

A single-center assessment of mental health and well-being in a biomedical sciences graduate program



A diversity of factors influence student mental health, arguing for the importance of longitudinal monitoring of, and accountability for, student mental health at graduate institutions.

Recent articles have shed light on the growing crisis of mental health problems in graduate schools^{1,2}. Emerging literature suggests mental health concerns affect up to 37 to 47% of graduate students in STEM, versus 18.5% of adults from the general US population³⁻⁷, while a recent systematic review has placed rates of anxiety and depression among graduate students at 24% and 17%, respectively⁸. Concerningly, only 36% of respondents in one survey reported seeking help for mental health concerns caused by their graduate work⁹. Not only do these surveys and reports underscore the many challenges from which mental health struggles may stem, but they also emphasize the diverse and multifactorial nature of mental well-being, including mentorship, career prospects, social support and financial security. Despite these recent efforts to investigate the extent of the problem, there is a dearth of longitudinal studies that include rigorous mental health assessment instruments, collect data on factors that contribute to mental health throughout graduate education, and describe areas for effective intervention^{10,11}.

On 11 March 2020, the World Health Organization declared the novel coronavirus (SARS-CoV-2) outbreak a global pandemic. In addition to preexisting challenges, graduate students' mental health concerns were further exacerbated by the pandemic¹². One survey using the Generalized Anxiety Disorder 2-item and Patient Health Questionnaire 2 to screen for symptoms of anxiety and depression found that, in mid-2019, 26% of graduate students had signs of anxiety and 15% showed depression symptoms, which increased in mid-2020 to 39% and 32%, respectively¹². COVID-19-associated lockdowns, social distancing and unemployment were in

part driving these increases^{13,14}. Additionally, transition to remote instruction and lack of access to laboratories during the lockdowns increased anxiety in biomedical research graduate students^{12,15}. Other studies have identified mental health changes during the pandemic to be transient and "statistically small," with the increase in mental illness symptoms subsiding by July 2020 (refs. 16,17). More efforts are needed to clarify the nature and persistence of mental health challenges to graduate students throughout the pandemic.

Current literature also highlights the lack of implementation and evaluation of interventions to improve graduate student mental health⁴. A recent study showed that doctoral program phase affected student well-being and motivation, with stress being highest during comprehensive exams and motivation being lowest during the dissertation phase¹⁸. Several independent surveys and task forces have set out to systematically identify areas of intervention and recommend evidence-based initiatives to improve student well-being^{3,5,19}. A student-led group at the Mayo Clinic Graduate School of Biomedical Sciences (MCGSBS) sought to identify student mental health challenges and programmatic shortcomings at our institution. Ultimately, these efforts are directed toward creating positive change through evidence-based intervention. Here, we assess a range of overall well-being measures in this student population before and after the onset of the COVID-19 pandemic.

Measures

Dependent variables. Two dependent variables were selected for the 2019 survey, life satisfaction and depression, while the 2020 and 2021 surveys added anxiety as a third dependent variable. Life satisfaction

was measured using the Satisfaction with Life scale²⁰. Depression was measured using the Center for Epidemiologic Studies Depression Scale (CESD-R)²¹. Anxiety was measured using the General Anxiety Disorder-7 (GAD-7) scale²². Measures were treated as dichotomous or categorical variables; detailed scoring is provided in Supplementary Table 1.

Independent variables. Independent variables included satisfaction with mentorship and advising, food insecurity, financial confidence, career prospects and social support. In 2020 and 2021, food insecurity was measured using a six-item version of the US Department of Agriculture's (USDA) food security survey²³. Social support was measured using the Interpersonal Support Evaluation List (ISEL-12)²⁴. To assess additional independent variables, a numerical Likert scale was used for University of California survey questions with agreement scale responses from "Strongly disagree" (1) to "Strongly agree" (7). The agreement scale scores for each subsection were summed; detailed scoring is provided in Supplementary Table 1.

Statistical analyses. All figures and tables were generated using GraphPad Prism and R 4.0.3. The minimal-risk IRB classification did not allow tracking students longitudinally, and each survey year instead collected a random convenience sampling. The SciPy Statistical Functions package was used to compute chi-squared tests for independence for the following variables: (i) depression changes pre- and post-pandemic onset for all students, women and LGBTQ+ students; (ii) changes in perceived social support pre- and post-pandemic; (iii) association between candidacy status and depression; and (iv) association between candidacy

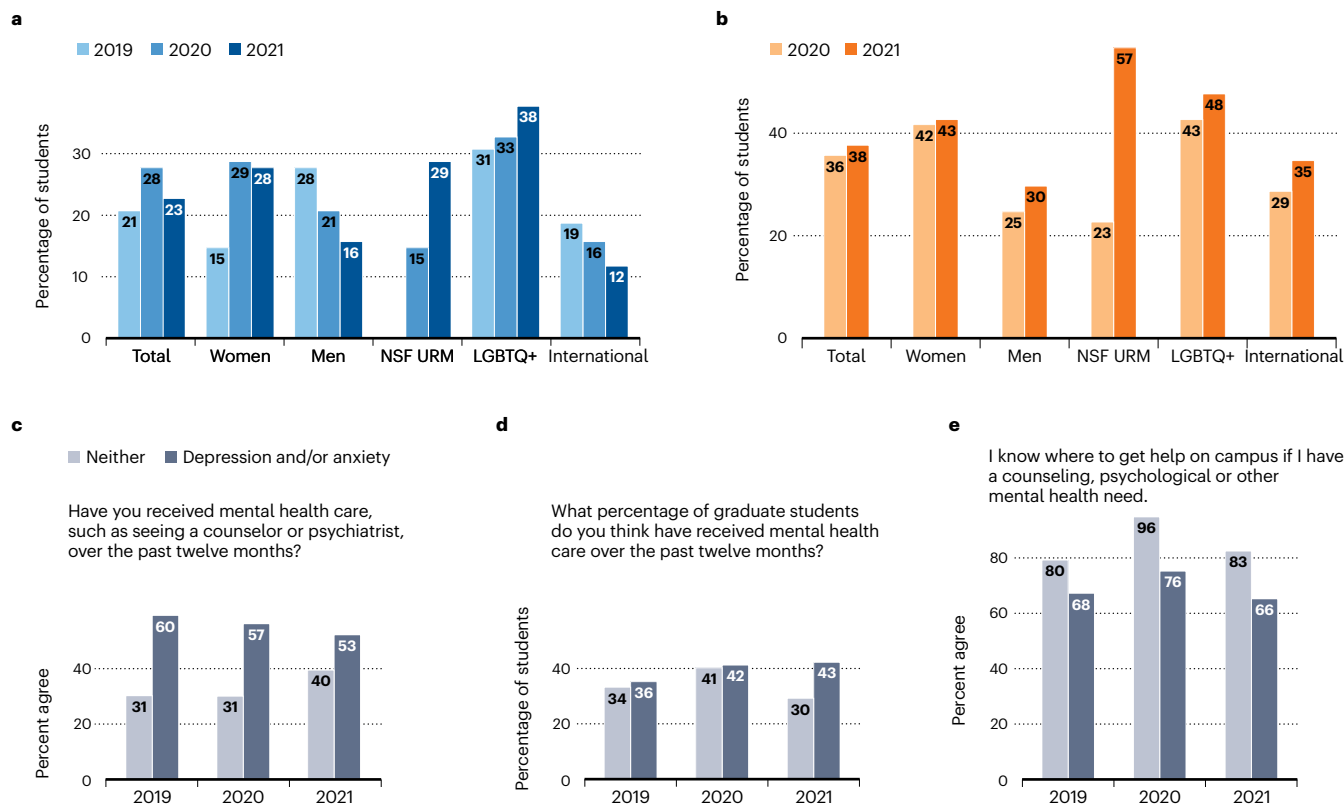


Fig. 1 | Depression and anxiety prevalence and treatment gap among MCGSBS respondents. a, Depression prevalence. **b**, Anxiety prevalence. **c**, Percentage of respondents seeking mental healthcare. **d**, Respondent prediction of mental

healthcare utilization by peers, **e**, Percentage of respondents knowledgeable about mental healthcare resources. Data on anxiety and NSF URM classification were not collected in 2019.

status and anxiety. A Bonferroni correction was applied to correct for multiple testing ($\alpha = 0.0083$). To identify which survey measures correlated with the main outcome measures (depression, anxiety, life satisfaction), we constructed a multivariable logistic regression model for each main outcome variable. Covariates with highly imbalanced classes (<10 responses for the minor class) were excluded. Respondents with missing values were omitted from the analysis, with 106, 107 and 117 responses used in the final models for 2019, 2020 and 2021, respectively. The following covariates were included in the model: gender, LGBTQ+ status, NSF URM status, year of study, financial confidence, program climate, mentorship and advising satisfaction, career prospects, overall health and academic progress. Food insecurity was included in logistic regression modeling for 2020 and 2021.

Results

A comprehensive well-being assessment survey was sent to 306 graduate students in 2019,

343 students in 2020 and 364 students in 2021. Response rates for these three years were 42%, 37% and 35% respectively. Descriptive characteristics of the respondent population are provided in Supplementary Table 2.

Depression and anxiety prevalence among MCGSBS respondents. Our results showed that 21% of 2019 respondents, 28% of 2020 respondents and 23% of 2021 respondents presented with symptoms of depression, measured using the CESD-R scale (Fig. 1a). While pre-pandemic anxiety data are not available, 36% of 2020 respondents and 38% of 2021 respondents had symptoms of anxiety, measured using the GAD-7 scale (Fig. 1b). Women and LGBTQ+ respondents reported higher rates of depression and anxiety symptoms than their peers in all survey years (Fig. 1). We also note that, from 2020 to 2021, rates of depression and anxiety symptoms increased for NSF URM respondents, though NSF URM status was not a significant correlate of anxiety or depression status in logistic regression (Supplementary Tables 5 and 6).

Pre- and post-pandemic changes. Survey data from 2019 indicates that symptoms of depression and life satisfaction were not significantly different pre- and post-pandemic onset ($P = 0.47$ and $P = 0.75$). This increase was not distributed evenly across demographic groups: female respondents reporting symptoms of depression increased from 15% in 2019 to 29% in 2020, though this increase was not statistically significant ($P = 0.09$). Similarly, symptoms of depression for LGBTQ+ individuals were not significantly different pre- and post-pandemic ($P = 0.94$). Lastly, students' perceived social support remained stable around 90% before and after pandemic onset ($P = 0.19$).

Treatment gap in MCGSBS respondents. Next, we wanted to better understand mental healthcare utilization in our respondents. In total, 40% of students in 2019 with symptoms of depression, 43% in 2020 with symptoms of depression or anxiety, and 47% of respondents in 2021 with symptoms of depression or anxiety had not sought mental healthcare in

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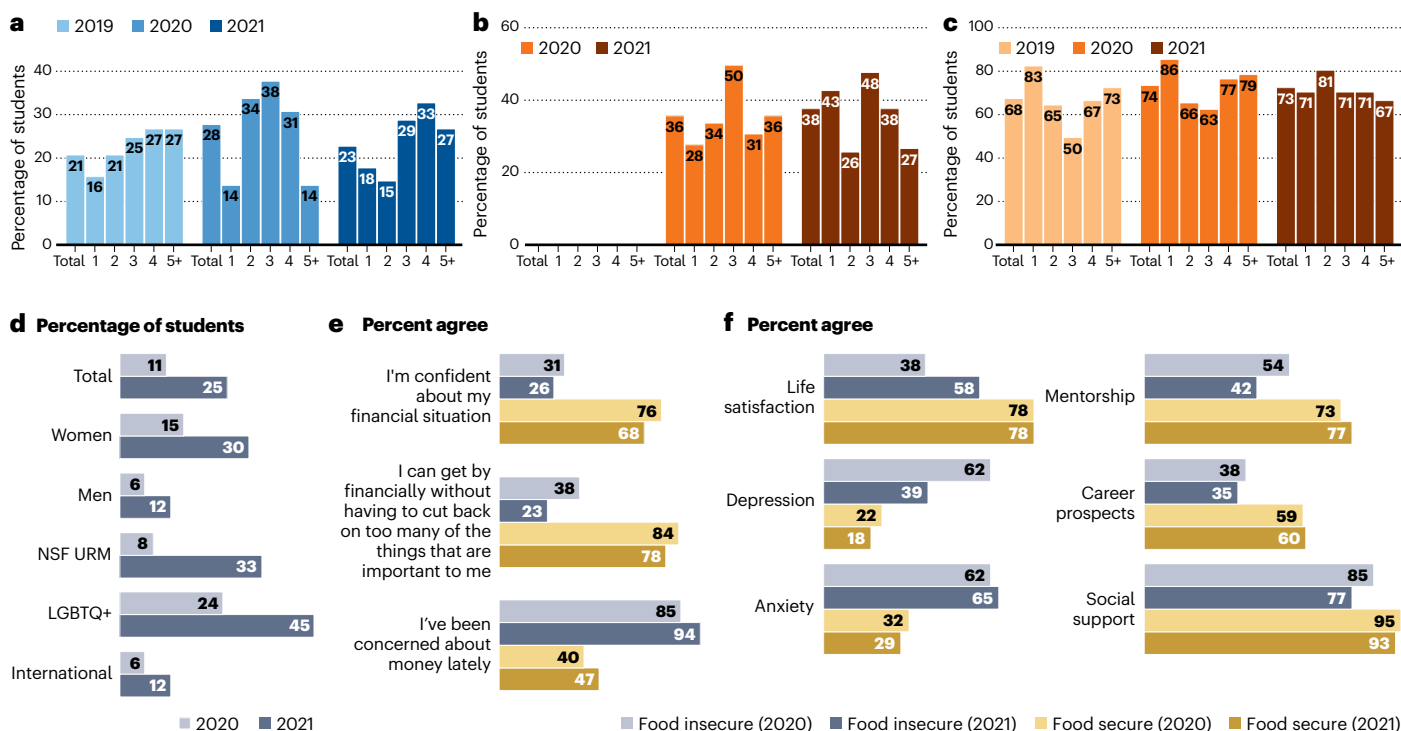


Fig. 2 | Program stage and food security are correlated with well-being outcomes. Prevalence across program year of **a**, depression, **b**, anxiety and **c**, life satisfaction. **d**, Food insecurity among respondents. **e, f**, Financial security (**e**) and well-being outcomes (**f**) across food-insecure respondents. Food security and anxiety data were not collected in 2019.

the past year (Fig. 1c). This may constitute a ‘treatment gap’ in which respondents experiencing symptoms of depression or anxiety are not using available resources. Respondents were asked to estimate the proportion of their peers actively seeking mental healthcare, and respondents reporting symptoms of depression or anxiety consistently underestimated this percentage, estimating 36%, 42% and 43% of peers were seeking mental healthcare for 2019–2021 (Fig. 1d) as compared to the true proportions of 60%, 57% and 53% (Fig. 1c). Fewer respondents reporting symptoms of depression or anxiety knew how to access mental health resources, as compared to respondents who did not report symptoms, across all years (Fig. 1e), suggesting communication of available resources as a contributing factor in this observed treatment gap.

Well-being outcomes vary across program stages. To evaluate the association of program stage on well-being outcomes, respondents were grouped by year of study. Symptoms of depression appeared to correlate with program year in 2019 and 2021, while in 2020 symptoms of depression peaked in third-year

respondents (Fig. 2a). The percentage of respondents with symptoms of anxiety was highest in third-year respondents and lower in later-stage respondents in 2020 and 2021 (Fig. 2b). Life satisfaction was lowest in third-year respondents in 2019 and 2020 (Fig. 2c). While the third year of study often coincides with the timing of student candidacy exams, we did not observe a significant association between symptoms of depression ($P=0.10$) or anxiety ($P=0.99$) and candidacy status. Nevertheless, these data indicate a potential association between program stage and well-being outcomes in MCGSBS respondents and suggests that the middle years of graduate study may be a time of increased mental health burden.

Food security correlates with well-being outcomes. Our results showed 11% of respondents experienced food insecurity in 2020, which more than doubled to 25% in 2021, with women and LGBTQ+ respondents reporting higher rates of food insecurity and men and international respondents reporting lower rates (Fig. 2d). In 2020 and 2021, food-secure respondents were more than twice as likely to report financial confidence compared

to food-insecure respondents (Fig. 2e). Food-secure respondents reported higher life satisfaction, fewer symptoms of depression and anxiety, higher satisfaction with mentorship, more optimism about career prospects and higher perceived availability of social support, as compared to food-insecure respondents (Fig. 2f). Despite this, food insecurity was not a significant covariate of life satisfaction or of symptoms of depression or anxiety (Supplementary Tables 4–6), indicating a role of other factors influencing food insecurity and mental health.

Overall health is a strong correlate with depression and anxiety. Multivariable logistic regression identified overall health as the only significant correlate of depression and anxiety. Better overall health was associated with lower odds of depression and anxiety symptoms for all three years while also being associated with increased life satisfaction in 2019 (Supplementary Table 3). Academic progress was the only covariate to be significantly associated with life satisfaction across all three survey years, while financial confidence was a significant correlate in 2019 and 2020 (Supplementary Table 3).

Discussion

Several studies over the past decade have identified a high prevalence of mental illness in graduate student populations^{2,25}, but there has been a lack of investigation into the causes. Our study identified specific correlates of mental illness and describes the impact of the COVID-19 pandemic. The main novel findings of this study are as follows: (i) Graduate students continue to experience high mental illness prevalence, with 23% of respondents reporting symptoms of depression and 36% of respondents reporting symptoms of anxiety in 2021; (ii) students underestimate the proportion of their peers seeking mental healthcare; (iii) a subset of students may be unaware of where to seek mental healthcare; (iv) food-insecure students demonstrated greater mental health burden and reported lower life satisfaction relative to their peers; and (v) rates of food insecurity in our student population doubled between 2020 and 2021. The rates of anxiety and depression identified in this graduate student population rank above those in the general US population. Depression rates in US adults are estimated at 8.1% while up to 15.6% of US adults are estimated to experience anxiety^{26,27}. Our findings for graduate students are consistent with other studies, which report depression prevalence from 24 to 39% and anxiety prevalence from 17 to 41%^{2,25}. Additionally, we report 25% of respondents demonstrated low or very low food security in 2021, more than double the 10.5% of American households estimated to be food insecure by the USDA²⁸. These findings point to continuing trends of graduate students suffering from a high mental health burden and high rates of food insecurity.

Outcomes before and after pandemic onset. While more respondents reported symptoms of depression in 2020 than 2019 and 2021, this change was not statistically significant. Furthermore, we did not observe significant changes in mental health within LGBTQ+ or female respondents, nor did we observe changes in perceived social support before and after the pandemic onset. Previous work has shown mixed results regarding pandemic-related changes in mental health^{29,30}, although a meta-analysis found that transient increases in mental illness symptoms decreased by May–July 2020 (ref. 16).

Demographics correlate with mental health challenges. Female and LGBTQ+ respondents reported higher levels of anxiety and depression symptoms and of food insecurity relative to their peers. Logistic regression

also identified gender and LGBTQ+ status as significant correlates of mental health status in 2019 and 2021, respectively. An abundance of previous work shows women and LGBTQ+ individuals suffer higher rates of anxiety and depression than non-LGBTQ+ individuals or men^{31–35}, and graduate students are no exception to this trend^{3,36,37}. These findings emphasize that mental health burdens are not evenly distributed within graduate student populations, and interventions designed to alleviate the mental health burden must consider the heterogeneous needs of these individuals.

Destigmatizing mental illness. This work identified an unmet mental healthcare need or treatment gap in this population and delineates the need to better empower students to seek mental healthcare. Recent student-led initiatives at our institution have hosted graduate trainees to discuss their mental health experiences and have outlined the process of self-assessing mental health needs and identifying local mental health providers. Empowering students to seek care may also require educators and program directors to smooth administrative hurdles that dissuade students from accessing care – for example, developing clear leave-of-absence policies for students who need to escalate care and communicating the importance of proactive mental healthcare. The goal of such interventions is not to ask faculty to serve as mental healthcare providers, but rather to ensure that they can support mentees in their search for mental healthcare.

Food insecurity and health correlate with mental health. Overall health was the main covariate associated with symptoms of depression and anxiety, a well-documented relationship^{38–40}. An additional component of physical health is access to adequate nutrition, and our findings demonstrate that 25% respondents reported food insecurity in 2021. These results are comparable to those of other reports: 29% of graduate students from the University of California reported food insecurity in 2017 (ref. 3), while more recent work from the State University of New York at Albany found 40.3% of respondents report food insecurity⁸. At our institution, LGBTQ+ and URM respondents faced higher levels of food insecurity than their peers, which has been observed in other studies⁸, a phenomenon that suggests that addressing food insecurity may improve recruitment and retention of under-represented graduate students. Food-insecure respondents reported more

mental illness symptoms, lower satisfaction with mentorship, and lower perceived career prospects, consistent with other recent studies^{8,41}. This suggests that providing adequate nutritional and financial support is vital to ensuring the health of students and the retention of a diverse trainee workforce.

Evidence for a ‘third year slump’. Many students consider the middle years of graduate school to be among the most difficult, colloquially calling this the ‘third-year slump’. Third-year students in 2019 and 2020 reported more symptoms of depression and lower life satisfaction than their peers, while anxiety was highest in third-year respondents for 2020 and 2021. Although year of study or candidacy status were not significant covariates in our logistic modeling, these findings suggest that the third year of study may present unique obstacles to student well-being. Other studies have identified program stage as significantly influencing student stress and program satisfaction¹⁸, and further work is needed to examine the effect of program year on student mental health.

Study limitations. The design of our study did not track individual students across years, and changes in survey measures from year to year may therefore derive from a different pool of respondents rather than changes in individuals. Additionally, the majority of responses were from female respondents (65% of respondents in 2021). While US adult women have been observed to have higher rates of anxiety and depression than men^{31,32}, the higher response rate among women may be the result of a greater willingness to discuss mental health^{42–44}. To refine our survey methodology, we made adjustments to several survey measures after 2019, and these changes limit our ability to assess food insecurity, anxiety and URM student well-being measures before and after the pandemic onset. Lastly, given the small size of our graduate program, we were not able to collect a large enough sample to report details for some groups – for example, transgender or nonbinary students. Despite these limitations, our study represents a nuanced insight into mental health changes at a graduate institution, capturing responses before and after the pandemic onset while identifying factors influencing student mental health.

Future work: guiding mental health interventions. We are continuing this survey annually at our institution, both to evaluate

longitudinal changes in student mental health and to monitor the impact of interventions designed to promote mental healthcare utilization and address food insecurity. This survey tool will support the implementation of well-being programs and advocacy work to benefit students, and we believe this proactive monitoring can be a useful example for other graduate programs as they attempt to improve the mental health and overall well-being of their student bodies. Importantly, this work also has lessons for administrators and mentors, who should recognize that students face outsized mental health needs as compared to the background US population. While faculty are not mental health providers, they nonetheless have a vital role in reducing stressors and supporting student access to mental healthcare resources.

Conclusions



While our work represents a single-institution assessment, this report is nonetheless important to demonstrate the diversity of factors influencing student mental health and argues for the importance of longitudinal monitoring of, and accountability for, student mental health at graduate institutions. Crucially, this work was student-initiated and student-driven: this allowed peer-to-peer communication to play a role in transparently disseminating survey results and implementing an array of possible interventions. Further work is needed to replicate this work at other institutions and determine other possible factors that have influenced student mental health before and after the onset of the COVID-19 pandemic.

Methods

Participants. We invited all MCGSBS master's, PhD and MD/PhD students in the PhD phase of their study to participate in the surveys. The 2019 survey included students at the Rochester, Minnesota and Jacksonville, Florida campuses, whereas the 2020 and 2021 surveys also included the Scottsdale, Arizona campus. Ethics approval was obtained from Mayo Clinic's institutional review board, which deemed this study minimal risk (IRB number: 19-009974). All individuals provided informed consent to be included in the study before completing the survey. We assessed demographic subpopulations within the student body: women; international students; lesbian, gay, bisexual, transgender and questioning (LGBTQ+) students; and under-represented racial and ethnic minorities as defined by the National Science Foundation (NSF URM).

Instrument development. A survey design team composed of students and faculty advisers adapted the Graduate Student Well-Being Survey published by the University of California Office of the President⁴ for use at MCGSBS. Minimal edits were made to the survey demographic questions to adapt the survey instrument to the MCGSBS program. After the first survey was administered in 2019, several changes were made to the survey design to (i) add the GAD-7 anxiety assessment, (ii) replace the food insecurity measure used by the University of California with the validated USDA six-item scale, and (iii) add a section to assess respondent under-represented minority status as defined by the NSF. Appropriate copyright permissions were obtained from the University of California, and a full list of the 153 survey questions can be found at <https://college.mayo.edu/media/mccms/content-assets/academics/biomedical-research-training/phd-program/student-life/student-organizations/2020-MCGSBS-Wellbeing-Survey.pdf>. A full list of validated measures used in this survey can be found in Supplementary Table 1.

Survey administration. The survey was advertised to MCGSBS students via e-mail announcements and informational sessions hosted by the survey design team, all of whom completed human subjects protection training. Survey responses were collected using Qualtrix (Provo, UT, USA). All surveys were administered in early November.

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References

- Gewin, V. *Nature* **490**, 299–301 (2012).
- Evans, T. M., Bira, L., Gastelum, J. B., Weiss, L. T. & Vanderford, N. L. *Nat. Biotechnol.* **36**, 282–284 (2018).
- UC Berkeley Graduate Assembly. *Graduate Student Happiness & Well-Being Report* (University of California Berkeley, 2014); http://ga.berkeley.edu/wp-content/uploads/2015/04/wellbeingreport_2014.pdf
- Guthrie, S. et al. *Understanding Mental Health in the Research Environment: A Rapid Evidence Assessment* (RAND Corp., 2017); https://www.rand.org/pubs/research_reports/RR2022.html
- Johns Hopkins University. *Task Force on Student Mental Health and Well-being* (Johns Hopkins University, 2018); <https://provost.jhu.edu/wp-content/uploads/2018/02/Task-Force-on-Student-Mental-Health-and-Well-being-Final-Report.pdf>
- Woolston, C. *Nature* **550**, 549–552 (2017).
- Villarroel, M. A. & Terlizzi, E. P. *Symptoms of Depression Among Adults: United States, 2019*. National Center for Health Statistics NCHS Data Brief No. 379 (2020); <https://www.cdc.gov/nchs/data/databriefs/db379-H.pdf>
- Coffino, J. A., Spoor, S. P., Drach, R. D. & Hormes, J. M. *Public Health Nutr.* **24**, 1889–1894 (2021).
- Woolston, C. *Nature* **575**, 403–406 (2019).
- Duffy, M., Thanhouser, C. & Derry, H. *Nat. Biotechnol.* **37**, 711–712 (2019).
- Evans, T. M., Bira, L. & Vanderford, N. L. *Nat. Biotechnol.* **37**, 712–713 (2019).
- Woolston, C. *Nature* **585**, 147–148 (2020).
- Vahratian, A., Blumberg, S. J., Terlizzi, E. P. & Schiller, J. S. *MMWR Morb. Mortal. Wkly. Rep.* **70**, 490–494 (2021).
- Berkowitz, S. A. & Basu, S. *JAMA Intern. Med.* **181**, 699–702 (2021).
- Chirikov, I. et al. *Undergraduate and Graduate Students' Mental Health During the COVID-19 Pandemic* (UC Berkeley Center for Studies in Higher Education, 2020); <https://escholarship.org/uc/item/80k5d5hw>
- Robinson, E., Sutin, A. R., Daly, M. & Jones, A. J. *Affect. Disord.* **296**, 567–576 (2022).
- Kunzler, A. M. et al. *Global. Health* **17**, 34 (2021).
- Sverdlík, A. & Hall, N. C. *J. Adult Contin. Educ.* **26**, 97–124 (2019).
- Barreira, P. & Bolotnyy, V. *J. Am. Coll. Health* <https://doi.org/10.1080/07448481.2022.2057804> (2022).
- Diener, E., Emmons, R. A., Larsen, R. J. & Griffin, S. J. *Pers. Assess.* **49**, 71–75 (1985).
- Eaton, W. W. et al. *Center for Epidemiologic Studies Depression Scale: Review and Revision* (CESD, 2004). <https://psycnet.apa.org/record/2004-14941-011>
- Spitzer, R. L., Kroenke, K., Williams, J. B. & Löwe, B. *Arch. Intern. Med.* **166**, 1092–1097 (2006).
- Blumberg, S. J., Bialostosky, K., Hamilton, W. L. & Briefel, R. R. *Am. J. Public Health* **89**, 1231–1234 (1999).
- Cohen, S. et al. *Social Support: Theory, Research and Applications* pp. 73–94 (Springer, 1985).
- Satinsky, E. N. et al. *Sci. Rep.* **11**, 14370 (2021).
- Brody, D. J., Pratt, L. A. & Hughes, J. P. Prevalence of depression among adults aged 20 and over: United States, 2013–2016. *NCHS Data Brief* <https://www.cdc.gov/nchs/data/databriefs/db303.pdf> (2018).
- Terlizzi, E. P. & Villarroel, M. A. Symptoms of generalized anxiety disorder among adults: United States, 2019. *NCHS Data Brief* <https://www.cdc.gov/nchs/data/databriefs/db378-H.pdf> (2020).

28. Coleman-Jensen, A., Rabbitt, M. P., Gregory, C. A. & Singh, A. *Household Food Security in the United States in 2020* (USDA Economic Research Service, 2020); <https://www.ers.usda.gov/webdocs/publications/102076/err-298.pdf?v=5384.5>
29. van der Velden, P. G., Contino, C., Das, M., van Loon, P. & Bosmans, M. W. G. *J. Affect. Disord.* **277**, 540–548 (2020).
30. Wong, S. Y. S. et al. *Br. J. Gen. Pract.* **70**, e817–e824 (2020).
31. Linzer, M. et al. *Am. J. Med.* **101**, 526–533 (1996).
32. Altemus, M., Sarvaiya, N. & Neill Epperson, C. *Front. Neuroendocrinol.* **35**, 320–330 (2014).
33. McDonald, K. *Issues Ment. Health Nurs.* **39**, 16–29 (2018).
34. Cochran, S. D., Mays, V. M. & Sullivan, J. G. *J. Consult. Clin. Psychol.* **71**, 53–61 (2003).
35. Petruzzella, A., Feinstein, B. A., Davila, J. & Lavner, J. A. *Arch. Sex. Behav.* **49**, 1755–1767 (2020).
36. Wilkins-Yel, K. G. et al. *Sex Roles* **86**, 208–232 (2022).
37. Arnold, A. C. et al. in *Proc. 2020 American Society for Engineering Education Conference* (2020); <https://par.nsf.gov/servlets/purl/10164497>
38. Velten, J., Bieda, A., Scholten, S., Wannemüller, A. & Margraf, J. *BMC Public Health* **18**, 632 (2018).
39. White, R. L. et al. *Am. J. Prev. Med.* **52**, 653–666 (2017).
40. Doherty, A. M. & Gaughran, F. *Soc. Psychiatry Psychiatr. Epidemiol.* **49**, 673–682 (2014).
41. Ahmad, N. S. S., Sulaiman, N. & Sabri, M. F. *Int. J. Environ. Res. Public Health* **18**, 5627 (2021).
42. Aneshensel, C. S., Estrada, A. L., Hansell, M. J. & Clark, V. A. *J. Health Soc. Behav.* **28**, 232–246 (1987).
43. Bilsker, D., Fogarty, A. S. & Wakefield, M. A. *Can. J. Psychiatry* **63**, 590–596 (2018).
44. Möller-Leimkühler, A. M. *J. Affect. Disord.* **71**, 1–9 (2002).

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Competing interests

The authors declare no competing interests.

Additional information

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