Addressing structural mentoring barriers in postdoctoral training: a qualitative study

W. Marcus Lambert
Department of Epidemiology and Biostatistics, SUNY Downstate Health Sciences University, Brooklyn, New York, USA

Nanda Nana
Virginia Commonwealth University, Richmond, Virginia, USA

Suwaiba Afonja
Albert Einstein College of Medicine, Bronx, New York, USA

Ahsan Saeed
Division of Infectious Diseases, Boston Children's Hospital, Boston, Massachusetts, USA

Avelino C. Amado
Weill Cornell Graduate School, Weill Cornell Medicine, New York, New York, USA, and

Linnie M. Golightly
Department of Medicine, Division of Infectious Diseases, Weill Cornell Medicine, New York, New York, USA

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Abstract

Purpose – Structural mentoring barriers are policies, practices and cultural norms that collectively disadvantage marginalized groups and perpetuate disparities in mentoring. This study aims to better understand structural mentoring barriers at the postdoctoral training stage, which has a direct impact on faculty diversity and national efforts to retain underrepresented groups in research careers.

Design/methodology/approach – A diverse sample of postdoctoral scholars ("postdocs") from across the USA were asked to participate in focus groups to discuss their training experiences. The authors conducted five 90-min focus groups with 32 biomedical postdocs, including 20 (63%) women and 15 (47%) individuals from underrepresented racial/ethnic groups (URG).

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Findings – A social-ecological framework was used to categorize both the upstream and downstream manifestations of structural mentoring barriers, as well as mentoring barriers, overall. Notable structural barriers included: academic politics and scientific hierarchy; inequalities resulting from mentor prestige; the (over) reliance on one mentor; the lack of formal training for academic and non-academic careers; and the lack of institutional diversity and institutional mentor training. To overcome these barriers, postdocs strongly encouraged developing a network or team of mentors and recommended institutional interventions that create more comprehensive professional development, mentorship and belonging.

Originality/value – For postdoctoral scientists, structural mentoring barriers can permeate down to institutional, interpersonal and individual levels, impeding a successful transition to an independent research career. This work provides strong evidence for promoting mentorship networks and cultivating a "mentoring milieu" that fosters a supportive community and a strong culture of mentorship at all levels.

Keywords Mentoring, Mentorship, Underrepresented groups, Structural barriers, Postdoctoral

Paper type Research paper

Introduction

Mentorship plays a pivotal role in shaping the personal and professional trajectories of postdoctoral scholars (Liénard *et al.*, 2018; Ma *et al.*, 2020). A postdoctoral mentor – often a more experienced scientist or principal investigator – serves not only as a guide in research endeavors but also as a primary source for career and psychosocial support. It has been shown that receiving effective mentorship has a significant positive effect on early-career researchers' satisfaction, self-efficacy and career outcomes (McConnell *et al.*, 2018; Scaffidi and Berman, 2011; Pfund *et al.*, 2016; National Academies of Sciences *et al.*, 2019; Afonja *et al.*, 2021). For example, mentorship of trainees, specifically in areas of grant-writing, is positively associated with increased publication productivity and self-efficacy (Gutiérrez *et al.*, 2021; Thorpe *et al.*, 2020; Jones *et al.*, 2021; Chou *et al.*, 2022), and mentoring in scientific communication skills increases research career intention (Cameron *et al.*, 2015; Cameron *et al.*, 2013). Furthermore, career coaching has been shown to effectively supplement traditional one-on-one research mentoring (Williams *et al.*, 2016; Thakore *et al.*, 2014).

Effective mentorship during postdoctoral training is also key for increasing workforce and faculty diversity (Patt *et al.*, 2021). Our previous work has shown that postdoctoral scholars from underrepresented groups (URGs) leave the academic research pathway in part due to perceptions of poor mentorship (Lambert *et al.*, 2020). The likelihood of biomedical postdocs choosing an academic research career increases as financial security, mentorship from their principal investigator (PI) and their sense of self-worth increase. We have also codified advice from postdoctoral trainees on pursuing a research career in academia, and one of the top recommendations was finding a strong mentor (Afonja *et al.*, 2021). Trainees from URGs do not often find mentors that match their identity, and it has been shown that higher levels of mentor-protégé psychological similarity are related to higher levels of psychosocial support and relationship satisfaction (Hernandez *et al.*, 2017; Pedersen *et al.*, 2022).

Postdocs, especially from URGs, face several structural mentoring barriers that impact their career outcomes. Structural mentoring barriers are policies, practices and cultural norms that (intentionally or unintentionally) perpetuate inequities in mentoring for some groups based on their identity. Structural barriers often favor an advantaged group while systematically disadvantaging a marginalized group (Simms *et al.*, 2015). For example, structural barriers have led to racial inequities in R01 funding (Taffe and Gilpin, 2021; Ginther *et al.*, 2011); however, structural *mentoring* barriers have exacerbated these outcomes. Unlike graduate students' dissertation or thesis committees, which often have an advisory or mentorship role for U.S. graduate students, postdoctoral researchers are not systematically assigned an advisory committee for this stage of training. In addition, many

institutions have not yet offered or required formal mentor training for faculty (Pfund *et al.*, 2013). Moreover, some institutions do not have postdoc offices or administrative positions to support postdocs. This can collectively lead to postdocs who are underpaid and exploited by PIs (McConnell *et al.*, 2018; Afonja *et al.*, 2021).

Moreover, faculty from URGs are often disproportionately tasked with service and mentorship responsibilities, known as a "minority tax" or "cultural taxation" (Padilla, 1994; Talbert *et al.*, 2021; Trejo, 2020; Rodríguez *et al.*, 2015). Women and faculty from underrepresented racial/ethnic groups are asked to serve on institutional committees, engage in outreach and educational activities, diversity efforts and mentor trainees much more so than their peers from well-represented groups (WRGs) (Trejo, 2020; Rodríguez *et al.*, 2015). This mentorship imbalance can have significant effects on the mentoring outcomes of trainees from URGs (Limeri *et al.*, 2019; Karalis Noel *et al.*, 2022).

Structural mentoring barriers can also negatively impact career outcomes. Many PhD and postdoc trainees report very little guidance from PIs or research mentors for a broad range of career paths (Lambert *et al.*, 2020; Woolston, 2019). This is often a result of structural barriers. When PIs are not well-equipped to support their trainee's entrance into an evolving career landscape, the responsibility often falls on the academic institution to provide supplementary career development services. Many postdocs, however, are exposed to minimal career development resources during their training, resulting in a lack of clarity, confidence and skills to efficiently find the right career fit (Gibbs *et al.*, 2015; Yadav and Seals, 2019). Even when postdocs are offered structured career development resources (e.g. individual development plans and/or workshops on transferable skills training), the perceived usefulness of these sessions varies (Nowell *et al.*, 2020; Steen *et al.*, 2021; Hobin *et al.*, 2014; Fuhrmann, 2016).

In this study, we use an ecological systems approach to categorize and understand the structural barriers to effective mentoring. This approach, rooted in the work of Bronfenbrenner, posits that individual behavior, well-being and outcomes are not isolated phenomena but are influenced by a complex interplay of factors across multiple systems (Bronfenbrenner, 1992). These systems range from the immediate social and cultural dimensions of an individual's environment to broader societal structures (Dahlberg and Krug, 2006; Stokols, 1996; Israel *et al.*, 1998). The ecological systems framework organizes these influencing factors into four primary dimensions or systems: macro-systems, exo-systems, meso-systems and micro-systems. *Macro-systems* encompass the overarching cultural and societal norms; *exo-systems* include settings that indirectly affect the individual, such as workplace policies; *meso-systems* involve the interactions between different *micro-systems*, like the relationship between mentors and mentees; and *micro-systems* focus on immediate relationships and settings, such as family and peer groups.

By applying this ecological systems approach, we aim to provide a comprehensive understanding of the interdependent factors that influence both individual behavior and broader outcomes. In the context of this study, this means examining how various levels of influence contribute to the effectiveness, or lack thereof, of postdoctoral mentoring. We hypothesize that there are a significant number of postdocs facing mentoring barriers that are structural and systemic in nature. In this article, we report the results of focus groups that explore the mentoring barriers faced by postdoctoral trainees and possible solutions to dismantle those barriers.

Methods

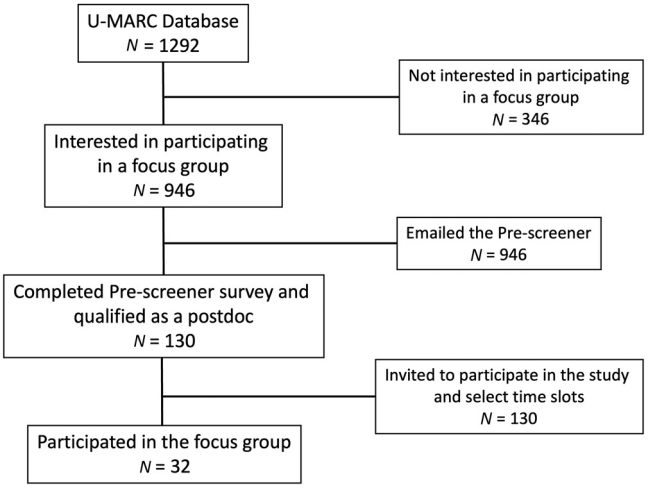
U-MARC database

Postdoctoral scholars interviewed during this study were recruited from the U-MARC database, which was developed in 2017 from US postdocs in the biological and biomedical

sciences. These postdocs completed the U-MARC (Understanding Motivations for Academic Research Careers) survey instrument and volunteered their contact information for future studies. The 70-item survey measures factors that determine career choice in science (Lambert *et al.*, 2020). Sampled postdocs in the database represent 6% of the total pool of appointed biomedical and biological postdocs (1,292 of 21,781) the year the survey was conducted (2017), according to the National Science Foundation (NSF). The sample represents wide, geographic (over 80 universities) and subfield diversity. The REDCap electronic data capture tool was used to collect and manage the database. REDCap (Research Electronic Data Capture) is a secure, Web-based application designed to support data capture for research studies (Harris *et al.*, 2009).

Selection of study participants

Of the 1,292 original survey participants, 346 indicated that they were not interested in participating in a follow-up focus group at the time of the original survey (Figure 1). Therefore, they were not included in this outreach. 946 postdocs were contacted and were invited to participate in a follow-up study about academic research careers. Postdocs were asked to complete a pre-screener survey that captured emails, names, race, ethnicity, citizenship status, their current academic institution, number of years as a postdoc and how likely they were to pursue a research-intensive faculty career. 130 respondents self-selected to join the focus group through the prescreening survey. All work was conducted under the approval of the Weill Cornell Medical College Institutional Review Board (IRB# 1612017849), and all candidates provided consent for participation in the study. All 130 respondents were invited to select time slots for the focus groups. We conducted five 90-min focus groups with 32 postdocs, including 20 women (63%) and 15 individuals from underrepresented racial/ethnic groups (47%). Three focus groups comprised postdocs from URGs, and two focus



Notes: Flow diagram of the process for selection of focus group participants; Abbreviations: U-MARC: understanding motivations for academic research careers

Source: Authors' own creation

Figure 1.
Flow chart of focus group participants

groups comprised postdocs from WRGs. All participants in the focus groups were awarded a $50 gift card as compensation for their time and voluntary participation.

Interviews and data analysis

Five focus groups were conducted virtually via Zoom with one moderator who guided the discussion and one co-moderator who helped to keep time. We began the focus group with introductions and a review of the study objectives and ground rules. We notified the participants to respect the privacy of the others and not repeat what was said in the focus groups. Participants were asked several open-ended questions from an interview guide that began with a discussion of their values and what they found most fulfilling in their work. We also asked, "what have mentors done to support or hinder your ability to pursue a research faculty career?" The study ended when data saturation was reached (the point at which no new information or themes were observed for the data). Each focus group was video recorded, after which the video was sent to an outside company for transcription. The transcripts of each session were stripped afterwards of any identifying information and each participant was assigned a participant ID number.

All the data was analyzed manually by an inductive method following these steps. First, each focus group was assigned to two researchers trained in qualitative coding. A process of open, axial, and then selective coding was followed by generally coding and discussing major concepts, categories and themes. These themes and categories were inductively generated during the research, according to the grounded theory method (Corbin and Strauss, 2008). The two researchers involved in the coding process each independently derived codes, and then met with a team of five to six researchers to help determine crosscutting themes and recurrent patterns. We repeated this cycle until we achieved thematic saturation, and novel themes stopped emerging from the data. NVivo 12, a qualitative transcript software, was used to assist with the coding of the data. Once all of the data were coded and themes emerged, we focused on the codes that dealt with aspects of mentorship, using an ecological systems approach to organize the mentoring barriers.

Results

To better understand the mentoring experiences of postdoctoral trainees, we interviewed a sample of 32 postdoctoral researchers across five 90-min focus groups. Twenty participants were women (63%), and 15 individuals were from underrepresented racial/ethnic groups (URG) (47%) (Table 1). These racial/ethnic groups include American Indian or Alaska Native, black or African American and/or Hispanic or Latino. Participants were well-represented across years of training, with 16% of participants in year 1 (less than 1 year of training), 22% in year 2, 25% in year 3, 16% in year 4, 13% in year 5 and 9% in year 6 or beyond. Of participants, 65% were at least somewhat likely to pursue a research-intensive faculty career, similar to previously reported national averages (Lambert *et al.*, 2020; Silva *et al.*, 2016). Participants from URGs skewed toward pursuing a research-intensive faculty career (60% very likely).

Throughout the rest of this manuscript, we delve into the mentoring barriers identified by postdocs across four broad levels: individual, interpersonal, institutional and systemic. Our exploration begins at the individual level, where personal attributes and self-perceptions often serve as the first layer of obstacles. We then move on to interpersonal dynamics, focusing on the relationships between mentors and mentees. The institutional level encompasses organizational policies and culture, while the systemic level addresses broader societal and academic norms. Our analysis is framed within Bronfenbrenner's

Sample characteristics	Total	URG	WRG
N	32	15	17
Gender			
Female	20	8	12
Male	12	7	5
Ethnicity			
Hispanic or Latino	9	9	0
Not Hispanic or Latino	22	0	22
Race			
American Indian or Alaskan Native	1	1	0
Asian	4	2	2
Black or African-American	6	6	0
White	22	7	15
Years as a Postdoc			
Less than 1 year	16%	13%	18%
1 – 2 years	22%	20%	24%
2 – 3 years	25%	20%	29%
3 – 4 years	16%	13%	18%
4 – 5 years	13%	27%	0%
5+ years	9%	7%	12%
How likely are you to pursue a research-intensive faculty career?			
Very likely	34%	60%	12%
Somewhat likely	31%	20%	41%
Neutral	13%	13%	12%
Not very likely	16%	7%	24%
Not likely at all	6%	0%	12%

Source: Authors' own creation

Table 1. Demographics of interview participants

ecological systems theory, allowing us to explore how these various layers interact and influence the mentoring experience. This framework provides a comprehensive lens through which we can better understand the complexities and nuances of postdoctoral mentorship.

Individual level

Barrier: access to mentors

The characteristics and experiences of the mentees involved in a mentorship relationship can shape the effectiveness of the mentoring. Thus, narrative responses from postdoctoral research participants were examined to understand how mentoring experiences were impacted by an individual's attitudes, beliefs, values and behaviors. Participants, particularly from the underrepresented focus groups, highlighted the challenges of being a woman, immigrant, first-generation or underrepresented scientist. One postdoc, for example, focused on the challenges of being a woman in academia and facing institutional policies that denied access to emails to postdocs on maternity leave, but not postdocs on paternity leave. Other female postdocs reaffirmed the challenges of being a woman in science, highlighting that leadership is often male-dominated. This made it challenging to find mentors who understood their lived experiences. Similarly, first-generation scientists also noted how their background did not afford them opportunities for great mentorship.

These postdocs persisted through the lack of strong mentors. In this study, "strong mentors" are defined as those who are actively present in the mentoring relationship, providing consistent guidance, support and opportunities for skill development to their mentees. This is in contrast to principal investigators or faculty members who may hold the title of "mentor" but do not engage in active mentoring practices.

However, some postdocs from racial/ethnic underrepresented backgrounds specifically sought out mentors from URGs. These URG mentors also served as role models for their URG mentees and fostered a strong motivation for persisting in academia. Subsequently, there became a strong desire to "make these mentors proud." We expand on this more in the mentoring solutions section below. A pattern expressed by many of these postdocs was the interest in more nurturing mentors. These are mentors who give positive feedback, help build a mentee's confidence and demonstrate patience and understanding. One postdoc from an URG noted that she joined the lab of a new URG PI and was surprised when he was not as nurturing:

> And then as a postdoctoral fellow, I joined the lab of a new PI who is a URM and it's actually been really challenging in the sense that he is– he will be a really great PI someday, but when I first joined he was just starting and he is very motivated and that motivation can be very grinding. He's not somebody who gives a lot of positive feedback and he's somebody who's constantly reigning me in. I was so used to somebody who nurtured any time that I wanted to do something. But, in some senses, what's been great about it is he has given– he's really pushed me to write grants. And he's really helped me improve as a public speaker, things that I really needed when I go speak at large conferences.

These comments show that the experiences of underrepresented postdocs have shaped mentoring outcomes in several ways. For some underrepresented scientists, aspects of their identity and background (e.g. being a woman or a first-generation student) affected access to strong mentors. This was not expressed among the postdocs from WRGs. Unlike their well-represented counterparts, postdocs from URGs struggled to find mentors willing to take the time to provide strong mentorship. They had to then persist through the lack of strong mentors to reach higher academic stages. Other scientists from URGs were attracted to and sought out more URG mentors, who were often nurturing in their mentorship style.

Barrier: vicarious experiences that lead to poor mentoring outcomes

Vicarious experiences allow individuals to learn from the experience of others. One postdoc noted how watching her PI struggle with obtaining grants partly influenced her future career choice:

> So I came in two years ago starting my postdoc with the intention of doing everything I could to get into an academic position. And between not getting any of the six grants that I applied to and watching my advisor struggle through trying to apply for tenure despite knowing that she's a phenomenal mentor and a really great scientist and she was awarded it but just the stress of that and the amount of work and everything I just kind of decided that that might not be career path for me.

Some mentors may feel helpless at the thought of mentees interpreting their struggles negatively. Thus, it is important to take an active role in managing the expectations of what it means to be a researcher in academia for trainees. Vicarious experiences can also manifest positively. Another postdoc noted how the success of her PI influenced her confidence and beliefs about her own potential for success:

> I had a lot of trepidation about pursuing a research focused faculty appointment versus a teaching focused faculty appointment at my former institution because my mentor was struggling to get

> RO1s funded, and it was just scary all the time. And now I'm in a postdoc position with someone who's very well-funded and has really mentored me in grantsmanship, and I feel a lot more confident about pursuing that sort of grant funded research career because I see that it's possible.

Postdocs noted how negative mentoring experiences overall impact their own approach toward mentoring. These quotes highlight the impact that previous vicarious and/or negative mentoring experiences have on both future mentoring relationships and career outcomes. They also reinforce the influence that one's background, beliefs and prior experiences have on the mentoring relationship and future mentoring practices.

Interpersonal level

Barrier: research advisors who lack good mentoring practices

Mentoring barriers at the interpersonal level were largely characterized by personal relationships between a research advisor and a mentee (dyadic). In one case, a postdoc characterized a research advisor as jealous, unsupportive and actively preventing growth and advancement. However, in most of the comments, the focus group participants noted that mentors were not actively creating barriers to their success. Rather, there was simply a lack of good mentoring or missed opportunities for mentorship. One postdoc highlights:

> You know, I'm sort of kicking myself after I left, because there were clearly all of these opportunities for, like, a URM supplement for his R01, and all these other things that I don't even know if he– I mean, I'm sure he didn't take advantage of it, but there were all of these missed opportunities that he just was not interested in even pursuing, because he was just not interested in having me write anything.

There was consensus that some PIs do not know how to be good mentors. They did not help with professional growth or create opportunities for advancement. One postdoc described his PI as a "boss, not a mentor." Others noted a misuse of their position and time by mentors, such as a burden of lab management responsibilities. Underneath the missed opportunities for good mentoring practices were specific issues such as misaligned expectations or poor communication.

In some cases, there were misaligned expectations around work-life balance that created challenges in the mentoring relationship. The postdocs found certain expectations from their mentors very discouraging especially if those expectations included longer-than-normal work hours and conflicts about time spent in the laboratory. Other misalignments were over opposing mentoring styles and fit. Similarly, other postdocs noted contrasting mentoring styles in their graduate and postdoctoral mentoring experiences. These helped to identify poor mentoring practices that had not been present in previous experiences.

Barrier: culturally disconnected mentors

The lack of cultural awareness or cultural humility was a common theme among the underrepresented focus groups. Some mentors, although well-meaning, do not know how to approach cultural differences and can appear as not being supportive. Other times, they can be insensitive and come off as offensive. One postdoc describes the difference between her two mentors:

> Thankfully the mentor I have now grew up on a farm in the middle of nowhere Missouri, so he pulled himself up by his bootstraps. But a previous co-mentor like his father was a faculty member at Berkeley and then his grandfather was a faculty. So that was a silver-spoon-in-mouth situation. So there were always snide comments here and there that you can interpret it as being derogatory. So it depends on the person. But I think, on the whole most people, just don't care, just publish and get grants, move on.

Another interesting point that arises from this particular quote is that this postdoc found commonality and shared values in the background of her current PI who helped himself succeed without the privilege of wealth and resources, as noted in contrast to the previous mentor.

Disconnect is not limited to just cultural backgrounds. Another focus group participant highlighted the disconnect between older and younger scientists (early career scientists). Both examples point to a significant barrier in cultural awareness and engagement that can exist for many postdoctoral fellows, especially from URGs.

Institutional level

Barrier: lack of institutional support for postdocs

According to the focus group participants, many institutions fail to provide services, training programs, support and attention to postdoctoral fellows. In addition, postdocs point out the need for formal training for faculty roles:

> [. . .] I am terrified out of my mind to even think about the faculty position. We really don't have any sort of training before a faculty position. You're told to publish while you're a postdoc, maybe get some grants, interview for faculty and then you're thrown to the sharks to really fend for yourselves. And if you've had some good mentors, they can provide guidance, but I mean at that point you're pretty much on your own, running your own business, you're accountable for people now, you're accountable for their future, their education as well as your own.

They highlight the need for more institutional support to transition into faculty careers, which has arisen in previous studies (Afonja *et al.*, 2021). A lack of mentoring was also noted as a key part of the lack of institutional support.

Barrier: lack of support for trainees from diverse backgrounds

Multiple participants of one particular focus group highlighted the lack of diversity in leadership positions and the lack of support for trainees from diverse backgrounds (URGs):

> But I also see it as a place where much of the leadership are professors who have been there for a very long time in their careers and, so, a lot of them are faculty, white men, in those positions making a lot of decisions [about] the way that they're running departments or their certain field of research. I find that discouraging, the lack of diversity and support of diverse students at the PhD level or at the postdoc level.

In their opinion, the lack of diversity in leadership positions has led to decision-making and views on career outcomes that have not evolved with the views of trainees. According to the postdocs, these types of barriers at the institutional level have led to a culture characterized by a lack of support and mentorship. Moreover, this culture is upheld by the leadership when little to no intervention occurs. It is similar to the mentoring gap previously described in the literature (Pollard *et al.*, 2021; Cross *et al.*, 2019). For marginalized trainees, access to mentoring networks is often more limited than that of their peers. Not everyone has equal access to mentors. This mentoring gap is frequently associated with a person's background, their race, class and gender, and is perpetuated by structural inequities. We expand on this phenomenon, pointing out the structural barriers that maintain the mentoring gap.

Systemic level

Barrier: academic politics

At the systemic level, postdocs focused on mentoring barriers such as "academic politics," scientific hierarchy and the structural reliance on one PI for career success as a postdoc. One postdoc noted:

> Well, in my experience, I feel I have the skills to do research, to design experiments, to teach graduate schools how to perform research. Still what I find difficult is this: managing the politics of, for instance, when you get a paper reviewed and then you have to reply and then how to deal with reviewers and with editors. And the same with funding how when you get your grant application gets reviewed, the correspondence with the program directors and the staff that make the decisions to fund your research or not. I find myself that I need mentoring in that aspect.

Managing correspondence with editors in the publication review process and program officers in the grant submission process is not something that is formally or systematically taught to postdoctoral fellows. One must usually rely on the mentorship of the research advisor/PI to teach these skills if not already learned. The postdocs felt that this structure limited their academic advancement. Scientific training hierarchy and power dynamics were also cited as a barrier, where a younger trainee's ideas were stifled.

Barrier: reliance on one mentor

An "over-reliance" on one mentor was problematic for the postdoc participants. One postdoc noted:

> One of the things in grad school that's kind of tough is that unlike in a corporation where you have sort of coverage from your bosses, when you're a PhD student, you're at the whim of your PhD mentor and you don't have a lot of security and support beyond that so if you have problems then it's not like you have other people who can support you in furthering your career, they're the one person you have to rely on and that can be a really hard thing.

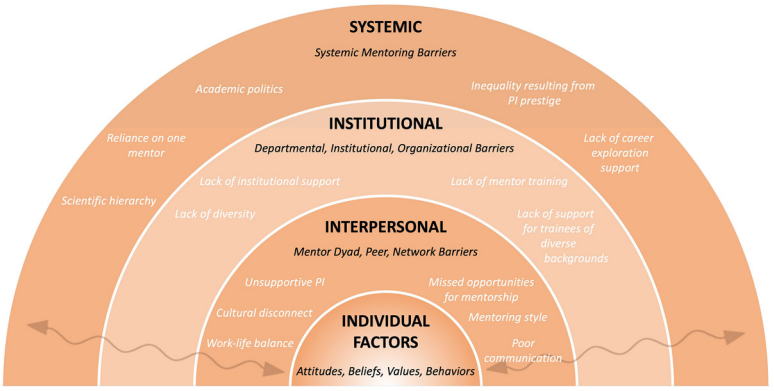
The impact of PI (and institutional) prestige was a common theme across focus groups. If mentors held a certain prestige in the scientific community, they could often create seemingly unfair advantages for certain trainees. One advisor, just based on their name, could have a large influence on a trainee's career trajectory. For example, this postdoc notes:

> [. . .] he's well known in the Alzheimer's field so the way he helped me is not even active, it's just passive. It's just from his name. The fact that I postdoc under my mentor, like what you were saying, [other participant], about the university. Well, also, the mentor is like the same, "Oh, you came out of So-and-So's lab. Well, then okay, you can get whatever position wherever", which they don't have to do anything for. I mean they'll write a letter of recommendation but it's just the name, really.

Barrier: lack of support for career exploration

Finally, the postdocs stressed the importance of mentor training and resources. Many postdocs feel unsupported by both their institutions and their mentors as they explore their career options after their postdoctoral training. If they do not find resources through their institution, they often turn to their mentors. Yet, many mentors lack the experience or resources to support non-academic career exploration.

Our modified social ecological model posits that mentoring outcomes are first affected by an individual's attitudes, beliefs, values and past behaviors (Figure 2). Personal backgrounds such as gender, race, ethnicity and age may also affect mentoring outcomes. Then, at the interpersonal level, mentoring outcomes are influenced by personal relationships such as those between a PhD advisor and mentee (dyadic), between two trainees (peer) or through a network such as the National Research Mentoring Network (Sorkness *et al.*, 2017; Blaney *et al.*, 2020). The professional relationships and social networks that a mentee takes part in have great potential to impact behaviors and outcomes. The institutional level of this social-ecological model focuses on the departmental, institutional and organizational-specific barriers that influence mentoring practices. Finally, policies,



Notes: Individual-level factors that influence mentoring outcomes are nested within mentoring relationships (dyads, peer mentoring, mentor networks), which are nested within the larger departmental, institutional and organizational barriers. Macro-level (systemic) factors, such as lack of career exploration supports in training paradigms, may influence institutional standards and policies, which may affect the dynamics of mentoring relationships, which ultimately affect individual attitudes, beliefs, values and behaviors (represented by the bi-directional arrows). Adopted from Bronfenbrenner's ecological model of human development

Sources: Derived from Bronfrenner's ecological theory of human development (Bronfenbrenner, 1977). Figure adapted from the Centers for Disease Control and Prevention social-ecological model framework for prevention Centers for Disease Control and Prevention (2022)

Figure 2.
Social ecological framework for mentoring barriers

practices and norms that are observed and/or perpetuated on a national or global level make up the systemic level. We organized postdoc-identified mentoring barriers on these four broad levels to better codify how structural mentoring barriers can permeate down to institutional, interpersonal and individual levels (Table 2).

Mentoring solutions

In addition to codifying the barriers that postdoctoral trainees face in their mentoring relationships, we present mentoring solutions to overcome many of those barriers. These proposed solutions were developed by the postdoctoral participants and organized into four groups:

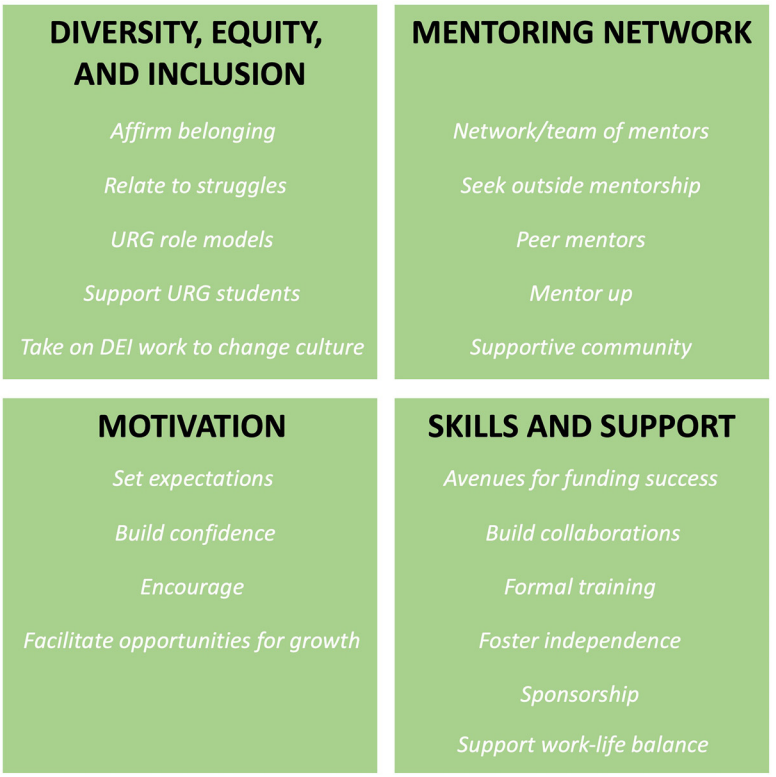
(1) mentoring solutions in diversity, equity and inclusion;
(2) encouraging and helping trainees to develop mentoring networks;
(3) promoting motivation; and
(4) building skills and support (Figure 3 and Table 3).

The format used in Figure 3 can serve as a printable toolkit or reminder for mentors as they interact with all of their trainees. Below, we highlight and describe in detail these mentoring solutions.

Theme type	Theme	Code
Individual (attitudes, beliefs, knowledge, behaviors)	Nurturing mentors	Accustomed to nurturing mentors
	Vicarious learning	Poor vicarious experience influenced career choice
	Vicarious learning	Impacted by negative mentoring experiences
	Vicarious learning	Success of PI can influence confidence and beliefs about one's own potential for success
	Disadvantaged backgrounds	Trained at less prestigious institutions
	Disadvantaged backgrounds	Discriminatory institutional policy around maternity leave
	Motivation	Desire to make mentors proud
	Motivation	Persisted through the lack of strong mentors
	Motivation	Fear of revealing non-academic career interests
	Work–life–community balance	Familial values impacted by work–life balance
	Work–life–community balance	Conflicted about proper balance between research and science/community outreach
Interpersonal (dyadic, peers, networks)	Missed opportunities for mentorship	Missed funding opportunities
	Missed opportunities for mentorship	Not all PIs know how to be good mentors
	Missed opportunities for mentorship	PI did not help with professional growth
	Unsupportive PI	Jealous, unsupportive PI sabotages trainees
	Unsupportive PI	Burden of lab management responsibilities due to lack of direction from PI in a small lab
	Unsupportive PI	Boss, not a mentor
	Mentoring style	Different mentoring styles
	Mentoring style	Poor co-mentorship environment
	Cultural disconnect	Culturally disconnected
	Cultural disconnect	Disconnect between older and younger scientists
	Work–life balance	Expect postdocs to work overtime with little consideration about work–life balance
	Work–life balance	Managing PI expectations about work–life balance
	Poor communication	Poor and miscommunication
Institutional (departments, institutions, organizations)	Lack of institutional support	Lack of institutional support
	Lack of mentor training	Lack of formal training for faculty roles
	Lack of diversity	Lack of diversity in leadership positions is discouraging
	Lack of support for trainees of diverse backgrounds	Lack of support for students from diverse backgrounds
Systemic (social and cultural norms, policies)	Academic politics	Managing correspondence with editors in publication review process
	Academic politics	Managing correspondence with program officers in grant submission process
	Inequality resulting from PI prestige	Prestige of PI creates unfair advantages
	Lack of career exploration support	PIs lack experience or resources to support non-academic career exploration
	Reliance on one mentor	Reliance on one mentor
	Scientific hierarchy	Limited academic freedom due to scientific hierarchy

Table 2.
Mentoring barriers

Source: Authors' own creation



Notes: Postdocs proposed solutions for overcoming mentoring barriers, organized into four themes: mentoring solutions in diversity, equity and inclusion; encouraging and helping trainees to develop mentoring networks; promoting motivation; and building skills and support
Source: Authors' own creation

Figure 3.
Mentoring solutions proposed by postdocs

Solution: affirm belonging

Trainees from URGs progress through academic pipelines often with feelings of not being fully welcomed or valued at their institution (Good *et al.*, 2012; Clark and Hurd, 2020). This can reinforce negative stereotypes and reduce self-efficacy to the point where URG trainees can begin to question their potential or motivation (Walton and Cohen, 2007). Our URG focus group participants highlighted the need for mentors to affirm trainees' sense of belonging:

> So, the perfect example, I think, was– I don't know if you all remember when Justice Scalia was talking about how black students shouldn't go to top-tier schools for science, that they should stick with lower-tiered schools. And this was all over the news and she called me into her office, and I was like, "Oh, God, I'm in trouble." And she says, you know, "I just want to let you know I heard everything in the news, but I just wanted to let you know specifically you belong here." And– I don't know– that was just a turning moment for me, where sometimes we hold things,

Mentoring solutions	Theme	Code
Diversity, Equity and Inclusion	Affirm belonging	Mentor affirms URG student's belonging
Diversity, Equity and Inclusion	Relate to struggles	URG mentor relates to mentee struggles
Diversity, Equity and Inclusion	Support URG students	Support URG students with mentorship, professional development and belonging
Diversity, Equity and Inclusion	Support URG students	URM PI not nurturing but helped development in other ways
Diversity, Equity and Inclusion	Take on DEI work to change culture	Participate in diversity and inclusion work to change academic culture
Diversity, Equity and Inclusion	URG role models	Increase diversity in faculty and leadership
Diversity, Equity and Inclusion	URG role models	URG mentor motivates desire to continue in science and increase diversity
Diversity, Equity and Inclusion	URG role models	Motivated by first-generation and mentors of color outside of academia
Mentoring network	Network/team of mentors	Develop a team of mentors
Mentoring network	Network/team of mentors	Create a network of mentors
Mentoring network	Network/team of mentors	Develop diverse mentorship network early in career
Mentoring network	Network/team of mentors	Have honest conversations with professionals across diverse fields early
Mentoring network	Network/team of mentors	Unofficial mentors and the importance of a community of mentors
Mentoring network	Seek outside mentorship	Sought outside mentorship to supplement in other areas
Mentoring network	Seek outside mentorship	Go outside of traditional channels for mentorship
Mentoring network	Seek outside mentorship	Honest advice from diverse network to help with career development
Mentoring network	Peer mentors	Peer mentors outside of discipline
Mentoring network	Peer mentors	Peer and near-peer mentorship
Mentoring network	Peer mentors	Peer mentorship
Mentoring network	Mentor up	Develop skills necessary to get the most out of mentors
Mentoring network	Supportive community	Look for an established, supportive community
Motivation	Expectations	Help mentee exceed expectations of themselves
Motivation	Build confidence	Build up mentee's confidence
Motivation	Build confidence	A mentor who builds up your confidence helps fight imposter syndrome
Motivation	Encourage	Encouraged by mentor
Motivation	Prioritize mentorship in lab choice	Prioritized mentoring in choosing a lab
Skills and support	Avenues for funding success	Mentor provides avenues for funding success
Skills and support	Build collaborations	Establishing new collaborations with other investigators
Skills and Support	Build collaborations	Facilitate opportunities for growth and networking
Skills and Support	Formal training	Better training for faculty positions
Skills and support	Foster independence	Help mentees gain independence through varied training and mentorship
Skills and support	Sponsorship	Mentee benefits from mentors' reputation
Skills and support	Support through processes	Mentorship during faculty and interview process
Skills and support	Support to pursue other interests	Mentors supported mentee in pursuing other interests
Skills and support	Support work–life balance	Support for time off, childcare, tenure clock

Table 3.
Mentoring solutions

Source: Authors' own creation

> especially as you're around students that maybe our peers don't hold in terms of just baggage [or] micro-aggressions or whatever it is. And so, just hearing that support that was outside of the realm of research was just really great for me.

Similarly, postdocs highlight the need to support URG students with mentorship, professional development and belonging.

Solution: participate in diversity and inclusion efforts

The postdocs also highlight the need for mentors to take on and participate in diversity and inclusion efforts themselves. For example, joining committees, recruiting URG trainees and conducting outreach efforts are important and can be impactful, but postdocs stress the need for mentors to think about building a more inclusive academic culture, which is often overlooked.

Solution: hire more underrepresented group role models

Another solution that was emphasized was the impact of URG mentors on URG trainees. URG mentors can relate to and understand the struggles of URG trainees. These are qualities that can be found in and practiced by non-URG mentors, as well. Postdocs note that URG mentors also motivate URG trainees to continue in science, thereby increasing diversity:

> So, for me, I wanted to do a postdoc because I had a fantastic graduate advisor. He was– he's Latino and he was very much if you're a minority, you should stay in science, because there's not a lot of us. So, my goal is ultimately to be a PI, so I can try to pull more under-represented minorities up into scientific fields, because there really aren't that many.

This demonstrates that there is a need to increase the number of URG faculty. Additionally, we found that trainees are also motivated by URG mentors outside of academia, particularly those in leadership positions.

Solution: create network/team of mentors

One of the most vocal recommendations that the participants offered was to create a team or network of mentors:

> And to reiterate on the mentorship theme that [the other participant] was mentioning, find yourself a mentorship team. I think that's really important to have many people that you can approach, and it doesn't have to be the same person– you don't have to go to the same person for grant-writing support that you do for work-life balance support. I think that it's important to have a whole team of mentors at your disposal.

There was a lot of encouragement to develop a diverse mentorship network early in one's career and have honest conversations with professionals across diverse fields. Honest advice from a diverse network of mentors will also help with career development. One postdoc introduced the concept of a "mentorship tribe," a community that includes unofficial or "mini" mentors, often peers, who offer guidance in specific situations:

> I think the term "tribe" was used at some point, your community, that it's– I think of the adage that it takes a village to raise a child. And sometimes it's leaning on those sort of unofficial mentors or mini mentors. Sometimes it's a peer that takes on very briefly a mentorship-type role for a moment, for a conversation. And that sounds like it's sort of reaching and being poetic, but it's really not, especially in the absence of, I would say, comprehensive, competent, official mentorship. It's just that's how you receive mentorship.

In addition to advocating for a community or network of mentors, the postdocs encouraged seeking mentorship outside of one's PI/primary mentor or even their department. Seeking external mentors may involve some self-reflection regarding one's gaps in skills or training. The postdocs encouraged going outside of traditional channels to get the appropriate mentorship or guidance when needed.

Solution: seek out peer mentors

Another recommendation emphasized by the focus group participants was the value of peer or near-peer mentors:

> I actually get a lot of mentorship from colleagues who are postdocs who are a little bit– in assistant professorship positions right now and that's where I've been meaning to look at. Even though they're not in the same discipline I'm in, I've actually been learning a lot from them.

Others agreed with the notion to seek out peer mentors, especially for career development.

Solution: mentor "up"

Postdocs also advised to develop the skills necessary to get the most out of mentors. There has been some literature describing the concept of "mentoring up" (Lee *et al.*, 2015). Mentoring up helps move toward a shared purpose. Effective mentoring is not simply defined by mentors guiding mentees, but also by mentees guiding mentors in collaboration. One postdoc notes:

> I think that as trainees there are skills that we need to develop in order to get the most out of our mentors because some of them are not naturally inclined that way.

Solution: build up mentee's confidence

It has been shown previously that higher research self-efficacy is associated with larger numbers of publications and a greater intention to pursue research-intensive careers (Lambert *et al.*, 2020). Postdocs have also highlighted the importance of building up a mentee's confidence and helping mentees exceed even their own expectations of themselves. One postdoc notes:

> I think that's probably the most important thing a mentor can do is to build up your confidence and let you know, "Hey, you are smart enough to do this. You can accomplish such and such". [. . .] And then my graduate mentor he's also saying, "Hey, you're a really smart man. You can do this and that".

This postdoc went on to note the importance of confidence building in fighting imposter syndrome:

> [A mentor who builds up your confidence] is definitely one of those things where if you ever have that imposter syndrome, you're like, well, these really, really smart people believe that I'm good enough to do it. And my track record says I'm good enough. So it sort of helps you get through those moments of self-doubt and that's very important.

Another postdoc described when their PI encouraged her mentees to think freely and develop their own ideas.

Solution: help provide avenues for funding success

Grants and funding are crucial for research success in academia. Postdocs note that the mentors who support their mentees in applying for funding and encourage learning how to

successfully acquire grants were the most helpful. Similarly, establishing new collaborations is important for long-term success. It was noted by one postdoc that establishing new collaborations was something that you have to "learn by doing it." Others noted that their mentors aided in this process, and this was valued.

Solution: better training and preparation for faculty positions

There seems to be a dire need for better training and preparation for faculty positions, as well as the application and interview process. Whether this is in the form of more formal training opportunities or workshop series or managed through individual mentors, postdocs highlighted the impact that this could have on their success:

> I actually think that it's almost impossible to go for a faculty interview or apply for faculty position without having great mentors. Having that experience behind your belt and having them really guide you through the process because it is so daunting and so exhausting that really without their help, it's nearly really impossible.

Solution: support mentees in their career development

One particular postdoc described her exploration and interest in the field of public health, although her PhD training was in the basic biomedical sciences. She talked about the support that her mentors offered her in exploring this route, which led to a unique faculty position that would allow her to combine both fields in a very translational research setting. Others confirmed the need for mentors to help broadly in career development.

Solution: offer support for time off, childcare, tenure clock

Another unique postdoctoral experience that highlights structural challenges, especially for women, is the tenure clock. The term "tenure clock" refers to the specific period of time during which a faculty member is evaluated for the award of tenure. This period varies by institution but commonly lasts around five to seven years from the time of initial appointment. During this time, the faculty member is expected to demonstrate excellence in research, teaching and service to the academic community, according to the institution's specific criteria for tenure. Failure to achieve tenure by the end of this period often results in the faculty member not being reappointed.

One postdoc, who had just accepted an offer for a faculty position, highlights the challenges posed by the rigid timelines in academia, particularly for those pursuing a PhD, postdoc and faculty positions. She argues that the inflexible nature of the "tenure clock" coincides with people's prime earning and reproductive years, creating a stressful collision course that is especially difficult for women to navigate. The postdoc avoided these challenges by entering academia at the age of 41, after already establishing a career, financial stability and a family in their 20s. They suggest that introducing more flexibility into the academic system, such as better leave policies and childcare support, could alleviate some of these pressures and make the path more manageable, particularly for women. This resonated with other members of the focus group.

Discussion

This study examined the experiences of URG and WRG postdoctoral researchers and discovered the following major findings:

- Broad systemic mentoring barriers can be mitigated through policies, networks and training.

- The lack of institutional diversity and mentor training are impacting mentoring relationships.
- Postdocs, especially from URGs, seek more nurturing mentors who understand their values and can build their confidence.

Our study brought to light the importance of policies, networks and training in mitigating broad structural mentoring barriers, especially at the systemic level. Mentoring barriers on the systemic level consistently impact barriers on the individual, interpersonal and institutional levels. For example, there has been an increase in postdoctoral trainees pursuing nonacademic careers. For some postdocs, like the one described earlier in this study who watched her advisor struggle through applying for tenure despite knowing that she is a phenomenal mentor and great scientist, the shift to a nonacademic career is largely based on negative (or absent) vicarious mentoring experiences. Upstream of this are the national and institutional pressures for teaching more courses and increasing grant funding, ultimately affected by federal funding and institutional business models. Academic structures like this systematically affect the dyadic relationship between mentor and mentee. Moreover, these structural mentoring barriers make it difficult to implement effective dyadic interventions. Fortunately, the postdocs in our study point out that these barriers can be mitigated. In addition to policy changes, building a network of mentors will provide postdocs with more than just one primary resource for career and professional development (Termini *et al.*, 2021; Marshall *et al.*, 2022; Higgins and Kram, 2001). A viable approach to institutionalizing mentorship networks is to establish a mentorship committee for postdocs, similar to the dissertation committees that support PhD students or the advisory panels associated with National Institutes of Health (NIH) K-awards. As a component of the postdoctoral experience, PIs should assist scholars in identifying and engaging with suitable committee members. As noted by others, training for both postdocs and PIs (in the context of mentor training) will help with positive outcomes (Shuler *et al.*, 2021). Subramanian *et al.* also suggest increasing collaborations between PIs and career development educators (Subramanian *et al.*, 2022).

It has also become clear from this study that the lack of formal institutional mentorship training is a structural barrier impacting mentoring relationships and outcomes of postdoctoral fellows, especially from URGs. In fact, both WRG and URG postdocs stressed the importance of this. Due to training grant requirements and *train-the-trainer* resources such as those offered by the Center for the Improvement of Mentored Experience in Research (CIMER), many institutions are now offering some form of mentor training. These trainings can be effective, as shown by Christine Pfund and others (Pfund *et al.*, 2014; Risner *et al.*, 2020). However, large effects of mentor trainings were not reported by the postdocs in our focus groups. We think this is largely due to the medium and frequency of mentor trainings, the trainings having minimal effects on changing the culture of mentorship at institutions and the inability of the trainings to affect the behavior of PIs with poor mentoring practices. Mentor training must be coupled with policy change, "checks and balances" to protect trainees and incentives and awards to promote good mentoring and culture change.

Similarly, a lack of diversity, particularly among faculty, continues to impact mentoring outcomes. Institutions have long been aware of this recruitment challenge, but less conscious of the exclusive environment that some URG postdocs experience. At the very least, postdocs want to be supported and treated as equally as graduate students. However, for URG trainees, there can be a poor sense of belonging at academic institutions due to factors such as implicit bias, microaggressions and an overall inequitable lack of support in

their training. Moreover, higher levels of mentor-mentee psychological similarity lead to higher levels of psychosocial support, relationship satisfaction and publications (i.e. Hispanic trainees with a Hispanic faculty mentor report engaging in more coauthoring opportunities than peers with non-Hispanic mentors) (Pedersen *et al.*, 2022). Some institutions have required diversity and/or implicit bias trainings for their staff, trainees and faculty. Others have also created cohort programs specifically for postdocs such as Institutional Research and Academic Career Development Awards (IRACDA) and the Carolina Postdoctoral Program for Faculty Diversity to help with both a sense of belonging and skill development toward faculty careers. The key feature of the NIH IRACDA program is that it combines postdoctoral research training with teaching experience, aiming to prepare scientists for a diverse range of academic careers. These efforts should be widely embraced among a myriad of tools to improve mentoring and diversity for postdoctoral trainees.

One unexpected and striking outcome of this study was the acknowledgment by many postdocs, especially those from URGs, that they sought or appreciated more nurturing mentors. These were mentors who often gave positive feedback, helped build their confidence, understood their values and demonstrated patience and understanding. For URG postdocs, they often found these characteristics in URG faculty mentors (or other peers). Thus, there was an affinity for women or underrepresented racial and ethnic group (African American/black, American Indian and Alaska Native, Hispanic/Latinx, Native Hawaiian and other Pacific Islander) mentors. Many URG postdocs were accustomed to nurturing URG mentors, due to the role that these types of mentors had played in their academic and scientific development. One postdoc was even surprised after joining the lab of a URG faculty member and realizing he was not as "nurturing" as she had hoped. She noted how he was not someone who gave a lot of positive feedback; however, she admitted that he kept her focused on the skills she needed to develop to be successful, such as focusing on grant writing and not getting too distracted by non-relevant (scientific or non-scientific) activities. Overall, postdocs derived a lot of motivation from nurturing mentors and often desired to make them proud.

Not all URG postdocs sought nurturing mentors, however. Some noted a historic lack of access to strong mentors in their journeys and scientific development and largely were able to "pull themselves up by their bootstraps." They did not attribute their success to effective mentorship, rather to hard work alone. The common themes between postdocs seeking nurturing mentors and those who attribute their success (thus far) to hard work were the barriers and hardships that both groups have had to overcome to reach this point in their training. These hardships were not unique to URGs and were found among international postdocs, first-generation and other often marginalized groups. To address this, postdocs suggested less reliance on one mentor and instead encouraged building a mentor network or team of mentors to foster success. There is a growing body of literature that shows that having a personal network of mentors improves retention in research careers (National Academies of Sciences *et al.*, 2019; Haeger and Fresquez, 2016). What is not clear, however, are the aspects of a mentoring network that are critical for the success of underrepresented early career researchers, and how URGs break into or create these networks.

The present study has some limitations. Though participants were diverse in terms of gender, race/ethnicity and training stage, our sample size was relatively small compared to the available pool of biomedical postdocs and did not represent the entire range of gender and racial/ethnic diversity in the USA. We also were not successful in recruiting postdocs from historically black colleges and universities for this study. It has been shown that

investigators at minority-serving institutions often have less access to collaborators and departmental colleagues with federal funding (Hemming *et al.*, 2019). Thus, we did not gain further insight into the structural mentoring barriers faced at minority-serving institutions. Furthermore, trainees were asked about the totality of their academic experiences rather than focusing specifically on aspects of mentorship only. Although we coded all of the data and observed data saturation, it is possible that we could have missed opportunities for postdocs to delve further into their mentoring experiences during the focus group. This work was a follow-up study conducted to inform unanswered questions for a larger survey study that assessed the factors that influenced postdocs' career decisions by race/ethnicity and gender.

In this manuscript, we discussed the major systemic, institutional, interpersonal and individual mentoring barriers faced by postdoctoral trainees and possible solutions. Overall, postdocs point out missed opportunities for mentorship and an overall lack of support for trainees at their stage. Not all PIs know how to be great mentors, but an understanding of the larger factors affecting mentoring outcomes, as outlined here, can help to enhance the culture of effective mentorship not just for postdocs, but other trainees as well. Many of the barriers outlined in this paper are generalizable to undergraduate, graduate and medical students. Moreover, academic institutions are not the only types of institutions that have the power to influence mentoring outcomes. We hope this social-ecological approach to understanding mentorship barriers provides a framework for improved mentoring outcomes for all types of institutions.

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Corresponding author
W. Marcus Lambert can be contacted at: marcus.lambert@downstate.edu