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Abstract

Recent self-reported and cross-sectional survey evidence documents high levels of mental health problems among PhD students. We study the impact of PhD studies on mental health care uptake using Swedish administrative records of prescriptions for psychiatric medication for the full population of PhD students. First, we provide descriptive evidence that PhD students collect psychiatric medication at a higher rate than a matched sample of individuals holding a master's degree, but at a lower rate than a matched sample from the general population. Second, we implement an event study analysis and document that, in the years preceding their PhD studies, prospective students collect psychiatric medication at a rate similar to that of a matched sample of individuals holding a master's degree. However, following the start of PhD studies, the use of psychiatric medication among PhD students increases substantially. This upward trend continues throughout the course of PhD studies, with estimates showing a 40 percent increase by the fifth year compared to pre-PhD levels. After the fifth year, which represents the average duration of PhD studies in our sample, we observe a notable decrease in the utilization of psychiatric medication.

Keywords: Mental health, PhD studies, psychiatric medication

JEL codes: I10, I23

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1. Introduction

Recent survey evidence suggesting high levels of self-reported mental health problems among PhD students has caused profound concern about a mental health crisis in graduate education (Eisenberg et al. 2007; Levecque et al. 2017; Pain 2017; Evans et al. 2018; Wong 2018; Dench, Nock, and Small 2020; Chirikov et al. 2020; Langin 2020; Forrester 2021; Almasri, Read, and Vandeweerdt 2022; Macchi et al. 2023; Bolotnyy, Basilico, and Barreira 2022; Garcia-Williams, Moffitt, and Kaslow 2014; Woolston 2022; 2019; 2017; Forrester 2021; Council of Graduate Schools & the Jed Foundation 2021). Satinsky et al. (2021) summarize this literature in a meta-analysis comprising 16 surveys that elicit mental health through validated instruments. Among the more than 23,000 PhD respondents in this sample, 24 and 17 percent report symptoms of depression and anxiety respectively.[1] Focusing exclusively on graduate students in economics, Bolotnyy, Basilico and Barreira (2022) and Macchi et al. (2023) find similar results. About 25 percent of the 513 PhD respondents at eight top-ranked U.S. economics departments (Bolotnyy, Basilico and Barreira 2022), and almost 35 percent of the 556 respondents at 14 European departments (Macchi et al. 2023) report moderate to severe symptoms of depression or anxiety. Putting these numbers in perspective, the prevalence of mental health problems among PhD students reported in these surveys is several times higher than that of the general population, and of more similar populations such as individuals with a university degree (WHO, 2017; Leveque et al 2017; Bolotnyy, Basilico and Barreira 2022). Mental health among graduate students thus appears to represent an exception to the otherwise frequently documented educational gradient in health (see, e.g., Currie 2009; Conti, Heckman, and Urzua 2010; Cutler and Lleras-Muney 2010).

This evidence has brought an important problem to light. However, to form appropriate policies to improve the mental health of PhD students, it raises at least two important questions. First, to what extent is the prevalence of mental health problems observed in surveys—typically consisting of smaller and selected samples and relying on self-reported measures—*representative* for the full population of PhD students? Second, is a high prevalence of mental health problems among PhD students driven by a *selection* of individuals with poor mental health into PhD studies, or do PhD studies have a direct negative *impact* on mental health?

[1] Predictors of psychological distress among PhD students are, e.g., difficulties maintaining a work-life balance, low job control, financial and career insecurity, lack of meaning and unsatisfactory supervisor relationships (e.g., Evans et al., 2018 and Woolston 2022).

We address these questions using administrative records of diagnosed mental health problems to study mental health care uptake among PhD students relative to comparable groups of the population over time. This approach allows us to make several meaningful contributions to previous, survey-based, evidence. First, our data cover the universe of individuals entering any Swedish PhD education between 2006 and 2017 across all academic fields. We can thus quantify the prevalence of mental health care uptake in the full PhD student population without selection. Since the register data extend to the full population, we can also systematically compare the development of mental health care uptake among the individuals in our PhD sample to that of other comparable sociodemographic groups. Second, since these records contain detailed and high-quality information on *all* collected medical prescriptions and hospitalizations, we can reliably assess the prevalence of depression and other mental health problems as diagnosed by medical expertise. This data complements previous evidence based on self-reported screening tools, which may overestimate the prevalence of mental health problems compared to structured clinical interviews (e.g., Levis et al. 2019; Thombs et al. 2018; Levis et al. 2020). Third, the panel structure of our data allows us to follow the health care uptake of each PhD student before and after they start their PhD studies. This enables us to study the change in mental health care uptake associated with the onset of PhD studies and address whether a high prevalence of mental health problems among PhD students arises because of selection into PhD studies or because of a direct negative impact thereof. Finally, the rich dataset and large sample allow us to meaningfully explore a broad array of correlations between mental health care uptake and individual and institutional factors such as age, gender, family composition, and research field.

A descriptive analysis shows that prospective PhD students collect psychiatric medication at a rate similar to that of a matched sample of individuals with a corresponding master's degree in the years preceding their PhD education, but lower than that of a matched sample from the general population. However, following the start of PhD studies, the use of psychiatric medication increases among the PhD students relative to the control groups. Five years after the start of PhD studies, the PhD students collect medication at a rate that is higher than that among highly educated individuals, and more similar to the general population.

In our main analysis, we implement an event study to identify the change in collected psychiatric medication associated with the start of PhD studies. In this analysis, we use the matched control group of individuals with a corresponding master's degree as a never-treated control group. Our estimates reveal a sharp increase in psychiatric medication among PhD

students following PhD start.[2] This increase grows throughout the PhD program. By the fifth, and in our sample often the last, year of PhD studies, the likelihood of collecting psychiatric medication has increased by about 40 percent relative to the year before PhD start. After the fifth year the use of psychiatric medication drops significantly. To evaluate the size of the estimated effect, we benchmark it against the impact on prescriptions of psychiatric medication of a traumatic life event—the unexpected death of a parent—and show that the impact of starting the PhD program is both stronger in relative terms and longer lasting.

A heterogeneity analysis indicates that the discontinuous increase in psychiatric medication following PhD start is present across all explored socioeconomic groups and research fields, except for the medical and health sciences.

Complementing our analysis based on prescriptions of psychiatric medication, we also explore the impact of PhD studies on more severe cases of mental health problems associated with hospitalizations. This analysis indicates a similar pattern for hospitalizations with a mental health diagnosis as documented for prescriptions—a substantial increase in hospitalizations occurs at the start of PhD studies together with a marked decline five years later. We argue that this is consistent with the interpretation that the observed increase in mental health care uptake at the start of PhD studies reflects a negative impact on underlying mental health rather than primarily a shift in health care utilization. Further, it indicates that PhD studies impact the whole distribution of mental health problems, and not only less severe cases.

Finally, we also estimate how the relative risk of being prescribed psychiatric medication during PhD studies varies with student characteristics. While correlational, this analysis provides actionable information for academic institutions and policy makers in terms of what groups of students are at risk of developing mental health problems during their studies.

[2] Our main results are largely consistent with those presented in a concurrent working paper by Keloharju et al. (2022) which also explores mental health outcomes among PhD students in Sweden. While the two papers are based partly on the same data, a few differences are relevant to mention. First, the data in Keloharju et al. (2022) end in 2015, and their difference-in-difference analysis is based on a sample of PhD students starting their PhD 2009-2011. Thus, our main analysis is based on a larger sample size and a longer event period. It also represents a more recent time period, which may simplify comparisons to more recent survey data. Second, Keloharju et al. (2022) assign PhD students to hard or soft sciences at the "establishment" level. In contrast, our data include individual-level and detailed information on each PhD student's research field, funding source and activity level. Among other things, this allows for an extended set of heterogeneity analyses (addressing, e.g., variation according to field gender composition and employment status). Third, our highly educated control group more closely resembles the PhD student sample since it is matched based on field and year of master's degree. Fourth, Keloharju et al. (2022) exclude all students in medicine, while we exclude research fields where registered PhD students have a low activity level on average. This approach allows us to drop fields where the PhD students allocate a substantial share of their time to clinical work, while still preserving as many research fields as possible in the final analysis. Fifth, we address the possible impact of confounding factors in terms of correlated shocks and changes in health care utilization.

This analysis indicates that older individuals, women, and those with a history of mental health care (but who were not medicating at the start of PhD studies) experience a higher risk.

In sum, we provide evidence that PhD studies are associated with a substantial increase in mental health care uptake. High rates of mental health problems in graduate education raises concerns not only about individual well-being but also about the organization of academic research, the professional conditions of early career researchers and how this may impact the productivity and selection of academic researchers. Our study provides important evidence for academic institutions and policy makers aiming to understand the gravity of the mental health crisis among PhD students.

In a broader perspective, mental health problems today constitute the leading cause for work disability across Western countries and a growing literature highlights working conditions as a factor contributing to this trend (see, e.g., Whiteford et al. 2010; Patel et al. 2018; Duchaine et al. 2020). By providing a causal estimate of the mental health impact associated with a specific career choice, we contribute also to this policy debate.

Below we present our data and method in Section 2 and our results in Section 3. Section 4 concludes.

2. Data

Our analyses rely on administrative data held by Statistics Sweden and the National Board of Health and Welfare. This section describes our main sample and comparison groups, and how we define our outcome variables.

2.1. The PhD student sample

To construct our sample of PhD students, we identify all individuals who started a PhD program in Sweden between 2006 and 2017 with available birth year and gender data (N=37,134). Since data on medical prescriptions are available from 2005, this means we observe prescriptions for all PhD students in the sample at least one year before starting their PhD studies. Next, we exclude individuals without a Swedish master's degree (N=12,138) and those not observable in the data the year before they start their PhD studies (N=563). These restrictions (i) ensure that we observe individual health care uptake during the year(s) before PhD start for everyone in our sample, and (ii) allow us to create a control group of highly educated individuals without a PhD education, matched to the PhD sample by year and field

of master's degree.[3] Further, since our aim is to capture the outcome of individuals whose *primary* activity is PhD studies, we exclude PhD students in fields with a median level activity below 70 percent (N=4,298).[4] The PhD students in our final sample (N=20,085) are included during the full study period independently of whether they drop out or not, since drop out is endogenous to, e.g., health problems. Summary statistics are presented in Table 1.

Table 1: Summary statistics of PhD sample

	All	MHS	NS	SS	ET	H	A
N	20,085	4,685	4,472	3,909	5,105	1,397	470
Median age at PhD start	28	29	27	31	27	31	30
Share female	0.46	0.61	0.38	0.56	0.29	0.53	0.65
Share foreign born	0.26	0.23	0.3	0.21	0.34	0.16	0.15
Share with young children at PhD start	0.17	0.21	0.09	0.26	0.11	0.23	0.2
Share on medication before PhD start	0.07	0.09	0.05	0.09	0.04	0.12	0.1

Notes: ***MHS*** = Medical & Health Sciences, ***NS*** = Natural Sciences, ***SS*** = Social Sciences, ***ET*** = Engineering & Technology, ***H*** = Humanities and ***A*** = Agriculture. *Share with young children at PhD start* is defined as share with children below ten years old at PhD start. *Share medicating before PhD start* refers to the share collecting psychiatric medication the year before the start of PhD studies.

2.2. Control groups

We construct two matched control groups: one from the general population and one from the highly educated population. The general population control group is based on individuals alive in 2006 who never enrolled in PhD studies in Sweden. The highly educated control group is, in addition, restricted to those with a Swedish master's degree.[5] Each control group is matched to the PhD population by gender, birth year and—for the highly educated control group—field and year of the master's degree.[6] The final control samples consist of 7,045,134 individuals for the general population and 306,430 individuals for the highly educated population. In our

[3] Including PhD students without a Swedish master's degree (N=4,670) in our analysis does not alter the results (see Figure OA1).
[4] 98.5 percent of the individuals excluded due to this criterion are PhD students in medical and health sciences, where many students work clinically alongside their PhD studies. Implementing other cutoff points does not importantly impact our results (see Figure OA2).
[5] In Sweden, master programs are separate from PhD programs. Consequently, individuals in the highly educated control group cannot have received their master's degree as part of PhD program.
[6] We rely on Statistics Sweden's 2-digit classification of fields of studies (SUN2000), covering 22 fields. For 2.2 percent of the PhD population, we cannot match exactly on gender, birth year, field of study and graduation year. For these cases, we stepwise relax the graduation year criterion to +/- 1 year, then +/- 2 years, and finally +/- 3 years until matched.

analyses, control individuals are weighted by the inverse of the number matched to each PhD student. Table OA1 compares the socioeconomic characteristics of the PhD sample and control groups.

2.3. Outcome variables

Our data contain comprehensive, high-quality individual-level information on *all* medical prescriptions collected in Sweden from any type of health care visit and is based on the Prescribed Drugs Register available since 2005. Our main measure of mental health care uptake, *psychiatric medication*, is a dummy variable indicating whether an individual collected any prescribed antidepressants (N06A), anxiolytics (N05B), or hypnotics and sedatives (N05C) as classified by to the Anatomical Therapeutic Chemical Classification System (ATC) in a given year.

As a secondary outcome, we study *hospitalizations for mental or behavioral disorders.* To this end, we construct a dummy variable indicating whether an individual was hospitalized for such disorders in a given year.[7] We construct this measure using data on all hospitalizations between the years 2005 and 2016 from the National Patient Register. We rely on the classification of diagnoses presented in the International Classification of Diseases (ICD) and include in our measure diagnoses for, e.g., major depression, anxiety disorders, sleep and eating disorders and substance abuse but exclude, e.g., intellectual disabilities and developmental disorders that are likely unrelated to PhD studies.[8] While hospitalizations are less frequent than prescriptions this measure allows us to focus on more severe and/or acute mental health problems compared to the use of psychiatric medication.

3. Results

3.1. The effect of PhD studies on mental health care uptake

Figure 1 presents descriptive evidence of the share of individuals in our PhD sample that collects psychiatric medication the years before and after starting their PhD compared to the control groups from the general and highly educated population. Control individuals are assigned a "placebo PhD start year" matching the start year of the PhD student they were

[7] This measure relies on the full scope of diagnoses available in the data which consist of one primary and two secondary diagnoses. Our results are robust to relying on the primary diagnosis only (see Figure OA3).

[8] Specifically, our measure of hospitalizations for mental disorders includes the following ICD-10 subcategories: F10-F19 (Mental and behavioral disorders due to psychoactive substance use), F23 (Acute and transient psychotic disorders), F30-F39 (Mood affective disorders), F40-F48 (Neurotic, stress-related and somatoform disorders), F50-F59 (Behavioral syndromes associated with physiological disturbances and physical factors), and F99 (Unspecified mental disorder.)

matched with. Figure 1 shows that the use of psychiatric medication has increased over time for all groups. This increase is partly driven by an age-related increase in mental health care uptake and partly by a general rise in psychiatric prescriptions in Sweden during this period.[9] In addition, Figure 1 shows that the use of psychiatric medication among prospective students' is similar to other highly educated individual before starting their PhD, and lower than the general population. However, after starting their PhD, their use of psychiatric medication increases relative to the other groups. Five years into the PhD program, PhD student use of psychiatric medication is close to that among the general population and higher than among other highly educated individuals.

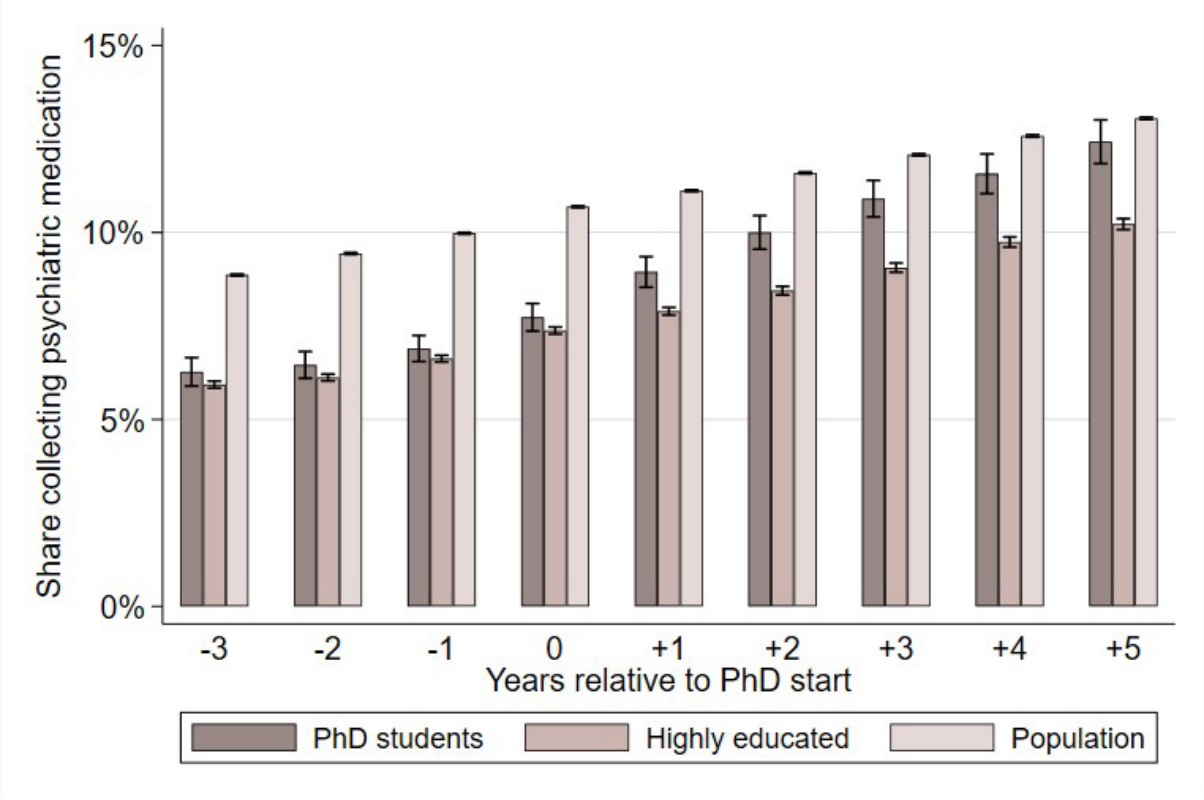

Fig. 1. Prescribed psychiatric medication relative to PhD start. The figure shows the share of individuals that collect psychiatric medication in the years before and after the start of PhD studies. The error bars show 95 percent confidence intervals. The control groups are constructed by matching individuals from the general population, or the highly educated population (those with a master's degree), m:1 to the PhD population by gender, birth year and – for the highly educated group – academic field and year of master's degree. Each control individual is given a "placebo" PhD start year equal to the start year of the PhD student they are matched with. Each control individual is weighted by the inverse of the number of control individuals matched to the same PhD student.

While Figure 1 is consistent with the conjecture that PhD studies are associated with an increase in mental health care uptake, we implement an event study with individual and

[9] Figure OA4 shows the use of psychiatric medication in the PhD population and the matched samples from the general and the highly educated population. Overall, there is a continuous increase in the share of individuals that collects psychiatric medication in all three samples.

calendar year fixed effects to identify the impact of PhD studies more precisely. The individual fixed effects allow us to control for all time-invariant individual factors and compare the mental health care uptake of the same individual before and after PhD start. The calendar year fixed effects account for the general time trend in prescription rates. In addition to our sample of PhD students (who are included in the treated group the year they start a PhD program), we include in the event study the sample of individuals with a master's degree but no PhD education as a never-treated control group. Our primary event study specification is:

$$Y_{ist} = \sum_{j=-8, j\neq -1}^{8} \beta_j I(t = j) + a_i + \theta_s + \varepsilon_{ist} \,. \quad (1)$$

In this specification, Y_{ist} is a binary variable indicating whether individual i has collected prescribed psychiatric medication in calendar year s and at event time t. The variables *I(t=j)* are event time dummies that take the value of 1 if the difference between the calendar year and the PhD start year is j years (this variable always takes the value 0 for the never-treated control group). The variable *I(t=0)* indicates the year of PhD start. We omit *I(t=-1)*, the year before PhD start, as a baseline. The variable *I(t=8)* captures all periods at least eight years after PhD start and *I(t=-8)* captures all periods at least eight years before PhD start. Finally, a_i denotes individual fixed effects and θ_s calendar year fixed effects. We cluster the standard errors at the individual level.

Our variable of interest, β_j, estimates the relative change in the share of individuals collecting psychiatric medication in the j^{th} year before or after PhD start, compared to one year before PhD start, controlling for time trends and time-invariant individual factors. Figure 2 presents the outcome of this analysis, expressed in relative changes.[10] The likelihood for PhD students to collect psychiatric medication increases sharply after the start of PhD studies, and this increase continues throughout the PhD program. Five years into the program, the propensity to collect psychiatric medication has increased by 39.5 percent (equivalent to a 2.5 percentage point increase) compared to the year before PhD start.[11]

After year five (the last year on average in our sample), the event study estimates diminish substantially, indicating a decrease in mental health care uptake. While it is important to stress that Figure 2 is not based on a balanced panel, these results are robust to using a

[10] To obtain the relative change, we divide β_j (the estimated percentage point change in psychiatric medication between *t=-1* and *t=j*) with the share of PhD students observed at *t=j* who collected psychiatric medications at *t=-1*.

[11] Our results are robust to using alternative event study strategies from the recent literature (Borusyak, Jaravel, and Spiess 2022; Sun and Abraham 2021; Callaway and Sant'Anna 2021), see Figure OA5.

balanced panel comprising students who can be observed for at least seven years after PhD start (see Figure OA6). An event study with a longer time span indicates that prescription rates—despite declining after year five—remain elevated 7-10 years after PhD start (see Figure OA7).

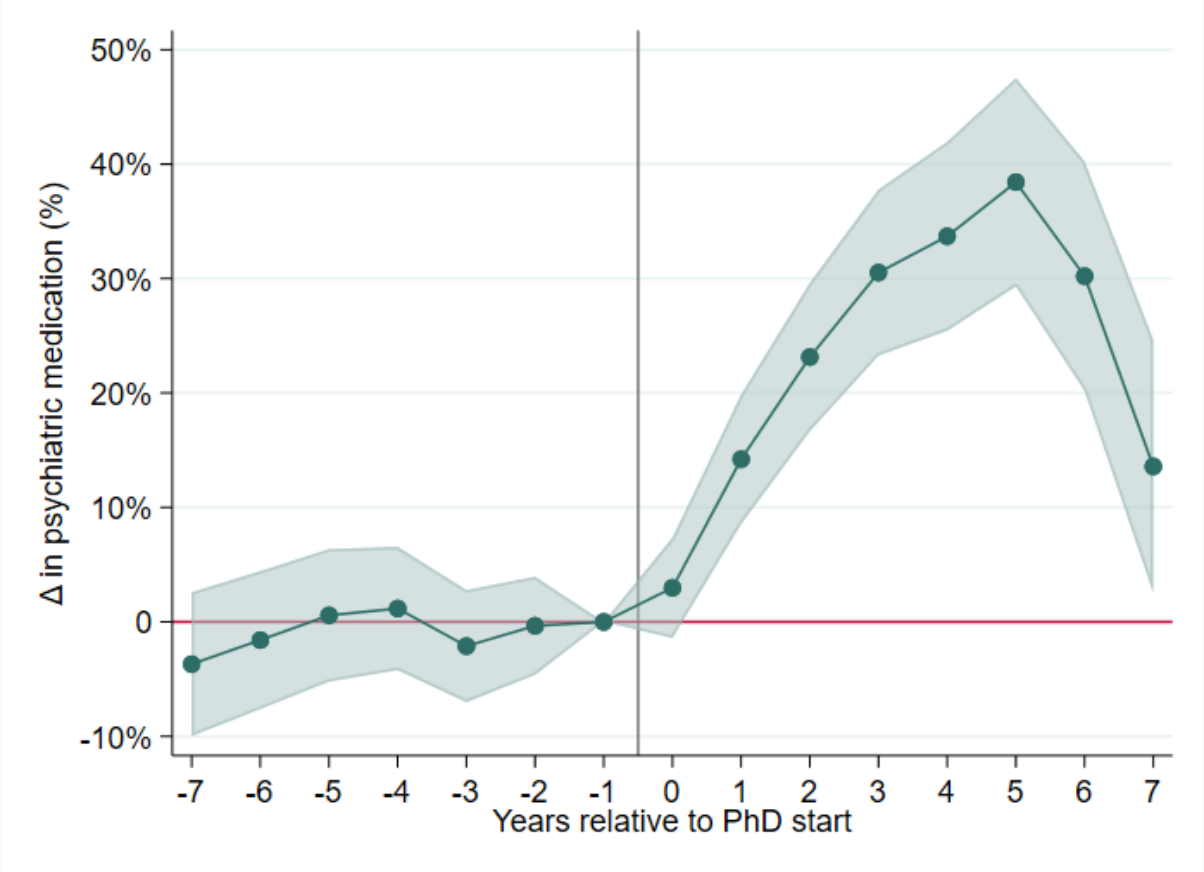

Fig. 2. Event study of the impact of PhD studies on prescribed psychiatric medication. The figure shows the estimated coefficients and 95 percent confidence intervals for the event study regressions corresponding to Equation (1). Outcome variable: Yearly indicator for collecting psychiatric medication. Control variables: Individual and calendar year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students and a never-treated control group consisting of individuals with a Swedish master's degree but no PhD studies, matched to the PhD population in terms of gender, year of birth, and field and year of master's degree, and weighted by the inverse of the number of individuals matched to the same PhD student. The effect is measured in percent relative to the PhD students' average uptake of psychiatric medication the year before PhD start and is obtained by dividing the estimated coefficient for each event time dummy with the mean value at baseline (t=-1) for the PhD students observed at the relevant event time.

Figures OA8 and OA9 present heterogeneity analyses by research field and student characteristics. The main takeaway from this analysis is that the use of psychiatric medication following PhD start increases for all student groups and academic fields, except for medical and health sciences. Men and women show similar increases in prescription rates, but the relative impact is directionally stronger for men due to their lower baseline prevalence. Younger students (under 28 at the start of PhD studies) and those foreign-born experience a larger relative increase in the use of psychiatric medication, while marital status and having

children appear to matter less. We also find no difference in the impact based on whether students are formally employed or funded by a scholarship, or whether they are part of the minority gender in their field.

To contextualize the estimated effect sizes presented in Figure 2, we conduct a similar event study estimating the impact of the sudden and unexpected loss of a parent on the use of psychiatric medication (for details on the sample and analysis see Online Appendix A). The loss of a parent, and the medical evaluation of an associated psychiatric treatment, are different from starting PhD studies. Hence, this comparison only aims to provide a rough benchmark of the impact of a painful life event on the use of psychiatric medication. Our estimates show a 28 percent (3-percentage point) increase in psychiatric medication use in the year of the parent's death. However, the use of psychiatric medication returns to pre-loss levels by the second year after the loss. Thus, compared to starting a PhD program, the impact of the sudden loss of a parent on the use of psychiatric medication is lower in relative terms and less persistent over time (see Figure OA10).

3.2. Testing identifying assumptions

The results presented so far show a sharp increase in mental health care uptake after PhD start. While this pattern is consistent with the conjecture that PhD studies have a negative effect on mental health, our results might also be driven by (i) correlated shocks associated with other major life events that coincide with PhD start, and/or (ii) changes in health care seeking behavior. This section presents additional analyses to address these possibilities.

First, we investigate correlated shocks. If the timing of PhD start coincides with other life changes—such as graduating from university, starting a new job, or moving to another city—the increase in mental health care uptake observed at the time of PhD start might be driven by these events rather than PhD studies. To address this, we re-estimate the event study of Figure 2 for the highly educated control group, estimating the change in psychiatric medication following graduation. This analysis shows no impact of university graduation on psychiatric medication (see Figure OA11). Thus, we find no indication that our estimates are driven by other life events coinciding with graduation.

Second, we investigate whether our estimates reflect changes in health care seeking behavior rather than underlying mental health. Given Sweden’s low-cost and universal health care, our findings are unlikely driven by a change in formal access to health care at the onset of a PhD. However, PhD studies could, e.g., be associated with increased information about health care providers generally, or mental health care providers specifically.

We first assess the importance of changes in mental health care seeking behavior by studying more acute and severe conditions we believe are less likely influenced by individual propensity to seek health care. We therefore implement our event study using as our outcome variable whether an individual was hospitalized for mental disorders in a given year.[12] The share of prospective PhD students that are hospitalized for mental or behavioral disorders is low at baseline (0.23 percent), and the effect of PhD studies is less precisely estimated. Still, Figure 3, shows a statistically significant and relatively larger effect on hospitalizations than on psychiatric medication. This suggests our findings reflect a deterioration in underlying mental health rather than a shift in health care seeking behavior. Moreover, it indicates that PhD studies have an impact not only on minor conditions evaluated to require only medication but also on more severe mental health conditions that result in hospitalization.

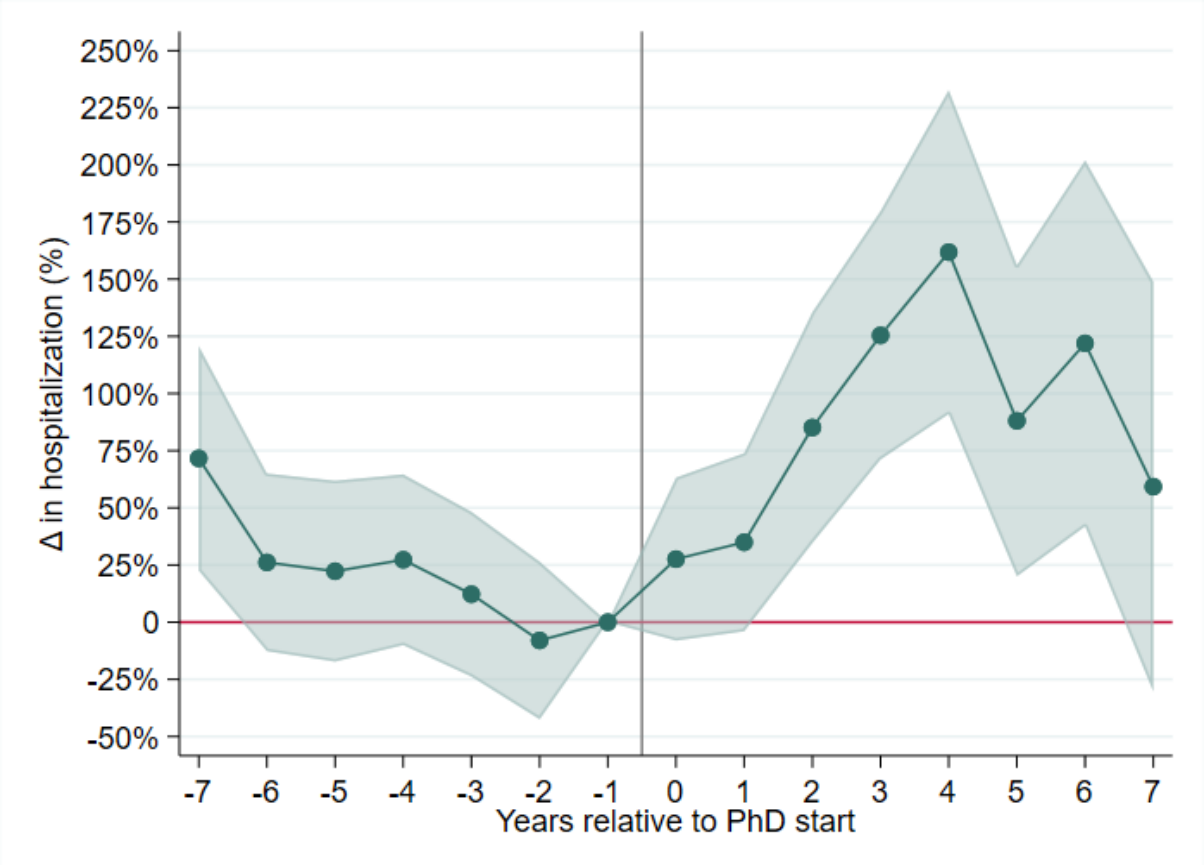

Fig. 3. Event study of the impact of PhD studies on hospitalizations for mental health problems. The figure shows the estimated coefficients and 95 percent confidence intervals for event study regressions corresponding to Equation (1). Outcome variable: Yearly indicator for hospitalizations for mental disorders (including mental and behavioral disorders due to psychoactive substance use, mood affective disorders, neurotic, stress-related and somatoform disorders, behavioral syndromes associated with physiological disturbances and physical factors, and unspecified mental disorders). Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students and a never-treated control group (with all event time indicators set to 0) consisting of individuals

[12] Note that individuals who are both hospitalized and prescribed psychiatric medication will be captured by both our measures.

with a Swedish master's degree but no PhD studies, weighted to resemble the PhD population in terms of gender, year of birth, and field and year of master's degree. The effect is measured in percent relative to the PhD students' average uptake of hospital visits and/or hospitalizations the year before PhD start and is obtained by dividing the estimated coefficient for each event time dummy with the mean value at baseline (t=-1) for the PhD students observed at the relevant event time.

We then assess a possible change in health care seeking behavior broadly by exploring if there is a *general* increase in prescriptions following PhD start. Thus, we implement our event study analyzing prescriptions for the six largest pharmacological groups (based on the ACT classification system). While prescriptions increase at the onset of PhD studies for several classes of drugs (most notably, drugs for the respiratory system, the alimentary tract and metabolism, and anti-infectives), these increases are considerably smaller than that observed for psychiatric medications (see Figure OA12). This suggests the observed effect on psychiatric medication is not primarily due to increased health care seeking behavior. Furthermore, our measure of psychiatric medication includes only medications whose main therapeutic use is classified as psychiatric by the ATC-code. It does not include medications otherwise classified, but which are systematically used to treat mental health problems. One example is sedative antihistamines—classified under the category "Respiratory System"—which were developed to treat allergies, but which are today primarily used to treat anxiety (Pagel and Parnes 2001; Thunander Sundbom et al. 2021). Indeed, further analysis reveals that the documented increase in prescription of respiratory medication at PhD start stems from an increased use of sedative antihistamines.[13] This indicates our narrow definition may underestimate the full impact of PhD studies on mental health-related prescriptions.[14]

Finally, our analysis cannot exclude that individuals who start PhD studies have, on average, a higher *propensity* for mental health problems than the control group, and that this propensity is triggered by the stress of PhD studies. Relying on the fact that some mental health problems are partly hereditary (Andreassen et al. 2023), we compare the mental health care uptake between the parents of the individuals in our PhD and master student samples but find no difference between the two groups of parents (see Table OA1).

3.3. Relative risks

The rich data and large sample size enable us to meaningfully explore how the association

[13] Among the six subcategories of the chapter "Respiratory System", sedative antihistamines is the only one showing a statistically significant increase after the start of PhD studies, peaking at approximately 35 percent in the fifth year.

[14] We also explore whether there is a general increase in hospitalizations at the start of PhD studies. The result for the six largest other categories of diagnoses (excluding those related to pregnancy and childbirth) is presented in Figure OA13. While less precise due to a smaller sample, this analysis also indicates a larger increase in hospitalizations for mental health disorders than for other categories of health problems.

between PhD studies and mental health care uptake varies with sociodemographic characteristics and institutional factors. In this section we focus on the relative risk of being prescribed psychiatric medication during PhD studies.

We restrict our analysis to PhD students not prescribed any psychiatric medication the year before PhD start and those observed at least two years before and one year after PhD start. This results in a sample of 17,159 individuals. To compute the relative risk of starting psychiatric medication during the PhD program, we estimate logistic regressions. The outcome variable takes the value 1 if the individual collected psychiatric medication at any time during the five years following the start of PhD studies, and 0 otherwise. The risk ratio of one group, relative to another, is the relative difference in the probability of collecting psychiatric medication during the PhD program.

Figure 4 shows both unadjusted (controlling only for PhD start year) and adjusted risk ratios (controlling for PhD start year, research field and all variables listed on the y-axis). The strongest and most robust predictors of starting psychiatric medication during PhD studies are age, gender and prior use of psychiatric medication. Individuals 31 years or older at PhD start experience a 1.51-1.65 times higher risk of collecting psychiatric medication during the PhD program than those younger than 26 at PhD start, and women experience a 1.67 times higher risk than men. The highest risk occurs among individuals who have already collected psychiatric medication at some point prior to starting the PhD program (excluding the calendar year preceding PhD studies), who are 2.84 times more likely to collect psychiatric medication during their PhD than those without a history of psychiatric medication. Being foreign-born is associated with a somewhat lower risk of collecting psychiatric medication, while being married or having children at PhD start are associated with a somewhat higher risk, although these effects are not statistically significant in the model with control variables.

Finally, we explore variation by two institutional factors: research field gender composition and type of employment contract. These factors may give an indication of possible mechanisms through which PhD education affects mental health, e.g., (i) by belonging to a gender minority at work, (ii) lack of access to social safety nets if funded by a scholarship rather than formal employment, or (iii) worry about future employment prospects. The risk of being prescribed psychiatric medication is not elevated for PhD students who belong to the minority gender[15], or those who are funded by scholarships or grants rather than through formal

[15] We define a gender as underrepresented in a research field if it comprises less than 35 percent of the PhD population in that field (defined at the finest available level of about 250 fields). Our results remain robust using

employment[16]. However, being employed by a company is associated with a 28 percent lower risk, relative to being employed by a university. This result may indicate that worries about future employment prospects or a future academic career negatively impacts mental health.[17]

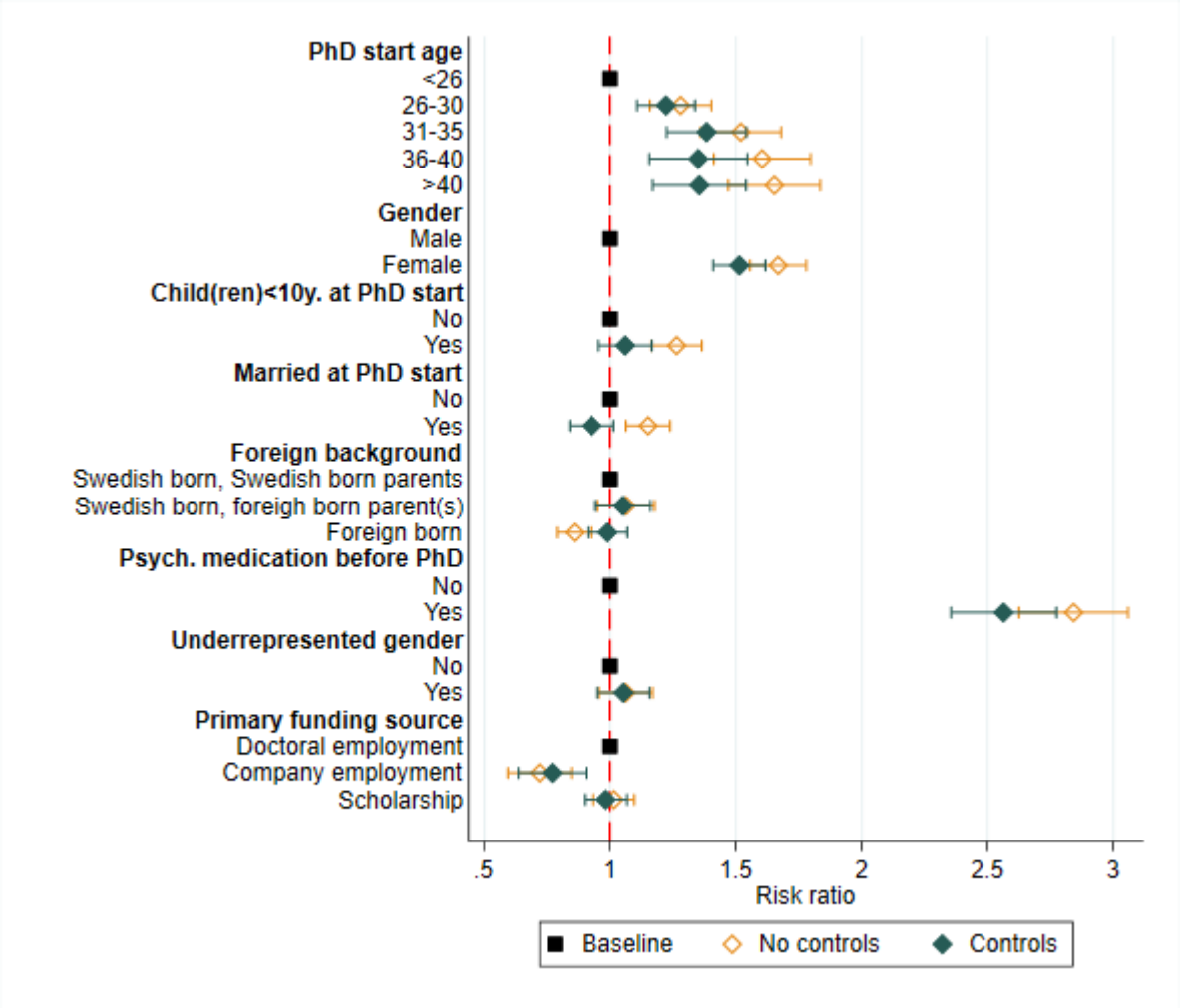

Fig. 4. Risk ratios of being prescribed psychiatric medication during PhD studies. Error bars show 95 percent confidence intervals. The sample is restricted to PhD students who were not prescribed any psychiatric medication in the calendar year before PhD start, and who we can observe at least two years before and one year after PhD start. The hollow orange diamonds ("No controls") are estimated controlling only for PhD start year dummies. The green diamonds ("Controls") are estimated controlling also for all variables listed on the y-axis and research field.

different cutoffs (see Figure OA14), except for the most underrepresented group (<15%), where the sample is small and estimates are imprecise.

[16] During the study period, PhD students could be formally employed or funded through external grants. Grant-funded payments were often tax-exempt and did not provide social insurance. While some institutions offered solutions for issues like parental leave, these were at least in some cases ad hoc and case-by-case.

[17] In a correlational analysis, we find that using psychiatric medication is associated with a 50 percent higher likelihood of dropping out (defined as 3 consecutive inactive semesters without a degree) compared to the average drop-out rate (see Table OA2).

4. Discussion

Recent survey evidence has raised concern about a high reported prevalence of mental health problems among graduate students. This study was motivated by the need to understand whether this extends to the full population of PhD students, and whether it is due to selection (into the surveys or PhD studies) or to a direct negative impact of PhD studies themselves. We use population-wide and longitudinal administrative records to study the impact of PhD studies on mental health care uptake among PhD students. We find that, prior to entering PhD studies, prospective students have a similar mental health care uptake as a matched sample of individuals with a master's degree in the same field but no PhD education. However, at the onset of PhD studies this similarity ends, and we document an important increase in the use of psychiatric medication among PhD students. Additionally, we find a subsequent decline in psychiatric medication usage after the fifth year, which corresponds to the average duration of PhD studies in our dataset.

The increase we document occurs broadly across various sociodemographic groups and academic fields, with the exception of the medical and health sciences. At the same time, exploring relative risk ratios, our data indicate that older individuals, women, and those with a previous history of using psychiatric medication have a higher likelihood of collecting psychiatric medication during their PhD.

As our analysis relies on population-wide records, these results are not impacted by sample selection. Further, the panel structure of the data allows us to rule out the possibility that the high prevalence of psychiatric medication among PhD students arises because of selection into PhD studies among individuals already using mental health care. Rather, our results provide support for a negative causal impact of PhD studies on mental health. However, a few limitations are worth discussing.

First, while population-wide administrative records have important advantages, they capture *diagnosed* mental health problems. Some individuals may hesitate to seek medical care, for example due to possible stigma associated with a mental health diagnosis (Clement et al. 2015). Therefore, these records may underestimate the prevalence of mental health problems in our sample. Importantly, if the degree to which mental health problems are associated with stigma varies between the environment faced by PhD students and that faced by our control group, this may impact our estimates.

Second, the ideal setting for establishing a *causal* effect of PhD studies on mental health care uptake would be an experiment in which a large number of individuals are randomly

allocated to start PhD studies or not and followed over time. As such an experiment is unfeasible, a population-wide event study represents the best alternative, allowing us to control for all individual characteristics that do not change at the onset of PhD studies by comparing the outcome for the *same* individual before and after PhD start. Moreover, our complementary analyses corroborate that the documented association between PhD studies and mental health care uptake is causal rather than driven by other life events that coincide with PhD start.

Third, an important question is the generalizability of our results to contexts outside of Sweden. Comparing our estimates to previous survey-based evidence indicates that mental health care uptake in the Swedish PhD population is similar to that reported among previous PhD populations. In our study, 13.5 percent of active PhD students received psychiatric medication in 2016. This is comparable to recent U.S. survey data indicating that 14.9 percent of PhD students in economics (Bolotnyy, Basilico, and Barreira 2022, surveyed the academic year 2017-2018) and 10-13.5 percent of PhD students in political science (Almasri, Read, and Vandeweerdt 2022, surveyed in 2020) received treatment for mental health problems. Further, the meta-analysis by Satinsky et al. (2021) finds that 24 percent of the responding PhD students state symptoms of depression and anxiety. Since previous literature indicates that the screening tools often used to assess mental health in surveys tend to overestimate the prevalence of depression compared to clinical interviews by about a factor of two (e.g., Levis et al. 2020, Levis et al. 2019; Thombs et al. 2018), also these estimates appear comparable to the numbers estimated in the PhD population explored here. Our results therefore seem relevant to academic and other stakeholders generally, beyond the Swedish context. However, with respect to the relative prevalence of mental health problems in the PhD population and the population at large our results differ somewhat from earlier research. While previous survey-based evidence reports a higher prevalence of mental health problems among the PhD respondents than in the general population (e.g., Bolotnyy, Basilico, and Barreira 2022, Levecque et al. 2017), we find that the PhD population collect psychiatric medication at a lower level than the general population before, and at a similar level at the end of, PhD studies.

Our study provides important evidence for academic institutions and policy makers aiming to understand the gravity of the mental health crisis among PhD students and to make more informed decisions on how to address it. If PhD studies negatively impact mental health, this likely decrease both academic productivity and causes a selection of researchers not only based on academic aptitude, but also mental resilience. Our results highlight the need to form comprehensive and efficient policies to promote mental health and improve the current work environment for early career researchers.

Our results also touch upon a wider discussion about a sustainable and productive working life against the background of high and increasing sickness absence due to mental health problems. Understanding what aspects of our working lives and careers impact our mental health and quantifying the associated impact is valuable. We contribute to this debate by estimating the impact of one career choice—the choice to pursue a PhD—on mental health outcomes.

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Online Appendix for The Impact of PhD Studies on Mental Health — A Longitudinal Population Study

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Anna Sandberg§

June 14, 2024

- Online Appendix A: Additional Details on the Population for the Sudden Loss of a Parent
- Online Appendix B: Additional Figures and Tables

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Online Appendix A: Additional Details on the Population for the Sudden Loss of a Parent

To provide the benchmark estimates of the impact on psychiatric medication following the sudden and unexpected loss of a parent, we rely on the population of individuals with at least a master's degree, whose parents are alive in 2006, matched m:1 to the PhD population by gender and birth year. The treated group consists of everyone within this group who lost a parent due to a sudden and unexpected event between 2006 and 2017. The control group consists of those in this group with both parents alive in 2017. Those whose parents died before 2006, or between 2006 and 2017 but out of causes that are not deemed sudden or unexpected, are dropped from this analysis. In all analyses, we weigh both the treated and control group by the inverse of the number of individuals matched to each PhD student, and in addition, we weigh the control group to resemble the treated group in terms of gender and birth year. We define a death as sudden and unexpected if the cause of death is any of the following: vehicle accidents, other types of accidents, external causes (excluding assault and murder), acute heart attacks, nontraumatic intracerebral haemorrhage, and cerebral infarctions (ICD-10 codes V01-V99, W00-W99, X00-X60, I21-I22, I61 and I63).

Online Appendix B: Additional Figures and Tables

Table OA1: Socioeconomic characteristics: PhD students and control samples.

	PhD students	Educated population	General population
Number of individuals	20,085	306,430	7,045,134
Share female	0.46	0.46	0.46
Share foreign born	0.26	0.25	0.29
Share with at least one foreign-born parent	0.10	0.11	0.11
Share with at least one parent with university/college degree	0.40	0.43	0.31
Share with at least one parent with a graduate degree	0.17	0.16	0.06
Share with at least one parent with a PhD	0.12	0.07	0.02
Share with at least one parent on psychiatric medication	0.48	0.49	0.51
Share with at least one parent with prior mental health hospitalization	0.10	0.09	0.13

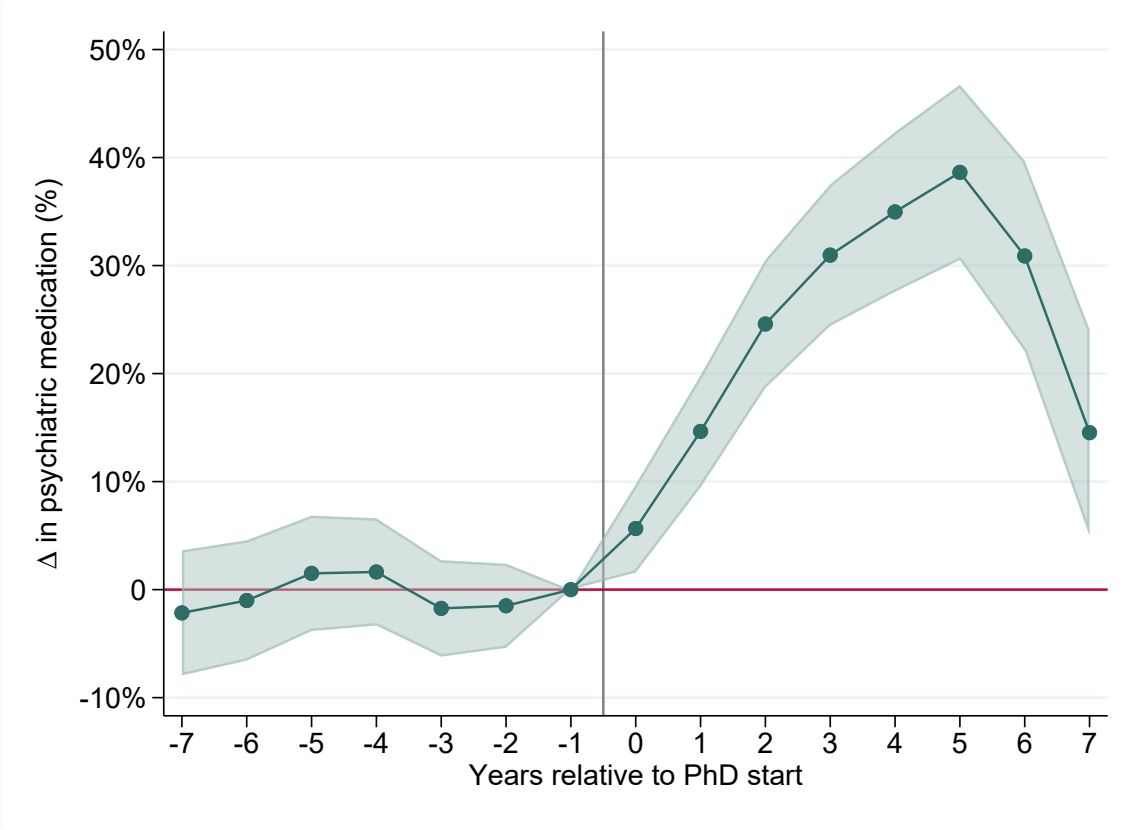
Notes: The tables shows a comparison of the average sociodemographic characteristics of PhD students and the individuals in our control samples. Parents with prior mental health hospitalization indicates if any parent was hospitalized for mental health issues any time between 2001-2004 in in-patient or out-patient care.

Table OA2: Association between uptake of psychiatric medication during PhD and probability of having three or more consecutive inactive semesters

	(1)	(2)	(3)
Psych. medication during PhD	0.020***	0.022***	0.020***
	(0.005)	(0.005)	(0.005)
Female			-0.000
			(0.004)
Age at PhD start			0.001***
			(0.000)
Observations	10,660	10,621	10,621
Dependent variable mean	0.041	0.041	0.041
	Indicators		
Start year FE	No	Yes	Yes
Research field FE	No	Yes	Yes

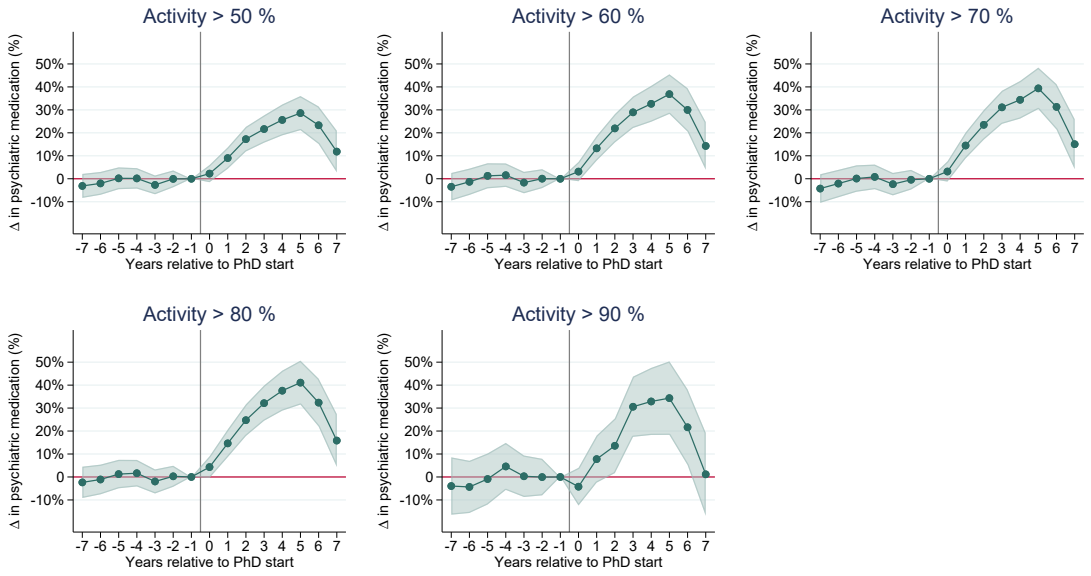
Notes: The tables shows the association between collecting psychiatric medication at any point in the five years after starting a PhD and the probability of having at least 3 consecutive inactive semesters (our proxy for dropping out of the PhD program). The sample includes only PhD students who started their PhD studies before or during 2011, in order to be able to observe their outcomes at least 6 years after PhD start. Columns (2)–(3) controls for PhD start year and research field fixed effects. The dependent variable mean depicts the average probability of having at least 3 consecutive inactive semesters in the sample.

Figure OA1: Main result relaxing the requirement to have a Swedish master's degree



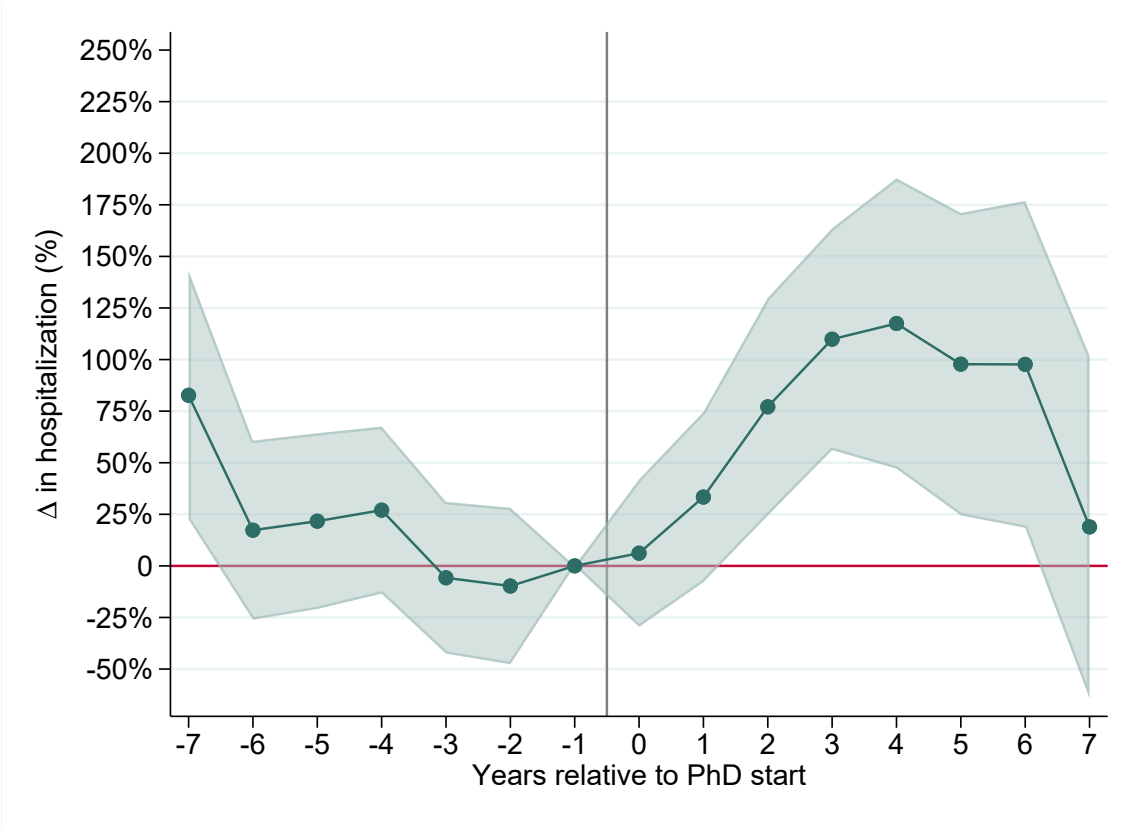
Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for the event study regressions corresponding to equation (1), on a sample of PhD students that is not restricted to having a master's degree from a Swedish university. Outcome variable: Yearly indicator for being prescribed and collecting psychiatric medication. Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students (with and without a Swedish master's degree) and a never-treated control group (with all event time indicators set to 0) consisting of individuals with a Swedish master's degree but no PhD studies, matched to the PhD population in terms of gender and year of birth, and weighted by the inverse of the total number of individuals matched to the same PhD. The effect is measured in percent relative to the PhD students' average uptake of psychiatric medication the year before PhD start. (Note: The percentage change in year X is obtained by dividing the coefficient for year X with the mean value at t=-1 for the phd students observed in year X.)

Figure OA2: Event study of the impact of PhD studies on collected psychiatric medication, using different cutoff-levels for activity



Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for the event study regressions corresponding to equation (1), separately for PhD students defined by different cutoff-levels of activity (a median activity in the main research field of at least 50, 60, 70 (same as main results), 80 and 90 percent). Outcome variable: Yearly indicator for being prescribed and collecting psychiatric medication. Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students in each research field and a never-treated control group (with all event time indicators set to 0) consisting of individuals with a Swedish master's degree but no PhD studies, matched to the PhD population in terms of gender, year of birth, and field and year of master's degree, and weighted by the inverse of the total number of individuals matched to the same PhD. The effect is measured in percent relative to the PhD students' average uptake of psychiatric medication the year before PhD start. (Note: The percentage change in year X is obtained by dividing the coefficient for year X with the mean value at t=-1 for the PhD students observed in year X.)

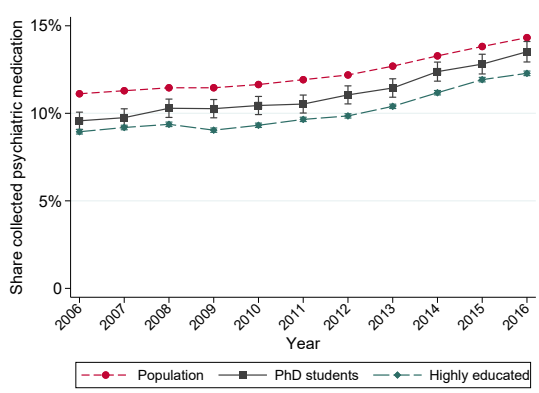
Figure OA3: Event study of the impact of PhD studies on hospitalizations for mental health problems, using one primary diagnosis



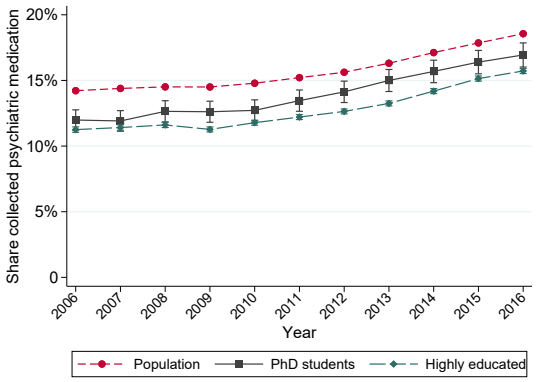
Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for event study regressions corresponding to Equation (1). Outcome variable: Yearly indicator for hospitalizations for mental disorders as the primary diagnosis (including mental and behavioral disorders due to psychoactive substance use, mood affective disorders, neurotic, stress-related and somatoform disorders, behavioral syndromes associated with physiological disturbances and physical factors, and unspecified mental disorders). Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students and a never-treated control group (with all event time indicators set to 0) consisting of individuals with a Swedish master's degree but no PhD studies, weighted to resemble the PhD population in terms of gender, year of birth, and field and year of master's degree. The effect is measured in percent relative to the PhD students' average uptake of hospital visits and/or hospitalizations the year before PhD start. (Note: The percentage change in year X is obtained by dividing the coefficient for year X with the mean value at t=-1 for the PhD students observed in year X.)

Figure OA4: Collected psychiatric medication over time, full sample and by gender

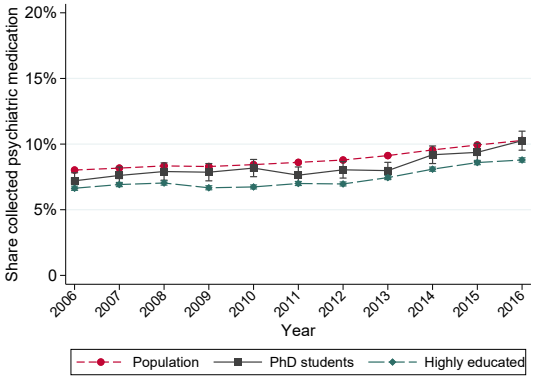
(a) Full sample



(b) Women



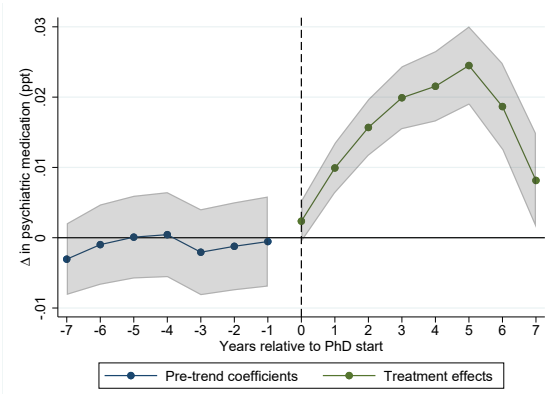
(c) Men



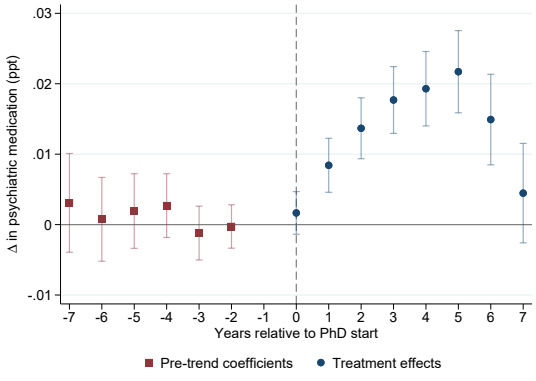
Notes: The figure presents average uptake of prescribed psychiatric medication for the full sample (a), women (b) and men (c). Error bars represent 95 percent confidence intervals. For each calendar year, the PhD sample includes all individuals who were active as a PhD student that year (restricted to those with a Swedish master's degree). The controls groups are weighted (separately for each calendar year) to resemble the PhD population in terms of gender and year of birth for both groups, as well as field of master's studies and graduation year for the highly educated population.

Figure OA5: Event studies of the impact of PhD studies on collected psychiatric medication, using alternative estimation methods

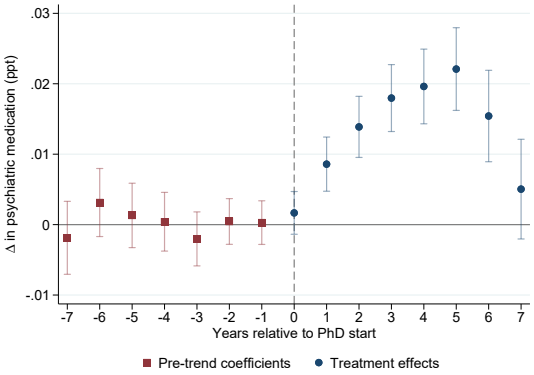
(a) Borusyak et al (forthcoming)



(b) Sun and Abraham (2021)

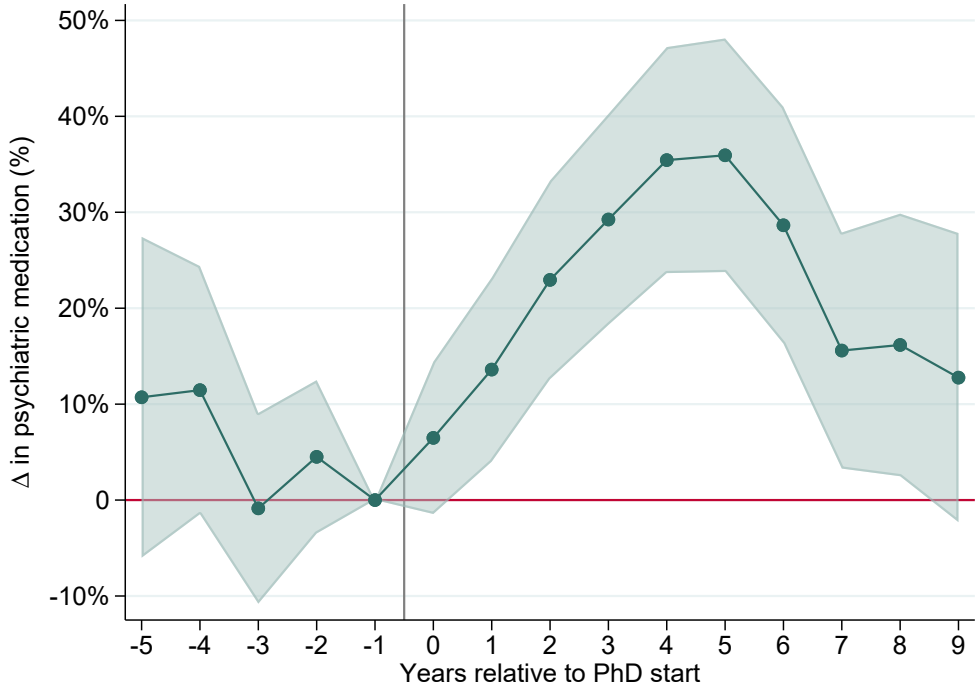


(c) Callaway and Sant'Anna (2021)



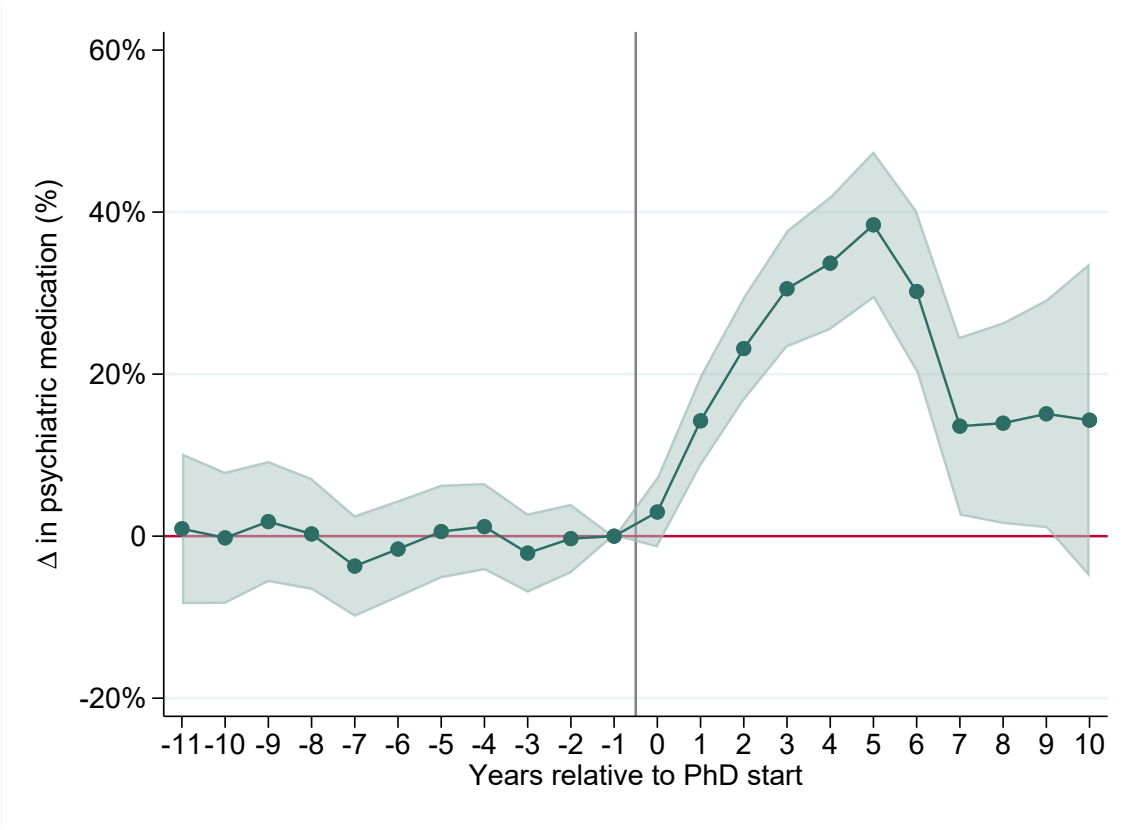
Notes: The figure shows the estimated coefficients and 95 percent confidence intervals using alternative event-study specifications. Outcome variable: Yearly indicator for being prescribed and collecting psychiatric medication. Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students and a control group consisting of individuals with a Swedish master's degree but no PhD studies, matched to the PhD population in terms of gender, year of birth, and field and year of master's degree, and weighted by the inverse of the total number of individuals matched to the same PhD. The effect is measured in percentage points. See Borusyak et al (forthcoming), Sun and Abraham (2021) and Callaway and Sant'Anna (2021) for further information.

Figure OA6: Event study of the impact of PhD studies on collected psychiatric medication, balanced sample



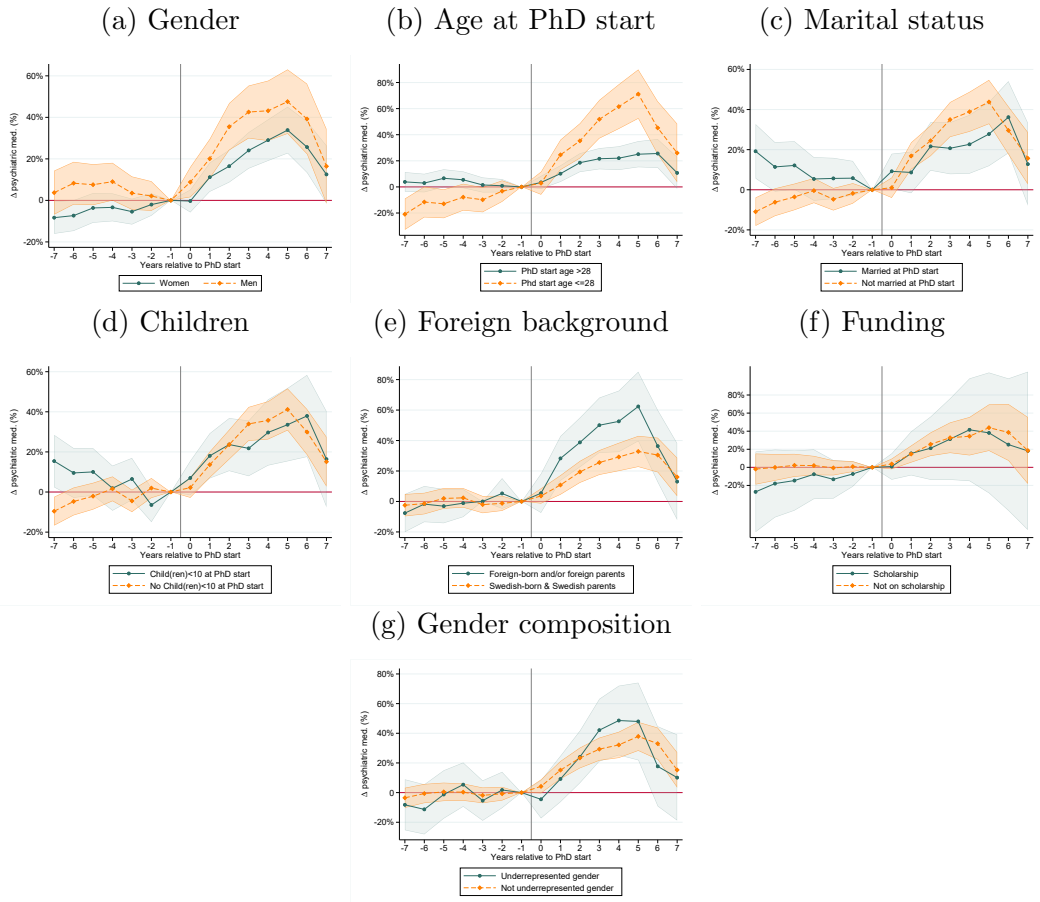
Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for the event study regressions corresponding to Equation (1), on a sample of individuals that can all be observed for all 13 study years and at least 7 years after PhD start. Outcome variable: Yearly indicator for being prescribed and collecting psychiatric medication. Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students and a never-treated control group (with all event time indicators set to 0) consisting of individuals with a Swedish master's degree but no PhD studies, matched to the PhD population in terms of gender, year of birth, and field and year of master's degree, and weighted by the inverse of the total number of individuals matched to the same PhD. The effect is measured in percent relative to the PhD students' average uptake of psychiatric medication the year before PhD start. (Note: The percentage change in year X is obtained by dividing the coefficient for year X with the mean value at t=-1 for the PhD students observed in year X.)

Figure OA7: Event study of the impact of PhD studies on prescribed psychiatric medication, longer event time



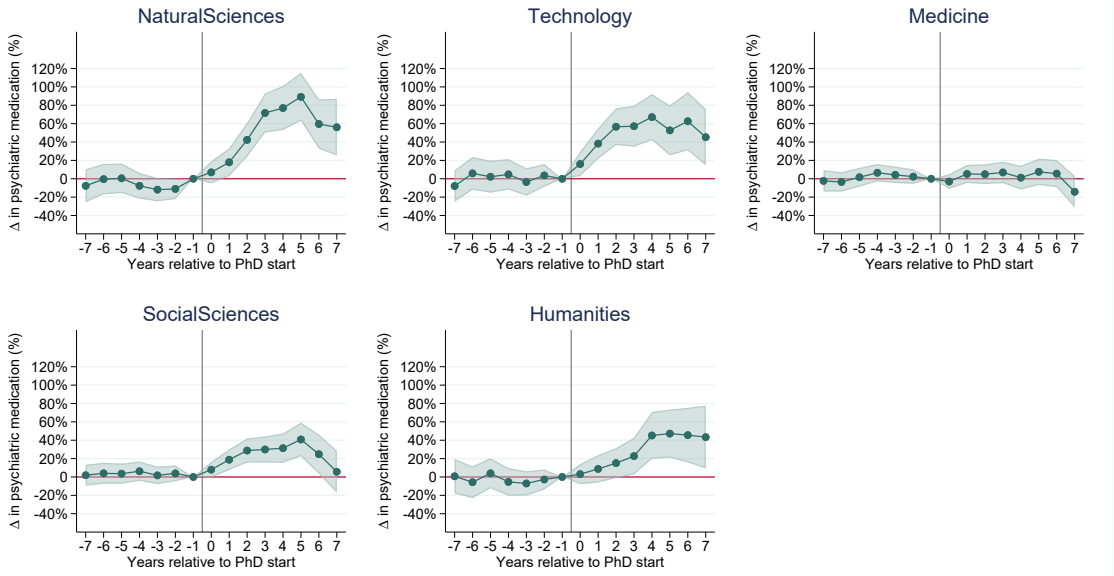
Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for the event study regressions corresponding to Equation (1), but without capping the event time dummies to eight years before or after PhD start. Outcome variable: Yearly indicator for being prescribed and collecting psychiatric medication. Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students and a never-treated control group (with all event time indicators set to 0) consisting of individuals with a Swedish master's degree but no PhD studies, matched to the PhD population in terms of gender, year of birth, and field and year of master's degree, and weighted by the inverse of the total number of individuals matched to the same PhD. The effect is measured in percent relative to the PhD students' average uptake of psychiatric medication the year before PhD start. (Note: The percentage change in year X is obtained by dividing the coefficient for year X with the mean value at t=-1 for the PhD students observed in year X.)

Figure OA8: Event study of the impact of PhD studies on collected psychiatric medication, by individual and institutional characteristics



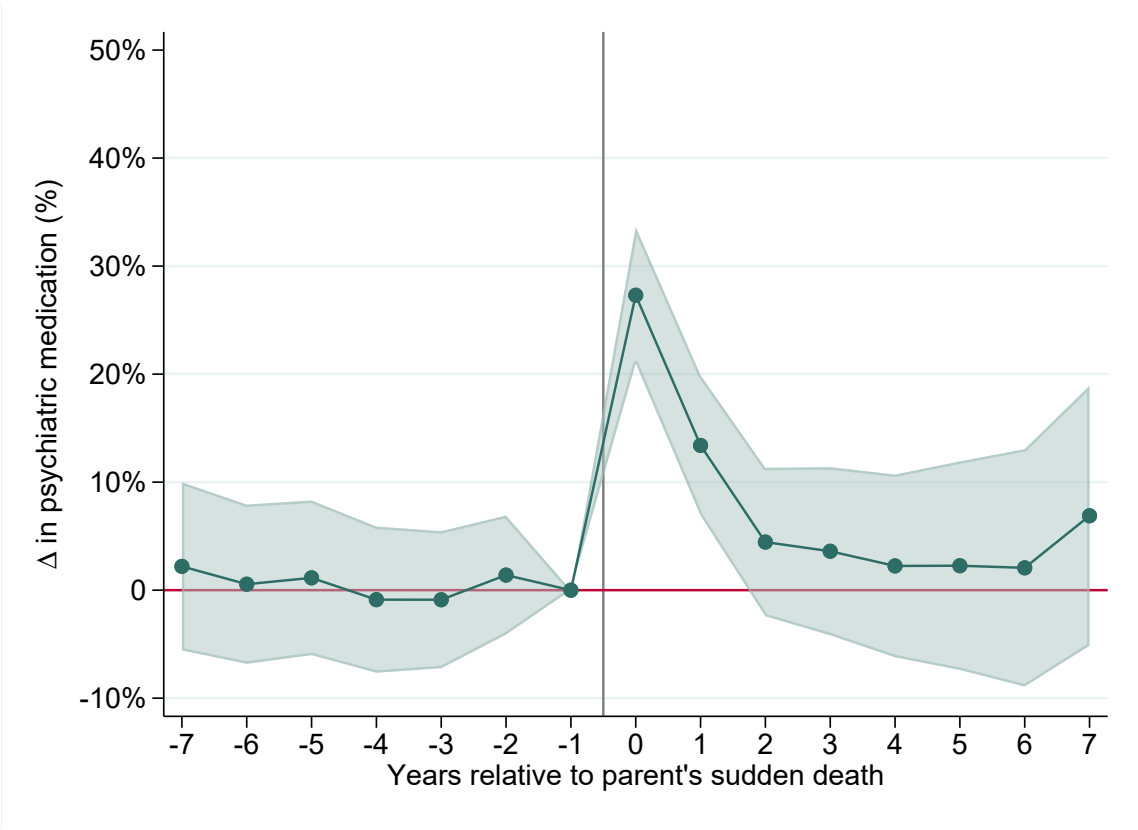
Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for the event study regressions corresponding to Equation (1), estimated separately for different groups. The sample splits are done by (i) PhD start age (above or below median), (iii) gender, (iv) having children below the age of 10 at PhD start, (v) being married at PhD start, (vi) foreign background, (vii) being of the underrepresented gender within your research field, and (viii) employment status. Outcome variable: Yearly indicator for being prescribed and collecting psychiatric medication. Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students and a never-treated control group (with all event time indicators set to 0) consisting of individuals with a Swedish master's degree but no PhD studies, matched to the PhD population in terms of gender, year of birth, and field and year of master's degree, and weighted by the inverse of the total number of individuals matched to the same PhD. The effect is measured in percent relative to the PhD students' average uptake of psychiatric medication the year before PhD start. (Note: The percentage change in year X is obtained by dividing the coefficient for year X with the mean value at t=-1 for the PhD students observed in year X.)

Figure OA9: Event study of the impact of PhD studies on collected psychiatric medication, by research field



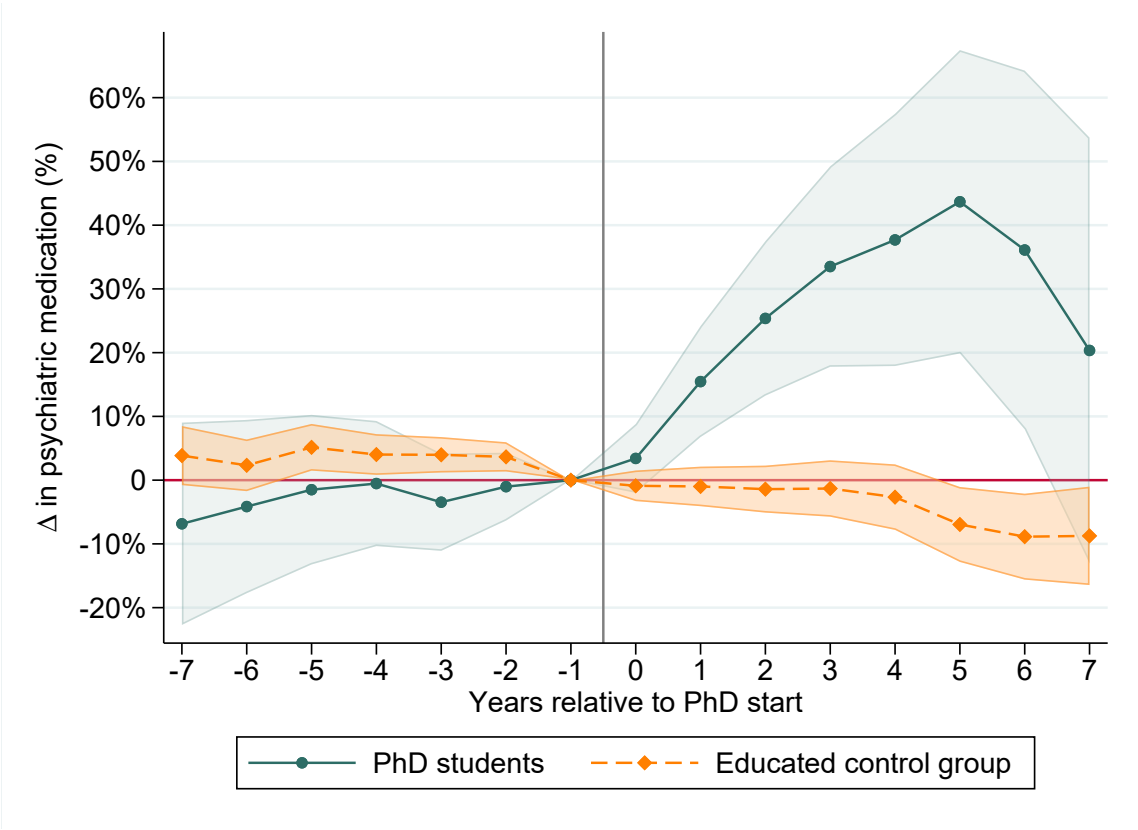
Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for the event study regressions corresponding to equation (1), separately for PhD students in each research field. Outcome variable: Yearly indicator for being prescribed and collecting psychiatric medication. Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students in each research field and a never-treated control group (with all event time indicators set to 0) consisting of individuals with a Swedish master's degree but no PhD studies, matched to the PhD population in terms of gender, year of birth, and field and year of master's degree, and weighted by the inverse of the total number of individuals matched to the same PhD. The effect is measured in percent relative to the PhD students' average uptake of psychiatric medication the year before PhD start. (Note: The percentage change in year X is obtained by dividing the coefficient for year X with the mean value at t=-1 for the PhD students observed in year X.)

Figure OA10: Event study of the impact of the sudden death of a parent on collected psychiatric medication



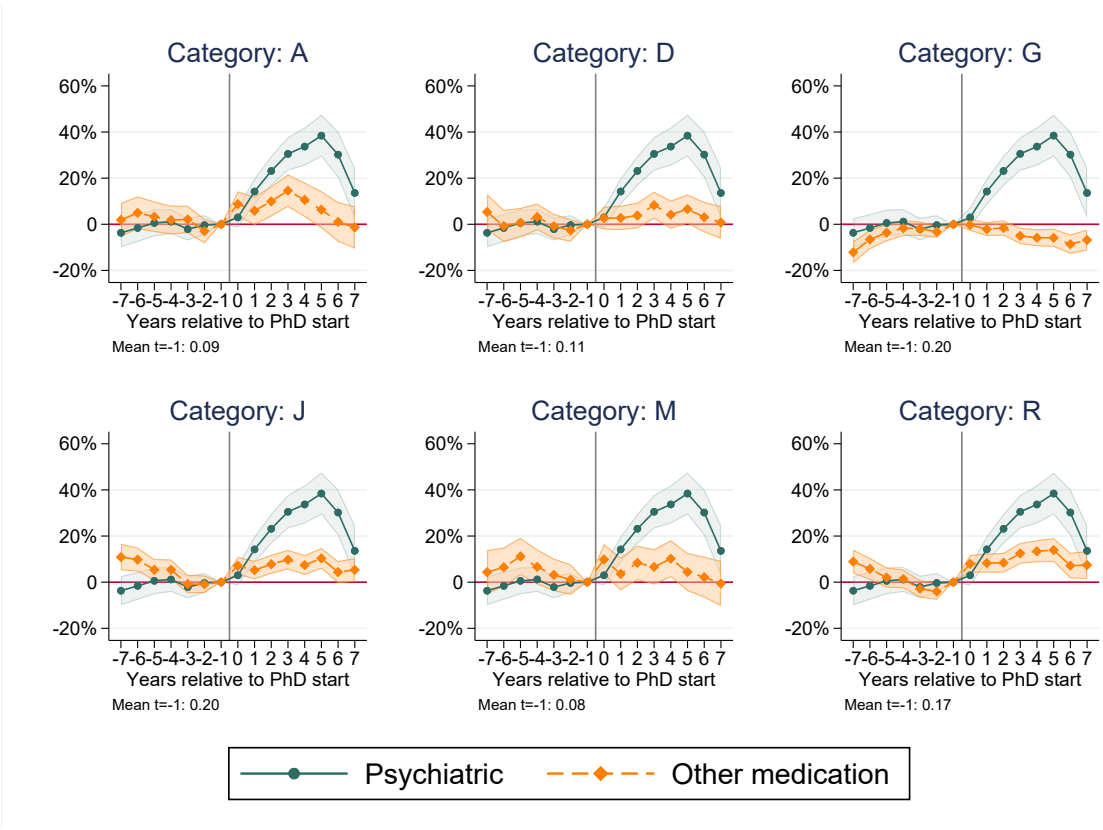
Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for the event study regressions corresponding to equation (1). Outcome variable: Yearly indicator for being prescribed and collecting psychiatric medication. Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after the unexpected loss of a parent. Standard errors are clustered by individual. The sample consists of individuals with a master's degree, who have both parents alive in 2006, matched m:1 to the PhD population by gender and birth year. The treated group comprises everyone in the sample who lost at least one parent suddenly between 2006 and 2017. We include deaths due to vehicle accidents, other accidents, external causes (excluding assault and murder), acute heart attacks, nontraumatic intracerebral hemorrhage, and cerebral infarctions (ICD-10 codes V01-V99, W00-W99, X00-X60, I21-I22, I61 and I63). The never-treated control group (with all event time indicators set to 0) comprises everyone in the sample who has both parents alive in 2017, weighted to resemble the to the treated population in terms of gender and year of birth. In addition, both samples are weighted by the inverse of the number of individuals that were matched to the same PhD student. The effect is measured in percent relative to the treated individuals' average uptake of psychiatric medication the year before the death of a parent. (Note: The percentage change in year X is obtained by dividing the coefficient for year X with the mean value at t=-1 for the treated individuals observed in year X.)

Figure OA11: Event study of the impact of PhD studies on collected psychiatric medication



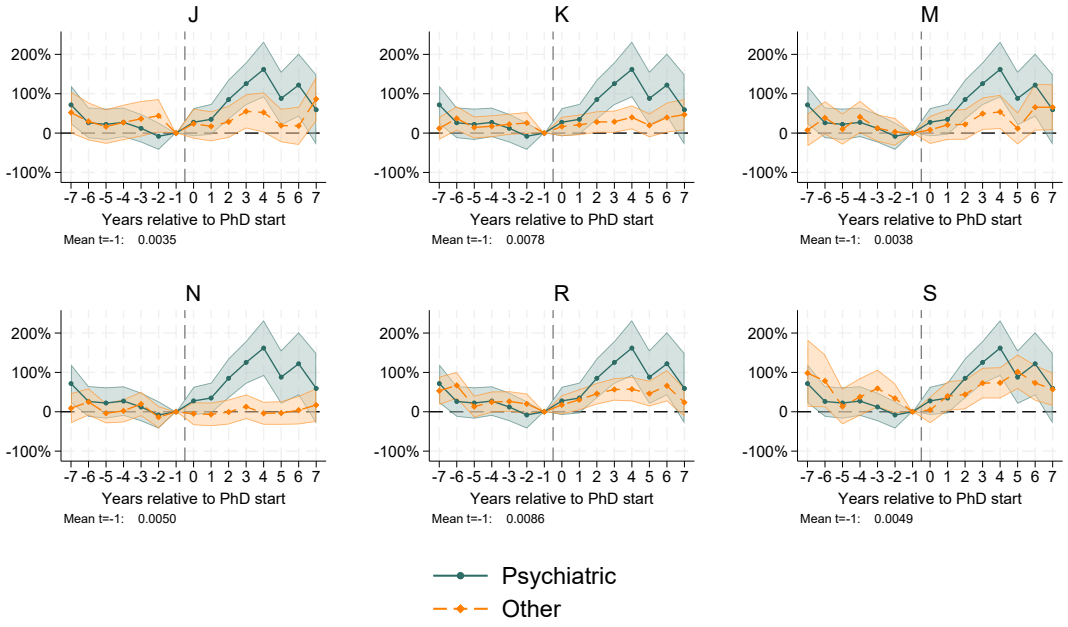
Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for event study regressions corresponding to Equation (1). Outcome variable: Yearly indicator for being prescribed and collecting psychiatric medication. Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The green solid line shows results for our sample of PhD students. The orange dashed line shows results for individuals with a Swedish master's degree but no PhD studies, matched to the PhD population in terms of gender, year of birth, and field and year of master's degree, and weighted by the inverse of the total number of individuals matched to each PhD. These individuals are assigned a "placebo" PhD start year equal to the year after they graduated from their master's studies. The effect is measured in percent relative to the average uptake of psychiatric medication the year before PhD start. In contrast to our main specification, these even study analyses do not include any never-treated control group.

Figure OA12: Event study of the impact of PhD studies on collected psychiatric medication compared to other classes of medications



Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for event study regressions corresponding to Equation (1). Outcome variable (solid blue line): Yearly indicator for being prescribed and collecting psychiatric medication. Outcome variables (dashed orange line): Yearly indicator for being prescribed and collecting other types of medication (type indicated by graph title). Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students and a never-treated control group (with all event time indicators set to 0) consisting of individuals with a Swedish master's degree but no PhD studies, weighted to resemble the PhD population in terms of gender, year of birth, and field and year of master's degree. Average take-up of each medication for PhD students at t=-1 are displayed below each figure. The effect is measured in percent relative to the PhD students' average uptake of medications the year before PhD start. (Note: The percentage change in year X is obtained by dividing the coefficient for year X with the mean value at t=-1 for the PhD students observed in year X.) The included ATC categories are A: alimentary tract and metabolism; D: dermatologicals; genito-urinary system and sex hormones; J: anti-infectives for systemic use; M: musculo-skeletal system; and R: respiratory system.

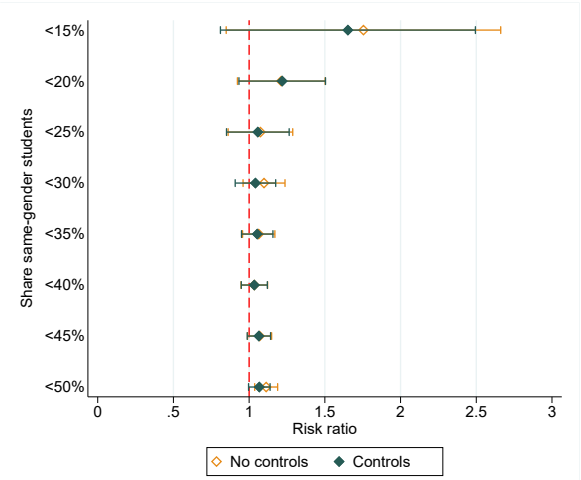
Figure OA13: Event study of the impact of PhD studies on hospitalizations for mental health problems compared to other causes of hospitalization



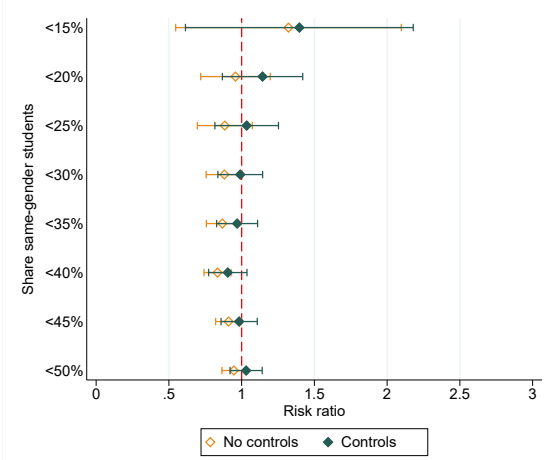
Notes: The figure shows the estimated coefficients and 95 percent confidence intervals for event study regressions corresponding to Equation (1). Outcome variable (solid blue line): Yearly indicator for hospitalizations for mental disorders (including mental and behavioral disorders due to psychoactive substance use, mood affective disorders, neurotic, stress-related and somatoform disorders, behavioral syndromes associated with physiological disturbances and physical factors, and unspecified mental disorders). Outcome variables (dashed orange line): Yearly indicator for hospitalizations for other causes (type of cause indicated by graph title). Control variables: Individual and calendar and year fixed effects, and event time dummies indicating years before/after PhD start. Standard errors are clustered by individual. The sample includes PhD students and a never-treated control group (with all event time indicators set to 0) consisting of individuals with a Swedish master's degree but no PhD studies, weighted to resemble the PhD population in terms of gender, year of birth, and field and year of master's degree. Average hospitalization rate for each cause for PhD students at t=-1 are displayed below each figure. The effect is measured in percent relative to the PhD students' average hospitalization rate the year before PhD start. (Note: The percentage change in year X is obtained by dividing the coefficient for year X with the mean value at t=-1 for the PhD students observed in year X.) The average uptake of each drug in the year before PhD start is displayed below each graph. The figure includes the 6 most common ICD-10 diagnosis recoded at a hospitalization spell (excluding childbirth). The included ICD-10 categories are J: diseases of the respiratory system; K: diseases of the digestive system; M: diseases of the musculoskeletal system and connective tissue; N: diseases of the genitourinary system; R: symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified; and S: injury, poisoning and certain other consequences of external causes.

Figure OA14: Risk ratios using different cut-offs for being underrepresented

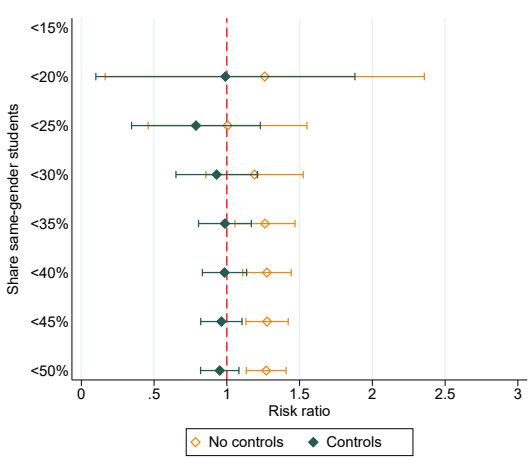
(a) All



(b) Women



(c) Men



Notes: The sample is restricted to PhD students who were not prescribed any psychiatric medication in the calendar year before PhD start, and who we can observe at least two years before and one year after PhD start. The figure shows risk ratios, estimated as described in Section 3.3 of the main paper. Each diamond represents the increased risk of being prescribed psychiatric medication during PhD studies for students who are enrolled in research fields where individuals of their own gender comprise less than X percent of the PhD population as compared to research fields where individuals of their own gender comprise at least X percent of the PhD population. When constructing this variable, research field is defined at the finest available level (differentiating between approzimately 250 research fields). The hollow orange diamonds ("No controls") are estimated controlling only for PhD start year dummies. The green diamonds ("Controls") are estimated controlling also for research field and all variables listed on the y-axis of Figure 4. Error bars show 95 percent confidence intervals. For men, we do not show the coefficient of "less than 15 percent" since this is estimated with very large confidence intervals ([-0.20;5.30] without controls, [-0.29;4.47] with controls).