change. Finally, three studies (DeBoer and Nyssen 1994; Crall, Friedman et al. 2009; Hewlett, Andersen, Atchison, Strauss 2009) described mixed interventions. Interestingly, two of these studies (Crall, Friedman et al. 2009; Hewlett, Andersen, Atchison, Strauss 2009) were dental pipeline studies that noted URM enrollment fluctuations throughout the four years of the program. Cited challenges included difficulty establishing a solid peer group due to lack of a critical mass of URM students, school location being far from many of the recruits' homes, increased competition for positions in dental school, lack of awareness among applicants of schools interested in URM enrollment, high tuition costs, and inability to offer full scholarships.

Results in context of emerging trends and literature

In order to address increasing population diversity and equitable representation of all demographic groups within the health professions workforce, HPE training programs have called for greater social accountability in this regard. To this end, administrators of HPE training programs have placed considerable effort into developing a critical mass of diverse student bodies within HPE programs. Nonetheless, recent trends in health professions demographics compared with population demographics suggest that these efforts and initiatives are not keeping pace with growth rates (AHRQ 2012; Cleland et al. 2012). In our review, two studies were identified in the South African context that offered a unique perspective. While these studies aligned with our definition of URM, namely populations that are under-represented in the health professions relative to their numbers in the general population, they highlight a context where the URM population being targeted is actually the majority population. One of these studies emphasized the need for a holistic approach across the continuum from recruitment, admission all the way to the structure of the undergraduate medical program, and its influence of successful completion (Colborn et al. 1995). Further, in the UK there has been considerable effort to widen access to HPE programs including such interventions as aptitude tests, situational judgment tests, personality assessments, and multiple mini-interviews. However, despite these efforts, Mathers et al. (2016) found that over the period 1996–2012, persistent advantages existed for certain demographic groups and the likelihood of acceptance into medical school remained highest among white applicants from grammar or independent schools. Females were more likely to gain acceptance only up until the year 2007 after which male acceptance became more common. Further, Steven et al. (2016) conducted a retrospective review of acceptance data in the UK from 2009 to 2012 and found a marked social gradient with overrepresentation of higher SES students and higher rates of application/acceptance of these students to medical schools. Authors concluded that

modifying the admission processes is unlikely to have a major effect on increasing socioeconomic diversity because so few students from low SES backgrounds apply in the first place. Therefore, more attention needs to be placed in supporting the process of applicants "getting ready" (recruitment; considering a health professions career, and preparing to apply) as well as "getting in" (application and admission; what happens during admission from those who apply). However, there was significant variation between medical schools with respect to markers of SES and application and acceptance rates, suggesting that adapting effective strategies for improving diversity is possible.

There has been ongoing development in the area of structural constraints in diversity growth, such as non-inclusive admission practices that focus primarily on academic performance including GPA and/or standardized tests. Much of the concern regarding shifting away from these traditional admission criteria has been related to stakeholder acceptability of diversity initiatives and the belief that this may lead to "lowering" admission standards and the subsequent performance of individuals admitted on nontraditional criteria once enrolled into an HPE program. Cleland et al. (2015) explored enactment of the widening access policy in the United Kingdom in a qualitative study including administrative representatives from 24 (out of 32) medical schools. The authors found differences amongst schools in terms of their commitment in applying the widening access policy to some extent due to fear that students would do poorly and threaten the reputation and/or funding of the school. Heller et al. (2014) further assessed diversity (related to race/ethnicity) in the United States between 2005 and 2009 in 124 accredited MD programs. Over this time period GPA and MCAT scores increased while URM enrollment decreased. This finding underscores that efforts to increase a diverse HPE student body may be compromised by the desire to maintain high academic ranking (which focuses on GPA and MCAT scores). The authors argue that the ranking of HPE programs, including medical schools, should take into account diversity scores to counterbalance this concern.

Although not within the scope of this review, there has also been growth in the evidence that academic performance of students admitted to HPE programs using nontraditional criteria is preserved (Helm et al. 2003; Felix et al. 2012). Ballejos et al. (2015) concluded that by altering weight of academic and nonacademic attributes but maintaining a minimum academic standard, admissions standards would not be compromised and yet diversity could be increased. Curtis et al. (2015) evaluated an alternate equity targeted admissions program for entry into HPE programs for Maori and Pacific Islanders in Australia and found that this altered admissions process was strongly associated with positive academic outcomes in the first year of tertiary study.

Taken together, recent trends in diversity in HPE programs and evidence from existing and emerging literature suggest that ongoing work is required in order to achieve diversity goals that meet the health care needs of the general population. However, the existing and emerging evidence supports that attaining these goals is possible through building on and strengthening of current interventions. Greater stakeholder, policy, and political commitment will likely be necessary if these goals are to be fully realized.

Strengths and limitations of the review

To our knowledge, this is the first systematic review of diversity initiatives inclusive of all HPE programs. This review encompassed and synthesized 44 years of published literature in this area and included a large breadth of studies examining many intervention types across all points leading up to admission into HPE programs. Loftin et al. (2012) provided a synthesis of interventions used to facilitate the recruitment, retention, and program completion of under-represented nursing students. Our current review expanded on this by including a wide range of HPE programs, by using a broader definition of URM, by considering multiple study designs and intervention types, and by capturing studies conducted worldwide. The key strengths of this review center around this wide scope of inclusion and the prospectively peer-reviewed and registered systematic review methodology. These strengths, combined with the qualitative synthesis of studies with independent comparator groups, allowed us to provide insights into key features of interventions that may be useful for future policy makers. In order to ensure that this focused analysis was aligned with the larger group of included studies, we conducted an analysis of studies without an independent comparator in order to ensure that the scope of interventions and promising emerging trends were fully represented.

Although our broad inclusion criteria allowed for a comprehensive review, the heterogeneity of the included studies also somewhat limited our ability to quantitatively synthesize the resulting studies. This was compounded by a lack of detailed outcome data for many of the included studies, which precluded the calculation of effect sizes, standardization of outcome reporting, and a meta-analysis. Our focused qualitative analysis of the studies with independent comparators provided a way of comparing studies with more similar design, which allowed us to isolate the key features of the interventions at hand. While this may have lessened attention to some higher quality studies without independent comparators, our analysis of the remaining studies lessened the chances that this occurred.

Despite executing a comprehensive and widely inclusive search strategy, the narrow scope of the existing literature limited this review. The majority of included studies were single centered, conducted in the United States, within medicine or dentistry, addressed ethnic/racial diversity, and reported positive results. This may limit the generalizability of our synthesis to some extent. However, it is an important finding in and of itself that needs to be addressed through future research initiatives. In addition, the dominance of positive findings in our review may represent publication bias. There is a possibility of selective reporting where authors only report on outcomes with favorable responses. However, we attempted to contact authors of all included studies to inquire about any unpublished work in attempt to mitigate these risks and we identified neutral and negative studies through our search strategies. The predominance of positive studies may also suggest that multiple intervention types are likely to be successful compared to no intervention or status quo. At present, there is insufficient discriminatory evidence to suggest that anyone intervention currently in use is clearly superior over another.

The included studies are also subject to several limitations. The most common cited limitations of individual studies included: lack of adjustment for confounders, small sample sizes, limited generalizability, non-randomized study design, missing data, limitations of the data sources, use of postal code as a surrogate for SES, use of programs rather than individuals as the unit of analysis, and brief follow-up periods. Common sources of bias identified through our QA included failure to control for differences between comparator groups, selection bias, and lack of description of the reliability and/or validity of outcome measurements. Importantly, only 27 (31%) of included studies explicitly defined the dimensions of URM they considered. Even in those studies that defined URM, often the dimensions of diversity actually considered in the study did not always fully align with those defined up front. This represents one of many situations where discussions of initiatives and programs to increase diversity would be substantially strengthened with analysis using a theoretical framework, such as CRT.

Many of the papers analyzed for this study identify increasing diversity as the main outcome for their initiatives without either defining or situating the study and its analysis within the broader context. For example, as mentioned above, two included studies in this review were set in the South African context (Mitchell et al. 1988; Colborn et al. 1995). A unique aspect that is notable in these two studies is that the URM population discussed is under-represented with respect the health care but is actually the majority population of the country. These studies would be enhanced by reference to their similarities and differences within prevalent the contexts of the more extensive published work from North America, Europe, and Australia.

Without a theoretical framework, the initiatives and effort in the "front end" of the medical education system will be negated by the outright and structural racism of the rest of the educational and health system, e.g. curriculum (both explicit and hidden), student support, and residency matching or further training. It would mean that the outcomes of the initiatives be tracked not to immediate outcomes of "increased diversity" of a particular class or program, but rather to broader outcomes such as how many of the URM students graduate, what residencies or further training do they pursue, what are their practice locations, how many become part of the senior leadership in academic institutions, and health delivery systems. CRT suggests that isolated incremental change can reinforce structural racism in the rest of the educational continuum. This theory further challenges the classical liberalism notion for being "overly caught up in the search for universals, such as admissions standards for university … … The [proponents of CRT] point out that this approach is apt to do injustice to individuals whose experience and situation differ from the norm" (Delgado and Stefancic 2017).

None of the studies in this review included a deeper look at diversity beyond the imperative to have some increase in the number of under-represented minorities in the student body in HPE programs. There was no discussion of CRT or discourse around how a surface approach to diversity may further normalize the power and privilege of the dominant race, class, or population in health professions schools. There is evidence that increasing the number of URM students in HPE programs can increase the number of health professionals who work with URM populations, but evidence is limited beyond that. In summary, although our analysis demonstrated interventions that increase diversity in HPE programs, we do not know if this will actually improve the health outcomes for these URM populations.

Implications for future research

Currently, available evidence is not strong enough to develop a framework for best practices for interventions to promote diversity within HPE programs. We propose a possible future research agenda, which may help to strengthen the evidence in order to progress knowledge toward this goal.

If the goal of increasing diversity within the HPE programs is to achieve broader representation of all URM within society, then there are several areas where future research could be expanded to create a more generalizable and representative approach. We propose the following roadmap for future research in this area:

1. There is a need for researchers to consider broader and more inclusive dimensions of diversity within URM. Most of the studies in our review focused on race/ethnicity and to a lesser extent SES and there were few or no studies that addressed gender, gender identification, sexual orientation, parental education attainment, geography, or recent migrant or refugee status.
2. Expansion of the URM applicant pools needs to be better examined as this is a rate-limiting issue identified in several of the studies included in our review. Many authors lament the limited applicant pool suggesting that researchers focus on wider collaborative approaches that expand this pool such as pipeline and mixed interventions.
3. There is a need for HPE programs to participate in well-designed, collaborative studies involving multiple sites that track students from the time of recruitment through admissions and into the work force. This will allow synthesis of longitudinal data targeting not only intervention effectiveness but also experiences with implementation, stakeholder acceptability, feasibility, and experience outside of the USA.
4. Researchers need to link into common theoretical conceptualizations to allow their studies to build upon each other. This may promote deeper discussions about power and privilege.
5. There is a need to examine underlying cultural and external pressures that limit HPE programs' acceptance of initiatives to increase diversity. For example, discussion of cost analysis of interventions was limited and may be barrier to more widespread implementation of diversity initiatives. Further, while there has been a philosophical shift toward greater social accountability and more discourse around the need for increased diversity in HPE programs, there has not necessarily been a matching cultural shift within HPE faculty, stakeholders, and policy makers. For example, there are still concerns that programs judged by the academic performance of their student body may slip in rankings should they adopt more holistic diversity programs. The large variation in applicant pools and acceptance rates of URM students amongst HPE

programs may be indicative of more effective implementation strategies of diversity interventions in some programs over others. Thus, a better understanding of facilitators and barriers to effective implementation of diversity interventions may help define and disseminate best practice recommendations.

Conclusions

Implementing effective interventions to increase diversity is a growing priority within many HPE programs in response to calls for greater social accountability both within HPE education and from broader health policy interests. In all areas, the majority of studies reported positive results, with the greatest representation in the areas of admissions and enrichment interventions. This suggests that any intervention type is likely to increase intended diversity dimensions over status quo. Further, through our focused qualitative analysis, we were able to identify key features of successful interventions. However, interpretation of these findings must consider several caveats. First, several of the included studies reported that current interventions increased the competiveness of the URM applicant pool but did not necessarily expand it. Thus, there is a need to focus efforts and resources further upstream. Second, the included studies in our review were limited in that they were most often single-center studies, conducted in the USA within medicine or dentistry, and primarily focused on ethnicity and race. Thus, this scope needs to be expanded in order to increase generalizability and applicability of findings. Third, wider stakeholder participation and careful consideration of the existing culture of academic institutions around perceived risks of increasing diversity may help facilitate more lasting and widespread adoption of these interventions. Finally, more mindful consideration of underlying theoretical frameworks would help to strengthen this growing body of literature. This review provides insights and direction for policy developers and researchers. By adapting, implementing and evaluating current and future interventions we can all work to advance the state of URM representation in HPE programs to better serve our patients' and populations' needs.

Acknowledgments

Disclosure statement

Glossary

Acceptance: A formal offer of entry into a school or program.

Affirmative action: A policy or program that favors populations that have historically been discriminated against or disadvantaged, such as underrepresented minorities, in order to increase their representation in the workplace or student body. Affirmative action programs may provide benefits, such as guaranteeing entry into an academic program.

Application: A formal request to seek entry into a school or program.

Complimentary selection criteria: Outlined by O'Neill (2013), as using criteria, such as personal attributes, to widen medical school access to applicants from diverse backgrounds. Complimentary selection criteria can include attributes, such as verbal or written communication skills, interpersonal skills, and the ability to cope appropriately with stress.

Conditional acceptance: Defined by Stagar (1998), as reserving a seat in a medical school class for a specific person based on an assumption that they will meet pre-determined criteria by the start of the next academic calendar year.

Diversity: Diversity within health care systems and educational programs refers to ensuring greater inclusion of those populations that are under-represented in the health professions relative to their numbers in the general population. Diversity includes such dimensions as race/ethnicity, religion, gender, sexual orientation, geographic origin, and socioeconomic status (Bediako et al. 1996).

Educational Disadvantage: Discontinuity between the competencies a learner brings and the competencies valued by an educational institution (Kellaghan 2001).

Graduate entry program: A program that requires that applicants obtain an initial university degree prior to entry.

Matriculation: The process by which a student acts on an acceptance offer to formally enter a particular health professions training program.

Minority: A category of people that are considered different from the majority, based on one or more observable human characteristics.

Pipeline programs: Programs whereby high achieving students from disadvantaged or underrepresented backgrounds are identified at the secondary or postsecondary school level and receive focused educational support and mentorship as they pursue medical school (Reiter et al. 2012). These initiatives vary in the number of students recruited for each program and range from several months to several years in length.

Post-baccalaureate program: A short-term program of study that takes place after the initial Bachelor's degree has been earned. Post-baccalaureate programs can target minority and disadvantaged students, who have previously applied unsuccessfully for admission to medical school, and provide enrichment experiences with the aim of making these students more competitive medical school applicants (Grumbach 2006).

Pre-admission program: A program designed to assist non-traditional applicants in strengthening their academic credentials in order to enter a health professions program. Pre-admission programs can also act as pipeline programs that target undergraduate students for mentorship and exposure to the healthcare professions (Vela 2010).

Representation: The difference in the proportional population of a certain racial/ethnic or otherwise underrepresented group from the proportion of health professionals of the same race/ethnicity or underrepresented group (Bailey 2013; Brown et al. 2009).

Special admissions: A school initiative whereby a student can be considered for academic admission if he/she meets a set of criteria. Criteria for special admission might include factors such as minimum GPA or entrance exam scores. Cornely (1999) describes examples where race or origin can also be included as a factor for admission.

Under-represented minority (URM): Any recognized minority group whose representation in healthcare is disproportionately lower when compared to the group's proportion in the general population. Minorities are often defined using categories of ethnicity/race but can also include other categories such as gender, geographic location, and socio-economic status.

Widening access: A school or program initiative designed to change entrance criteria in order to increase access for specific applicants or groups. Watson (2005) describes examples of widened access that include criteria such as educational experience, ethnic background, age, marital status, disability, and socio-economic background.

Notes on contributors

Kristen Simone, BSc (Hons), MD, is a first-year Obstetrics and Gynecology resident at the University of Alberta. As a medical student, she was a recipient of a Summer Studentship in Health Professions Education grant at the University of Alberta.

Rabia A. Ahmed, MD, FRCPC, is an Associate Professor and consultant in the Division of Infectious Diseases, Department of Medicine at the University of Alberta. She works with underserved communities and has completed a BEME on promoting research among clinical educators.

Jill Konkin, BA(Hons), MD, CCFP, FCFP, FRRMS, is a Professor in the Department of Family Medicine and the Associate Dean and Division Director, Community Engagement. Her portfolio includes Indigenous, inner city, global and rural and regional health as well as community-engaged research. Initiatives of the Division are oriented to social justice and health equity. She has developed, implemented and continues to support significant undergraduate medical education interventions, including a longitudinal integrated clerkship and the delivery of a second year undergraduate course in communities in Northern Alberta. Her research is focused on longitudinal integrated clerkships, professional identity formation, and social accountability. She is currently a co-PI for a systematic review of the literature on social accountability and another on Indigenous health curricula. Her clinical work is as a locum for comprehensive rural family physicians.

Sandra Campbell, BA, MLS, AALIA (CP), is a Public Services Librarian at the University of Alberta John W. Scott Health Sciences Library and library liaison to the School of Public Health and the Faculty of Medicine and Dentistry. She is also an expert database searcher and information literacy instructor. She has recently coauthored and provided librarian support and consultation on recent BEMEs on musculoskeletal Clinical Skills, Audience Response Systems, and Team-Based Learning.

Lisa Hartling, MSc, PhD, is an Associate Professor in the Department of Pediatrics and is the Director of the Alberta Research Centre for Health Evidence and Director of the University of Alberta Evidence-based Practice Center. In this role, she oversees approximately 20 staff in the production of systematic reviews, health technology assessments, and methodological research for evidence synthesis. She is a reviewer with The Cochrane Collaboration (Acute Respiratory Infections, Anesthesia, Injury, Wounds, Heart, and Infectious Diseases Groups). She has coauthored more than 30 systematic reviews. She has also coauthored a BEME on Musculoskeletal Clinical Skills, a BEME on Audience Response Systems, a BEME on Team-Based Learning, and a BEME on promoting research among clinical educators.

Anna E. Oswald, BMSc, MD, MMEd, FRCPC, is an Associate Professor in the Division of Rheumatology, Department of Medicine at the University of Alberta. She is a consultant rheumatologist, co-director of pre-clerkship education, and director of competency-based medical education at the University of Alberta. She has a Masters in Medical Education degree from the University of Dundee. She is a Clinician Educator for the Royal College of Physicians and Surgeons of Canada. She has coauthored a systematic review on problem-based learning and has been the team lead for a BEME on musculoskeletal Clinical Skills, a BEME on Audience Response Systems, a BEME on Team-Based Learning, and a BEME on promoting research among clinical educators. She is the team lead for this review.

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