UCLPRESS

Article title: The effects of cumulative stressful educational events on the mental health of doctoral students during the COVID-19 pandemic

Authors: Vasilis Sideropoulos[1], Emily Midouhas[2], Dora Kokosi[3], Jana Brinkert[4], Keri Ka-Yee Wong[5], Maria A. Kambouri[6]

Affiliations: Psychology and Human Development, Institute of Education, UCL, 25 Woburn square London WC1H 0AA, UK[1], Institute of Child Health, UCL, 30 Guilford St, London WC1N 1EH, UK[2]

Orcid ids: 0000-0002-5767-5426[1], 0000-0002-2962-8438[5], 0000-0002-8564-1944[6]

Contact e-mail: m.kambouri@ucl.ac.uk

Preprint statement: This article is a preprint and has not been peer-reviewed, under consideration and submitted to UCL Open: Environment Preprint for open peer review.

Links to data: www.doi.org/10.5522/04/16583861

DOI: 10.14324/111.444/000105.v1

Preprint first posted online: 01 November 2021

Keywords: COVID-19, Doctoral students, Educational experiences, Mental health, Stressful events, Health

The effects of cumulative stressful educational events on the mental health of doctoral students during the COVID-19 pandemic.

Sideropoulos, V.,[1] Midouhas, E.,[1] Kokosi, T.,[2] Brinkert, J.,[1] Wong, K.K. [1] & Kambouri, M*.[1]

1. Department of Psychology and Human Development, UCL Institute of Education, University College London, London, UK

2. Department of Population, Policy and Practice, UCL Great Ormond Street Institute of Child Health, University College London, London, UK

Word count: 5142

*Correspondence to: Maria Kambouri, UCL Institute of Education, University College London, London, UK. m.kambouri@ucl.ac.uk

Abstract

High rates of psychological distress including anxiety and depression are common in the doctoral community. With the COVID-19 pandemic taking a toll on mental health it is necessary to explore the risk and protective factors for this population. Using data from the Covid-19: Global Study of Social Trust and Mental Health, the present study examined the relationship between COVID-19-related cumulative stressful educational experiences and doctoral students' mental health problems. Moreover, it assessed the role of attentional ability and coping skills in promoting good mental health.

Mental health problems were assessed using the 9-item Patient Health Questionnaire and the 7-item Generalized Anxiety Disorder Questionnaire to measure depression and anxiety symptoms, respectively. We measured coping skills using a 14-item questionnaire and attentional ability using a 7-item questionnaire.

The results of multiple linear regression analyses showed that cumulative stressful educational experiences were related to increased depression symptoms but not anxiety symptoms in fully adjusted models. Additionally, coping skills and attentional ability were related to both depression and anxiety symptoms. Finally, no associations between mental health problems and demographic factors or other covariates were found.

The experience of multiple educational stressful events due to COVID-19 is a key risk factor for increased mental illness in the doctoral community. This could be explained by the uncertainty that the COVID-19 pandemic has caused to the students.

Keywords: *COVID-19, doctoral students, educational experiences, mental health, stressful events*

58

59 **Introduction**

60 A growing body of psychological and psychiatric evidence reveals that the impact of COVID-19
61 pandemic on mental health has become of increasing global concern (1). Similarly, the World Health
62 Organization has expressed concerns over the impact of the pandemic on the psycho-social aspects of life
63 (2). A recent systematic review and meta-analysis comparing data prior to and during the COVID-19
64 pandemic (3), documented a moderately small increase in mental health symptoms during the outbreak of
65 the pandemic, however mental health symptoms declined and were comparable to pre-pandemic levels by
66 mid-2020 for most populations (2,3). Nonetheless, small effects have meaningful cumulative consequences
67 at the population level and for specific groups. For instance, there is evidence suggesting that those with
68 pre-existing mental health problems were at a higher risk during the COVID-19 pandemic (4); in particular,
69 those with pre-existing mood disorders such as depression, symptoms tended to be larger (3,4).

70 While there is an increase in mental health disorders across the global population, it is more
71 meaningful to examine the subpopulations separately. Doctoral students in particular are a vulnerable
72 subgroup of the population that is often prone to mental illness (5), and perhaps especially at risk during
73 the pandemic. Hence, understanding the impact of the pandemic on their mental health is vital. Over time,
74 doctoral students' mental health has become a focal topic in educational research due to alarmingly high
75 rates of clinical symptoms experienced by doctoral students (6) and the consequences of mental health
76 disorders on doctoral students' training (5,7). Previous studies reported that one in three doctoral students
77 is at risk for a common psychiatric disorder (5), with anxiety and depression being six times higher amongst
78 doctoral students compared to the general population (6). Of those experiencing mental health distress, one
79 in three are hesitant to seek access to institutional advice and support services in the UK; some reasons are
80 the lack of signposting to mental health services in universities as well as the lack of parity from higher
81 education support services (6,8). The lack of access to non-academic support (e.g., personal and/or pastoral
82 support) for mental health could lead to an accumulation of personal and professional adversities (8) – key
83 question for investigation in this study.

84 Previous research has only looked at specific single risk factors associated with doctoral students'
85 mental health. A large body of research on stressful life events has indicated that the accumulation of risk
86 is more important than specific single factors risk for mental health problems (9). Yet little is known about
87 the role of cumulative stressful educational factors in the mental health problems of doctoral students.
88 Specific educational factors that have been associated with worsening doctoral students' mental health
89 include a) supervisory problems which can lead to personal or professional conflicts (10); b) limited access

to resources such as the lack of support from the department they are hosted in (11); c) domain specific expertise, including the lack of supervisor and student knowledge in mental health which can result in students being insufficiently supported (12); d) lack of general work processes which most doctoral students face as they embark on a PhD/Professional Doctorate degree straight after their academic training (12); e) external or personal challenges such as moving houses or experiencing family problems (6, 13); and f) project-related challenges such as intellectual property issues (13). The extent to which doctoral students experienced these factors as well as how such factors, taken together, jointly affect mental health problems, is unclear.

While researchers have investigated different institutional- and individual-level factors that could provide insight into doctoral students' mental health, research on the link between cumulative and global factors and mental health is limited. This is particularly important as evidence from the mental health literature which suggests that, rather than specific types of individual events, the accumulation of multiple adverse experiences have a worse effect on people's mental health (14, 15). Numerous studies have documented the cumulative effects of multiple stressful events experienced by a person in the general population and their association with mental health (14). For instance, there has been work showing the impact of cumulative exposure to poor housing can have adverse effects on mental health and wellbeing (16). Similarly, psychiatric, and clinical studies used this approach to understand the impact of cumulative childhood trauma on mental health (17) as well as the accumulation of physical, psychosocial and health adversities' impact on academic achievement of children (18). In addition, findings from a psychiatric report indicated that cumulative effects of life events have an impact on both physical and mental health (15) and certain circumstances of life such as workload, changing patterns of familiar meetings, can cause mental health turbulence. Thus, the accumulation of multiple adverse experiences during the pandemic may be predicted as an added risk for subgroups of individuals.

Moreover, there is limited evidence of factors that might promote mental health in doctoral students' population. There are two factors – coping and attentional skills – that show promise in terms of being able to promote good mental health in doctoral students. There is evidence that training in coping skills – cognitive or behavioral strategies used to reduce negative emotions due to stressors - can be effective when it comes to the maintenance of wellbeing and good mental health (19) particularly for those with anxiety-related disorders. Yet not much is known about the role of coping in depression and social dysfunction disorders for doctoral students. Whilst there is some research examining the relationship between coping skills and depression in undergraduate and graduate student populations (which primarily includes master's students, 20;21;22), to our knowledge, no research has explored coping skills amongst doctoral students. However, there is no research on coping skills and doctoral students' mental health. Likewise, the role of

attention and its relationship with anxiety and depression has not been addressed either in the doctoral literature despite the evidence showing that better attentional control skills are likely to promote better mental health in college students (23). Identifying both risk- and promotive factors may help offer better support to students in the future.

Taken together, investigation into doctoral students' mental health should be based on multidimensional frameworks that account for diverse and multiple factors that may affect one's emotional state. Epidemiologists and mental health researchers have used different methods and techniques to study mental health along with the prevalence and risk factors by using advanced and complex statistical approaches that can account for several factors (24). In this current work, we focus on the accumulation of adversities and their impact on mental health in doctoral students within the context of the COVID-19 pandemic and its associated educational challenges. In addition, we take into consideration the challenges of doctoral students through an ecologically inspired framework where the challenges that lead to poor mental health are placed into three domains (25): the macro-level factors such as institutions' structure and policies, the meso-level factors such as relationships with staff and other students and finally, the micro-level factors such as interpersonal relationships and individual characteristics (26). This is particularly meaningful given that previous research has shown how synergistic approaches to mental health allow for better understanding and help prevention and relapse (27). In addition, understanding challenges that doctoral students face offers ways to mitigate difficulties and provide support (14). However, an integrated approach to doctoral students' mental health is yet to be operationalized in research.

Consequently, the purpose of this study is to explore the effect of cumulative stressful educational events on doctoral students' mental health during the COVID-19 pandemic. Specifically, it examined whether doctoral students' mental health problems (anxiety and depression) are affected by an accumulation of multiple stressful events (rather than specific types of single events) ranging from interpersonal characteristics to institutional policies as well as exogenous factors such as the impact of COVID-19 on the students. In this paper, we use the sum of stressful educational events in an analogous way to mental health research in other fields (16,17,18).

The present study

The aim of this study was to explore the impact of an accumulation of multiple stressful events, 'cumulative stressful educational events' (CSEE), on doctoral students' mental health during the COVID-19 pandemic by considering a range of variables (including macro-level factors (whether PhD students belong to a research lab), meso-level factors (funded versus self-funded students) and micro-level factors (age,

ethnicity)) presented in the Methods section below. Furthermore, we explore the relationship of coping and attentional skills as factors that may promote good mental health.

2. Methods

We used data from the longitudinal COVID-19: Global Study of Social Trust and Mental Health (28), from Wave 2 when survey data were collected between 17th October 2020 and 31st January 2021. The data were collected using an anonymous survey that was distributed via Qualtrics, an online survey tool. Further details on study methodology can be found elsewhere (https://osf.io/fe8q7/). The study received ethical approval from the UCL Institute of Education (REC 1331) in April 2020.

2.1 Participants

For this paper, we only considered participants who provided complete responses on the mental health scales. 155 doctoral students (79.4% female) aged 23 to 69 (*Mean* = 30.24, *SD* = 7 years) completed the online survey. The majority of participants were in their 2nd year of studies (*n* = 39) at the time the survey was completed. A more detailed breakdown of the demographic and educational variables of our sample is presented in Table 1.

The participants were recruited through social networks and word of mouth. Anyone above the age of 18 with access to the study link was eligible for the main COVID-19 study. In our study, we considered only those participants who stated that they were currently studying for either a Doctor of Philosophy (PhD) or a Professional Doctorate degree. Participants who reported that they were a doctoral student were shown an extra set of questions about their doctoral experience and the challenges they faced thus far through open-ended and closed questions.

<< Insert Table 1>>

2.2 Materials

A list of the measures used in the survey can be accessed freely on the OSF website (26): https://osf.io/fe8q7/. In the current study, we examined data from four questionnaires, demographic questions and other open-ended and closed questions which can be found below.

2.2.1 Mental Health

The 9-item Patient Health Questionnaire (PHQ-9) (29) which uses a 4-point scale (not at all [0], several days [1], more than half the days [2], nearly every day [3] was used to assess depressive symptoms. A high score denotes higher levels of depressive symptoms with a score of 15 being the clinical cut-off. We

calculated the reliability of our scales, Cronbach's α = .88 for both unstandardized and standardised measures.

The 7-item Generalized Anxiety Questionnaire (GAD-7) (30) which uses a 4-point scale (not at all [0], several days [1], more than half the days [2], nearly every day [3]) was used and high summed scores reflect higher levels of anxiety. The clinical cut-off point for GAD-7 is a score above 15. Reliability was calculated for this scale too; Cronbach's α = .91 for for unstandardized and α = .90 for standardised.

2.2.2 Coping skills and attentional abilities

The 14-item Coping Skills Questionnaire (31) which uses a 4-point scale (not true about me [1], a little true about me [2], somewhat true about me [3], mostly true about me [4]) and was used to assess cognitive, emotional, and behavioral methods of dealing with problems. Higher summed scores indicate higher levels of coping. Cronbach's α = .81 for for both unstandardized and standardised.

An adapted 7-item version of the 18-item Adult ADHD self-report scale (ASRS-v1.1) (32) which uses a 5-point scale (never [0], rarely [1], sometimes [3], often [4], very often [5]) to assess lower attentional focus. Higher summed scores indicate lower levels of attentional focus. For this scale, Cronbach's α = .78 for unstandardized and α = .79 for standardised.

2.2.3 Cumulative Stressful Educational Events (CSEE)

Cumulative stressful educational events (CSEE) were measured with a newly developed composite variable based on the total number of events experienced. Participants were asked to report on a number of different questions ranging from the impact of COVID-19 on their research to problems they have experienced during their doctoral training. To create the cumulative variable, we used the total score of those binary variables, and the maximum number of stressful educational events was 5. Table 2 presents the exact questions along with the N of participants per answer as well as the percentages.

<< Insert Table 2 >>

2.2.4 Covariates

Participants reported their age, gender, ethnicity, whether they are part of a research group and whether they are funded/self-funded students. These variables, apart from age, were then categorized into binary variables and were included in our analyses as covariates; ethnicity (White vs Non-White); gender (Female vs Male); part of a research group (Yes vs No); funded (yes, funded vs no, self-funded).

2.4 Ethics

Ethical approval for the study was obtained from the Ethics Committee of UCL Institute of Education prior to the data collection (REC 1331, REC 1345). Respondents provided online consent to participate in the study and to be followed-up.

2.5 Data Analysis

First, we described our sample using descriptive statistics. Next, we ran a series of linear regression models for each mental health outcome – anxiety and depression. The first model had the cumulative events as the main independent variable. The second model adjusted for all covariates. The third model added the two individual-level variables that we expected would promote mental health, coping skills and attentional ability. Therefore, we ran a total of 6 models.

3. Results

3.1 Descriptive Statistics

The data show that a small proportion of the doctoral students (14.28%, n= 18) scored above the cut-off threshold for clinical depressive symptoms and similarly, only a few doctoral students scored above the cut-off threshold for clinical anxiety symptoms (21.43%, n=19). Table 3 presents an overview of the mental health questionnaires.

<< Insert Table 3 >>

3.2 Predictors of Depression

In the multiple linear regression models (Table 4 for Coefficients, Table 6 for Model Output), the experience of CSEE ($\beta = 1.16$, $p<.001$) is associated with higher levels of depressive symptoms. When adjusted for covariates, CSEE ($\beta = 1.11$, $p<.001$) and ethnicity ($\beta = 2.44$, $p = .05$) were associated with higher depressive symptoms. Finally, when adjusted for the cognitive factors, both coping skills ($\beta = -0.21$, $p<.001$) and lower attentional abilities ($\beta = .65$, $p<.001$) were associated with higher depressive symptoms in the doctoral community.

<< Insert Table 4 >>

3.3 Predictors of Anxiety

For the multiple linear regression models of anxiety (Table 5 for Coefficients, Table 6 for Model Output), the experience of CSEE ($\beta=0.72$, $p<.02$) is associated with higher anxiety symptoms only in the null model. When adjusted for covariance, none of the factors were associated with anxiety. Finally, in our last model

where we adjusted for the cognitive factors, we found again that low coping skills (β = -.17, p <2.09e-3) and lower attentional abilities (β= .55, p < 1.27e+7) were associated with higher anxious symptoms.

<< Insert Table 5 >>

<< Insert Table 6 >>

Discussion

In this paper, we explored the impact of cumulative stressful educational events (CSEE) on doctoral students' mental health during the COVID-19 pandemic between 17th October 2020 and 31st January 2021 by operationalizing into our model a range of variables from macro-meso-micro level factors related to the university experience. The consideration of multiple variables into our linear modelling is rooted in the evidence that strongly suggests that doctoral students' mental health should be investigated in a more complex and synthetic way (25). Our statistical approach allows for a better understanding of the specific effects of CSEE on doctoral students' mental health, specifically anxiety and depression.

Whilst the current pandemic has affected the mental health of much of the population (1,2,3), our findings show that 28.3% of doctoral students reported milt to severe depressive symptoms and 79.4% of them reported moderate to severe symptoms for anxiety in our sample. Our findings are in line with previous research conducted prior to the pandemic (5,6,7,8,10) which shows that doctoral students experience high levels of depression and anxiety. Furthermore, our findings align with other research that suggests an increase in mental health difficulties in doctoral students' during the COVID-19 pandemic (34).

As part of our second statistical analyses, we computed six different multiple linear regression models of which three were focused on the predictors of depression and three on the predictors of anxiety. Our findings indicated that those who experienced multiple stressful educational events were more likely to experience higher levels of depression – which again is in line with previous mental health research on depression (5,6,7). When CSEE and covariates were adjusted for in our models, only CSEE and ethnicity were associated with higher levels of depression. Therefore, our study provides more evidence that ethnicity, plays a key role in predicting mental health in educational settings (33). Finally, when we adjusted for cognitive factors (coping and lower attentional skills), both factors were associated with higher levels of depression which provides further evidence for the association between poor coping skills and depression (19, 20, 21, 22) as well as attention and depression (23). Crucially, these findings are novel in the literature of doctoral students' mental health. They provide further insight on understanding how those with poorer coping skills are more likely to experience higher levels of depression as well as those with lower attentional skills, suggesting that additional support in these skillsets may benefit doctoral student's experience during

the pandemic. Similar to the work of other studies (19,20,21), coping skills can play a key role in the experience of mental health. However, other demographic factors such as age and gender were not associated with depression contrary to previous studies that have highlighted gender contrasts in doctoral students (6,13). Furthermore, being part of a group and being self-funded were not significant predictors of depression, which supports our theory that it is the accumulation of events rather than the experience of singular events, such as finances, that could lead to higher levels of mental health distress.

Conversely, we computed multiple linear regressions to explore the factors that are associated with anxiety during the same wave. CSEE was one of the key predictors in our model 4 for anxiety – suggesting that the more CSEE the doctoral students experienced the higher the levels of self-report anxiety. As expected, these findings support the current evidence available in the educational literature (5,6,7,) as well as the experience of multiple stressful events and their impact on anxiety (16, 17, 18, 19). Although one of the covariate factors (ethnicity) in our depression models was significantly associated with the dependent variable, when we adjusted for covariates in the anxiety models none of remaining factors were significant. Such evidence highlights the complexity of the concept of mental health and the need for research to investigate mental health through multidimensional lenses. Mental health disorders are strongly associated with biological as well as environmental factors (1,14). Here, we see that the accumulation of both environmental and biological factors can better explain mental health adversities. Finally, in the models where we adjusted for cognitive factors (coping and lower attentional skills) we see a similar pattern to the depression models where both factors are associated with higher levels of anxiety. Specifically, those with lower coping skills scored higher whereas those with lower scores on lower attentional skills scored lower, supporting past study findings (20,21).

Overall, our statistical models provide robust evidence on the effects of CSEE on doctoral students' mental health during the COVID-19 pandemic. These findings not only replicate the outcomes of previous research, but they also add to the new evidence based on the statistical approach to consider the sum of CSEE. This result is relatively novel in the doctoral literature, and so is using coping skill levels as a predictor of mental health deterioration.

Despite the evidence that CSEE has a significant effect on students' mental health during the COVID-19 pandemic, this study is not without limitations. First, the study uses cross-sectional data from a longitudinal survey with no pre-pandemic data on the mental health levels of doctoral students. Hence, our assumptions about the levels of mental health could only be based on the previous literature available (5,6,7). Secondly, our findings must be considered strictly within the context of the COVID-19 pandemic

and so this study highlights that further research is needed on the effects of cumulative stressful educational events CSEE on doctoral students' wellbeing.

Furthermore, although we explored several different factors that could contribute to doctoral students struggling with depression and anxiety, our data were restricted for two reasons: a) we do not have specific measurements about the supervisory-student relationship which seems to be one of the leading factors that impact mental health (10) and b) we have not used a full standardized scale to measure lower attentional abilities. Hence, for the former, it is important to examine in depth the dynamics of the supervisor-student relationship considering its impact on mental health (10, 14) and for the latter, a standardized method needs to be used in future studies on the measurement of attentional abilities. Finally, the sample in the present study is not representative of the population to account for all the challenges students face in higher education institutions as doctoral students. For example, researchers have demonstrated the stress and strain of black doctoral students in STEM (33) and this is not captured in our sample. Hence, it is important that future studies attempt to collect data from a more diverse population.

To the best of our knowledge, this is the first study that investigates the effects of multiple stressful educational experiences on doctoral students' mental health during the COVID-19 pandemic. While there have been several studies around doctoral students' mental health (6,10,11, 12,14), most of them have focused on the exploration of factors rather than the consideration of a synergistic approach to it as other researchers studied in other areas (17,18,19). The present findings indicate that those experiencing CSEE are likely to exhibit higher levels of depressive and anxiety symptoms, with a good proportion reporting clinical levels of depressive and anxiety symptoms (X% and Y%, respectively). In addition, through this work we provide further evidence on the effectiveness of coping skills as a protective factor of mental illness, potentially given evidence for upskilling doctoral students with better coping skills. Our findings also highlight the need for more research in the area and the factors that contribute to poor mental health to understand better how to prevent doctoral students from experiencing multiple stressful educational events.

Acknowledgements

We would like to thank all the participants for taking part in our project. Thanks also go to UCL's Change Makers Research Initiatives for funding our Better Together project on exploring risk factors for doctoral students' wellbeing. In addition, we'd like to thank the UCL Global Engagement Fund for funding the COVID-19: Global Study of Social Trust and Mental Health.

Author Contributions

MK conceived the idea. VS, MK, DK and JB co-designed the study and recruited the data for the project. VS and EM planned and carried out the data analysis. KW provided the dataset. All authors contributed to the interpretation of the results. All authors discussed the results and contributed to the write-up of the manuscript.

Conflicts of interest

All authors declare no conflicts of interest.

Reference List

1. Pfefferbaum B, North C. Mental Health and the Covid-19 Pandemic. New England Journal of Medicine. 2020;383(6):510-512.
1. Mental health and psychosocial considerations during the COVID-19 outbreak [Internet]. World Health Organisation. 2021 [cited 27 October 2021]. Available from:
2. Robinson E, Sutin A, Daly M, Jones A. A systematic review and meta-analysis of longitudinal cohort studies comparing mental health before versus during the COVID-19 pandemic in 2020. Journal of Affective Disorders. 2021;296:567-576.
3. Neelam K, Duddu V, Anyim N, Neelam J, Lewis S. Pandemics and pre-existing mental illness: A systematic review and meta-analysis. Brain, Behavior, & Immunity - Health. 2021;10:100177.
4. Levecque K, Anseel F, De Beuckelaer A, Van der Heyden J, Gisle L. Work organization and mental health problems in PhD students. Research Policy. 2017;46(4):868-879.
5. Stubb J, Pyhältö K, Lonka K. Balancing between inspiration and exhaustion: PhD students' experienced socio-psychological well-being. Studies in Continuing Education. 2011;33(1):33-50.
6. Barry K, Woods M, Warnecke E, Stirling C, Martin A. Psychological health of doctoral candidates, study-related challenges and perceived performance. Higher Education Research & Development. 2018;37(3):468-483.
7. Waight E, Giordano A. Doctoral students' access to non-academic support for mental health. Journal of Higher Education Policy and Management. 2018;40(4):390-412.
8. Keinan G, Shrira A, Shmotkin D. The association between cumulative adversity and mental health: considering dose and primary focus of adversity. Quality of Life Research. 2012 Sep;21(7):1149-58.
9. Sverdlik A, C. Hall N, McAlpine L, Hubbard K. The PhD Experience: A Review of the Factors Influencing Doctoral Students' Completion, Achievement, and Well-Being. International Journal of Doctoral Studies. 2018;13:361-388.
10. Pyhältö K, Vekkaila J, Keskinen J. Exploring the Fit between Doctoral Students' and Supervisors' Perceptions of Resources and Challenges vis-à-vis the Doctoral Journey. International Journal of Doctoral Studies. 2012;7:395-414.
11. Pyhältö K, Toom A, Stubb J, Lonka K. Challenges of Becoming a Scholar: A Study of Doctoral Students' Problems and Well-Being. ISRN Education. 2012;2012:1-12.
12. Evans T, Bira L, Gastelum J, Weiss L, Vanderford N. Evidence for a mental health crisis in graduate education. Nature Biotechnology. 2018;36(3):282-284.
13. Thune T. Doctoral students on the university–industry interface: a review of the literature. Higher Education. 2009;58(5):637-651.
14. Amaral AP, Serra AV. Cumulative Effect of Life Events in Physical and Mental Health. European Psychiatry. 2009 Jan;24(S1):1-.
15. Turner R, Lloyd D. Lifetime Traumas and Mental Health: The Significance of Cumulative Adversity. Journal of Health and Social Behavior. 1995;36(4):360.

16. Bentley R, Baker E, Mason K. Cumulative exposure to poor housing affordability and its association with mental health in men and women. Journal of Epidemiology and Community Health. 2011;66(9):761-766.
17. Schilling E, Aseltine R, Gore S. The impact of cumulative childhood adversity on young adult mental health: Measures, models, and interpretations. Social Science & Medicine. 2008;66(5):1140-1151.
18. Quach J, Nguyen C, O'Connor M, Wake M. The Cumulative Effect of Health Adversities on Children's Later Academic Achievement. Academic Pediatrics. 2017;17(7):706-714.
19. Esmaeilimotlagh M, Oveisi K, Alizadeh F, Asadollahi Kheirabadi M. An investigation on coping skills training effects on mental health status of university students. Journal of Humanities Insights. 2018 Mar 1;2(01):37-42.
20. MacDonald HZ, Olsen A. The role of attentional control in the relationship between mindfulness and anxiety. Psychological reports. 2020 Jun;123(3):759-80.
21. Patias, N. D., Von Hohendorff, J., Cozzer, A. J., Flores, P. A., & Scorsolini-Comin, F. (2021). Mental health and coping strategies in undergraduate and graduate students during COVID-19 pandemic. *Trends in Psychology*, 1.
22. Son, C., Hegde, S., Smith, A., Wang, X., & Sasangohar, F. (2020). Effects of COVID-19 on college students' mental health in the United States: Interview survey study. *Journal of medical internet research*, *22*(9), e21279.
23. Wasil, A. R., Franzen, R. E., Gillespie, S., Steinberg, J. S., Malhotra, T., & DeRubeis, R. J. (2021). Commonly reported problems and coping strategies during the COVID-19 crisis: A survey of graduate and professional students. *Frontiers in psychology*, *12*, 404.
24. Heo J, Lim H, Yun SB, Ju S, Park S, Lee R. Descriptive and predictive modeling of student achievement, satisfaction, and mental health for data-driven smart connected campus life service. In Proceedings of the 9th International Conference on Learning Analytics & Knowledge 2019 Mar 4 (pp. 531-538).
25. Johnson G. An Ecological Framework for Conceptualizing Educational Risk. Urban Education. 1994;29(1):34-49.
26. Jones-White D, Soria K, Tower E, Horner O. Factors associated with anxiety and depression among U.S. doctoral students: Evidence from the gradSERU survey. Journal of American College Health. 2021:1-12.
27. Thieme A, Wallace J, Meyer T, Olivier P. Designing for mental wellbeing. Proceedings of the 2015 British HCI Conference. 2015.
28. Wong KK & Raine A, (2020). COVID-19: Global social trust and mental health study.
29. Kroenke K, Spitzer RL. The PHQ-9: a new depression diagnostic and severity measure.
30. Spitzer RL, Kroenke K, Williams JB, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. Archives of internal medicine. 2006 May 22;166(10):1092-7.
31. S. Hamby, J. Grych, and V. Banyard. Coping scale, 06 2015
32. Adler LA, Faraone SV, Sarocco P, Atkins N, Khachatryan A. Establishing US norms for the Adult ADHD Self-Report Scale (ASRS-v1. 1) and characterising symptom burden among adults with self-reported ADHD. International journal of clinical practice. 2019 Jan;73(1):e13260.
33. McGee E, Griffith D, Houston II S. "I know I have to work twice as hard and hope that makes me good enough": Exploring the stress and strain of Black doctoral students in engineering and computing. Teachers College Record. 2019 Apr 1;121(4):1-38.
34. Byrom N. COVID-19 and the Research Community: The challenges of lockdown for early-career researchers. Elife. 2020 Jun 12;9:e59634.

Tables & Figures

Table 1. Demographic and educational variables by n of cases and percentages.

Demographic & Covariate Variables	n	%
Age (Years)		
18-24	11	8.1
25-34	103	75.7
35-44	14	10.3
45-54	5	3.7
55+	3	2.2
Gender		
Female	123	80.92
Male	29	19.8
Ethnicity		
White	103	66.45
Non-White	52	33.55
Year of Studies		
First year	38	26.2
Second year	39	26.9
Third year	31	21.4
Fourth year	21	14.5
Fifth year	12	8.3
Sixth year	4	2.8
Part of a research group		
Yes	102	70.8
No	42	29.2
Funded		
Yes	34	23.4

No, self-funded	111	76.6

Table 2. Characteristics of the stressful educational events collected from the sample prior to summing up as a cumulative variable.

Cumulative Stressful Educational Events	**n**	**%**
Is there any impact on your research because of COVID-19?		
Yes	84	67.7
No	40	32.3
Did you interrupt your PhD?		
Yes	13	10.4
No	112	89.6
Did you have to make any adaptation to your research projects?		
Yes	65	52.0
No	60	48.0
Did you have to change a supervisor in the last 6 months?		
Yes	12	9.6
No	113	90.
Is there any other problem you've experienced?		
Yes	23	20.0
No	92	80.0

Table 3. Overview of the mental health questionnaires split into the threshold categories for clinical symptoms

Mental Health Questionnaires	**n**	**%**
Depression		
None-minimal	55	35.5
Mild	56	36.1
Moderate	23	14.8

Moderately Severe	14	9
Severe	7	4.5
Anxiety		
Moderate	32	20.6
Mild	88	56.8
Severe	35	22.6

436

437

Table 4. Coefficients for Depression Models

Model		Unstandardized	Standard Error	Standardized	t	p	VS-MPR*	95% CI	
								Lower	Upper
Model 1 – Depression - CSEE	(Intercept)	5.44	0.96		5.64	1.26e -7	184282.98	3.53	7.35
	Cumulative Events	**1.16**	**0.39**	**0.27**	**2.96**	**3.76e -3**	**17.53**	**0.38**	**1.94**
Model 2 – Depression – CSEE & Covariates	(Intercept)	5.48	5.33		1.03	0.31	1.02	-5.09	16.04
	Cumulative Events	**1.11**	**0.41**	**0.26**	**2.73**	**7.36e -3**	**10.18**	**0.31**	**1.92**
	Age	-0.06	0.10	-0.06	-0.58	0.57	1.00	-0.26	0.14
	Ethnicity	**2.44**	**1.24**	**0.19**	**1.97**	**0.05**	**2.42**	**-0.01**	**4.89**
	Gender	-5.20e -3	1.50	-3.22e -4	-3.46e -3	1.00	1.00	-2.98	2.97
	Part of a Group	-1.90	1.29	-0.15	-1.47	0.14	1.32	-4.45	0.66
	Funded/Self-funded	0.63	1.40	0.04	0.45	0.66	1.00	-2.16	3.41
Model 3 – Depression, CSEE, Covariates & Cognitive Factors	(Intercept)	-1.74	5.63		-0.31	0.76	1.00	-12.91	9.43
	Cumulative Events	**0.74**	**0.34**	**0.17**	**2.18**	**0.03**	**3.40**	**0.07**	**1.40**
	Age	-0.07	0.08	-0.07	-0.86	0.39	1.00	-0.24	0.09
	Ethnicity	0.94	1.05	0.07	0.89	0.38	1.00	-1.15	3.02
	Gender	0.71	1.24	0.04	0.57	0.57	1.00	-1.74	3.16
	Part of a Group	0.60	1.13	0.05	0.53	0.60	1.00	-1.64	2.83
	Funded/Self-funded	0.32	1.16	0.02	0.28	0.78	1.00	-1.97	2.61
	Lower Attentional Abilities	**0.65**	**0.10**	**0.52**	**6.32**	**6.49e -9**	**3.01e +6**	**0.45**	**0.86**
	Coping Skills	**-0.21**	**0.07**	**-0.23**	**-3.08**	**2.67e -3**	**23.28**	**-0.34**	**-0.07**

* Vovk-Sellke Maximum *p* -Ratio: Based on the *p* -value, the maximum possible odds in favor of H_1 over H_o equals $1/(-e\ p \log(p))$ for $p \leq .37$ (Sellke, Bayarri, & Berger, 2001).

438

Table 5. Coefficients for Anxiety Models

Model		Unstandardized	Standard Error	Standardized	t	p	VS-MPR*	95% CI	
								Lower	Upper
Model 4 – Anxiety - CSEE	(Intercept)	4.45	0.77		5.75	7.73e -8	290554.31	2.92	5.99
	Cumulative Events	**0.72**	**0.32**	**0.21**	**2.29**	**0.02**	**4.09**	**0.10**	**1.35**
Model 5 – Anxiety - CSEE & Covariates	(Intercept)	5.01	4.36		1.15	0.25	1.06	-3.63	13.64
	Cumulative Events	0.62	0.33	0.18	1.88	0.06	2.11	-0.03	1.28
	Age	-0.07	0.08	-0.08	-0.80	0.43	1.00	-0.23	0.10
	Ethnicity	0.41	1.01	0.04	0.40	0.69	1.00	-1.60	2.41
	Gender	1.44	1.23	0.11	1.17	0.25	1.07	-1.00	3.87
	Part of a Group	-0.79	1.06	-0.08	-0.75	0.46	1.00	-2.88	1.30
	Funded/Self-funded	-0.28	1.15	-0.02	-0.25	0.81	1.00	-2.56	1.99
Model 6 – Anxiety – CSEE, Covariates & Cognitive Factors	(Intercept)	-1.28	4.55		-0.28	0.78	1.00	-10.30	7.73
	Cumulative Events	0.31	0.27	0.09	1.14	0.26	1.05	-0.23	0.85
	Age	-0.08	0.07	-0.09	-1.15	0.25	1.06	-0.21	0.06
	Ethnicity	-0.86	0.85	-0.08	-1.01	0.31	1.01	-2.54	0.83
	Gender	2.02	1.00	0.16	2.03	0.05	2.63	0.04	4.00
	Part of a Group	1.34	0.91	0.13	1.47	0.14	1.32	-0.47	3.15
	Funded/Self-funded	-0.54	0.93	-0.05	-0.58	0.56	1.00	-2.39	1.31
	Lower Attentional Abilities	**0.55**	**0.08**	**0.56**	**6.64**	**1.42e -9**	**1.27e +7**	**0.39**	**0.72**
	Coping Skills	**-0.17**	**0.05**	**-0.24**	**-3.16**	**2.09e -3**	**28.56**	**-0.28**	**-0.06**

* Vovk-Sellke Maximum *p* -Ratio: Based on the *p* -value, the maximum possible odds in favor of H_1 over H_o equals $1/(-e\ p \log(p))$ for $p \leq .37$ (Sellke, Bayarri, & Berger, 2001).

Table 6: *Multiple linear regression outputs*

Models	**Multiple Linear Regression Outputs**
Model 1 - Depression	F(1,114)=8.22, p<4.49e-3, R2=.07, R2 adjusted=.06
Model 2 - Depression & Covariates	F(5,110)=3.02, p<.01, R2=.12, R2 adjusted=.08
Model 3 - Depression, Covariates & Cognitive Factors	F(7,107)=11.27, p<.001, R2 =.42, R2 adjusted=.39
Model 4 – Anxiety	F(1,114)=4.79, p<.03, R2 =.04, R2 adjusted=.03
Model 5 – Anxiety & Covariates	F(5,110)=1.20, p<.32, R2 =.05, R2 adjusted=.01
Model 6 – Anxiety, Covariates & Cognitive Factors	F(7,107)=9.55, p<.001, R2 =.38, R2 adjusted=.34