Examining the Effects of STEM Climate on the Mental Health of Graduate Women from Diverse Racial/Ethnic Backgrounds

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The current state of mental health needs among graduate students is a growing crisis worldwide (Evans, Bira, Gastelum, Weiss, & Vanderford, 2018; Hyun, Quinn, Madon, & Lustig, 2006). A recent study of 2,279 individuals (90% PhD students and 10% Master's students) from 26 countries found that graduate students were more than six times as likely to experience depression and anxiety than the general population, with 39% reporting moderate-severe depression and 41% reporting moderate-severe anxiety (Evans et al., 2018). These global trends are also evident among graduate students in the United States. A study conducted at the University of California Irvine revealed that over the prior 12 months, 9.9% of the graduate students had considered suicide (Louden & Skeem, 2008). Graduate students within science, technology, engineering, and mathematics (STEM) disciplines appear to be at an especially high risk for experiencing mental health concerns (Deziel, Olawo, Truchon, & Golab, 2013; Saravanan & Wilks, 2014; UC Berkeley Graduate Assembly, 2014). A 2014 report from the University of California Berkeley found that 43-46% of bioscience graduate students experienced depression during their graduate studies (UC Berkeley Graduate Assembly, 2014). These concerns are especially salient for women in STEM, with evidence suggesting higher levels of stress and anxiety, and lower overall mental health in comparison to their male counterparts (Deziel et al., 2013; Saravanan & Wilks, 2014). Although these studies highlight the growing mental health concerns among graduate students in STEM within the United States, more research is needed to better understand the ways in which chilly STEM climate influences students' mental health, particularly students who are underrepresented in STEM (i.e., women, women of color, etc.).

Women from diverse racial/ethnic backgrounds – women who identify as Black, Latina, White, Asian, Indigenous, and Bi/Multi-racial – encounter rampant acts of sexism, microaggressions, and racism in STEM (Ong et al, 2017). According to Ong et al. (2017), microaggressions experienced within the STEM environment, such as having one's presence and abilities questioned, and racialized and gendered harassment, can contribute to feelings of isolation, a decreased sense of belonging within one's program, and in turn greater intentions to discontinue STEM graduate programs (Ong et al., 2017). However, there is a paucity of research that have examined the impact of these experiences on the mental health of women in STEM and in turn their STEM persistence (Cabay, Bernstein, Rivers, & Fabert, 2018; Mcgee & Bentley, 2017; Ong, Smith, & Ko, 2017; Ong, Wright, Espinosa, & Orfield, 2011). Navigating the rigor of STEM programs is difficult in and of itself, but to do so while also contending with gendered and racialized encounters and widely unsupportive STEM environments can be unduly challenging. The multiplicative toll of these encounters can increase the likelihood of experiencing symptoms of anxiety, depression, stress, and overwhelm. To address this gap in the literature, the current study examined the ways in which STEM environments influenced the mental health and wellbeing of U.S.-based STEM graduate women from diverse racial/ethnic backgrounds and the potential impact these concerns had on students' academic persistence.

Theoretical Framework

Social Cognitive Career Theory (SCCT: Lent, Brown, & Hackett, 1994) provides a theoretical foundation for the current research. SCCT is a widely studied framework used to

explain educational and career persistence intentions in higher education. Among its applications, SCCT has been employed in empirical examinations of persistence intentions among women and students of color in STEM (e.g., Byars-Winston, Estrada, Howard, Davis & Zalapa, 2010; Lee, Flores, Navarro, & Kanagui-Munoz, 2015; Navarro, Flores, Lee, & Gonzalez, 2014). The key predictive elements in SCCT include self-efficacy (confidence in one's ability to successfully perform a task), outcome expectations (beliefs about the consequences of performing specific behaviors), and contextual factors (environmental supports and barriers). Regarding the latter, contextual factors, SCCT posits that these factors can either enhance or constrain educational and career progress (Lent, Brown & Hackett, 2000). To date, limited attention has been given to examining the impact of barriers such as institutional structures and STEM departmental climate on the mental health of women in STEM and in turn on STEM persistence. The advancement of women in STEM hinges on identifying, understanding, and combating the underlying factors that contribute to early departures from STEM doctoral programs. Therefore, this paper illuminates the ways in which STEM environments impact the mental health and wellbeing of STEM graduate women from diverse racial/ethnic backgrounds and the potential impact of these concerns on academic persistence. The work presented here is part of a larger NSF-supported study within the *Career*WISE research program (CW), that focuses on understanding and strengthening the persistence of women in STEM doctoral programs (Bekki, Smith, Bernstein, & Harrison, 2013; Bernstein, 2011).

Methods

Procedure

The data used in the current study are drawn from a larger study of 33 women interviewed to date. Eligible participants for this larger study were women who identified as Black/African American, LatinX, and White/Caucasian who either completed STEM doctoral degrees or chose to leave prior to completion since 2015. Participants who completed their degrees were recruited from avenues such as academic departments, while participants who discontinued their STEM PhD programs were recruited using methods such as snowball sampling. All participants received a $50 gift card upon completion of their participation.

Participants first completed a screening and demographic survey, followed by a 60 to 90-minute semi-structured interview via the Zoom video conferencing platform. Five questions and related probes were designed to elicit participants' perceptions of support and barriers encountered during their STEM doctoral programs.

Participants

The data reported here focuses on the experiences of six participants randomly selected from the broader study sample, two of whom completed their doctoral degree and four of whom chose to discontinue their STEM PhD program since 2015. These six participants attended five different universities from across the United States and represented five STEM disciplines. Participants self-reported their race/ethnicity as White/Caucasian (N = 3), Black/African American (N = 1), Hispanic/LatinX (N = 1) and mixed race (N = 1). Participant demographic information is included in Table 1.

Table 1

Participant Demographic Information

Pseudonym	Race/Ethnicity	PhD Completion Status	Degree Field
Becky	European American/White	Completed	Engineering
Giselle	Hispanic/LatinX	Did not complete	Biological Sciences
Tiara	Black/African American, European American/White	Completed	Mathematics
Angela	Black/African American	Did not complete	Engineering
Erin	European American/White	Did not complete	Physical Sciences
Nadia	European American/White	Did not complete	Engineering

Analysis Plans

A constant-comparative, open coding process was used to identify meaning units of data (statements or examples) that represented each code (Glaser, 1965; Saldaña, 2014). First, meaningful units related to mental health challenges in the STEM environment were identified from the transcribed interviews with participants. Second, open coding was used to organize these meaningful units into themes along three dimensions: (a) difficulties in the STEM environment, (b) coping strategies, and (c) effect on students and STEM outcome. The organization of these themes formed the basis of the codebook for this study (See Table 2).

To establish interrater reliability between three members of the research team, Krippendorf's alpha (α) was calculated using the KALPHA SPSS macro (Hayes & Krippendorf, 2007). Krippendorf's α measures the degree of agreement in the application of a code to each individual unit of data on a scale of 1.000 (perfect agreement) to 0.000 (perfect disagreement). Values were determined to be acceptable if $\alpha > .67$. Using 1000 bootstrapped samples, the probability of failing to achieve a reliability of at least 0.67 was also calculated for each code, and p-values less than 0.05 were considered acceptable. Krippendorf's α values and *p*-values for each code are located in Table 2.

Table 2

Codes Used in Analysis and Interrater Reliability Values

Theme	Code	Definition	Krippendorf's alpha (α)	*p*-value

	Lack of interpersonal support in academic setting	Participant describes feeling unsupported by their professors, mentors/advisors, peers/friends, colleagues, or general program climate within the academic setting	0.796	0.006
	Difficult interpersonal interactions with peers, staff, post-doc, etc.	Participant describes difficult interpersonal interactions with program staff, professors, lab mates, or colleagues in academic setting	0.885	0.003
Difficulties in STEM Environment	Impact of Gendered, Racialized, & Cultural Encounters on Mental Health	Ways in which gendered, racialized, and cultural encounters in STEM influenced the onset or exacerbation of mental health concerns	0.922	0.000
	Academic Difficulties	Participant describes difficulties related to their academics and research	0.865	0.000
	Self-Doubt	Participant describes doubting their abilities in academic settings (e.g. imposter syndrome, lack of confidence)	0.884	0.000
Effect on Student Outcome	Impact on Mental Health	Participant states that they experienced mental health-related distress during doctoral studies and/or discusses cause of mental health-related distress	0.838	0.000
	Utilization of counseling services	Participant explicitly states that they utilized mental health counseling services during their doctoral studies, describes reasons for seeking counseling services, and/or discusses experience/impact of counseling	0.949	0.000

Coping Strategies and the lack thereof	Acknowledgement of discussing mental health concern in an academic setting	Data highlighting that a participant did discuss mental health concerns with advisor, PIs, program staff, professors, lab mates, or colleagues	0.912	0.000
	Acknowledgement of NOT discussing mental health concern in an academic setting	Data highlighting that a participant did not discuss mental health concerns with advisor, PIs, program staff, professors, lab mates, or colleagues	0.798	0.007
	Interpersonal support in academic setting	Participant describes receiving support from advisor, PIs, program staff, professors, lab mates, or colleagues in academic setting specifically related to mental health concern/distressing encounter	0.816	0.000
	Limited Awareness and Understanding of Effective Coping Strategies	Participant describes limited understanding and awareness of effective strategies to cope with distress	1.000	0.000

Results

Three overarching themes were identified from participants' responses: difficulties in the STEM environment, coping strategies, and the effect on students and STEM outcome.

Difficulties in the STEM Environment

Participants reported that difficulties in the STEM environment contributed to or exacerbated mental health concerns during their doctoral studies. Six categories of difficulties within the STEM environment were identified: lack of interpersonal support in the academic setting, difficult interpersonal interactions, gendered, racialized, and cultural encounters, academic difficulties, self-doubt, and limited awareness and understanding of effective coping strategies.

Lack of interpersonal support in the academic setting. All six participants reported that a lack of interpersonal support in the academic setting contributed to their decreased mental health. This lack of support existed across three groups of people: 1) professors, advisors, and mentors; 2) colleagues, peers, and friends; and 3) program climate. Becky described a negative interaction with a post doc in her lab that triggered a debilitating panic attack. She disclosed this to her advisor but felt unsupported by his response. She stated,

> I did tell my advisor the next day that I had [an] anxiety attack and … I remember leaving and thinking that I wish that I had gotten more support ...he did provide it to a certain extent but it wasn't to the extent that I felt like I needed.... for me the anxiety attack really was a terrifying ordeal and I remember thinking that the way he reacted didn't seem as though it was in proportion to what I had been feeling at the time.

Angela described feeling unsupported by members of her lab after witnessing police violence towards Black individuals in the media. She recalled,

> It was hard to go back to the lab when I'm in an environment where everyone else in the lab, whether they be international students or just people who aren't getting the same type of social media, barraged with the same imagery when they log into Facebook or when they log into Instagram or Twitter. I didn't feel like they empathized or could really understand what it felt like to feel so insignificant, even though we're both pursuing the same type of degree… I feel like they couldn't understand what it was I had to bring with me emotionally every day. That was a really discouraging time.

Witnessing unsupportive interactions experienced by other students also impacted participants' perceptions of support. For example, Erin reported that other female colleagues' experiences caused her to lose trust in her program and contributed to an unsupportive climate. She stated,

> Some of my fellow female students have encountered some issues that I feel reflect poorly on the program and has kind of made me lose a little bit of respect, a little bit of faith in what they're doing. And them not being supported kind of makes me feel like… if I needed to go to them for something, that I would not be supported either.

Regardless of where mental health concerns originated, a lack of support in the academic setting had the potential to negatively impact participants' mental and emotional wellbeing.

Difficult interpersonal interactions. All six participants reported experiencing difficult interpersonal interactions in the academic setting, such as hurtful or dismissive comments, language and communication difficulties, and stalking/harassment. For example, Becky described how a negative interaction with a postdoc in her lab contributed to persistent feelings of anxiety. She stated,

> There was a period during the fourth year of my PhD where I had talked to a new postdoc who had joined the lab and he wasn't feeling very confident in my results… That conversation filled me with so much anxiety, I had an anxiety attack that night… I had like a lot of anxiety presenting my data at lab meetings because I knew this postdoc was going to be harassing me.

Additionally, Nadia reported that being stalked and harassed by members of her program contributed to her experience of anxiety and depression. She recalled,

> At that time…some students were harassing me and stalking me… it was emotionally and mentally putting me under pressure in the sense that I was feeling like some people

> who are stalking me everywhere and they are trying to sabotage my relationship and put me in a vulnerable position … it was a very traumatic situation for me and it was a factor of why I was diagnosed with depression and anxiety.

These difficult interpersonal interactions were sometimes so impactful that they interfered with participants' academic progress. Giselle reported that she chose to leave her lab after negative interactions with professors in which her concerns about the validity of data were dismissed. She explained,

> I presented it to my PI… And he said, 'Prove it to me.' I was like, 'I'm giving you some computer data, but I would need thousands of dollars and machinery that we don't have to prove you that I think this is wrong.' He said, 'No, no, prove it to me. Come with a plan and prove it to me.'…And then I talked to the associate professor, and of course she was like, 'Oh, no, no, no. Maybe you're wrong. We are right.' And it was just so frustrating, so frustrating. And I can't remember exactly when I left, but then I said, 'I can't do this [any]more. I cannot do it because I don't feel comfortable with the data.'

These salient experiences had the potential to negatively impact participants' mental health, their sense of safety and security, and their persistence within their academic programs.

Impact of gendered, racialized, and cultural encounters on mental health. All six participants reported that they experienced gendered, racialized, and cultural encounters during their doctoral studies that negatively impacted their sense of wellbeing. These experiences included derogatory and dismissive comments, microaggressions, and internalized pressure to represent their race or gender. Some participants experienced these situations firsthand, while other participants observed these encounters within their academic department at large. For example, Giselle recounted multiple experiences in which she and other international students were publicly criticized for their word pronunciations. She stated,

> I remember personally one of my PIs rotation, he stopped me in the middle of a presentation to correct me on how to say a word, like, 'We don't say that word. That's not how you say it. This is how you say it'… It caught me off guard. And it didn't only happen to me. It happened to my friends, like I said, one of the girls from [country in Asia], she was told in her feedback, 'Oh, you need to improve your English. It's very distracting.' Then the question is, 'You understood the data?' [He said,] 'Oh, yeah.'

Additionally, Tiara experienced microaggressions from her cohort that negatively impacted her confidence. She reported,

> There was at least one person in my cohort who jokingly said, essentially, that I only got into the program because I was a Black woman. Adding to that, that I had failed Q1 and somehow still stuck around, it was just like another stab at that confidence, like you don't actually belong here. You're only here to fill the quota.

Participants also described feeling internalized pressure to act as a representative of their race and gender. When asked about the impact of these identities on her experiences, Tiara stated, "It was more pressure about being a black female in STEM. Most of the pressure just came

internally." Angela also expressed that she struggled with the decision to leave her program as a result of this pressure. She reported,

> Having come up through my undergrad program where it was drilled into us how important it is to have this minority PhD pipeline, and how gruesome the statistics are on Black representation, that was a motivator for me not to [leave]. Because we need women, like Black women PhDs, like we need those… That was something that I was afraid and like, 'Oh, I've let down the culture. [But] I just, I can't do it, and I'm so sorry guys.

These gendered, racialized, and cultural experiences significantly impacted participants' sense of belonging, self-worth, and overall wellbeing during their doctoral studies.

Academic difficulties. All six participants reported that academic difficulties, such as comprehensive exams, coursework, dissertation progress, and research difficulties, contributed to their decreased mental health. For example, Tiara reported that her self-esteem suffered after failing her first qualifying exam. She stated,

> Early on at the beginning of my second year of the program, we had our first qualifying exam and I failed it. That sort of destroyed me… I guess I defined myself by my academic success and like that definition of me just crumbled.

Participants also reported struggling to balance academic tasks with caring for their mental health. For example, Erin reported that she delayed taking her comprehensive exams as a result of prioritizing self-care. She explained,

> In undergrad, I had gotten to a pretty bad place not taking enough time for self-care so I promised myself when I went to grad school that I wouldn't repeat that mistake. So, I really took a couple months to make sure I developed some of that self-care in grad school. That delayed me probably about four months or so, so when it came time to do my comprehensive exams, I went to my advisor in early January. I was supposed to take my comprehensive exams that April. I told him, 'I'm not ready for this. I need more time.' That was kind of its own setback.

The impact of academic difficulties on participants' mental health also had the potential to interfere with degree progress. In Angela's case, difficulties related to her dissertation led to feelings of discouragement and ultimately contributed to her decision to discontinue her program. She reported,

> I really didn't have the [physical science] background…It was just completely foreign to me, and it was discouraging because I'm like, 'How will I ever be able to make a contribution if I'm still on the catch-up game?' That really made me doubt my ability to craft a dissertation that was going to actually pass… That was a huge weight and a huge… source of discouragement for me, and ultimately was my choice to leave.

These academic difficulties took a toll on participants' mental health, sometimes to the extent of interfering with participants' persistence in their doctoral studies.

Self-doubt. All six participants reported that feelings of self-doubt during their doctoral studies had a negative impact on their mental health. Participants' experiences of self-doubt included feelings of inadequacy or incompetency, lack of belonging, and imposter syndrome. Tiara reported that she experienced feelings of self-doubt and symptoms of depression, even after passing her qualifying exams. She stated, "[I] passed it, but I was still, it just took a hit for the confidence. I just didn't feel like I was capable of doing the program anymore."

Self-doubt also prevented participants from seeking support from the people around them. For example, Becky reported that she struggled to communicate her needs due to her feelings of imposter syndrome and concerns about how she would be perceived. She stated,

> I suffer from imposter syndrome and so... sometimes I'll feel as though everyone else knows something and that I'm the one person in the room who doesn't know it or I don't want to appear as though I'm not thinking as critically as other people or I'm not as smart as other people... I think that there was a lot of times in my PhD that I did not fully communicate what I needed because I was afraid of being thought of as not as intelligent, not a good scientist, so on and so forth.

Participants' self-doubt also had the potential to impact persistence in their doctoral studies. For example, Giselle reported that feelings of worthlessness and inadequacy contributed to her decision to leave her program. When asked about her thoughts and feelings at this time, she recalled, "I wasn't worth it, like maybe I'm not smart enough, maybe I wasn't good enough, maybe I'm just not cut [out] for it… I just thought I couldn't make it. And I thought that I couldn't be a scientist. That was it." These feelings of self-doubt contributed to participants' psychological distress and often had the potential to interfere with degree completion.

Effect on Students and STEM Outcome

The process of navigating negative STEM encounters took a significant toll on students' mental health and in turn their STEM persistence.

Impact on Mental Health. All six participants described experiencing a myriad of interactions in their STEM environments that caused or contributed to increased distress. Salient among them were academic challenges. Given their record of success, participants not only had a hard time digesting these academic difficulties but also struggled with integrating these challenges with their identities. Tiara stated that failing her qualifying exams "destroyed" her. She went on to share,

> I was one of like three people who failed the qualifying exam out of 30 who took it. But having never failed anything in my life, I was just like, "Oh, this is the end of everything." I didn't expect it to hit me as hard as it did but I ended up in a depression…I lost like 15 to 20 pounds over the course of the month because I was so anxious I couldn't keep any food down. I would just throw it up like half hour after eating it. I was just crying nonstop.

Even after passing her qualifying exam the second time around, Tiara continued to feel depressed and unmotivated. She shared,

> I had hoped that passing the exam would help but literally every time I would start an assignment or go to a certain assignment, I would just cry for like two hours and then go to bed. It was just so hard to get motivated to do things.

Giselle echoed similar sentiments and noted that the culmination of these academic challenges was debilitating to her wellbeing. She too described experiences of panic attacks and depressive symptoms. Nadia described a turning point when she became concerned about her mental health. She recalled saying to herself, "This is really mentally affecting me." Erin noticed the toll that graduate school had on her mental health and attributed this to the lack of preparation on the part of advisors and mentors. She stated,

> I had realized the mental and emotional toll that grad school was heaping on [me], honestly, unrealistic level[s] of expectations, the multiple projects, and the teaching, and still dealing with personal life, and all while being thrown in the deep end. No one actually ever teaches you how to do research. You just kind of sink or swim.

Giselle's increased mental distress led to her decision to take a leave of absence. She shared,

> I had to take a leave of absence, because I couldn't deal with it. I had to take a break… if I had not left, I would have probably start considering suicide, just because it was overwhelming.

Erin also choose to delay her academic milestones to take care of her wellbeing. She stated, "I can't push off my own mental and physical health, so my comprehensive exams got pushed off." Even after deciding to discontinue her Ph.D program, Giselle noted that the trauma she endured during her program continued to have lasting effects. She stated,

> [Even] after I left grad school, I would wake up screaming. And it was the worst thing… when I think about it, it's not traumatic like being beaten or tortured. It was different. [But] it messed me up.

It is evident from these participants' experiences that STEM environments, interactions with colleagues in STEM, and the academic challenges that accompany the graduate work take a significant toll on students' mental health and wellbeing. The effect stems from both one-time encounters as well as the culmination of multiple negative encounters. Further, these effects are debilitating and long lasting.

Coping Strategies and the Lack Thereof

When faced with mental health concerns during their doctoral studies, some participants described utilizing various strategies to cope. Five of these strategies included: utilization of counseling services, discussing (or not discussing) mental health concerns in the academic environment, and interpersonal support in the academic setting. While some students identified avenues to cope with mental health concerns, others described unfamiliarity with resources and strategies to alleviate their distress. These experiences were discussed in theme Limited Awareness and Understanding of Effective Coping Strategies.

Utilization of Counseling Services. All of the participants explicitly discussed utilizing counseling services in response to their mental health concerns. Nadia, Tiara, and Giselle specifically commented that they utilized the counseling services available on their campuses. Giselle shared that "The university health services has a really good counseling program… I think I owe them… just probably not to have gone to extremes through my depression." Tiara also ultimately used the counseling services at her campus to help with her anxiety. She shared,

> It still took another few months to finally reach out to the counseling center again, to seek counseling… I think I got to a point where I realized I really needed help. I appreciated it. I appreciated it more after the fact but there is still a component of like, "Why couldn't I just do this myself? Why couldn't I just snap out of it? But I came to appreciate it… It was weird but it was really great.

Becky, Erin, and Angela utilized counseling, but did not explicitly specify that it was from the university counseling center. For example, in response to the mental distress she was experiencing, Angela reported that she " was already in counseling at the time, and so it was something that I was able to go to my counselor and vent and emote with her." Erin shared some of the academic stressors she was experiencing that motivated her to seek counseling support. She stated,

> I went through probably a six-month to a year-long span, a little bit before, and then a couple months after my qualifying exams, figuring out what I wanted to do and how I would do it. Probably the most difficult part of that decision was really the feeling of failure, feeling like even though I was making an active cost-benefit decision [that] the PhD was not worth the emotional, mental cost when I did not need it, it still felt like a failure to switch from a PhD to a master's. That was the second time I went to counseling. I was just kind of working through those feelings of failure, even though it was an active decision.

All the participants expressed that they found the utilization of counseling to be helpful. Becky, for example, described how going to counseling in response to the anxiety attacks she had experienced in her research laboratory, gave her useful tools. She shared,

> I did feel as though I was able to get good insights. He showed me how to like if I had another anxiety attack, breathing mechanisms that I could do to kind of stimulate my parasympathetic system and slow my heart rate and stuff like that, calm my system down.

Erin also described two of the specific tools that she found helpful in counseling in the following quote,

> I actually ended up attending counseling [o]n two separate occasions…we just focused on identifying what I could control and what I can't control. Things I can control for example are, to a certain extent, when my qualifying exams are. Right? …For the times that I had … panic attacks, I had to learn breathing techniques and the [counseling center] helped me with that. Like how to cut a thought, because most of it is my body just reacting to a thought.

Finally, Nadia shared her experiences with counseling in response to the stalking she experienced.

> When I was going to [a] counselor, she was teaching me skills that was helpful for me to basically overcome the situation or basically to meditate or how to be aware and conscious about my feelings and my emotions and how to not have overthinking and how to handle my situation and my stress...So, my counselor was providing support in the sense that emotionally giving some advice, what I can do, how can I help myself to move forward, what other things that can be motivating for me at this point of time.

Acknowledgement of Discussing Mental Health Concern in an Academic Setting. All six of the participants confirmed that they chose to discuss their mental health concerns in an academic setting. These conversations occurred with advisors, PIs, program staff, professors, lab mates, and colleagues. During a challenging time in her program, Becky disclosed a recent anxiety attack to her lab mate. However, she decided against discussing the attack in detail because she felt "inferior" to this particular student, whose work was progressing quicker than Becky's. Although she shared minimal details of her attack, Becky felt supported by her friend and referred to her as "very good supportive friend."

Giselle shared related difficulties working with her advisor and her lab mates. She was so invested in her research that she limited her time for family. Unfortunately, her mother passed away during her second rotation. Giselle had a strong relationship with a program director at her university, and she discussed her personal and academic challenges with her. The program director made Giselle feel very comfortable. Giselle stated, "she would always have her door open, figuratively and literally, and she would always say, "Come to my office if you need me. I'll listen to you." She would literally listen."

Erin received similar support from her advisor. She struggled with anxiety in undergrad and it persisted into graduate school. Her anxiety challenges became very apparent before her initial scheduled comprehensive exams. She immediately sought out her advisor and told him "I'm not ready for this. I need more time." He supported her and helped her to get an extension.

Angela had someone outside of her advisor with whom she shared details of situations occurring in her life that increased her anxiety. Angela stated that she had a strong bond with one of the program administrators at her university and shared,

> I didn't want to take those kind of things to my advisor, not on a regular basis. And so having someone who knew me academically and also knew me personally, like that was really important.

Angela, like other study participants, benefitted from having individuals in their academic STEM environments with whom they could share their mental health struggles.

Acknowledgement of NOT Discussing Mental Health Concern in an Academic Setting. There were various reasons why these STEM doctoral women chose not to discuss their mental health challenges with others. For example, Becky was impacted by the gender and race of her two lab mates with whom she chose not to discuss her struggles. She explained,

> The guys that I did not seek help from were both white males. I do think that the fact that they were white males played a role on why I didn't seek their support. I think it had to do with the fact that ... I don't know there's almost aggression that I perceived being part of their personalities. I don't know if aggression is the right word. Lack of humility...a little bit of arrogance... the way that they look at the world was the right way and was the [only] way to look at the world. Yeah, I think that that kind of play[ed] into it, to an extent.

Becky felt like they were too "arrogant" for her to disclose personal information. Erin was uncomfortable with talking to her advisor because she was unsure about how he would respond. "I didn't want to talk to my advisor about it because I was still working through my own feelings of feeling like I had failed in some way or like I was running away, and I was not certain of his response," added Erin.

Tiara failed her qualifying exams and slipped into a depression. She attempted to go to the counseling center, but they did not have immediate availability, and then Tiara became discouraged. Like Erin, Tiara also decided against sharing these difficult moments tied to mental health with her advisor. Giselle thought she had to be "strong," which prevented her from talking to her PI when she hit a rough patch. Similarly, Angela regarded her advisor as "disingenuous," which is why she refrained from sharing her struggles with him. There were a number of reasons why these participants did not feel comfortable discussing their mental health challenges. Having a better understanding of these will make us more aware of what they need to be successful.

Interpersonal Support in the Academic Setting. Participants received interpersonal support from a variety of sources in their academic settings, including advisors, friends, and university staff members. Advisors, for example, were frequently mentioned by participants for providing both instrumental and psychosocial support to participants in response to mental health challenges. Psychosocial, or emotional support from advisors was received extremely positively by participants. Becky, for example, had experienced anxiety about conducting some of the experimental tasks required of her in her research lab. She describes her advisor's support in response to this as follows.

> I think it was his optimism in me, is probably what encouraged me because I think he was pretty good at projecting optimism and saying, I think you can do this at this point and also, making certain that I knew that it was okay to make mistakes, he wasn't going to be angry or anything like that. I think the combination of those two, kind of helped me to just move forward and work with experiments.

Similarly, Erin described the impact of the emotional support provided to her by her advisor while she was experiencing a very stressful time with a family situation, which in turn impacted her mental health.

> One moment. I'm tearing up a little bit. I think really knowing that he cared about my personal and mental wellbeing as well as my academic performance was probably the most powerful part of that support.

Another critical source of support for participants was their academic peers at the university. Giselle, for example, talked about the support she received from her friends. She shared,

> One of the things I liked was there was a lot of students from different backgrounds. And the reason I say this, my best friends from there were my peers, so there were three girls that I became friends with, and we would talk about this and we would cry and do everything... Their words of support to me [meant] that I didn't feel like I was crazy. Like if I look around and I said, "Am I crazy, or is this happening?" then they're like, "No, Giselle, it's happening." And we shared similar struggles. Language struggles. Cultural struggles.

Nadia also talked about receiving support from her friends. She stated,

> They were just able to [give me] some advice me on how to handle the situation and sometimes they were just listening to me and they were able to confirm or validate my feelings that the situation is complicated, it's hard, it's a hard position, it's a tough position to be at. I feel like helping me, giving advice and validating my feelings and just listening to me...

Finally, several participants also described the importance of support from university staff members during their times of distress. Angela, for example, described the emotional support she received from a staff person in the office of graduate education at her doctoral institution.

> I knew that she...understood what it is I came for and what it is I needed in terms of support because it's not just, oh, here's an article on how to write a good abstract. That's not the kind of support I needed. I needed something deeper and more personal. I did talk to her because I felt safe with her, and I knew that she cared, and that's demonstrated by her actions and her passions. When I talked to her about it, she had given me some advice. Largely what she did was listen, which was all I really needed for someone to do.

Nadia also commented on the instrumental support she received from a school official in reshaping her working environment as she dealt with the difficult decision of leaving her program and also supporting her mental health.

> I talked to a student school official with my advisor and my counselor so I was like, "I can't really handle this situation anymore." I think at that time because they were already aware of my difficulties, they agreed to my decision because most of the time when a PhD student says, "I don't want to continue," the school doesn't really agree and they try to push students who are finishing, [to] completing the program. But for my case, because I was mentally affected by that, I was really exhausted. I feel like I needed a break from the environment and it seemed they kind of agreed to leave the program so then I left my lab. I was just TAing and I was not going to the lab or not interacting with my advisor and I feel like that helped. I just had a break and then I was able to spend some time off and evaluate my situation.

Limited Awareness and Understanding of Effective Coping Strategies. Although some of the participants had lab mates, advisors, PI's, family, or friends with whom they could discuss

their mental health challenges, others were not aware of coping mechanisms and resources or were uncomfortable discussing their past with others. Becky disclosed, “I wasn’t fully aware of the resources that existed”. Tiara was in her sixth year of her program before she realized that there were communities that she could seek support from within her university. Giselle left her doctoral program before she discovered what and who she needed to be connected with in order to persist. She shared,

> I also think mental health, like even if you don't feel like you're depressed, talking about it with professionals, mental health professionals, can help prevent thoughts that sometimes are just artificial, that may not have a basis, like, ‘Giselle, you're not good.’ Well, where is that coming from? You are good. You got accepted into a program. What is it? What is causing that? So, if I had an earlier intervention on that, I would have been doing that.

Like Giselle, Angela left her doctoral program. She disclosed,

> I had my struggle with depression, and I didn't understand it, and I didn't know how to communicate it. I didn't know how to deal with that. Just a lack of awareness and the lack of self-care damaged me in that regard.

These women shared experiences of having limited understanding and awareness of effective strategies to cope with stress. Sometimes, their lack of awareness resulted in persistence, and other times, it did not.

Summary

Taken together, these results highlight the ways in which STEM environments impact the mental health of graduate women from diverse/racial ethnic backgrounds. As anticipated counseling services seemed to be a helpful resource, but support from within the STEM environments, particularly from advisors, were regarded as very helpful.

Discussion

The current study sought to examine the ways in which STEM environments impact the mental health and wellbeing of graduate women from diverse racial/ethnic backgrounds. Additionally, we sought to understand the ways in which participant’s mental health concerns had the potential to impact persistence in their degree programs. Prior research on graduate student mental health has focused primarily on the prevalence of mental health concerns within this population, suggesting a growing need to address the mental and emotional wellbeing of graduate students. However, in order to address this growing need, it is essential to understand the factors that contribute to these mental health challenges. Furthermore, given the high prevalence of mental health concerns within STEM populations (Deziel, Olawo, Truchon, & Golab, 2013; Saravanan & Wilks, 2014; UC Berkeley Graduate Assembly, 2014), it is especially important to consider the impact of the academic climate on graduate student mental health.

The findings of the present study suggest that the STEM environment can have a profound and lasting impact on the mental health and wellbeing of graduate women in STEM.

All six participants endorsed experiencing depression, anxiety, and panic attacks during their doctoral studies, and directly linked these mental health concerns to experiences in their doctoral programs. Six types of difficulties within the STEM environment were identified as factors that contributed to or exacerbated participants' mental health concerns. These included a lack of interpersonal support in the academic setting, difficult interpersonal interactions, gendered, racialized, and cultural encounters, academic difficulties, and self-doubt. These difficulties were prevalent amongst those who left their programs as well as those who completed.

Not only were these adverse STEM encounters detrimental to graduate women's mental health, they were also shown to impede persistence. Participants reported that the emotional impact of challenges within the academic setting, specifically difficult interpersonal interactions, academic difficulties, and self-doubt, contributed to their decisions to leave their doctoral programs. Further, racialized, gendered, and cultural encounters negatively affected participants' sense of belonging, self-worth, and overall well-being. These difficulties contributed to participants' questioning their abilities to succeed in their degree programs, and in turn impeding persistence in their intended career trajectories. These results are consistent with the effects of contextual barriers within the SCCT framework (Fouad, et al., 2016).

Participants in this study also discussed the various ways that they coped with mental health challenges, including the utilization of counseling services, discussing (or not discussing) mental health concerns in the academic environment, and interpersonal support in the academic setting. Consistent with existing literature (Hyun et al., 2006), all six participants perceived the utilization of counseling services as helpful. Specifically, participants reported that they benefited from learning specific skills, as well as the emotional support that counseling provided. While this study did not assess the relationship between counseling services and persistence, these findings suggest that counseling may provide additional support for participants when they encounter challenges during their doctoral studies. Despite the benefits of counseling, at least one participant described dissatisfaction with the wait times to be seen by the university counseling center. This type of delay can also exacerbate mental health distress.

Coping also took the form of discussing (or not discussing) mental health challenges with others in the academic setting. All six participants reported that they discussed mental health concerns with individuals in their academic environment, including advisors, PIs, program staff, professors, lab mates, and colleagues. However, these interactions had the potential to either mitigate or exacerbate participants' mental health concerns. Participants who perceived these interactions as supportive described experiences of emotional support, such as encouraging words and actions, as well as instrumental support, or tangible, concrete assistance. Regardless of the type of support provided, participants noted the salient impact of feeling understood, listened to, and cared about in these interactions. Other participants described experiences in which they disclosed their mental health challenges within the academic setting and felt unsupported. In these instances, participants felt as though their concerns were dismissed or not taken seriously. This discouragement was amplified by a lack of awareness and understanding of mental health and the resources available.

Participants also reported instances in which they intentionally did not discuss mental health concerns within the academic setting. Some participants indicated that they were deterred from seeking support due to fear of how they would be perceived or how the person would respond. Others avoided discussing these concerns with certain individuals who they perceived as arrogant, aggressive, or disingenuous, or with whom they did not have shared racial, gender,

or cultural identities. Prime, Bernstein, Wilkins, and Bekki (2015) suggest that advisor support (or the lack thereof) in the midst of challenges can either support or hinder persistence in one's doctoral studies. This is consistent with the findings of the present study, which draws attention to the power held by those in academic positions to either support or discourage students who confide in them. Additionally, these findings highlight the responsibility of academic programs to cultivate spaces in which students feel that they can seek support when they are struggling mentally or emotionally.

Implications

The findings of this study suggest that difficulties within the academic setting can negatively impact the mental health and wellbeing of diverse women in STEM and can, in turn, interfere with academic persistence. This has important implications for both mental health practitioners and academic programs. Mental health professionals in college counseling centers should be informed of the unique challenges faced by diverse women in STEM and make extra efforts to ensure that this population is aware of the mental health services available to them. Additionally, when working with this population, practitioners should be aware of the potential impact of academic climate, especially racist and sexist interactions, on mental health concerns. Lastly, practitioners should consider facilitating support groups for women in STEM to provide additional social support as a buffer against negative experiences in the academic setting that have the potential to negatively impact psychological wellbeing.

These findings also have significant implications for academic programs. Given the prevalence of mental health concerns within graduate student populations, it is crucial that academic departments make students aware of available mental health resources and encourage students to seek additional support when concerns arise. Additionally, faculty members and administrators should be aware of the ways in which program climate can impact student wellbeing and success. With this awareness, programs can work to eradicate the negative encounters that deter wellbeing and provide support to students when mental health concerns arise. Lastly, programs should be conscious of the needs of diverse students and strive to create an environment that is respectful and supportive of various racial, gender, and cultural identities. Through the collaborative efforts of trained mental health professionals and academic departments, students may be better equipped to manage challenging situations, obtain support when mental health concerns arise, and ultimately persist in their intended career trajectories.

References

Bekki, J. M., Smith, M. L., Bernstein, B. L., & Harrison, C. J. (2013). Effects of an online personal resilience training program for women in STEM doctoral programs. *Journal of Women and Minorities in Science and Engineering*, 19, 17-35.

Bekki, J. M., Wilkins-Yel, K.G., Arnold, A. C., Francies, R. F., Coley, C. E., Bernstein, B. L., & Randall, A. K. (2020). Perceptions of advisor support for personal (vs. academic) issues: Understanding the differential experiences of women of color who completed STEM Ph.D. programs vs. those who chose to leave prior to completion. Paper accepted to *CoNECD: Collaborative Network for Computing & Engineering Diversity Conference*, Crystal City, VA.

Bernstein, B. L. (2011). Managing barriers and building supports in science and engineering doctoral programs: Conceptual underpinnings for a new online training program for women. *Journal of Women and Minorities in Science and Engineering*, 17(1), 29-50. doi:10.1615/jwomenminorscieneng.v17.i1.40

Bernstein, B. L., Jacobson, R., & Russo, N. F. (2010). Mentoring woman in context: Focus on science, technology, engineering, and mathematics fields. In C. A. Rayburn, F. L. Denmark, M. E. Reuder, & A. M. Austria (Eds.), *A handbook for women mentors: Transcending barriers of stereotype, race, and ethnicity* (pp. 43–64). Westport, CN: Praeger.

Byars-Winston, A., Estrada, Y., Howard, C., Davis, D., & Zalapa, J. (2010). Influence of social cognitive and ethnic variables on academic goals of underrepresented students in science and engineering: a multiple-groups analysis. *Journal of counseling psychology*, *57*(2), 205.

Cabay, M., Bernstein, B., Rivers, M., & Fabert, N. (2018). Chilly climates, balancing acts, and shifting pathways: What happens to women in STEM doctoral programs. *Social Sciences*, *7*(2), 23. doi: 10.3390/socsci7020023

Deziel, M., Olawo, D., Truchon, L., & Golab, L. (2013, July). Analyzing the mental health of engineering students using classification and regression. In *Educational Data Mining 2013*.

Evans, T. M., Bira, L., Gastelum, J. B. Weiss, L.T., & Vanderford, N. L. (2018) Evidence for a mental health crisis in graduate education. Nature Biotechnology, 36(3), 282-284.

Fouad, N., Santana, M., Lent, R., & Brown, S. (2017). SCCT and underrepresented populations in STEM fields: Moving the needle. *Journal of Career Assessment, 25*(1), 24-39.

Glasser, B. (1965), *The Constant Comparative Method of Qualitative Analysis in Social Problems*, 12(4), Berkeley, CA, University of California Press.

Golde, C. M. (2005). The role of the department and discipline in doctoral student attrition: Lessons from four departments. *The Journal of Higher Education, 76*(6), 669–700. doi: 10.1353/jhe.2005.0039

Hyun, J. K., Quinn, B. C., Madon, T., & Lustig, S. (2006). Graduate student mental health: Needs assessment and utilization of counseling services. Journal of College Student Development, 47(3), 247-266. doi:10.1353/csd.2006.0030

Lee, H. S., Flores, L. Y., Navarro, R. L., & Kanagui-Muñoz, M. (2015). A longitudinal test of social cognitive career theory's academic persistence model among Latino/a and White men and women engineering students. *Journal of Vocational Behavior, 88,* 95-103.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior, 45*(1), 79- 122. http://dx.doi.org/10.1006/jvbe.1994.1027

Louden, J. E. & Skeem, J. (2008) Results of UC Irvine survey of graduate students' mental health [PDF file]. Retrieved from https://www.grad.uci.edu/forms/current-student/SurveyResultsJS.pdf

Mcgee, E. O., & Bentley, L. (2017). The troubled success of black women in STEM. *Cognition and Instruction, 35*(4), 265–289. doi: 10.1080/07370008.2017.1355211

Mousavi, M., Sohrabpour, Z., Anderson, E., Stemig-Vindedahl, A., Golden, D., Christenson, G., & Bühlmann, P. (2018). Stress and mental health in graduate school: How student empowerment creates lasting change. *Journal of Chemical Education, 95*(11), 1939.

Navarro, R. L., Flores, L. Y., Lee, H. S., & Gonzalez, R. (2014). Testing a longitudinal social cognitive model of intended persistence with engineering students across gender and race/ethnicity. *Journal of Vocational Behavior*, *85*(1), 146-155.

Ong, M., Smith, J. M., & Ko, L. T. (2017). Counterspaces for women of color in STEM higher education: Marginal and central spaces for persistence and success. *Journal of Research in Science Teaching*, *55*(2), 206–245. doi: 10.1002/tea.21417

Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the Double Bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational Review*, *81*(2), 172–209. doi: 10.17763/haer.81.2.t022245n7x4752v2

Prime, D., Bernstein, B. B., Wilkins, K. G.**,** & Bekki, J. M. (2015). Measuring the advising alliance for female graduate students in science and engineering: An emerging structure. *Journal of Career Assessment,* 22, 1-15.

Saldaña J. Coding and analysis strategies. In: Leavy P, editor. *The Oxford handbook of qualitative research*. Oxford: Oxford University Press; 2014.

Saravanan, C., & Wilks, R. (2014). Medical students' experience of and reaction to stress: The role of depression and anxiety. The Scientific World Journal, 2014, 1-8. doi:10.1155/2014/737382

UC Berkeley Graduate Assembly (2014). Graduate student happiness and well-being report [PDF file]. Retrieved from http://ga.berkeley.edu/wellbeingreport/