

## RESULTS OF THE 2022 MENTAL HEALTH SURVEY OF THE PLANETARY SCIENCE COMMUNITY.

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**Introduction:** The mental health struggles within academia and research are well recognized in the science community [e.g., 1–3] and have been further illustrated by the numerous cultural memes and comics (e.g., PhD Comics). With the recent COVID-19 pandemic, mental health has become a topic of concern more so than ever before, as depression and anxiety have become an invisible consequence of social isolation and distancing [4]. In addition, recent social events in the United States have reignited attention towards important social injustices surrounding people of color, women, and LGBTQ+ in academia [5–8]. If diversity, equity, inclusion, and accessibility are to become major components of improving planetary science [e.g., 9,10], it is also important to understand the mental health status of the community, as it could expose deeply embedded policies, rules, and culture that may hinder any work in sustaining and advancing people belonging to marginalized groups.

Studies have been conducted to further understand the mental health of those in academia [1–4]. These studies have shown that before the pandemic, there was a mental health crisis among graduate students [1,2], which became a larger problem with increasing anxiety and depression due to the pandemic [3]. Soon after, the planetary science community recognized this concern in the recent 2023 Planetary Science Decadal White Paper, which proposed that NASA should invest in understanding the scope and impact of mental health problems within the planetary science community and how to address the issue [11].

In this study, we conducted a mental health survey to examine the mental health of the planetary science community. We examined the overall anxiety, depression, and stress severity of the community, rather than diagnosing the community's condition or determining the proportion of the population having a clinical anxiety, depressive, stress, or trauma-related diagnosis. To emphasize, the results are not intended to make clinical diagnoses, nor are they being used to do so for the purpose of this study.

**Survey and Methods:** We conducted an IRB-approved survey from September 14, 2022 to November 21, 2022 with a total of 308 samples. We advertised our survey mainly online through e-mail,

social media (e.g., Facebook and Twitter), and online newsletters (i.e., PEN editor and LPI newsletter). We also had flyers at the DPS meeting in October 2022. We additionally relied on re-sharing of our promotion efforts to increase awareness of our survey.

In this survey, we examined three constructs— anxiety, depression, and stress. We measured anxiety and depression with additional instruments. The first instrument that we used is the Depression Anxiety Stress Scale (DASS), which focuses on low mood, motivation, and self-esteem [12]. We used the long-form survey, which consisted of 42-items using a 4-point scale. This assessment has high internal consistency and has been shown to be stable over time with construct and convergent validity [13]. We note that with this assessment, the scale was used over the past year rather than the past week, as the academic schedule can result in a range of mental states due to various events, such as conferences, teaching duties, and programmatic deadlines.

We also employed two assessments commonly used in the counseling community, the Generalized Anxiety Disorder-7 (GAD-7) and the Patient Health Questionnaire-9 (PHQ-9). The assessments measure anxiety and depression, respectively [14]. The GAD-7 uses a 4-point Likert scale and exhibits good internal consistency with test-retest reliability (i.e., reliability of using the same test with the same group) [15]. Further, the GAD-7 is moderately good at screening disorders that are anxiety-related (i.e., generalized anxiety, panic, and social anxiety disorders) and trauma/stress-related (i.e., post-traumatic stress disorder) [16]. Similarly, the PHQ-9 showed excellent internal and test-retest reliability and can be successful at screening major depressive disorder [17].

In addition to these five instruments, we also asked several demographic questions, such as gender, race/ethnicity, LGBTQ+ identity, job title within planetary science, coping strategies, and some background of professional or graduate position (e.g., what year in grad school, will you continue in planetary science, when did you graduate).

**Results:** In this following section, when we mention anxiety and depression, we are looking at preliminary results of the GAD-7 and PHQ-9,

respectively, as the anxiety and depression results from the DASS will be explored further in the future. We also looked at the stress scale from the DASS to compare stress between groups.

In comparing graduate students, postdocs, and full professional researchers, we identified that 55% and 58% of graduate students experience moderate or more severe anxiety and depression, respectively, than any other group. This translates to nearly 3 in 5 graduate students experiencing moderate anxiety and depression or worse. Further, we found that 1 in 5 graduate students suffer from severe anxiety (the highest severity level according to the GAD-7) at 22%. As for postdocs, the results are slightly less severe with 48% and 50% of postdocs experiencing moderate or more severe anxiety and depression, respectively. However, moderate or more severe stress is similar between graduate students and postdocs (53% and 52%, respectively). As for planetary scientists in government, soft-money positions, or tenure-track positions, moderate levels of anxiety, depression, and stress or more severe were <40% of the population.

When comparing three investigated gender groups, male, female, and non-binary, we also noticed some differences. For instance, female-identifying and non-binary populations experience moderate or more severe anxiety (43% and 40%, respectively) and stress (45% and 55%, respectively) at a greater percentage than the male-identifying population (26% and 38% for anxiety and stress, respectively). Moderate levels of depression or more severe depression appear similar across the studied genders (40–44%).

We also compared populations between those who indicated that they identify as LGBTQ+, those who are questioning LGBTQ+, and those who do not identify as LGBTQ+. We observed that the LGBTQ+ and questioning population experiences greater moderate or more severe anxiety, depression, and stress (46%, 48%, and 52%, respectively) than those who do not identify as LGBTQ+ (31%, 40%, and 39%, respectively).

In another comparison, we examined differences between the White population and the combined population consisting of people of color and those who are mixed race (including mixed with White). Moderate or more severe depression and stress were similar between the two populations (43–44% and 41–44%, respectively). However, a greater proportion of people in the people of color and mixed population were experiencing moderate or more severe anxiety (47%) than the White population (34%).

**Discussion and Future Work:** Our comparisons are preliminary, and the differences between populations have not yet been tested for statistical

significance, which is the next step in our study. Current results suggest that mental health improves as people advance their planetary science careers. On the other hand, it may instead be that those who experience greater amounts of anxiety, depression, and stress exit the field, with mental health factors being a contributor of attrition; ~40% of graduate students and ~20% of postdocs and full professionals stating that they are either unsure if they are going to continue in planetary science. Because anxiety, depression, and stress appear greater in those belonging to marginalized populations (e.g., women, LGBTQ+, people of color), it may be that these groups are leaving planetary science due to the lack of support and/or an unaccommodating work environment for people of diverse backgrounds. If this is the case, then recruitment efforts to bring in greater diversity in planetary science, such as those currently tried by NASA HQ [e.g., 9,10] may be hindered due to the cultural practices and policies within the planetary science community that may obstruct their professional advancement. To further explore this hypothesis, we are formulating a follow up survey to investigate potential reasons for the greater anxiety, depression, and stress of marginalized populations and graduate students in planetary science.

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