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MAJOR ARTICLE

Positive factors related to graduate student mental health

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ABSTRACT

Objective: Graduate students report high levels of distress, levels that professionals are calling a mental health crisis. Researchers have identified several factors that may exacerbate student distress, but our objective was to assess positive aspects that may attenuate distress. **Methods:** Over 3600 graduate students from 10 campuses responded to questionnaires assessing depressive symptoms as well as both positive and negative aspects of their current lives. **Results:** Both negative factors (financial concerns, poor mentorship, and perceived institutional discrimination) and positive factors (social support, departmental social climate, and optimism about their career prospects) are related to depressive symptoms in the expected directions, although the positive factors have stronger effects. Further, positive factors buffer the effects of the negative aspects on depressive symptoms. **Conclusion:** Although findings are correlational and do not imply causation, results suggest potentially modifiable factors that universities should consider when considering graduate student well-being.

Addressing the graduate student mental health crisis

Over two decades ago, a study examining suicide rates among students in the Big Ten Universities found higher rates among graduate students than undergraduates.¹ This study received much attention, partially because the focus on mental distress in higher education is predominantly on undergraduate students.² A few studies have compared distress rates between undergraduate and graduate students with some studies suggesting that mental health concerns are sometimes higher among undergraduate students³ - but researchers argue that universities should recognize the needs of graduate students as well as identify the unique challenges that graduate school presents.^{4,5} A number of studies across North America, Europe and Australia have revealed high levels of distress among graduate students.^{2,6,7} Approximately 35% to 45% of surveyed graduate students report having had stress-related problems that interfered with their academics or well-being, or reported experiencing high levels of emotional exhaustion and feeling drained by work.^{2,8,9} One study found that graduate students believed that their mental health had declined over the course of their graduate studies,¹⁰ and another found that over a third of students sought help for anxiety or depression during their graduate school experience.¹¹ Overall, rates of selfreported depression and anxiety are six times higher among graduate students compared to those of the general

population⁶ and higher than their same-aged, college educated peers. ⁴ Given this accumulating evidence, The National Academies of Sciences, Engineering, and Education (2018) has called for universities to provide stronger support for graduate student mental health.¹²

Many studies have identified a number of negative factors for levels of distress related to institutional structure, financial hardship, the academic climate of the training program, and poor mentoring.^{2,6,12} Although a number of potential protective factors have also been enumerated, fewer studies have empirically tested the links between these positive factors and overall levels of distress. Moreover, no study has examined how hypothesized positive factors may buffer the effects of negative factors on levels of distress. Empirical investigations are critical for helping us to understand how best to decrease distress among graduate students. The current study examines positive factors that are associated with lower levels of depressive symptoms. In addition, we examine whether they serve to buffer the adverse effects of negative factors associated with higher levels of depressive symptoms among graduate students.

Negative factors

Many of the identified negative factors for distress among graduate students are similar to those faced by working adults outside of the academy, including financial concerns,

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conflicts with job supervisors, and discrimination.^{13,14} Among graduate students, researchers have long established a link between financial distress and poorer psychological functioning regardless of the area of study.^{6,15} In addition, graduate students who have less satisfying or positive advisor mentorships, or who meet less often with their advisors, tend to experience greater distress.^{2,6,8,16} The role of mentors varies across doctoral versus master's level programs, particularly for master's degree programs where students complete a final exam and not a master's thesis. In those types of degree programs, mentors are not as influential as they are for programs where students are dependent on a mentor's guidance and evaluation of their thesis. For students who report having a mentor, the quality of their relationship with this mentor is related to their well-being.⁶ In one study, for example, half of all graduate students who experienced moderate to severe anxiety or depressive symptoms felt that their advisor did not provide adequate mentorship, a finding noted for both doctoral and master's level students.⁶ Finally, graduate students who reported poor social climate in their department also reported lower motivation and participation.¹⁷ Graduate students have reported discrimination as a result of their gender,¹⁸ sexual orientation,¹⁹ and race or ethnicity,²⁰ In one study, more than half of graduate students reported experiencing discrimination in their graduate program.²¹ Regardless of the source of bias, perceived discrimination is related to high rates of distress.²

Positive factors

A growing number of studies have also begun to identify potential positive factors in graduate education that may reduce levels of distress. For example, many studies have found that social support, both from friends and family members, is related to lower levels of stress and increases in satisfaction.^{2,23} Similarly, feeling supported from the university is related to lower levels of distress and greater feelings of satisfaction.²⁴ Finally, feelings of optimism are consistently related to higher levels of well-being.23,25 A third of respondents in an international survey reported thinking that their graduate training would give them a significant career advantage,¹¹ although no study has examined the importance of feeling optimistic about future career prospects for graduate students' level of distress. Recent reports from the European Commission and the American National Academy of Sciences, Engineering and Medicine have highlighted the need to address concerns that doctoral training is too narrowly focused and lacks training for nonacademic careers.^{1,12,26} Given that graduate programs exist to train students for a wide range of career opportunities, we also examined whether optimistic attitudes about career prospects would be related to reductions in distress.

The current study

We sought to determine the relative importance of negative and positive factors for graduate student mental health as a

necessary first step to address the issue. To this aim, we surveyed over 3600 graduate students across the 10 University of California campuses, one of the largest public university systems in the United States. Participants included full-time doctoral students in social sciences, sciences and humanities, and master's students in academic (e.g., Master's in History) and professional programs (e.g., Masters in Business Administration). Students completed a Web-based survey that asked them about both negative and positive aspects of their graduate school experience. They also completed a validated 20-item questionnaire that assessed depressive symptoms (CESD-R²⁷). We examined whether positive aspects of the educational experience, including social support,² the social climate in their academic department,²⁸ and optimism about future career prospects,^{25,29} mitigated the adverse effects of negative factors on depressive symptoms. Negative factors included financial concerns, poor mentorship, and negative bias from their program (i.e., discrimination, or harassment). Because we included questions about mentors, only master's and doctoral students who reported having a mentor were included in the study.

Methods

Participants and procedure

From February through April of 2016, the University of California's (UC) Institutional Research and Academic Planning emailed a link to an online survey to graduate students across the 10 UC campuses.³⁰ The survey was based on the 2014 Berkeley Graduate Student Happiness & Well-Being Survey.²⁹ Over 13,400 students were invited to participate based on a stratified random sampling method that oversampled small sub-groups including underrepresented minority students. All campuses except one offered monetary compensation or iPad minis as incentives. The study was reviewed by a campus Institutional Review Board (IRB), which determined that the study posed minimal risks and fell into the exempt category.

Approximately 40% (N = 5,356) of invited students responded to the survey. Students who were in residency or professional Ph.D. programs (N=833) or who did not report the degree type they were pursuing (N=110) were excluded from the study. We also excluded any master's students (N = 432) or academic Ph.D. students (N = 181) who did not report having an advisor because we wanted to examine the factor of having an unsupportive mentor relationship. Master's students with an advisor did not report a different level of depressive symptoms than master's students without an advisor, t(1404) = 1.59, p = .11. Ph.D. students with an advisor did not report a different level of depressive symptoms than Ph.D. students without an advisor, t(2997) = 0.31, p = .76. Next, we excluded any students with missing values for the variables of interest. In terms of demographic variables, four students were excluded who did not report their sex at birth and 90 students were excluded who did not report whether they were an international student, because we wanted to examine the factors of sex and international student status. Five students were

Table 1. Participant characteristics (N = 3,679).

Variable	N
Gender	
Female	2,013
Male	1,666
Ethnicity	
Asian	932
Underrepresented minority	838
White	1,340
Other	569
Degree	
Academic Master's	419
Professional Master's	504
Academic Doctoral	2,756
Discipline	
Humanities	649
Social Sciences	670
STEM	1,519
Professional Field	748
Other	93

missing depressive symptoms scores. The most common missing risk/protective factor was social support (N=11), and 11 participants were missing either financial concerns, bias, or optimism. Participants of the current study included everyone who completed all the variables of interest, had an advisor, and who were either pursuing an academic doctoral degree (N=2,756), an academic master's degree (N=419), or a professional master's degree (N=504), resulting in 3,679 participants (see Table 1).

The majority of participants were female ($N_{\text{female}} = 2,013$; $N_{\text{male}} = 1,666$), identified as heterosexual (N = 3,043), and reported their ethnic origin as White (N = 1,340), followed by Asian (N = 932). Participants who reported their ethnicity as American Indian (N = 61), Black (N = 208), or Chicano or Latinx (N = 569) were included in an Underrepresented Ethnic Minority category, and 569 participants reported their ethnicity as Other/Unknown/Decline to state. Nearly a quarter of participants were international students (N = 840). About one-third (N = 1,211) were either married or in a domestic partnership), and the 10 participants who declined to report their relationship status were included in the group reporting that they were not married or in a domestic partnership.

Measures

Participants reported demographic information and measures in the order listed below. They also completed measures not included in the present study asking about life satisfaction, living conditions, sleep quality, physical health, progress in academic program, knowledge of campus resources, leisure activities, diet, drug use, religiosity/spirituality, growth mindset, commuting to campus, finances, disability, and their opinions about the funding of graduate student services.

Depressive symptoms

Depressive symptoms were assessed by the Center for Epidemiologic Studies Depression Scale Revised (CESD-R²⁷).

The CESD-R asks participants to rate the extent to which they experienced each of 20 symptoms in the past several weeks on a scale ranging from 1 (Not at all or less than one day in the last week) to 5 (Nearly every day for 2 weeks). Symptoms were based on the Diagnostic and Statistical Manual of Mental Disorders (5th Edition) criteria for a major depressive episode, including feelings of sadness and guilt, loss of interest in activities, fatigue, poor sleep and appetite, and suicidal ideation. To ensure that scores were consistent with the previously validated and reliable CES-D cutoffs,³¹ the CESD-R scale from 1-5 was recoded to a 0-3 scale, with the two highest scores both recoded to 3, as recommended.²⁷ Only people who responded to all questions were included. A total score of 16 or greater is the cutoff score indicative of, or being at risk for, clinical depression.³¹ The cutoff value for a severe depressive episode is \geq 28. Summed scores ranged from 0 to 60 (M = 14.30, SD = 12.11; $\alpha = .95$).

Financial concerns

Participants rated three items about being concerned about money lately, feeling confident financially (reverse-coded), and having ability to get by financially (reverse-coded), on a scale from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*). The average score ranged from 1 to 7 (M = 4.26, SD = 1.68; $\alpha = .85$).

Poor mentor relationship

To assess mentor relationship quality, participants answered 11 items based on the advisor relationship index used by Hyun and colleagues.² Questions asked about the extent to which they viewed their mentor as: impeding their career development; not advocating for them; being supportive of their priorities, career goals, financial wellbeing, and personal wellbeing (all reverse-coded); being actively involved in their academic training and career development (reverse-coded); facilitating collaboration and sponsorship (reverse-coded); and being a real mentor (reverse-coded) using a scale from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*). Scores were averaged to form the unsupportive mentor relationship index (M = 2.83, SD = 1.25; range: 1-7; $\alpha = .93$).

Received negative bias from program

One question asked, "Over the past twelve months, have you been on the receiving end of a significant instance of bias, discrimination or harassment by someone in your graduate program (another student, a faculty member, a member of the administration or staff, or by more than one of the previous choices)?" Participants who selected "yes" (to receiving bias; N=478) or "unsure" (N=383) were coded as having received negative bias (1) and those who selected "no" (N=2818) were coded as not having received negative bias (0).

Table 2. Descriptive statistics for depressive symptoms and correlated risk and protective factors.

Variable	M or % Yes	SD	Range	Alpha	1	2	3	4	5	6	7
1. Depressive symptoms	M = 14.30	12.11	0.00 - 60.00	0.95	1	31***	21***	23***	36***	38***	40***
2. Financial concerns	M = 4.26	1.68	1.00 - 7.00	0.85		1	17***	19***	20***	33***	34***
3. Poor mentor relationships	M = 2.83	1.25	1.00 - 7.00	0.93			1	16***	21***	40***	21***
4. Bias from department	Yes = 23%	n/a	0.00 or 1.00	n/a				1	18***	38***	16***
5. Social support	M = 3.06	0.62	1.00 - 4.00	0.89					1	37***	23***
6. Support from department	M = 5.03	1.06	1.00 - 7.00	0.88						1	41***
7. Optimism about career	M = 4.28	1.83	1.00 - 7.00	n/a							1

Note. *** p < .001.

Support from program

The perceived social climate of the department and university was assessed by 11 items asking participants the extent to which they agreed to statements about: feeling valued and included by peers, faculty, the administration, and staff; a sense of community in their program and university; and the extent to which their program minimized administrative paperwork. Responses ranged from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*), and responses were averaged together $(M = 5.03; SD = 1.06; \alpha = .88)$.

Optimism about future career prospects

Participants rated the extent to which they were upbeat about their post-graduation career prospects on a scale from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*). Responses ranged from 1 to 7 (M = 4.28, SD = 1.83).

Social support

The 12-item Interpersonal Support Evaluation List³² had participants rate statements about whether they believed they had access to tangible support (receiving aid), appraisal support (receiving guidance), or belonging support (being accepted, having someone to with which to do leisure activities), on a scale from 1 (*Definitely false*) to 4 (*Definitely true*). Responses ranged from 1 to 4 (M=3.06; SD=0.62; α = .89).

Analytic strategy

Because our participants were nested within schools, we first tested whether we needed to adjust for campus-level effects using multi-level-modeling. An empty model for depressive symptoms modeled both within and between campus variance and tested whether each estimated parameter had significant variance necessary for modeling. The estimate of between-campus variance in depressive symptoms (.36 SE = .28) was not significantly different than 0 (Z = 1.27, p<.10), and was much smaller than the within-campus variance estimate (98.05, SE = 1.98), which indicated significant variance for further modeling (Z = 49.39, p<.0001). Given the non-significant campus effects, we used a regression that pooled all participants in one regression model.

We used regression analyses to determine the extent to which positive and negative factors were uniquely related to depressive symptoms, and whether positive aspects attenuated the relationship between the negative factors and depressive symptoms. Levels of depressive symptoms were

the outcome variable for our regression models. In model 1, we entered our covariates which included: gender (1 = female); relationship status (1 = partnered or married); ethnicity (with Asian, underrepresented ethnic minority, and "other" groups each dummy-coded and compared to the White group); international student (1 = yes); discipline (with Social Sciences, STEM, Professional Fields, and Other each dummy-coded and compared to Humanities), and degree type (1 = Ph.D). In model 2, we added all three negative factors (financial concerns, poor mentorship, perceived bias from one's department). In the final model, we added the positive factors including social support, support from the department, and feeling optimistic about job prospects, to test their unique association with depressive symptoms, and to test whether they attenuated associations between the negative factors and depressive symptoms.

Results

The zero-order correlations between depressive symptoms and each of the positive and negative factors are shown in Table 2. Consistent with prior findings, descriptive analyses indicated high rates of depressive symptoms among graduate students. Over a third of doctoral students (39%; N=1076) and nearly a third of master's students (30%; N=278) reported depressive symptoms that are severe enough to warrant a further assessment for depressive disorder (i.e., a CESD-R score of 16 or higher). Approximately 14% of graduate students reported severe levels of distress (total score ≥ 28 ; see Figure 1a).

Negative and positive factors associated with depressive symptoms

In our regression model predictors of depressive symptoms, our first model including only the covariates was significant and accounted for less than four percent of the variation in depressive symptoms (see Table 3). Depressive symptoms were higher among women, international students, those unmarried or unpartnered, those studying Humanities versus STEM, people studying Humanities versus a Professional Field, and people pursuing a Ph.D. degree. Ethnicity showed no association with levels of depression.

In the next model, we tested our hypothesis that the negative factors would each uniquely contribute to the model predicting depressive symptoms after accounting for demographic factors. All three factors were significant, together accounting for an additional 13% variance in



Figure 1. Depressive symptoms among graduate students.

(a) Prevalence of students scoring at the cutoff point for risk for of having clinical depression and a severe depressive episode for master's and doctoral students; (b) Zero-order correlations between depressive and both positive and negative factors; (c) Standardized beta weights from regression analyses showing that the associations between negative factors and depressive symptoms are attenuated when positive factors are included in the model.

Note: All betas are greater than zero at p < .001. Analyses included gender, ethnicity, international student status, marital/partnership status, and pursuing a Ph.D. (vs. Master's) as covariates.

depressive symptoms, R = 0.41, F(10, 3,653) = 52.80, p < .001; $\Delta R^2 = 0.13$, F(3, 3,653) = 188.91, p < .001. Greater financial concerns, poorer mentorship, and perceived bias were related to greater depressive symptoms.

The final model added the three positive factors to Model 2. This final model accounted for 29% of the variance in depressive symptoms. When re-assessing the covariates in this model, after the addition of the positive factors, pursuing a Ph.D. versus master's degree was no longer associated with depressive symptoms, $\beta = 0.01$, t = 0.69, p = .49. Female participants tended to report higher levels of depressive symptoms than male participants, $\beta = 0.03$, t = 2.01, p < .05. Asian participants tended to report lower levels of depressive symptoms than White participants, $\beta = -0.05$, t = -3.10, p < .01. In this final model, discipline was no longer significantly

related to depressive symptoms. The full regression model revealed that positive factors accounted for 12% of additional variance in depression, and that each positive factor was significantly associated with depressive symptoms.

Exploring an alternative model

Before examining whether positive factors buffered the effects of the negative factors, we first explored an alternative model, where positive factors were entered first (in model 2), followed by negative factors (in model 3). A model with only the covariates and the positive factors accounted for 27.3% of the variance in depressive symptoms. In contrast, the model only including covariates and the negative factors (described above) accounted for 16% of the variance. Including the

Table 3. Hierarchical multiple regression analysis predicting depressive symptoms (N = 3,679).

	Model 1	Model 2	Model 3
Predictor	B(SE, β)	B(SE, β)	B(SE, β)
Female vs. male	1.25(.41, .05)**	0.38(.38, .02)	0.71(.35, .03)*
Asian	-0.77(.53,03)	-0.48(.50,02)	-1.42(.46,05)**
Underrepresented ethnic minority	0.35(.53, .01)	-0.39(.50,01)	-0.58(.46,02)
Other ethnicity	0.45(.67, .01)	0.17(.63, .01)	-0.42(.58,01)
International student	-2.52(.54,09)***	-1.94(.51,07)***	-2.07(.47,07)***
Married/in partnership vs. single	-2.16(.42,08)***	-1.72(.40,07)***	-1.02(.37,04)**
Pursuing Ph.D. vs. Master's	2.01(.52, .07)***	2.01(.49, .07)***	0.32(.46, .01)
Social Science	-1.13(.66,04)	-0.28(.62,01)	0.50(.57, .02)
STEM	-3.06(.57,12)***	-1.40(.54,06)**	0.40(.51, .02)
Professional Field	-3.10(.69,10)***	-2.11(.65,07)**	0.33(.61, .01)
Other Discipline	0.93(1.32, .01)	1.48(1.23, .02)	2.07(1.14, .03)
Financial concerns		1.70(.12, .24)***	0.86(.11, .12)***
Poor mentorship		1.48(.15, .15)***	0.30(.15, .03)*
Bias from department		4.39(.45, .15)***	-2.46(.44, .09)***
Social support			-4.55(.30,23)***
Department social climate		1	-1.12(.21,10)***
Optimism about career		1	-1.59(.11,24)***
Adjusted R ²	.04	.17	.29
R ² change	.04	.13	.13

Note. White is the reference group for the dummy-coded ethnicity variables. Humanities is the reference group for the dummy-coded discipline variables. *p < .05. **p < .01. ***p < .001.

negative factors added an additional 1.9% variance, for a final model accounting for 29% of the variance in depressive symptoms. These results, together with the findings above, indicate that positive factors have a stronger association with depressive symptoms than do negative factors.

Testing indirect effects of positive factors in the final model

In the final model, the beta weights for each negative factor was significant; their decreased values compared to a model without positive factors, however, suggested that positive factors play a buffering role. To test each of their effects on the negative factors, we conducted bootstrapped mediation analyses (1,000 re-samples). The SPSS PROCESS 3.1 macro³³ allowed us to take the full model and test the significance of the indirect effect of each positive factor on the association between depressive symptoms and the negative factor of interest, while simultaneously accounting for the other positive factors, the five significant demographic factors (female, single, ethnicity, international student status, degree type) and the other two negative factors. Note that we did not include the non-significant covariate (discipline) in these models, although the results remained unchanged in models that included them in these tests.

As mentioned above, a model including only the five covariates and the other two negative factors (poor mentorship and perceived bias) found that greater financial concern was associated with more depressive symptoms (b = 1.75, SE = 0.11, t = 15.38, p < .001). Testing the effects of positive factors on this association, however, revealed that this association was partially reduced by social support (Indirect effect = 0.2841; SE = 0.04; 95% CI = 0.22 - 0.35), support from one's department (Indirect effect = 0.1386; SE = 0.03; 95% CI = 0.08 - 0.20), and optimism about job prospects (Indirect effect = 0.4781; SE = 0.05; 95% CI = 0.39 - 0.57). After adjusting for these three positive factors (mediator variables), the association between financial concerns and depressive

symptoms significantly decreased by 49% (b = 0.85, SE = 0.11, t = 7.68, p < .001). Ultimately, greater social support, a more supportive department social climate, and greater optimism about job prospects led to a weaker association between financial concerns and depressive symptoms.

We then examined the effect of positive factors on the association between poorer mentorship and depressive symptoms. Without inclusion of the positive factors, receiving less support from one's mentor was related to more depressive symptoms (b = 1.44, SE = 0.15, t = 9.42, p < .001). This association was significantly reduced when including the effects of social support (Indirect effect = 0.3903; SE = 0.05; 95% CI = 0.30 - 0.50), department social climate (Indirect effect = 0.3332; SE = 0.07; 95% CI = 0.20 - 0.48), and optimism about career prospects (Indirect effect = 0.4116; SE = 0.05; 95% CI = 0.32 - 0.51). After adjusting for the effects of these three positive factors, the association between poor mentor relationship and depressive symptoms remained significant, but significantly decreased by 78% (b = 0.31, SE = 0.15, t = 2.02, p < .05).

In the third analysis, we examined the effect of positive factors on the association between greater perceived bias and depressive symptoms. The association between perceived bias and depressive symptoms was significantly reduced in the full model by the effects of social support (Indirect effect = 0.7647; SE = 0.13; 95% CI = 0.53 - 1.03), department social climate (Indirect effect = 0.7674; SE = 0.16; 95% CI = 0.44 - 1.10), and optimism about career prospects (Indirect effect = 0.5109; SE = 0.12; 95% CI = 0.29 - 0.75). After adjusting for these positive factors (mediator variables), the association between perceived bias and depressive symptoms was still significant, although reduced by 46% (b = 2.43, SE = 0.43, t = 5.60, p < .001).

Discussion

When considering the mental health needs of graduate students, universities often direct their efforts to those already experiencing moderate to severe distress. These approaches are clearly necessary, but we also need to focus on prevention strategies to reduce levels of depressive symptoms before they become more severe. A first step in this process is to identify both risk and protective factors that contribute to graduate student mental health, universities have examined a number potential risk factors.⁶ Consistent with existing literature, results indicate that lack of funding, poor faculty mentorship, and institutional discrimination are related to depressive symptoms among graduate students. Interestingly, we found higher depressive symptoms among students in the humanities compared to students in STEM and professional programs in the model that examined covariates and negative factors in graduate school. This is a finding that has been documented in prior studies,³ yet in the final model when we add positive factors, levels of depressive symptoms no longer varied by discipline. This finding suggests that differences in levels of these positive factors are responsible for differences in depressive symptoms across disciplines.

Our findings also offer insight into positive factors that are related to lower levels of depressive symptoms, including social support, climate of the department, and optimism about one's career prospects. Further, positive factors mitigated the adverse effects of the commonly recognized risk factors on depressive symptoms. Positive factors do not erase the reality of financial stress, poor mentorship, and perceived institutional discrimination, nor do they erase their effects on levels of depressive symptoms. Our results suggest, however, that positive factors serve protective roles, both by directly reducing negative distress and also by mitigating the damaging effects of negative factors (such as financial stress) on student's mental health.

Cultivating social connection at the individual and the institutional level

Our results suggest that universities should foster graduate students' positive social relationships to decrease levels of depression. This need is especially important given that graduate students frequently relocate away from family and friends, and they often spend hours alone studying and producing independent projects. Our social support measure included questions asking about people in these students' community: those who live nearby, such as people who could share a meal, provide a ride home, or provide company for a day out or to see a movie. Many universities have started to address social isolation among their students by creating learning communities to foster social interaction, or by providing structured residential social planning. A growing number of universities are recognizing the importance of creating graduate student centers where students have their own physical space to socialize that is away from the undergraduate students whom they often supervise, and the faculty who serve as their evaluators. These relationships include not only those with their peers, but a relationship with their institution that provides them with a sense of belonging in a positive social climate. Current findings provide empirical support to suggest that social belonging to one's academic institution, an important correlate for wellbeing and success among undergraduate students,³⁴ applies to graduate student populations as well.

Cultivating professional development

In addition, our results indicate that universities need to implement programs to better prepare graduate students for future careers. A recent report from the National Academies of Sciences, Engineering, and Medicine about graduate training advocated for increases in professional development programs among doctoral students who represent the future of biotechnology and other sciences.¹² The report highlighted the need to provide graduate students with networking communities, professional core competencies, and information to prepare for future careers. According to the report, adhering to a traditional training model where students work almost exclusively with a single mentor in a narrow area of research is no longer sufficient training for an increasingly diverse and global workforce.35,36 Students who desire a nonacademic career often feel poorly equipped in their professional skills outside of those that are necessary for running their advisor's lab or work group.²⁶ Similarly, students interested in academic work also need to expand their training for an increasingly interdisciplinary and global research community. Providing strong professional training skills, internship experiences, and contacts in the larger workforce can provide students with a greater sense of control for their future. Universities are beginning to offer such programs, and providing these trainings will enable students to feel more optimistic about their career prospects. This confidence, in turn, has the potential to decrease their feelings of anxiety and hopelessness regarding life after graduate school.

Limitations and future directions

The current study used a cross-sectional design, so we cannot presume causality. Although we hypothesized that the negative factors are risk factors for depression, only longitudinal analyses can confirm these associations. We are bolstered, however, by findings in the larger literature that indicate that financial hardship, problems with bosses, and discrimination are risk factors for depression for all adults regardless of gender and occupation. Similarly, we hypothesized that our positive factors are protective factors, but once again only longitudinal analyses can test this question. These positive factors may instead simply reflect the result of depression, providing insight only into the severity of emotional distress. We are optimistic, however, that longitudinal studies in the larger literature documenting the positive effects of social belonging, social support, and optimism would apply to graduate students as well. Only longitudinal studies involving graduate students, however, can test these hypotheses.

In addition, future studies can examine in greater details both the negative and positive factors that were included in our models. For example, we asked about perceived bias, discrimination, or harassment, we did not specify the reason for this poor treatment. Prior studies have established negative effects on mental health from perceive discrimination regardless of the reason for this discrimination.²¹ Nonetheless, universities would benefit from knowing the source of this bias so they can address this behavior on their campuses.

Finally, one positive factor (optimism about career prospects) and one negative factor (received negative bias from the program) were assessed by one item. As a result, these items are subject to more error than the factors measured using multiple-item scales (such as social climate; financial concerns; or poor mentorship relationship. Participants may have varied in how they interpreted the single item, or were unsure what was meant by the items. In addition, single items may provide less variability across the sample, making effects more difficult to detect. Although the large sample size helps to mitigate some concern about measurement error, future research would benefit from asking about experiences of discrimination or feelings regarding people's optimism about their job prospects with greater precision.

Conclusion

Studies of graduate students across the globe report similarly high rates of distress.^{2,6,7} Universities need information about targets of intervention that may be most effective to reduce levels of distress among graduate students. Our results suggest that positive factors exert strong direct effects on well-being, as well as buffer the effects of negative factors. We need to continue to focus on negative factors that lead to distress, but we also need to focus on enhancing factors that strengthen student resiliency and that create a healthier environment. Providing students with resources that allow them to feel optimistic about their future careers and feel supported by their peers are aspirational goals for all universities and necessary steps in the training of our future leaders in science and technology.

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Conflict of interest disclosure

The authors have no conflicts of interest to report. The authors confirm that the research presented in this article met the ethical guidelines, including adherence to the legal requirements, of United States and was reviewed by the University's review board but was determined to pose minimal risks and fell into the exempt category.

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