

How the COVID-19 Pandemic Reshaped Demographic Variation in Mental Health Among Diverse Engineering Student Populations

Andrew Danowitz^{a*} and Kacey Beddoes^b

^aComputer Engineering, California Polytechnic State University, San Luis Obispo, USA; ^bEngineering Dean's Office, San Jose State University, San Jose, USA

Email: adanowit@calpoly.edu. ORCID: 0000-0002-4842-2005. Address: 1 Grand Ave, San Luis Obispo, CA 93407 USA.

How the COVID-19 Pandemic Reshaped Demographic Variation in Mental Health Among Diverse Engineering Student Populations

Mental health issues have long posed a challenge on university campuses. While no population is immune, research has shown that students from marginalized backgrounds can have higher rates of mental health issues and suffer worse outcomes as a result. These discrepancies have been attributed to everything from different cultural norms to the micro-aggressions and other barriers that students from marginalized populations face on university campuses. With the onset of COVID-19 in the United States, many residential universities switched to a remote learning model, fundamentally changing the relationship between students, campus, and family support. This work uses survey data from students in the United States to explore how COVID-19 affected mental health issues among students from different backgrounds. While the pandemic drastically increased rates of depressive disorder among all respondents, discrepancies between mental health rates for women and Hispanic/Latinx compared to men and White respondents either decreased or disappeared. Additionally, respondents identifying as Asians were less likely to screen positive for several mental health conditions than White, Non-Hispanic respondents. These findings may point to important new insights about the ways in which engineering education undermines some groups' mental health.

Keywords: mental health; COVID-19; pandemic; gender; ethnicity; disability

Introduction

Unmet mental health needs have reached a crisis level on university campuses (Flatt 2013). The number of students dealing with depression is increasing (Gallagher 2008; Storrie, Ahern, and Tuckett 2010), and suicide is the second leading cause of death for U.S. university students (Taub and Thompson 2013). Psychological distress also plays a key role in student attrition (Gerdes and Mallinckrodt 1994; Wynaden, Wichmann, and Murray 2013). For those who remain, mental wellness problems decrease students' energy, concentration, and motivation in and for university (Eisenberg, Lipson, and Posselt 2016). Contributing to these issues, many students who suffer from mental health issues do not receive mental health services (Eisenberg, Golberstein, and Gollust 2007), potentially as a result of well-documented barriers to student help-seeking and stigmas surrounding mental health issues in higher education (Beddoes and Danowitz 2022; Cage et al. 2020).

The onset of the global COVID-19 pandemic has worsened this situation (Huckins et al. 2020; Tasso, Hisli Sahin, and San Roman 2020). In the Spring of 2020, students were faced with several stressful events, from loss of loved ones to difficulty meeting basic needs (Danowitz and Beddoes 2020). Making matters worse, the decision by many universities to close physical campuses and move to remote learning greatly limited access to campus-based mental health resources and counseling (Beddoes and Danowitz 2021).

This article explores the mental health of diverse student groups in engineering at the conclusion of the first semester of widespread COVID-19 incidence in the United States. More specifically, it examines how mental health discrepancies between marginalized and dominant groups changed during the pandemic. This analysis points to unexpected benefits of remote learning and introduces new considerations for its continued use.

Literature Review

Mental health (In)Equity

In many countries around the world, including Australia, mental health challenges do not impact all groups of students equally (Wilson and Wilson 2020): Students in marginalized populations are more likely to suffer from mental health issues and have different mental health needs than students from dominant groups (Taub and Thompson 2013). Being a member of a racial or ethnic minority or a lower socio-economic group puts one at increased risk of lower mental health (Cokley et al. 2013; Larcombe et al. 2016). Women students experience more psychological issues than men students but are more willing to seek help (Hicks et al. 2013) and LGBTQA students experience lower mental health status than heterosexual students (Johnson et al. 2013).

With research from the United States and Australia showing the burdens of COVID-19 disproportionately falling on marginalized communities (Macias Gil et al. 2020) and women (Rossell et al. 2021), it stands to reason that COVID would have a disproportionate mental health impact on engineering students from these groups. That assumption, however, does not account for different cultural and socio-economic conditions faced by students from non-dominant populations. For example, COVID-induced campus closures forced many residential students to move back to their family homes. While this removes students from on-campus support networks and material aid, research suggests that some first-generation university student populations have interdependent family support relationships and family responsibilities that are strained by residential university life (Covarrubias et al. 2019; Tseng 2004); these students might find the COVID-induced move to remote learning helps meet both familial and academic expectations. Some student populations also derive critical support from their families and home communities (Ayón, Marsiglia, and Bermudez-Parsai 2010; Dennis, Phinney, and Chuateco 2005); and a move home could show positive results for these groups. If nothing else, a move away from campus environments might help to shield members of marginalized groups from damaging micro-aggressions and stereo-type threats that are known to hamper student performance and mental health at universities in Australia, as well as other countries (M. J. Lee et al. 2020; Lloyd and Szymakowski 2017).

While none of this is to understate the negative effects of the COVID-19 pandemic, it is possible that the move to remote, online learning had features that mitigated some of the negative outcomes that students might otherwise have faced.

Engineering Education

Potentially due to its well-documented culture of stress and shame (Beddoes and Danowitz 2022; Huff et al. 2021; Jensen and Cross 2018), and the prevalence of stereotype threat in STEM fields (M. J. Lee et al. 2020; Bell et al. 2003) engineering students suffer from mental health issues at similar (M. F. Lee and Wan Adam 2016; Lipson et al. 2016) or higher rates (Loosemore, Lim, and Ilievski 2020) than their non-engineering peers, a trend that has continued into the pandemic. However, engineering students are less likely than their peers in other majors to seek help for mental health issues (Hyun et al. 2006; Lipson et al. 2016). When combined with microaggressions and other inequities directed at engineering students of color, women, and first-generation university students (Cokley et al. 2013; Ellis et al. 2019; Hicks et al. 2013; M. J. Lee et al. 2020; Shadick and Akhter 2013; Taub and Thompson 2013), it is

perhaps no surprise that research shows that these students face worse mental health outcomes.

One U.S. survey found that women respondents were more likely to screen positive for major depressive disorder (by a factor of 2.3), panic disorder (by a factor of 4.4), other anxiety disorders (by a factor of 2.2), and PTSD (by a factor of 1.9) than male peers (Danowitz and Beddoes 2022). The same study found that engineering students who identify as Hispanic or Latinx were more likely to screen positive for major depressive disorder (by a factor of 3.2) and PTSD (by a factor of 2.5) than respondents who identified as non-Hispanic/Latinx White; and that respondents reporting a physical disability were more significantly likely to screen positive for major psychological distress (by a factor of 2.2), other (non-major) depressive disorder (by a factor of 3.3), and PTSD (by a factor of 2.9).

Effects of Pandemics on Mental Health

While there is limited research on the mental health impacts of global pandemics, research focused in the Australasian region has shown that local and regional pandemics have been detrimental (Taylor et al. 2008; Xu et al. 2011). Early COVID-19 specific studies are bearing out those predictions for student populations by finding significant impacts on students' mental health. A survey of STEM graduate students revealed that 40% had symptoms of generalized anxiety disorder and 37% had symptoms of major depressive disorder, which were significantly higher than data from 2019 (Chirikov et al. 2020). A spring 2020 student success survey at one university revealed that 57% of undergraduates and 42% of graduate students reported stress and anxiety negatively impacting their academic success 'a lot', and 34% of students who had been planning to continue schooling in fall 2020 reported that mental health concerns would affect their plans (Jackson, Johnson, and Zheng 2020). A U.S. nationwide survey of engineering undergraduates from Summer 2020 found that COVID-19 had significantly increased baseline stress levels for engineering students (Danowitz and Beddoes 2020).

Methods

Survey design

The findings presented in this article come from a U.S. survey of engineering students between May and July of 2020. The instrument for this study is based on the instrument used in Danowitz and Beddoes to allow for direct comparison with pre-COVID mental health datasets of engineering students. The instrument is composed of the following three preexisting and widely used mental health surveys:

- (1) *The Patient Health Questionnaire (PHQ)*: screens for depression, anxiety, and eating disorders (Spitzer et al. 1999; Zivin et al. 2009).
- (2) *The Kessler 6*: measures serious cases of non-specific psychological distress in individuals (Kessler et al. 2002).
- (3) *The Primary Care – Post-traumatic Stress Disorder (PC-PTSD)*: screens for Post-Traumatic Stress Disorder (PTSD) (Cameron and Gusman 2003; Hegel et al. 2006; Khaylis et al. 2011; Van Dam et al. 2010).

The instrument also included demographic questions, and questions about pre-existing

mental health diagnoses and disabilities. These questions were combined into a single online survey hosted on the research.net survey platform and were guarded with an informed consent survey page.

Data collection

With the approval of California Polytechnic State University's Institutional Review Board (ethics approval board), data collection occurred from May to July 2020, during the height of COVID-related school closures in the U.S. The survey was distributed through several direct and indirect channels. These channels include an email list for California State University engineering deans, select American Society for Engineering Education division and regional email lists, the Society of Women Engineers, the /r/EngineeringStudents subreddit, and GradCafe's Engineering Student forum. To incentivize participation, we offered \$5 Amazon.com gift-cards to the first 1000 survey respondents to provide valid .edu email addresses. All students were presented with a plain language informed-consent document that they had to affirmatively agree to (via online survey button click) to participate in the survey.

Respondents

Since recruitment was conducted over the open internet and since an incentive was offered, there were initially several fraudulent responses. We eliminated responses from all respondents who did not possess a valid .edu email address. We attempted to verify remaining recipients by confirming that the respondent's reported university offered the respondents' reported engineering major. For this analysis, we then filtered out all respondents who do not attend a U.S. 4-year non-profit institution that offers 4-year engineering program. We further filtered down to select only the subset of respondents who had completed enough of the survey to receive at least one screen (positive or negative) on the included instruments. After these steps, 628 responses remained from individuals at 133 institutions. Demographic characteristics of respondents are shown in **Table 1** *Error! Reference source not found.*

Table 1. Number of respondents in each category

Year in program (n)	
1	84
2	133
3	163
4	154
5	61
6+	28
Prefer not to respond	5
Race or ethnicity (n)	
White	365
Hispanic or Latino	94
Asian	83
Black or African American	46
American Indian or Alaska Native	23
Mixed Race	7

Native Hawaiian or other Pacific Islander	6
Self-reported as ‘Other’	1
Prefer not to respond	3
Gender (n)	
Female	249
Male	376
Non-Binary	1
Prefer not to respond	2
Sexual Orientation (n)	
Heterosexual	571
LGBTQA	44
Bisexual	25
Gay	6
Lesbian	8
Asexual	3
Questioning or unsure	2
Prefer not to respond	13
Parents’ Education (n)	
Bachelor’s Degree	308
Post-Bachelor’s training	102
Completed some university	71
High school or equivalent	63
Associate’s degree	42
Some formal schooling	37
Prefer not to respond	5
Disability (n)	
Physical	20
Learning	177
Other factors (n)	
Attends private institution	229
International student	181
Diagnosed with mental health condition	33
Veteran	157

The respondent population was largely composed of White non-Hispanic/Latinx (58%) individuals, men (60%), heterosexuals (91%), and non-first-generation university students (65%)—defined as at least one parent receiving a bachelor’s degree or higher.

Data analysis

Quantitative data analysis for this work was performed using the R open-source statistical computing language (R Core Team 2022) and the analysis of student mental health and demographic differences was modelled after the work in Danowitz and Beddoes (2022). R packages used for data analysis include Rmisc, tidyverse, dplyr,

kimisc, checkmate, ggplot2, Hmisc, zoo, stats, flipPlots, tidytext, kableExtra, formattable, htmltools, webshot, and pscl. We scored the individual mental health screening instruments for each respondent. For the Kessler 6, the scoring threshold for moderate psychological distress proposed and validated by Prochaska et al. (2012) is used in addition to the original scale for severe distress. Where respondents provided answers to only some questions in a screen, if they provided enough information to score the instrument, their result was included for that screen.

A logistic regression was run against demographic factors to determine which groups of respondents have significantly different screening rates ($p \leq 0.05$) from the baseline population. Since much of the existing literature lumps Lesbian, Gay, Bisexual, Trans, Queer, and Asexual students into a monolithic LGBTQA group, we aggregate these populations to allow both for a more direct comparison with prior literature. Due to the small number of non-gender-conforming respondents, this group was dropped from analysis. Additionally, since there were insufficient positive screens for Bulimia across the respondent pool, Bulimia and Binge Eating disorder were combined into a single ‘eating disorder’ category for regression analysis.

Table 2. Populations used in regression.

Factor	Selected groups
Race	White*
	Hispanic or Latino
	Asian
	Black or African American
	American Indian or Alaska Native
	Mixed Race
	Native Hawaiian or other Pacific Islander
Gender	Man*
	Woman
Sexuality	Heterosexual*
	LGBTQA
Learning disability	No*
	Yes
Physical disability	No*
	Yes
Parents' education	Bachelor's Degree*
	Post-Bachelor's training
	Completed some university
	High school or equivalent
	Associate's degree
	Some formal schooling
Private school	No*
	Yes
International Student	No*
	Yes

* indicates baseline population.

After reducing the data set, the population groups shown in Table 2 were used for regression. These were encoded as 12 independent binomial regression variables.

Over-represented populations were used as baseline populations.

Limitations

There are some limitations to this study that may limit the generalizability of results. First, recruitment for the post-COVID survey included calls for participation over the open internet. Since this survey was conducted anonymously, we had no independent way to verify a respondent's enrollment. Also, the post-COVID data was collected over a relatively brief period comparatively early in the U.S. COVID-19 pandemic (May–July 2020), and student mental health considerations have likely changed since then.

Results

The overall mental health screen rates for the respondent population are shown in Figure 1. Of the 532 respondents who completed all screens for potentially diagnosable mental health conditions (a subset of the 628 students who completed at least one screen), 70% had at least one positive screen. Drawing from all 628 respondents, a total of 86% of respondents had positive screens for either moderate or major unspecified psychological distress, with 50% of respondents testing positive for either Major or Other Depressive disorder, 21% testing positive for panic disorder or other anxiety, and 27% testing positive for PTSD-like symptoms.

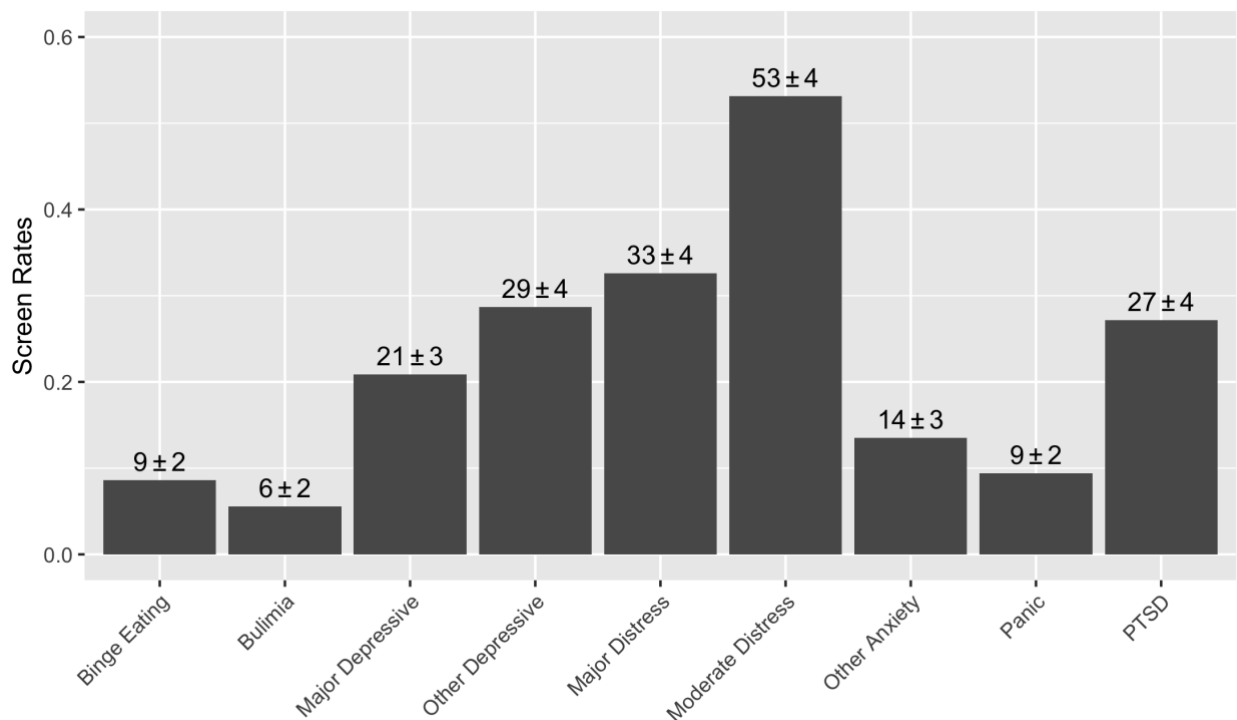


Figure 1. Positive screen rates from Dataset 2.

Logistic regressions were used to identify factors associated with each mental health condition. All models were computed using the generalized linear model (glm) function in R, and all models took the form shown the following equation.

*glm(diagnosis, ~race + gender + sexuality + parents_education
+ physical_disability + learning_disability + sexuality
+ international + public_private)*

The results of this analysis are summarized in Table 3. Results are given as odds ratios showing the likelihood that a respondent in a group will screen positive for a measure compared to the baseline populations. The McFadden pseudo R^2 is reported in the table R^2_{adj} as an indicator of the percentage of variation explained by factors included in the model.

Table 3. Statistically significant mental health screens by demographic.

Population	Condition	Odds ratio	Lower Interval	Upper Interval	p	R^2_{adj}
American Indian or Alaska native	Kessler Major	3.3	1.4	8.5	.0091	.044
	Kessler Moderate	0.29	0.10	0.73	.012	.018
Asian	PTSD	0.19	0.029	0.67	.027	.055
	Other Anxiety	0.25	0.059	0.72	.024	.073
Black or African American	PTSD	0.41	0.20	0.79	.012	.055
	Major Depressive	2.1	0.99	4.2	.048	.061
Mixed Race	Eating Disorder	9.9	1.6	58	.0097	.042
Native Hawaiian or other Pacific Islander	Other Anxiety	7.4	1.3	42	.019	.073
LGBTQA	Other Anxiety	2.9	1.2	6.5	.014	.073
Parents: high school or equivalent	Other Depressive	0.38	0.14	0.89	.035	.12
Parents: post-bac training	Other Depressive	0.40	0.19	0.80	.012	.12
	PTSD	0.37	0.18	0.70	.0033	.055
Parents: less than high school	Major Depressive	2.8	1.0	7.9	.046	.061
Learning disability	Other Depressive	3.7	1.9	7.4	< .001	.12
	Major Depressive	0.41	0.19	0.89	.026	.061
International	Major Depressive	2.8	1.3	6.0	.0071	.061
Private University	Major Depressive	1.7	1.1	2.7	.016	.061

Shaded lines in Table 3 indicate cases where a population had lower odds of screening positive for a condition than the baseline population.

Respondents who identified as ‘Hispanic or Latinx,’ women respondents, respondents whose parents’ highest level of education is either an Associate’s degree or some university, and those respondents reporting a physical disability did not differ from the baseline population on any measure and are omitted from the table.

Discussion

The mental health trends identified in the previous section provide insight into the overall mental health of different demographic groups during the COVID-19 pandemic. Since the primary research question we sought to address with this work was to examine how mental health discrepancies between marginalized and dominant groups changed during the pandemic, however, we explicitly view the data presented here in comparison against published pre-pandemic data (Danowitz and Beddoes 2022) to infer how COVID may have changed mental health for engineering students on a larger

scale. Screening rates for Bulimia across the entire population increased (5 ± 2 post-COVID vs. 1.5 ± 0.8). Rates for major and other depressive disorders have likewise significantly increased from their pre-COVID rates, with 50% of respondents screening positive for some form of depressive disorder. This jump is mirrored in the percentage of respondents screening positive for at least one mental health condition: 70% of respondents versus 50% in the pre-COVID literature (Danowitz and Beddoes 2022). While the significant increase in rates of depression is perhaps not surprising—research has shown a link between acute stress and onset of depression (Hammen et al. 2009; Kessler 1997; Stroud, Davila, and Moyer 2008)—it helps quantify the unique and unprecedented toll that COVID-19 took on the mental health of students.

A summary comparison of pre-COVID-19 mental health screens (from Danowitz and Beddoes (2022) versus post-COVID-19 mental health screens are shown in Table 4. Some respondent groups fared better than previous research might indicate. Respondents with physical disabilities showed no significant differences in mental health screens versus respondents with no disabilities. This stands in stark contrast with pre-COVID mental health data that showed this group faring significantly worse than those not identifying as physically disabled (Danowitz and Beddoes 2022), and significant previous literature documenting the challenges faced by students with disabilities in a university context (McCall et al. 2020; Trammell 2009; Weatherton, Mayes, and Villanueva-Perez 2017). Because other research has found that those with physical disabilities face additional burdens as a result of the COVID-19 pandemic (Kamalakannan et al. 2021), our result may be a function of the small sample size (22 respondents identifying with a physical disability and only 14 of those completed all screens). Conversely, research has shown that the on-campus stigmas for disability can be so severe that some with invisible disabilities choose to forego accommodations rather than be identified as having a disability (Aquino and Bittinger 2019). For these students, the move to online-learning and a move closer to family support systems could lessen some of the stigmas and burdens otherwise faced at university. Regardless, more directed research in this area would be beneficial to identify how campuses can better support remote participation of students with physical disabilities.

Table 4. Comparison of pre- vs. post-COVID-19 mental health conditions.

Respondent population	Pre-COVID conditions	Post-COVID
Women	Increased odds of: Major depressive Panic disorder Other anxiety PTSD	No statistical differences
Hispanic/Latinx	Increased odds of: Major depressive PTSD	No statistical differences
Asian	No statistical differences	Decreased odds of: Other anxiety PTSD
LGBTQA	Increased odds of Kessler Moderate	Increased odds of other anxiety
Physical Disability	Increased odds of: Kessler Major	No statistical differences

Parents' edu: Assc deg	Other depressive PTSD Increased odds of: Major depressive PTSD	No statistical differences
Parents' edu: Some coll	Increased odds of Kessler major	No statistical differences
Parents' edu: Post-Bac	Increased odds of other anxiety	Decreased odds of: Other depressive PTSD

Other groups also fared better when compared to the pre-COVID data. In previous studies, women and Hispanic respondents had significantly higher odds of screening positive for major depressive disorder than men and White non-Hispanic students respectively. This data shows no such increased odds. While this may be indicative of higher depression rates overall, these groups significantly improve on other measures. Women no longer have increased odds of panic, other anxiety, or PTSD-like symptoms, and Hispanic/Latinx students no longer have higher odds of screening positive for PTSD-like symptoms.

Furthermore, other marginalized groups fared better than the baseline population on significant measures. Respondents identifying as Asian were significantly less likely to screen positive for other anxiety (25% as likely) and PTSD-like symptoms (40% as likely) than the baseline White non-Hispanic population. Pre-Covid, screens between these two groups showed no statistically significant differences (Danowitz and Beddoes 2022). While there is risk in making generalizations, especially based on broad racial categories like 'Asian' that obscure group differences (McEwen 2002, 18), it appears that the COVID-19 pandemic and the move from a residential campus learning environment to a remote learning environment improved some mental health measures for marginalized student groups.

While we lack specific data to indicate why these groups may be faring better on some measures post-COVID compared to pre-COVID, we posit that some of the improvement may be due to the prevalence of stereotype threat and microaggressions that women and minorities are known to face on university campuses (M. J. Lee et al. 2020; Bell et al. 2003; Camacho and Lord 2011). Students from certain marginalized groups have also been documented to draw support from their home communities (Covarrubias et al. 2019; Tseng 2004; Ayón, Marsiglia, and Bermudez-Parsai 2010; Dennis, Phinney, and Chuateco 2005), which could account for some of these gains. With some research showing increased rates of domestic violence during the pandemic (Piquero et al. 2021), however, and other research documenting that the pandemic disproportionately harmed marginalized communities (Macias Gil et al. 2020; Rossell et al. 2021), it is also possible that the worst-off engineering students in these groups were unable to participate in this survey, skewing the results for these demographic groups. While we certainly hope this is not the case, it bears further research.

Given the prevalence of distance education in Australia and that it has been a leading area of engineering education research there (Jesiek, Borrego, and Beddoes 2008; Jesiek et al. 2009), these findings point to interesting opportunities for future research. Namely, additional comparative studies that examine differences between marginalized groups' experiences and outcomes with in-person learning compared to distance learning seem particularly important, and engineering education researchers may be well positioned to conduct such studies.

Improvement was not measured among all groups, however. Respondents identifying as Black or African American, and those identifying as international students were more than twice as likely to screen positive for major depressive disorder than their White peers, and respondents identifying as Native Hawaiian or other Pacific Islander and those identifying as members of the LGBTQA community faced large odds of screening positive for other anxiety. Finally, respondents identifying as mixed race were nearly 10 times as likely to screen positive for an eating disorder than their White peers. While we lack targeted pre-COVID data for engineering students from most of these groups to determine whether these discrepancies have increased or decreased, based on the data, these groups could certainly benefit from targeted support and outreach.

From a socio-economic perspective, as proxied by parents' education, there are stark changes in mental health from pre- versus post-COVID data. Whereas pre-COVID, respondents whose parents had completed only a bachelor's degree fared better than respondents whose parents had any other educational background (Danowitz and Beddoes 2022), in the post-COVID data, respondents whose parents had only completed high school and those whose parents had completed post-bachelor's work fared better than the baseline population on depressive measures. Those whose parents completed some university or a two-year degree were not significantly different on any measure than those whose parents had completed a bachelor's degree. Those whose parents had less than a high-school education, however, fared significantly worse than the baseline population for major depressive disorder. This group has no comparison in the pre-COVID published literature; however, the fact that these respondents are nearly 3 times as likely as the baseline population to screen positive for major depressive disorder is certainly an area of concern.

The final major result from our study is that respondents attending a private non-profit engineering program were 1.7 times as likely as students attending public non-profit programs to screen positive for major depressive disorders. This discrepancy is particularly surprising and points to a need for further analysis of COVID-19 policies and student supports that may contribute to these discrepancies.

Conclusions

This study explores how the COVID-19 pandemic has affected mental health among engineering university students, and how it has shifted mental health disparities among populations. Our analysis finds that the pandemic greatly increased rates of major and other depression across respondents and has led to a situation where 70% of respondents had at least one positive screen for a mental health condition.

For populations for which published pre-COVID mental health data are available, we find fewer negative mental health discrepancies for most marginalized groups, and some instances where marginalized groups fare better on mental measures than the baseline population. These findings may be of particular interest in Australia, where distance education is particularly prominent compared to some other countries. While this study was unable to capture any insight for why this occurred, factors stemming from cultural differences regarding family and community for different groups and the well-documented stressors and barriers faced by People of Color and women in fields like engineering likely play a role. These results, and the promise that mental health discrepancies could potentially be reduced among different groups point to the need for universities to reassess campus cultures, curriculum and instruction

decisions, and the role of family support in ensuring learning equity among their student bodies.

Acknowledgments

The authors would like to thank their colleges, and their Institutional Review Boards for helping to make this research possible. They would also like to thank their student participants.

Disclosure

The authors report there are no competing interests to declare.

Funding

The work of Andrew Danowitz was supported by the National Science Foundation under Grants EEC-1929478 and EEC-2029206. The work of Kacey Beddoes was supported by the National Science Foundation under Grants EEC-1929484 and EEC-2029206. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

References

- Aquino, Katherine C., and Joshua D. Bittinger. 2019. "The Self-(Un)Identification of Disability in Higher Education." *Journal of Postsecondary Education and Disability* 32 (1): 5–19.
- Ayón, Cecilia, Flavio F. Marsiglia, and Monica Bermudez-Parsai. 2010. "Latino Family Mental Health: Exploring the Role of Discrimination and Familismo." *Journal of Community Psychology* 38 (6): 742–56.
- Beddoes, Kacey, and Andrew Danowitz. 2021. "Learning from Universities' Responses to the COVID-19 Pandemic: Lessons for the New Normal." Paper presented at the SEFI Annual Conference, Berlin.
- . 2022. "In Their Own Words: How Aspects of Engineering Education Undermine Students' Mental Health." Paper presented at the American Society for Engineering Education Annual Conference, Minneapolis, MN.
- Bell, Amy E., Steven J. Spencer, Iserman, Emma, and Christine E.R. Logel. 2003. "Stereotype Threat and Women's Performance in Engineering." *Journal of Engineering Education* 92 (4): 307–12.
- Cage, Eilidh, Melissa Stock, Alex Sharpington, Emma Pitman, and Rachel Batchelor. 2020. "Barriers to Accessing Support for Mental Health Issues at University." *Studies in Higher Education* 45 (8): 1637–49.
- Camacho, Michelle Madsen, and Susan M. Lord. 2011. "'Microaggressions' in Engineering Education: Climate for Asian, Latina and White Women." In *2011 Frontiers in Education Conference (FIE)*.
- Cameron, Rebecca P., and D. Gusman. 2003. "The Primary Care PTSD Screen (PC-PTSD): Development and Operating Characteristics." *Primary Care Psychiatry* 9 (1): 9–14.

- Chirikov, Igor, Krista M. Soria, Bonnie Horgos, and Daniel Jones-White. 2020. "Undergraduate and Graduate Students' Mental Health During the COVID-19 Pandemic." *UC Berkeley: Center for Studies in Higher Education*.
- Cokley, Kevin, Shannon McClain, Alicia Enciso, and Mercedes Martinez. 2013. "'An Examination of the Impact of Minority Status Stress and Impostor Feelings on the Mental Health of Diverse Ethnic Minority College Students.'" *Journal of Multicultural Counseling and Development* 41 (2): 82–95.
- Covarrubias, Rebecca, Ibetle Valle, Giselle Laiduc, and Margarita Azmitia. 2019. "'You Never Become Fully Independent': Family Roles and Independence in First-Generation College Students." *Journal of Adolescent Research* 34 (4): 381–410.
- Danowitz, Andrew, and Kacey Beddoes. 2020. "Effects of COVID-19 on Engineering Students' Baseline Stress." Paper presented at the Australasian Association for Engineering Education Annual Conference, Virtual Conference.
- . 2022. "Mental Health in Engineering Education: Identifying Population and Intersectional Variation." *IEEE Transactions on Education* 65 (3): 257–66.
- Dennis, Jessica M, Jean S Phinney, and Lizette Ivy Chuateco. 2005. "The Role of Motivation, Parental Support, and Peer Support in the Academic Success of Ethnic Minority First-Generation College Students." *Journal of College Student Development* 46 (3): 223–36.
- Eisenberg, Daniel, Ezra Golberstein, and Sarah E. Gollust. 2007. "Help-Seeking and Access to Mental Health Care in a University Student Population." *Medical Care* 45 (7): 594–601.
- Eisenberg, Daniel, Sarah Ketchen Lipson, and Julie Posselt. 2016. "Promoting Resilience, Retention, and Mental Health." *New Directions for Student Services* 2016 (156): 87–95.
- Ellis, James M., Candice S. Powell, Cynthia P. Demetriou, Carmen Huerta-Bapat, and A. T. Panter. 2019. "Examining First-Generation College Student Lived Experiences with Microaggressions and Microaffirmations at a Predominately White Public Research University." *Cultural Diversity and Ethnic Minority Psychology* 25 (2): 266–79.
- Flatt, Alicia Kruisselbrink. 2013. "A Suffering Generation: Six Factors Contributing to the Mental Health Crisis in North American Higher Education." *College Quarterly* 16 (1): 1–17.
- Gallagher, Robert P. 2008. "National Survey of Counseling Center Directors." The American College Counseling Association.
- Gerdes, Hilary, and Brent Mallinckrodt. 1994. "Emotional, Social, and Academic Adjustment of College Students: A Longitudinal Study of Retention." *Journal of Counseling & Development* 72 (3): 281–88.
- Hammen, Constance, Eunice Y. Kim, Nicole K. Eberhart, and Patricia A. Brennan. 2009. "Chronic and Acute Stress and the Prediction of Major Depression in Women." *Depression and Anxiety* 26 (8): 718–23.
- Hegel, Mark T., Caroline P. Moore, E. Dale Collins, Stephen Kearing, Karen L. Gillock, Raine L. Riggs, Kate F. Clay, and Tim A. Ahles. 2006. "Distress, Psychiatric Syndromes, and Impairment of Function in Women with Newly Diagnosed Breast Cancer." *Cancer* 107 (12): 2924–31.
- Hicks, Terence, Michael Herndon, Adriel Hilton, Prince Attah, and Vikki Armstrong. 2013. "Assessing Life Styles, Stressors and Health Status among a

- Predominantly African American On-Campus and Off-Campus Student Population." *College Quarterly* 16 (3): 13.
- Huckins, Jeremy F., Alex W. daSilva, Weichen Wang, Elin Hedlund, Courtney Rogers, Subigya K. Nepal, Jialing Wu, et al. 2020. "Mental Health and Behavior of College Students During the Early Phases of the COVID-19 Pandemic: Longitudinal Smartphone and Ecological Momentary Assessment Study." *Journal of Medical Internet Research* 22 (6).
- Huff, James L., B. Okai, K. Shanachilubwa, N.W. Sochacka, and J. Walther. 2021. "Unpacking Professional Shame: Patterns of White Male Engineering Students Living in and out of Threats to Their Identities." *Journal of Engineering Education* 110 (2): 414–36.
- Hyun, Jenny K., Brian C. Quinn, Temina Madon, and Steve Lustig. 2006. "Graduate Student Mental Health: Needs Assessment and Utilization of Counseling Services." *Journal of College Student Development* 47 (3): 247–66.
- Jackson, Melinda, Camille Johnson, and Lillian Zheng. 2020. "SJSU Spring 2020 Student Success Survey Summary Report." San Jose, CA: San Jose State University.
- Jensen, Karin J., and Kelly J. Cross. 2018. "Work in Progress: Understanding Student Perceptions of Stress as Part of Engineering Culture." In *2018 ASEE Annual Conference & Exposition*. Salt Lake City, Utah.
- Jesiek, Brent K, Kacey Beddoes, Deepika Sangam, and Maura Borrego. 2009. "Mapping Local Trajectories of Engineering Education Research to Catalyze Cross-National Collaborations." Paper presented at the SEFI Annual Conference, Rotterdam, The Netherlands.
- Jesiek, Brent K, Maura Borrego, and Kacey Beddoes. 2008. "Engineering Education Research: Global Trends and Collaborative Opportunities." Paper presented at the Research in Engineering Education Symposium (REES), Davos, Switzerland.
- Johnson, R. Bradley, Symphony Oxendine, Deborah J. Taub, and Jason Robertson. 2013. "Suicide Prevention for LGBT Students." *New Directions for Student Services* 2013 (141): 55–69.
- Kamalakannan, Sureshkumar, Sutanuka Bhattacharjya, Yelena Bogdanova, Christina Papadimitriou, Juan Carlos Arango-Lasprilla, Jacob Bentley, Tiago S. Jesus, and International Networking Group of the American Congress of Rehabilitation Medicine Refugee Empowerment Task Force. 2021. "Health Risks and Consequences of a COVID-19 Infection for People with Disabilities: Scoping Review and Descriptive Thematic Analysis." *International Journal of Environmental Research and Public Health* 18 (8): 4348.
- Kessler, Ronald C. 1997. "The Effects of Stressful Life Events on Depression." *Annual Review of Psychology* 48 (1): 191–214.
- Kessler, Ronald C, Gavin Andrews, Lisa J Colpe, Eva Hiripi, Daniel K Mroczek, S-LT Normand, Ellen E Walters, and Alan M Zaslavsky. 2002. "Short Screening Scales to Monitor Population Prevalences and Trends in Non-Specific Psychological Distress." *Psychological Medicine* 32 (6): 959–76.
- Khaylis, Anna, Melissa A. Polusny, Christopher R. Erbes, Abigail Gewirtz, and Michael Rath. 2011. "Posttraumatic Stress, Family Adjustment, and Treatment Preferences among National Guard Soldiers Deployed to OEF/OIF." *Military Medicine* 176 (2): 126–31.

- Larcombe, Wendy, Sue Finch, Rachel Sore, Christina M. Murray, Sandra Kentish, Raoul A. Mulder, Parshia Lee-Stecum, Chi Baik, Orania Tokatlidis, and David A. Williams. 2016. "Prevalence and Socio-Demographic Correlates of Psychological Distress among Students at an Australian University." *Studies in Higher Education* 41 (6): 1074–91.
- Lee, M. F., and W. M. H. Wan Adam. 2016. "A Comparison Study of Methods to Solve the Mental Health Problem between the Engineering and Non-Engineering Students." In *2016 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, 179–83.
- Lee, Meggan J., Jasmine D. Collins, Stacy Anne Harwood, Ruby Mendenhall, and Margaret Browne Hunt. 2020. "'If You Aren't White, Asian or Indian, You Aren't an Engineer': Racial Microaggressions in STEM Education." *International Journal of STEM Education* 7 (1): 48.
- Lipson, Sarah Ketchen, Sasha Zhou, Blake Wagner III, Katie Beck, and Daniel Eisenberg. 2016. "Major Differences: Variations in Undergraduate and Graduate Student Mental Health and Treatment Utilization Across Academic Disciplines." *Journal of College Student Psychotherapy* 30 (1): 23–41.
- Lloyd, Natalie Anne, and Jolanta Szymakowski. 2017. "Student Experiences in First-Year Engineering Classrooms--Exploring Issues of Gender in an Australian Programme." *Australasian Journal of Engineering Education* 22 (1): 23–32.
- Loosemore, Martin, Benson Lim, and Marco Ilievski. 2020. "Depression in Australian Undergraduate Construction Management, Civil Engineering, and Architecture Students: Prevalence, Symptoms, and Support." *Journal of Civil Engineering Education* 146 (3): 1–14.
- Macias Gil, Raul, Jasmine R. Marcelin, Brenda Zuniga-Blanco, Carina Marquez, Trini Mathew, and Damani A. Piggott. 2020. "COVID-19 Pandemic: Disparate Health Impact on the Hispanic/Latinx Population in the United States." *The Journal of Infectious Diseases* 222 (10): 1592–95.
- McCall, Cassandra, Ashley Shew, Denise R. Simmons, Marie C. Paretti, and Lisa D. McNair. 2020. "Exploring Student Disability and Professional Identity: Navigating Sociocultural Expectations in U.S. Undergraduate Civil Engineering Programs." *Australasian Journal of Engineering Education* 25 (1): 79–89.
- McEwen, Marylu K., ed. 2002. *Working with Asian American College Students: New Directions for Student Services*. 1st edition. San Francisco, Calif: Jossey-Bass.
- Piquero, Alex R., Wesley G. Jennings, Erin Jemison, Catherine Kaukinen, and Felicia Marie Knaul. 2021. "Domestic Violence during the COVID-19 Pandemic - Evidence from a Systematic Review and Meta-Analysis." *Journal of Criminal Justice* 74 (May): 101806. <https://doi.org/10.1016/j.jcrimjus.2021.101806>.
- Prochaska, Judith J., Hai-Yen Sung, Wendy Max, Yanling Shi, and Michael Ong. 2012. "Validity Study of the K6 Scale as a Measure of Moderate Mental Distress Based on Mental Health Treatment Need and Utilization." *International Journal of Methods in Psychiatric Research* 21 (2): 88–97.
- R Core Team. 2022. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing.
- Rossell, Susan L, Erica Neill, Andrea Phillipou, Eric J Tan, Wei Lin Toh, Tamsyn E Van Rheenen, and Denny Meyer. 2021. "An Overview of Current Mental Health in the General Population of Australia during the COVID-19 Pandemic: Results

- from the COLLATE Project." *Psychiatry Research* 296 (February): 113660.
<https://doi.org/10.1016/j.psychres.2020.113660>.
- Shadick, Richard, and Sarah Akhter. 2013. "Suicide Prevention in a Diverse Campus Community." *New Directions for Student Services* 2013 (141): 71–81.
- Spitzer, Robert L, Kurt Kroenke, Janet BW Williams, and Patient Health Questionnaire Primary Care Study Group. 1999. "Validation and Utility of a Self-Report Version of PRIME-MD: The PHQ Primary Care Study." *Jama* 282 (18): 1737–44.
- Storrie, Kim, Kathy Ahern, and Anthony Tuckett. 2010. "A Systematic Review: Students with Mental Health Problems—A Growing Problem." *International Journal of Nursing Practice* 16 (1): 1–6.
- Stroud, Catherine B., Joanne Davila, and Anne Moyer. 2008. "The Relationship between Stress and Depression in First Onsets versus Recurrences: A Meta-Analytic Review." *Journal of Abnormal Psychology* 117 (1): 206–13.
- Tasso, Anthony F., Nesrin Hisli Sahin, and Gabrielle J. San Roman. 2020. "COVID-19 Disruption on College Students: Academic and Socioemotional Implications." *Psychological Trauma: Theory, Research, Practice, and Policy* 13 (1): 9–15.
- Taub, Deborah J, and Jalonda Thompson. 2013. "College Student Suicide." *New Directions for Student Services* 2013 (141): 5–14.
- Taylor, Melanie R, Kingsley E Agho, Garry J Stevens, and Beverley Raphael. 2008. "Factors Influencing Psychological Distress during a Disease Epidemic: Data from Australia's First Outbreak of Equine Influenza." *BMC Public Health* 8 (1): n.p.
- Trammell, Jack. 2009. "Postsecondary Students and Disability Stigma: Development of the Postsecondary Student Survey of Disability-Related Stigma (PSSDS), Journal of Postsecondary Education and Disability." *Journal of Postsecondary Education and Disability* 22 (2): 106--116.
- Tseng, Vivian. 2004. "Family Interdependence and Academic Adjustment in College: Youth From Immigrant and U.S.-Born Families." *Child Development* 75 (3): 966–83.
- Van Dam, Debora, Thomas Ehring, Ellen Vedel, and Paul M. G. Emmelkamp. 2010. "Validation of the Primary Care Posttraumatic Stress Disorder Screening Questionnaire (PC-PTSD) in Civilian Substance Use Disorder Patients." *Journal of Substance Abuse Treatment* 39 (2): 105–13.
- Weatherton, Yvette Pearson, Renae Danielle Mayes, and Carol Villanueva-Perez. 2017. "Barriers to Persistence for Engineering Students with Disabilities." Paper presented at the ASEE Annual Conference & Exposition, Columbus, OH, June 24.
- Wilson, Kate F, and Kate Wilson. 2020. "How Do Students in Different Minority Groups Experience First-Year Engineering?" *Australasian Journal of Engineering Education* 25 (1): 66–78.
- Wynaden, Dianne, Helen Wichmann, and Sean Murray. 2013. "A Synopsis of the Mental Health Concerns of University Students: Results of a Text-Based Online Survey from One Australian University." *Higher Education Research & Development* 32 (5): 846–60.
- Xu, J., Y. Zheng, M. Wang, J. Zhao, Q. Zhan, M. Fu, Q. Wang, J. Xiao, and Y. Cheng. 2011. "Predictors of Symptoms of Posttraumatic Stress in Chinese University Students during the 2009 H1N1 Influenza Pandemic." *Medical Science Monitor*:

International Medical Journal of Experimental and Clinical Research 17 (7):
PH60–64.

Zivin, Kara, Daniel Eisenberg, Sarah E. Gollust, and Ezra Golberstein. 2009. "Persistence of Mental Health Problems and Needs in a College Student Population." *Journal of Affective Disorders*, 180–85.