Secção/Área temática / Thematic Section/Area:
Sexualidade e Género

Academia lockdown: the gendered effects of COVID-19 on academic working conditions and performance

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Abstract
The COVID-19 outbreak and containment measures brought substantial disruptions to academic activities. A growing body of empirical literature has acknowledged that the lockdown caused by the pandemic has disproportionately affected women, namely due to the traditionally gendered division of labour in society. Using the lens of intersectionality, this paper explores the effects of the first COVID-19 lockdown on working conditions, academic time use, work-life balance challenges and scientific productivity of female and male academics, drawing from the results of a survey of 281 faculty members from one major Portuguese public university. The survey findings provide a sound indication that gender inequalities are shaping the effects of the COVID-19 crisis on conditions, time, and efficacy of academic work, making it particularly more difficult for academic women, especially younger mothers in non-tenure-track positions, to correspond to the "ideal type of academic" during the pandemic crisis.

Keywords: COVID-19; gender; academia

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Introduction

COVID-19 is having strong consequences for people's working conditions and work-life articulation, and academics are no exception. Although countries faced different degrees of lockdown and social distancing during the "first wave" of the COVID-19 pandemic, schools and universities in most affected countries adopted online classes and remote activities, altering many academics´ working conditions and professional dynamics.

As the lockdown triggered by the pandemic progressed, anecdotal accounts on social media and in the press, as well as early empirical studies (e.g., Kim and Patterson, 2020; Malisch et al., 2020; Minello, 2020; Myers et al., 2020; Yildirim and Eslen-Ziya, 2020), increasingly acknowledged the pandemic's gendered effects in academia, accentuating, in particular, how the concomitant closure of university´s campuses, schools and childcare and other care facilities might regress women's progress towards equality (Cook, 2020). As education and care services shut down (and with the impossibility of benefitting from informal care), academic staff were required to remotely manage their fieldwork research and laboratories and to transfer courses to online platforms, while simultaneously caring for and home-schooling their children. Academic women, especially those with young children or other care responsibilities, are likely to find themselves at the heart of these conflicting domestic and professional pressures, as long-standing evidence demonstrates that women perform significantly more domestic labour and care work than men, including in academic households (Schiebinger et al., 2011).

Gender inequities in academia are not new – they have been observed long before March 2020, when COVID-19 hit higher education institutions. Even before the pandemic, non-academic responsibilities, as well as academic duties, were not equally distributed by gender, with female academics spending more time not only on domestic and childcare responsibilities compared to men, but also on the so-called "academic housekeeping" and on emotional work within academic institutions (Lynch, 2010). Along with time allocation inequalities, disparities between men´s and women´ success were observed in publication rates, citations, recognition, academic rankings and leadership positions within academia, which commonly favour men over women (Cardel et al., 2020; Huang et al., 2020; EC, 2019). During the pandemic,

systemic barriers hindering the productivity and career advancement of female academics, particularly those with family and household responsibilities, appear to have been exacerbated, as the policies to mitigate the effects of the COVID-19 outbreak rely on the ambiguity of women's social position: between public and private, between home and university, between care and intellectual work.

Using the lens of intersectionality, this paper aims to explore the impacts of the COVID-19 lockdown on working conditions, work-life balance, time use, and scientific productivity of Portuguese female and male academics during the "first wave" of the COVID-19 pandemic. We draw on the results of a survey of 218 faculty members from a major Portuguese public university to examine how and to what extent gender inequalities are shaping the impact of COVID-19 on academic working conditions, time and performance, delving into the connections with other axes of inequality, such as family circumstances, age and tenure status.

Method

The study was conducted at a major Portuguese public university (with more than 25.000 students) under the scope of the SUPERA project – Supporting the Promotion of Equality in Research and Academia. It followed a survey research design where the data were collected from an online questionnaire administered to the universe of faculty members. The questionnaire was sent to the academic staff mailing list and remained active between 10 and 20 September 2020. A total of 281 questionnaires were duly filled and returned, corresponding to an approximate response of 14% of all academic staff. Although the sample selection method was dependent on respondents' choice, interest and motivation, the call for participation was presented as a survey on working conditions and perceptions on academic performance during the COVID-19 crisis in order moderate the effects of self-selection associated to surveys on gender issues. Furthermore, the characteristics of the respondent sample in terms of sex/gender, academic ranks and scientific areas are broadly in line with those of the overall academic population of the institution (which follows the general trends observed for the country and for the EU-28 – EC, 2019), although some variances can be found.

Table 1. Respondents´ general information

Characteristics		Frequency (N)	Percent (%)	% of Women	% of Women Portugal (2016)
Gender	Female	153	54,4		48.8
	Male	126	44,8		51.2
	Non-binary	2	0,7		-
Academic rank	Grade A	20	7,1	40,0	26.3
	Grade B	35	12,5	57,1	40.8
	Grade C	126	44,8	50	47,8
	Grade D	98	34,9	63,3	52.5
Scientific area (where the activity is carried out)	Natural and Exact Sciences	85	30,2	43,5	51
	Engineering and Technology	61	21,7	39,3	29
	Medical & Health Sciences	78	27,8	61,5	58
	Social Sciences	63	22,4	63,5	53
	Humanities and Arts	41	14,6	68,3	51
Type of contract	Permanent	155	55,2	47,7	
	Not permanent	126	44,8	62,7	
Parental status (children up to 12 in the household)	With children	76	27,7	48,7	
	Without children	198	72,3	57,6	

Notes: (1) Grade A: Full Professor, Research Coordinators; Grade B: Associate Professors, Principal Investigators; Grade C: Assistant Professors /Researchers; Grade D: Other academic personnel (Assistants; Lecturers, Monitors; Research fellows with/without PhD (non-tenure track positions). (2) Parents are defined as those having children, regardless of their age.

The representation of women and men in the sample is relatively balanced (54% and 45%, respectively), although female respondents are overrepresented compared to the overall university staff and national and European population by about 8 p.p., 5 p.p. and

13 p.p., respectively. The overrepresentation of female respondents comparing to the universe is particularly prominent in the top levels of the academic career (Grade A and Grade B).

The survey questionnaire was introduced by a short presentation of its aims and a note informing on the anonymity of the data collection process. It consisted of both closed and open-ended questions (later categorized using content analysis), and included a series of questions about working conditions and strategies for accommodating distance teaching/remote work, time allocation (to domestic, family and academic work) and scientific production during the COVID-19 lockdown. The period covered by survey responses was from 9 March to 31 July 2020, corresponding to the time where all in-person activities were suspended at the University, with teaching and research community members developing academic activities from home (teleworking). In Portugal, primary schools remained closed during this whole period and childcare services (nurseries, kindergartens, etc.) and other social assistance facilities were closed for the majority of it, only being allowed to open with very limited access from the beginning of June.

Data was processed and analysed using the SPSS statistical software (version 26) and a range of statistical analyses of the material were conducted. Descriptive and inferential, univariate, bivariate and multivariate statistical analyses were carried out: frequency analysis, contingency analysis, association and correlation, parametric and non-parametric tests, and linear and categorical regressions (ordinal and binominal).

Using the lens of intersectionality, the dependent variables were broken down by sex/gender on its connections to other social categories combining to inform academics' identities, namely age, type of contract/tenure status and presence of children in the household. All of the survey results discussed here as differing over sex/gender (0 = women, 1= men), age (interval), with children up to 12 (0 = no, 1 = yes) and type of contract (0 = non-permanent, 1=permanent) are statistically significant. Due to small sample size (2 cases), we did not examine outcomes for individuals who identified as nonbinary. For statistical inference, we considered test statistics with p-values at or below 0.1 to be significant.

Results

1. (Remote) Working conditions

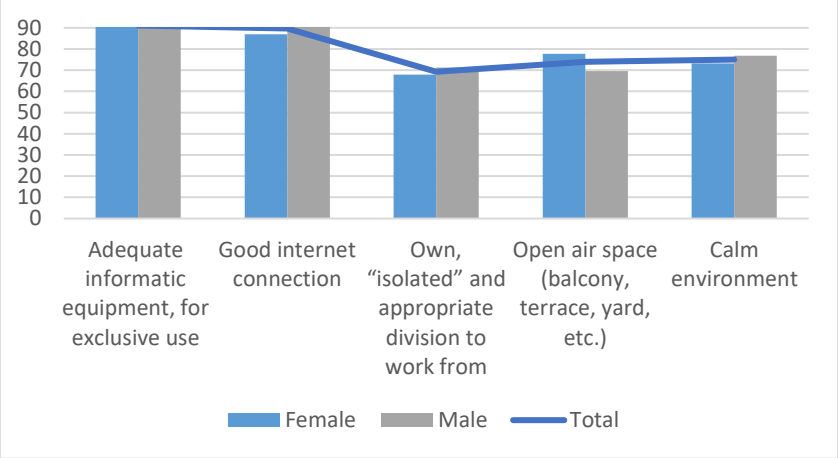
In response to the first wave of the pandemic, the Portuguese government (and many other countries' authorities) mandated their citizens to stay at home. During the lockdown, many people had to develop their professional activity from home, combined with their household work. Most countries, as was the case of Portugal, also closed their schools and day-care facilities, which greatly increased childcare needs.

In this context, the lockdown disrupted how academics carried out their activities. With university campuses and research centres closing down, faculty members had to complete their research and teaching duties from home. Conducting remote scientific research generally requires not only adequate infrastructures in terms of space, home-office and telecommuting equipment, but also a quiet and interruption-free environment (as concentration is critical for creative thinking), as well as good emotional/physical conditions to face the multiple demands of the new circumstances.

The working environment at home (workspace and resources)

Although a large share of the respondents claim to have the basic/essential conditions of space and resources for carrying out remote work, about 3 out of 10 do not have adequate environment and housing conditions (quiet environment, own room to work in and outdoor space). Digital infrastructures are the most accessible to academic staff (9 out of 10 academics say they have good computer equipment and a good internet connection), while an "isolated" and appropriate room to work from is the less available to academic staff.

Figure 1. Resources for remote work (%)



Statistical analyses reveal that **access to some of these essential resources is not uniform in the academic population and is influenced by sex, parental status, age and tenure status**.

Chi-square tests show that, although men tend to report greater accessibility to most of the listed resources, only the **availability of outdoor space** (greater in women: $\chi 2$ = 3,381; p=,066) and **good internet connection** (greater in men: $\chi 2$ = 3,381; p=,080) are statistically significant. When accounting for the influence of **parenthood,** we find some explanation for the latter result, as we observe a negative effect of motherhood ($\chi 2$ = 2,993; p=,084), not observed in fatherhood, on the speed of the internet connection (probably due to the network overload). Moreover, **maternity appears to be an important factor hampering the access of women to all other listed resources**, with the exception of "open air space at home"[i], while, in the case of men, parenting only plays a significant role on the access to a calm environment ($\chi 2$ = 11,206; p=,001).

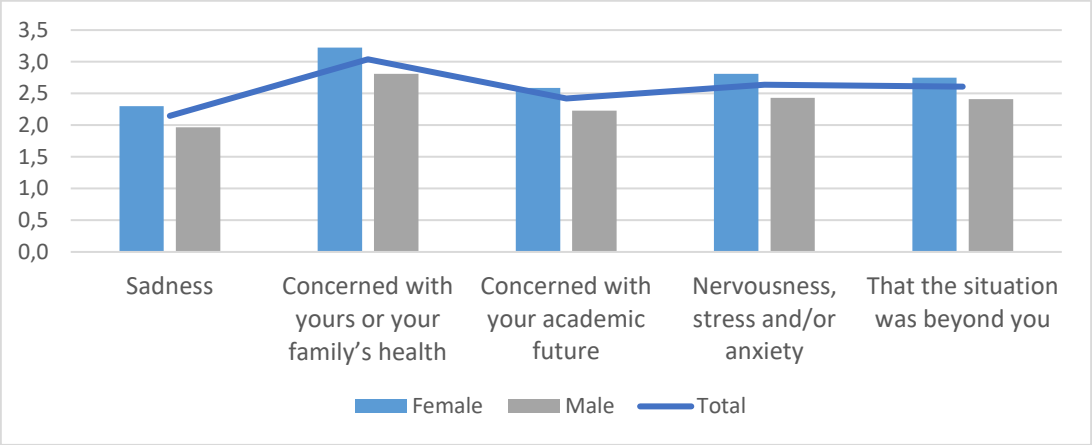
Age[ii] and employment/tenure status[iii] also influence access to conditions for remote work. The **availability of an isolated, proper space and of a quiet environment to work is less accessible at younger ages** (respectively, r=,219; p=,000; r=,109; p=,070), while **people with precarious contracts have limited access to a proper, separate working space** ($\chi 2$ = 5,439; p=,020). When intercepting these variables with gender[iv], we observe that, while precarious work arrangements approximate men and women on the limited access to an isolated, proper space to work, **younger male academics do not experience the relative disadvantage younger female face[v] on the access to proper housing conditions and environment to work remotely**.

Emotional conditions to work: the psychological impact of the pandemic

The (harmful) impact of the COVID-19 pandemic on stress and emotional state has been the focus of a great deal of public and scholar attention (see Brooks et al., 2020). In turn, gender differences in emotional response to the pandemic, whereby women experiment greater severity of psychological impacts, are largely acknowledged in scholarship (Lorena García-Fernández et al., 2020; Ausín, 2020).

In our study, concerns about health, anxiety and the perception of lack of control over the situation are the emotions most commonly associated with the period of confinement, "often" affecting 8 out of 10 and 6 out of 10 academics, respectively.

Figure 2. Psychological/emotional effects of the lockdown (N= 281; mean values)[*]



[*]Scale: 1 – Never; 2- Rarely; 3 – Often; 4 - Always

Nonetheless, results of Mann-Whitney tests indicate that the **psychological impact associated with the confinement is not uniform,** being **particularly perverse for women, who most often experience all the listed effects**[vi]. Academics with children up to 12 years old are also particularly apprehensive, both in terms of health and of their professional future (respectively, U = 6526; p =, 06; U = 6311; p =, 035), which is **an indicator of the special vulnerability of people with children to the uncertainty associated with COVID-19.** The interception of parenthood and gender was measured using the non-parametric two-way Anova, indicating that there is no statistically significant interaction between the two factors, i.e., the "parenthood" factor does not significantly influence the response of the "sex/gender" factor in the emotional effects of COVID (and vice-versa). Nonetheless, we can observe a trend for **increased**

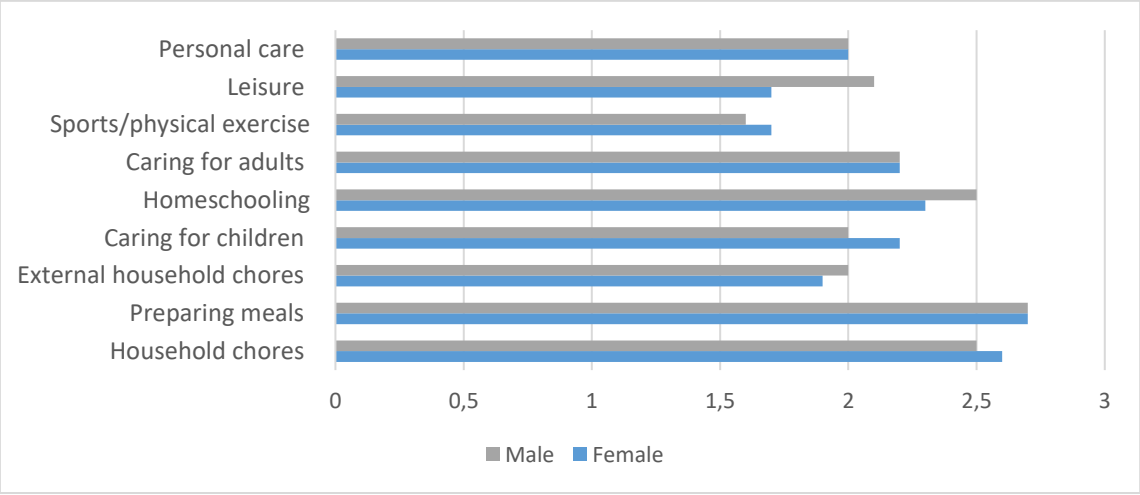
convergence between men and women who have young children on concerns about their professional future and feelings of anxiety and stress, which appear to be particularly amplified by paternity (although remaining lower when compared to academic mothers).

The particular exposure to **uncertainty regarding their professional future** experienced by female and academics with children is **shared by younger respondents** (Spearman's p = -, 415; p =, 000) and people on **precarious contracts** (U = 4578; p =, 000), accompanied by feelings of **stress/anxiety and sadness** which parenthood seems to amortize.

Domestic labour and care under lockdown

With the sudden transition to remote work, primary schools´ closure and limited access to childcare, family and household responsibilities have grown dramatically. As shown in figure 3, the time dedication of academic respondents to personal activities, household chores and care work was strongly impacted by the lockdown. Household duties, caregiving and home-schooling chores were the activities that most academic respondents (more than two thirds) dedicated more time to, in detriment of sports and leisure activities, which were reduced in more than half of the cases.

Figure 3. Changes in time allocation to personal and household tasks under lockdown (mean values) (N=281)



*Scale: 1 – Less time; 2- No difference; 3 – More time.

The unequal distribution of domestic duties that are observed also among academic households (Bianchi et al., 2012) means that female academics are likely to be

disproportionately affected by the pandemic, compared with their male colleagues. To explore how these inequalities played out during the lockdown, further analysis of survey data along gender lines is needed, intersecting with other social categories that shape academics´ experience.

In order to investigate whether gender, parental status, age and type of employment contract affect perceived changes in housework and personal activities, we estimate a series of ordered logistic regressions, where we control for those factors. The results highlight the heterogeneity of academics´ experiences. We report our findings in Table 2, where we explore how the lockdown affected internal household chores, cooking and meal preparation, caring for children, home-school support for children, caring for adults, sports/physical exercise and leisure activities.[vii]

Table 2. Impact of COVID on daily housework and personal routines of academics: Estimates and significance of logistic regression models.

	Internal household chores	**Cooking**	**Caring for children**	**Home-schooling**	**Caring for adults**	**Sports**	**Leisure**
Gender (women)	0,61** (0,274)	0,598* (0,287)	0,504 (0,656)	0,032 (0,408)	0,638** (0,331)	0,074 (0,246)	-0,892*** (0,241)
With children (up to 12)	1,117*** 0,348	0,939** (0,369)	3,408*** (0,751)	1,713*** (0,455)	-0,786* (0,42)	-0,59** (0,29)	-0,839*** (0,275)
Age	-0,001* (0,016)	0 (0,017)	-0,065 (0,055)	-0,026 (0,028)	0,028 (0,02)	0,001 (0,015)	-0,018 (0,014)
Tenure-track position	0,367 (0,357)	0,115 (0,376)	0,194 (0,649)	-0,462 (0,512)	0,211 (0,42)	-0,207 (0,317)	-0,055 (0,303)
Pseudo R2	0,076	0,053	0,556	0,262	0,087	0,052	0,089
Observ.	266	266	104	143	257	266	266

Standard errors in parentheses. – ***p < 0.01; **p < 0.05; *p < 0.1.

A first general observation that emerges from the analysis of the results is that **women, and especially younger academics with children, are most affected by the burden of domestic and family work** and by the reduction of personal time.

Table 2 shows that having young children appears to be the most important predictor of the perceived effects. The **presence of young children in the household has strong explanatory power not only of the perceived increased burden in care and support devoted to children** (hygiene, playtime, home-schooling, etc.) ($p < 0.01$), but also in domestic labour more broadly: internal household chores (cleaning, washing dishes and clothes, etc.) ($p < 0.01$) and cooking/preparing meals ($p < 0,05$). What is more, parents appear to be most affected by reduced personal time for leisure ($p < 0.01$) and physical exercise ($p < 0.05$). Nonetheless, if we delve further into the analysis, exploring the interactions between parental status with the other variables across each of the predicted outcomes, we observe that **having children does not affect the academic population, particularly female and male members, in similar ways**.

As seen in the table, the gender variable is positive in all the models measuring care and housework and statistically significant in four of the seven models, even after controlling for other variables that are relevant to frame individuals' behaviours, including parental status. In particular, women reported being affected at greater rates in terms of their routines in domestic duties inside the home ($p < 0.05$), preparing meals/cooking ($p < 0,1$) and caring/support for dependent adults (elderly, disabled people, etc.) ($p < 0.05$). Moreover, notwithstanding the relevance of gender asymmetries observed in domestic and home-schooling responsibilities, leisure time emerges as the realm of the major inequalities between female and male academics, as gender is an especially significant factor on this variable´s explanation model ($p < 0.01$), whereby women emerged as more negatively affected in their leisure routines irrespective of their parental status, age or employment status.

These findings indicate that the **pandemic has disproportionately affected the personal time and the exposure to domestic and care work of female academics during the lockdown, compared with their male counterparts**. Nonetheless, in some dimensions, **a trend for more gender balance can be found. We observe that the perceptions of men and women with children up to 12** in an identical situation in terms of age, and employment status **move very closely together** in terms of alterations to daily routines related to childcare (hygiene, playtime, etc.), home-schooling, and household chores outside the home (grocery shopping, paying bills, etc.).

2. Impacts of the new working conditions during the lockdown on work-family conflicts and academic time usage

Effects on work-family conflicts

The new working conditions imposed by the lockdown and the transition to remote work demanded rapid material, logistical and technical adaptations, while simultaneously requiring academics to deal with increased household and emotional burdens arising from COVID-19 restrictions. These new conditions under which professional/academic activity is to be developed, which appear to **distinctively affect women and early career, precarious academic parents**, also affect work-family negotiations and conflicts, posing differentiated challenges in reconciling competing employment and family time demands.

Both anecdotal and data-driven early evidence suggests that work-family conflicts hindering female faculty's career advancement are exacerbated during COVID-19, because women's care responsibilities become amplified under the emotional strain of the pandemic (Crook, 2020; Minello et al., 2020; Burk, Mausolf and Oakleaf, 2020). Research conducted by Myers et al. (2020) indicate that female academics and those with young dependents are disproportionately bearing the effects of the load of additional fulltime caregiving and home-schooling responsibilities on academic work, as female scientists, especially those with very young children (ages 0-5), reported significant decreases in hours worked during the pandemic.

Our findings are broadly aligned with this early research, but they substantially deepen the analysis, showing substantial gender differences in work-life balance challenges during the pandemic and in the ability to devote time to academic work. Further analysis of respondents' perceptions on work-family life relations and (negative) spill-over between domestic duties and academic work during lockdown give new insights to understand the gendered implications of COVID-19 on academic routines and performance.

We utilize six ordinal dependent variables that measure these perceived challenges: (1) Dedication/support to family negatively affected my academic performance during the COVID-19 pandemic; (2) Household work negatively affected my academic performance during the COVID-19 pandemic; (3) Accumulation of tasks and difficulty in performing them negatively affected my academic performance during the COVID-19 pandemic; (4) I frequently felt difficulties in working several hours uninterrupted; (5) In

many occasions, I worked at unusual hours during confinement; (6) It was hard to maintain a work-life balance during the confinement. Accordingly, we estimate a series of ordered logistic regressions, where we control for gender, parental status, age and employment status.

Table 3. Negative *spillover* between household duties and academic work: Estimates and significance of logistic regression models

	Support to family affected academic perfor-mance	**Domestic work affected academic perfor-mance**	**Accumul a-tion of tasks affected academic perfor-mance**	**Difficultie s in working several hours uninter-rupted**	**Work at unusual hours**	**Work-life conflict**
Gender (women)	0,192 (0,228)	0,572*** (0,229)	0,464** (0,226)	0,474** (0,236)	0,554** (0,254)	0,242* (0,148)
With children (up to 12)	1,48*** (0,269)	1,125*** (0,262)	0,592** (0,256)	0,22 (0,269)	0,35 (0,283)	0,79*** (0,182)
Age	0,003 (0,014)	0,013 (0,014)	0,018 (0,013)	-0,023* (0,015)	0,012 (0,016)	-0,008 (0,009)
Tenure-track position	-0,001 (0,29)	0,122 (0,289)	-0,079 (0,287)	0,032 (0,309)	0,038 (0,327)	0,038 (0,192)
Pseudo R2	0,126	0,094	0,039	0,043	0,039	0,109
Observ.	266	266	266	252	249	258

Standard errors in parentheses.

***p < 0.01; **p < 0.05; *p < 0.1.

Literature has long stated that the work-family conflict among academics has a clear gender cut, with women experiencing more hardships in balancing their family duties and their academic work (Santos and Cabral-Cardoso, 2008; Woodward, 2007). The pandemic might exacerbate this gender divide as the lockdown blurred the boundaries between public and private spheres, making the negotiation between public and private upon which careers are organized potentially more painful.

Our results indicate that female academics, especially those with young children in the household, face disproportionate work-life balance challenges during the pandemic, as compared to their male counterparts. Table 3 shows that gender and

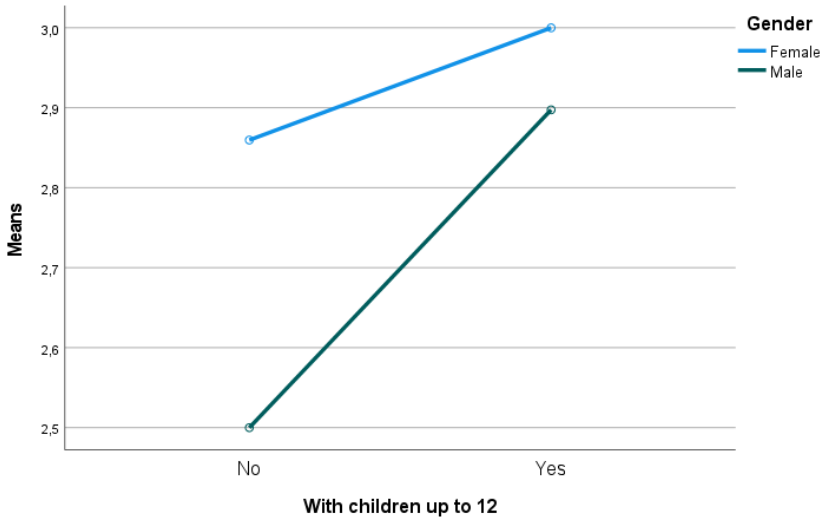
parental status, interacting to a greater or lesser extent, are prominent predictors of most perceived negative spill-over between domestic/family duties and work demands. Academics with children up to 12, especially females, with similar ages and employment status, appear to be most exposed to work-life balance struggles (respectively, $p > 0,01$; $p > 0,1$), affecting both professional routines, notably as a result of accumulation of tasks and difficulty in performing them (for both factors, $p > 0,05$), and domestic duties (for both, $p > 0,01$). On the other side, the effect of gender overshadows the effect of parental status concerning the perceived difficulty in working several hours without being interrupted ($p > 0,05$), and the (increased) need to work at unusual hours during confinement ($p > 0,05$). Somewhat conversely, the presence of young children in the household effects appear not to be significantly divergent by gender, as parental status is the only statistically significant predicting factor of the perceived negative spill-over between family support and work demands.

Effects on professional/academic time usage

When we asked academics **how the COVID-19 pandemic had influenced the amount of time dedicated to academic/scientific work**, nearly two-thirds reported that the pandemic had a significant effect[viii].

The **perception of the influence of the pandemic on availability for academic/scientific work is greatly influenced by the respondents' gender and parental status**, as confirmed by the ordinal regression model[ix], also accounting for the effects of age and employment contract (which do not present a significant influence). Female academics and people with young children in the household are those who most emphasize the influence of COVID-19 on the amount of time dedicated to professional work: 68% of women and 67% of people with children up to 12 declare that COVID-19 has a moderate or large influence compared to 54% of men and 48% of academics without children. Interestingly, gender is the factor with more predictable influence in the model (after considering the effects of age and parental and employment/tenure status), which points to the **prominence of the sex/gender characteristics in understanding the effects of the working conditions imposed by the COVID-19 pandemic** on the time allocated to academic work.

Figure 4. Perceived influence of COVID-19 on academic working time, by gender and parental status



When we delve further into the interception of gender and parental status on the perceived influence of the lockdown on working time (see figure 4), we observe that the presence of children in the household tend to move men closer to women on a greater perception of the impact of COVID-19 in time dedication to academic work. On the other hand, **whereas women with and without children** are relatively **close on the perception of the pronounced impact of COVID-19** on their professional working time, **parental status strongly affects men's perception**, placing male academics with children as the most affected in this regard.

Results displayed in figure 5 provide further evidence on the (unequal) implications of COVID-19 in academic time usage. In general terms, the **confinement guided academic staff to reinforce time investment in teaching** (teaching courses, supervising dissertations / internships, etc.) (increasing 26% compared to the period before the lockdown) and **university management activities / services** (heading / coordinating faculty / department/ course programs, acting as members of scientific / pedagogical boards / commissions, etc.) (18%), **while moderating time investment in research**

(scientific production, participation in research projects, participation in jury committees, etc.) (decreasing 17%) **and in knowledge transfer and valorisation** (decreasing 31%).

Figure 5: Average change in weekly hours dedicated to the different areas of academic work before and during confinement: total; female/male academics; academic without/with children up to 12.

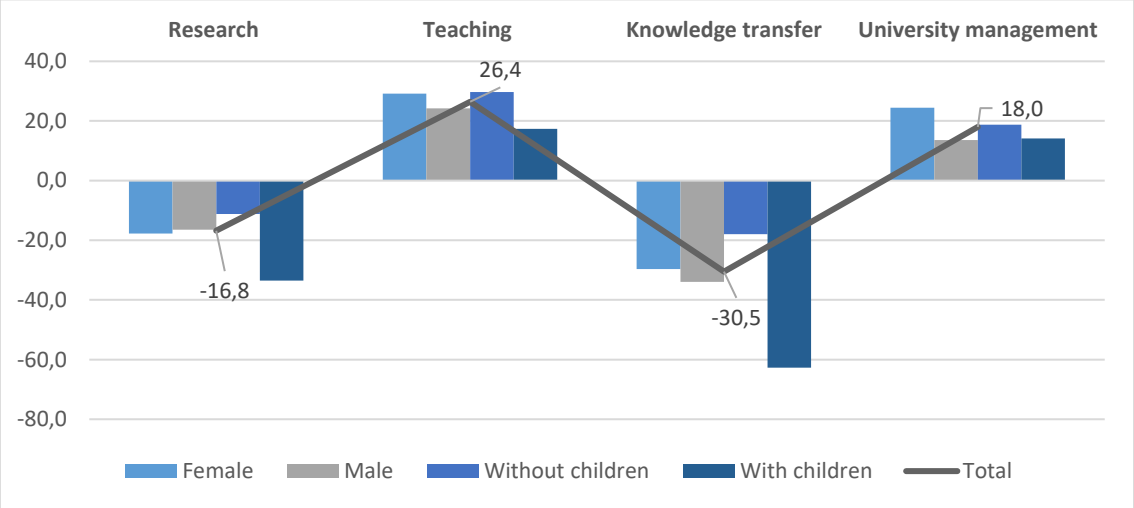


Figure 5 makes visible the **differentiated impacts of the lockdown on the time commitment to the various areas of academic activity accordingly to gender and parental status.** Overall, descriptive statistics displayed in the table portray **female academics and academics with young children as the ones who make the major adjustments in the amount of time dedicated to each of the domains of academic work**. The most pronounced adjustments are held by academic staff with children in the "research" and "knowledge transfer" areas, with a reduction of around 34% and 63% in time dedication, respectively. Along gender lines, we can observe that the reinforcement of teaching and university management activities during the COVID appear to be specially bound to female dedication.

In order to delve further into these differences and estimate the statistical significance of the gender and parental factors in the changes on time allocation "before" and "during" 'stay-at- home' periods, the "repeated measures Anova" was used.

First of all, statistically significant differences between the two periods are observed in the four areas of the academic work[x], **echoing the magnitude of the effects of the new working conditions arising from COVID-19 on academic time usage.** Second, "tests of within-subjects effects" show that **the main differences in time usage observed**

between the two periods are assigned to parental status. Hence, we see that the significant **decrease in the number of weekly hours devoted to research and to knowledge transfer during the pandemic is strongly dependent on the existence of young children in the household**[xi], whereas gender does not influence the observed differences in time allocation across the two periods in a statistically significant way. Nonetheless, results of the "test of between-subject effects" (which do not focus on the changes between the two periods, but on the differences in overall time allocation across parental status and gender categories) show that **gender has a statistically significant effect on the overall time** (before and during the COVID-19 pandemic) **dedicated to teaching and knowledge transfer** (more weekly hours by female compared to male academics)[xii], while parental status does not present a statistically significant effect on the overall time dedicated to any of the areas of academic work.

The desegregation of the academic domains of work in more specific tasks **provides further insights on changes in patterns of time usage triggered by the COVID-19 pandemic, and makes gender differences**, which were diluted in the prior broader analysis, **visible**. In the survey, we asked academic staff to indicate whether they dedicated less time (1), the same time (2) or more time (3) to each of the 13 academic activities listed, in comparison with their weekly averages before the pandemic. In order to summarize the information presented in these variables and explore their correlations, Categorical Principal Components Analysis (CATPCA)[xiii] was used. Using the eigenvalue rule "greater than 1" as a retention criterion, it was possible to summarize relational information between variables in five orthogonal components that explain 67% of the total variance of the original variables. Table 4 reproduces the "weights" of each variable in each component and explains the variance percentage. This exercise made it possible to reveal logics shaping large partitions of experiences on the adjustments in time usage arising from COVID-19 restrictions.

Table 4. Adjustment patterns on academic time usage during COVID-19 pandemic: PCA loadings

	Component				
	1	2	3	4	5
Preparing and overseeing classes and exams	-,178	,680	-,361	-,445	-,266
Consulting with/supervising students	-,161	,750	-,401	-,386	-,009
Managing research projects	,587	,120	-,286	-,140	,430
Collecting and analysing data/samples	,407	,243	-,383	,348	,456
Writing papers, articles or books	,788	-,153	-,171	-,046	-,181
Writing research, innovation or transfer proposals	,737	,011	-,028	,137	-,199
Reviewing and evaluation papers or research project applications	,708	-,047	-,129	,102	-,131
Self-training (reading scientific papers and books, attending webinars etc.)	,702	-,078	,233	-,353	-,318
Applications (job openings, management/leadership bodies, grants, etc.)	,664	-,063	-,060	-,062	-,120
Knowledge transfer and dissemination activities (presentations at scientific events, organizing seminars and trainings, etc.)	,348	,397	,859	-,411	,352
Participating in work meetings (including board/commission)	,187	,648	,194	,472	-,315
Faculty/department, course and board/commission management/service	-,043	,703	,274	,468	-,086
Participating in selection and evaluation juris (recruitment and PhD/master's examinations)	,363	,237	-,017	,071	,362
Eigenvalue	3,558	2,362	1,576	1,363	1,129
Explained variance (%)	24,0	15,9	10,6	9,2	7,6

According to the weight of each variable, it is possible to name the first component as "**Research outputs and career development**" (which explains nearly a quarter of the total variance). This component is characterized by the strong reinforcement of the knowledge production axis of the academic activity, particularly oriented to research performance and recognition, which is highlighted by the positive large loads with the variables "Writing papers, articles or books", "Writing research, innovation or transfer proposals", "Reviewing and evaluation papers or research project applications" and "Self-training". The second component, which we label as "**Teaching and institutional service**", explains over 15% of the total variance in the original variables. This component clearly differs from the previous for its focus on the reinforcement of teaching and

(university) management activities, evidenced by the strong effect of the variables "Preparing and overseeing classes and exams", "Consulting with/supervising students" "Participating in work meetings" and "Faculty/department, course program and board/commission management". The third component, named "**Knowledge transfer and dissemination**" distinguishes itself for concentrating its adjustment focus on increasing time dedication to knowledge transfer and dissemination activities (presentations for scientific events, organizing seminars and trainings, etc.). Explaining less than 10% of the total variance, components 4 and 5, called "**University management activities**" and "**Research process**" are characterized by a strong reorientation towards management tasks (work meetings and faculty/department, course and board/commission management), and research management and data analysis, respectively.

In order to add characterization elements (namely gender, parental status, age and tenure status) to each of the components (which describe change patterns on academic time usage during COVID-19), the scores associated with the components extracted in the Categorical Analysis of Principal Components were used to run linear regression analysis[xiv].

Table 5. Adjustment patterns on academic time usage during COVID-19 pandemic: Estimates and significance of linear regression models

	Research outputs and career development (PC 1)	**Teaching and institutional service (PC 2)**	**Research processes (PC 5)**
Gender (women)	-0,148 (0,123)	0,345** (0,127)	0,219* (0,135)
With children (up to 12)	- 0,553*** (0,144)	-0,023 (0,149)	0,212 (0,157)
Age	-0,007 (0,008)	-0,002 (0,008)	0,002 (0,008)
Tenure-track position	-0,189 (0,163)	0,293* (0,168)	-0,254 (0,178)
Pseudo R2	0,066	0,038	0,029

Standard errors in parentheses. – ***p < 0.01; **p < 0.05; *p < 0.1.

Results of linear regressions reported in Table 5 show that **gender and parental status are prominent predictors of the various configurations of adjustments on academic time usage during the lockdown**. We can observe that having young children in the household tend to significantly (p<0,001) dissociate respondents from the first "pattern

of academic time adjustment" (PC1), which is linked to an **increased focus on knowledge production activities, namely personal capacity building, the attraction of competitive funding and production of research outputs**, which are particularly associated with academic excellence and recognition, and are critical to career development. Results obtained for PC2 - Teaching and management activities – also give support to previous findings drawn on descriptive statistics on the variation in weekly hours dedicated to the different axes of academic work before and during confinement. Gender is the main predictor factor of the adherence to this adjustment pattern, **displaying women as particularly bound to the reinforcement of teaching (preparation and conducting classes and student orientation) and institutional and departmental service (which include the so-called academic housekeeping)** that occurred during the COVID-19 pandemic. Gender is also the prominent factor (although only marginally significative) in the explanation of the variation observed in PC5 (research processes), positioning academic women as more prone to reinforce time dedication to research management and data analysis (eventually less demanding in terms of concentration, focus and "isolated, protected time" than writing a scientific paper for publication).

Effects on perceived efficacy in accommodating contingencies associated with COVID-19

In addition to demands for adjustment in time dedication to different academic activities, the new remote working conditions of academics have important implications on their perceived performance efficacy.

In general, academic staff tend to modestly assess their performance efficacy in the different domains of academic activity during lockdown[xv], most particularly in the research realm, but also in teaching and management activities: 69% of respondents (equal female and male ratios) tend to disagree with the statement "I felt very productive, scientifically" (N= 272); 57% of female and male respondents tend to disagree with the statement "I felt very effective in teaching tasks" (N = 201), and 58% (mostly men, 63%, comparing to 54% of women) tend to disagree with the statement "I felt very effective in management tasks" (N= 199).

Ordinal regression models (see table 6) reveal that gender differences emerging from descriptive contingency analysis, namely those related to management tasks, lose relevance in multivariate analysis, which take into account other intercepting factors.

Table 6. Perceptions on efficacy of academic performance: Estimates and significance of linear regression models

	Research	**Teaching**	**Management**
Gender (women)	-0,079 (0,234)	-0,052 (0,276)	0,265 (0,287)
With children (up to 12)	-0,683** (0,268)	-0,322 (0,315)	-0,709** (0,337)
Age	-0,001 (0,014)	0,002 (0,017)	-0,014 (0,018)
Tenure-track position	0,134 (0,302)	-0,335 (0,351)	+0,188 (0,378)
Pseudo R2	0,032	0,012	0,033
Observ.	258	188	188

Standard errors in parentheses. – ***p < 0.01; **p < 0.05; *p < 0.1.

Table 6 shows that having children in the household is the only factor with statistically significant influence on perceptions of efficacy, even after accounting for the effect of gender, age and professional status. **Academics with young children in similar situations in terms of age, gender and contractual situation are more likely to have a negative perception of their scientific productivity and efficacy in management tasks during the pandemic**.

3. Impacts of COVID-19 in scientific productivity

Although the lockdown period was relatively short compared to normative research timelines, making it difficult to determine the specific impact of the COVID-19 pandemic on academics´ productivity, data from journal submissions and preprint servers offer some indication and point to gendered disparities over the past few months. Reports from journal editors indicate that, while overall journal submissions increased during the pandemic, the proportion of those submissions authored by women has, in most cases, dropped (Flaherty, 2020; Fuchs-Schündeln, 2020; Wiegand et al., 2020). In the same vein, studies analysing preprint offers evidence that the pandemic is disproportionately hindering the productivity of female scholars (King and Frederickson, 2021; Vincent-Lamarre, Sugimoto and Larivière, 2020; Viglione, 2020).

To explore the impacts of the pandemic in scientific production, we asked respondents to indicate the number of outputs submitted before (between January 2019 and February 2020) and during the "stay-at-home order" (between March 2020 and February 2020). The listed outputs are mainly linked to research, although some are connected to pedagogical activities and knowledge transfer and dissemination.

Table 7. Number of scientific outputs produced before and during lockdown: Total, Female and Male (monthly mean values)

	Before			During		
	Total (N=163)	Female (N=140)	Male (N=121)	Total (N=250)	Female (N=132)	Male (N=116)
Books	0,01	0,01	0,01	0,02	0,02	0,02
Book chapters	0,05	0,06	0,04	0,07	0,07	0,06
Articles in "peer-reviewed" Journals	0,21	0,18	0,26	0,31	0,27	0,35
Edition/Co-Edition of Volumes/Special Editions of Scientific Journals	0,02	0,02	0,02	0,03	0,03	0,02
"Working papers"	0,03	0,02	0,03	0,02	0,02	0,03
Scientific event proceedings	0,08	0,08	0,08	0,06	0,05	0,07
Reports	0,03	0,03	0,04	0,05	0,05	0,05
Scientific dissemination articles	0,02	0,02	0,02	0,02	0,03	0,02
Manuals/Pedagogical resources	0,01	0,01	0,01	0,00	0,00	0,00
Total	**0,48**	**0,44**	**0,52**	**0,61**	**0,57**	**0,64**

The overall monthly mean values point to an increase in academic production during the confinement (see Table 6): we found that there was an increase of more than one quarter (29%) in the monthly mean number of scientific outputs (submitted to publication) during the period of confinement, from 0,48 (N= 263) to 0,61 (N=250). The greatest reinforcement occurred in books and peer-reviewed publications in journals, while conference proceedings and working papers, as well as pedagogical publications, suffered the greatest disinvestment during the lockdown. Quite surprisingly, descriptive statistics appear to indicate that the greatest increase in the overall number of scientific outputs was observed amongst women (even though without statistical significance, as

we will see), although the overall number of scientific outputs submitted to publication by women (comparing to men) remains lower during that period.

In order to delve further into the changes detected in the patterns of scientific production over the period of lockdown, compared to the previous period, and estimate the statistical significance of the gender and parental factors in the observed changes, the "repeated measures Anova" was used. Results of the "test of between-subject effects" show that, **when solely considered, neither gender** ($F = 0{,}544$; $p > 0{,}05$) **nor parental status** ($F = 0{,}300$; $p > 0{,}05$) have **a statistically significant effect on the changes in scientific production observed over the two periods**. Nonetheless, when considered in combination, being men/women and having/not having young children in the household play a statistically significant role in the differences observed between both periods ($F = 6{,}297$; $p < 0{,}05$). Whereas in the case of women without children and men with and without children, there was an increase in output submission during the stay-at-home order, in the case of **academic mothers,** an inverse trend is observed (see figures below). This means that the **interception of gender and parental status contributed decisively to shape the conditions for scientific production during the lockdown**.

Figure 6.2. Monthly scientific output before and during lockdown: Male

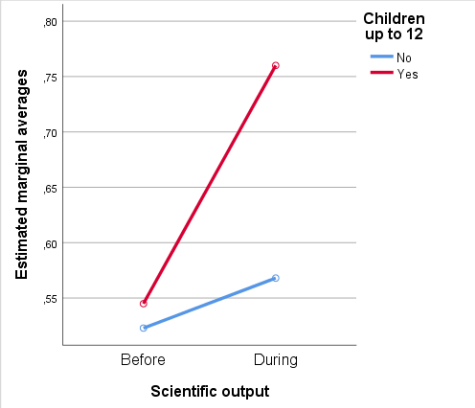
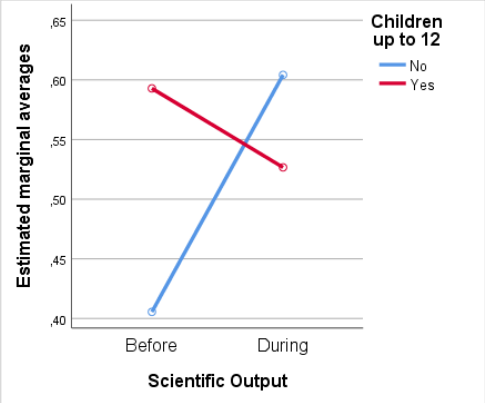


Figure 6.1. Monthly scientific output before and during lockdown: Female



Descriptive statistics on satisfaction levels with academic performance, point to greater unsatisfaction with the academic results on the part of women (45% are unsatisfied or very unsatisfied as compared to 36% of men), where more extreme perceptions are observed, although the differences are not statistically significant, as we will demonstrate.

Ordinal regression simultaneously accounting for gender, parental status, tenure status and age only highlight, with marginal statistically significance (p <0,1), the predictive effect of tenure status and parental status on satisfaction differences, **linking academics with children and precarious contracts to decreased levels of satisfaction with academic productivity during the lockdown**. The relevance of the contractual status to understanding the satisfaction with scientific performance is even more relevant as **tenure status is the only factor presenting predictive power in the linear regression models used to explain the overall academic production before and during confinement.** We observe that, among academics with precarious contracts, the overall number of outputs submitted to publication before (P<0,05) and during (p<0,05) lockdown tends to be lower as compared to colleagues with permanent contracts, even after controlling for age, gender and parental status. This might reflect the position of relative disadvantage of academics in precarious contractual arrangements in terms of access to institutional resources and professional/academic formal and informal networks. This understanding is reinforced by strong correlations observed between concerns with academic future and overall academic output either before (Rho = -,194, p<0,01) and during (Rho = -,225, p<0,01) the pandemic, whereby higher levels of concern are associated with worse levels of academic output. Moreover, although only marginally (<p=0,01), **this gap has worsened with the pandemic, as the influence of contractual status in the observed differences in output submission between the two time periods is statistically significant**[xvi].

Whereas tenure status is the only factor with statistical significance in the linear regression models used to explain the overall academic production before and during confinement, when we desegregate the analysis by **type of output, gender emerges as a statistically relevant explanation factor (along with type of contract) of the submission of articles in "peer-reviewed" journals** (p<0,05). As such, and although gender differences do not play a significant role in the explanation of any other output indicator, the significantly lower level of journal submissions by women as compared to men is particularly compelling, as this kind of publication is highly ranked in career evaluation and academic recognition.

Conclusions

Although limited in scale and scope, this study provides sound quantitative evidence on the uneven effects of the alterations and disruptions on academic work arising from COVID-19 (Pereira, 2020) on men and women, making visible or exacerbating pre-existing inequalities in terms of working conditions, work-family/life balance options, academic time usage and scientific performance. The findings highlight not only the greater severity of the effects of the pandemic crisis on academic women, but also the particular disadvantage of junior academics with young children and/or in precarious working arrangements to respond to the strong demands and high standards of academic performance during the pandemic.

Our survey results indicate that **academic women are more exposed not only to the severity of psychological/emotional effects** of the COVID-19 crisis but also to the increased burden of domestic work during the "stay-at-home order", broadly in line with early international research on the effects of the pandemic in housework routines of academics (Jung, 2020; Yildirim and Eslen-Ziya, 2020) Moreover, the pandemic appears not only to **disproportionately affect the housework and care routines of women** (especially younger academic mothers), but also the **personal routines of female academics**, as previously suggested by Burk, Mausolf and Oakleaf (2020).

The increased household and emotional burdens arising from COVID-19 restriction have also effects on the work-family negotiations and conflicts, posing distinctive challenges to reconcile competing time demands of professional work and family. The survey results show **substantial differences between male and female respondents´ perceptions on how the pandemic has affected their academic work**. Female academics and academics with young children in the household are those who most emphasize the influence of COVID-19 on the amount of time dedicated to professional work, closely following the results of recent research in the US academic context (Myers, 2020). Moreover, when analysing the changes on time allocation to the various domains of the academic activity, we see that the **reinforcement of teaching** and institutional and departmental service observed during the confinement **is specially bound to female dedication,** lending strong support to early interview based studies. In the case of **academic mothers (and fathers), the priority given to teaching occurs at the expense of research activities**, which are critical to career progression.

The study also gives important insights on the extent to which **the differentiated burdens imposed by the lockdown on female scholars and scholars with young**

children had an impact on academic productivity, although it is too early to get an accurate picture on this regard. In some contrast with previous findings (e.g., Cui, Ding and Zhu, 2020; Flaherty, 2020; Zimmer, 2020), our results **provide mixed evidence** that the pandemic has disproportionately affected the academic productivity of female academics during the lockdown, compared with their male counterparts. When solely considered, neither gender nor parental status had a significant effect on the changes in scientific production observed between the two periods. Nonetheless, when considered in combination, gender and parental status displayed a significant influence in the differences observed between the pre-pandemic and pandemic period, **placing women scientists with children up to 12 at particular disadvantage as compared to women without children and men (with and without children**). The decrease in academic output is even more pronounced among those who are **precariously employed**. Considering that academic outputs, particularly research publication, are currently key merit criteria underpinning professional evaluation, this may translate into increased inequalities in the promotion and carer progression between mothers, and childless scholars and men.

This research points to the necessity of academic institutions and funding organisations to take into consideration the disproportionate academic effects of the pandemic (not only in research productivity but also in time and conditions of academic labour) on particular groups of academics (women, those with children, with precarious contacts and/or junior staff) by putting in place policies and measures to mitigate new academic inequalities.

Notas

[i] Adequate informatics equipment, for exclusive use ($\chi 2$ = 3,604; p=,058); Own, "isolated" and appropriate division to work from ($\chi 2$ = 11,206; p=,001); Calm environment ($\chi 2$ = 32,026; p=,000).

ii In order to estimate the association of age (interval) with the availability of each of the resources for remote work (dummy variables 0/1), a Biserial Correlation was performed.

iii To assess whether the availability to the listed resources for remote working (No/Yes; binominal) is dependent on employment status (Without/with permanent contact; binominal) chi-square tests were used.

[iviv] In order to explore the influence of the interaction of age and gender on the availability of each of the resources for remote work, a series of biserial correlations were performed separately for the female and male samples.

[v]. Own, "isolated" and appropriate division to work from (r= ,152; p= ,067); Open air space (r= ,157; p= ,59); Calm environment (r=,136; p=,99).

[vi] Sadness (U = 6854,0; p = ,000); Concerned with yours or your family's health (U = 6849,0; p = ,000); Concerned with your academic future (U = 7697,0; p = ,003); Nervousness, stress and/or anxiety (U = 7355,0; p = ,000); That the situation was beyond you (U = 7701,5; p = ,002);

[vii] Models not statistically significant (i.e. external household chores; personal care) were not included in the table.

[viii] Scale used: 1- No influence, 2 - Small influence, 3 - Moderate influence, 4 - Large influence. Observations (N): Male - N = 126, Female - N = 153.

[ix] In order to estimate whether "gender", "parental status", "age" and "type of contract" have a statistically significant effect on the probabilities of response to the variable "How has the COVID-19 pandemic influenced the amount of time dedicated to your academic/scientific work", a ordinal logistic regression was used. The model is statistically significant (p > 0,05) although the effect size is low (R^2_N= 0,047). Results - Gender: $b_{(female)}$ = 0,603 (0,23), p = <0,01); Parental status: $b_{(with\ children)}$ = 0,579 (0,26), p < 0,05); Age: *b* = 0,017 (0,014), p > 0,05); Employment contract: $p_{(permanent)}$ = -0,073 (0,29), p = > 0,05).

[x] Research: F = 32,164, p < 0,001; Teaching: F = 18,717, p < 0,001; Knowledge transfer: F = 21,985, p < 0,001; University management and other tasks: F = 6,234, p < 0,005) (Tests of within-subjects effects).

[xi] Research: F = 7,417, p < 0,05; Knowledge transfer: F = 3,303, p < 0,1 (Tests of within-subjects effects).

[xii] Teaching: F = 3,549, p < 0,05; Knowledge transfer: F = 7,598 p < 0,05.

[xiii] Principal component analysis (PCA) is a technique for reducing the dimensionality of large datasets, increasing interpretability and, at the same time, minimizing information loss. It does so by creating new uncorrelated variables that successively maximize variance (Jolliffe and Cadima, 2016).

[xiv] Regression models not statistically significant, namely, Knowledge transfer and dissemination (component 3) and University management activities (component 4) were not included in the table.

[xv] To assess efficacy perception, we asked respondents to indicate the extent of their (dis)agreement (in a scale of 4 values, in which 1 corresponds to strong disagreement and 4 to strong agreement) with the following statements: During the lockdown… "I felt very productive, scientifically" (N= 272), "I felt more effective in teaching" (N = 201), "I felt very effective in management tasks"(N= 199).

[xvi] To estimate the statistical significance of contractual status in the observed changes "repeated measures Anova" was used. Results of the "test of between-subject effects" show that contractual status has marginal significant influence in the changes in output production over the two time periods ($F=1,414$, $p<0,01$).

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