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Children, care time, career priority – What matters for junior scientists' productivity and career perspective during the COVID-19 pandemic?

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Abstract.
BACKGROUND: The coronavirus (COVID-19) pandemic brought about restrictions, additional workload, insecurity, or need for inventing new routines for professionals worldwide. The pandemic and its restrictions have been discussed as a career shock.
OBJECTIVE: Adding knowledge to this, our study investigated the academic and family (care) situation of young scientists in a German technical university.
METHODS: We conducted an online survey including young scientists from a technical university in Germany in April 2021. 346 participants (mean age 33 years, 37% women) gave self-ratings on academic and life situation during the pandemic year, care work, preferences for scientific career and family life.
RESULTS: Family and career were independent priorities ($r = 0.021$, $p = 0.676$). Two thirds (68%) of the young scientists reported no deterioration in scientific outcome during the pandemic year. But, care times and number of children impacted negatively on scientific productivity in terms of publications. This was true for both women and men.
CONCLUSIONS: Young scientists need individual support for their career perspective, according to their concrete career level and life situation.

Keywords: Corona, pandemic, COVID-19, career, science, gender

1. Introduction

The impact of gender role differences has been discussed within recent months during the coronavirus (COVID-19) pandemic. The pandemic brought about restrictions, additional workload, insecurity, or need for inventing new routines for professionals worldwide [1–6]. In 2020, scientists all over the world have been affected from freezing of hiring and closed labs, 61% out of 7670 said that the pandemic has negatively affected their career prospect [7]. It has been argued that especially parenting scientists, often women, have been disadvantaged due to higher children and family care load [8]. Furthermore, the pandemic and its restrictions have been discussed as a career shock with potential impact for change in attitudes towards a scientific career, or changes in one's own professional biography.

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Adding knowledge to this, our study investigated the situation of young scientists in a German technical university. Besides checking for gender differences or status differences, our aim was to investigate similarities and differences between junior scientists with different priorities: not yet clear priorities, priority for scientific career, for family, or both.

1.1. COVID-19 pandemic: A career shock?

The COVID-19 pandemic has greatly changed working life. The Dutch industrial and organizational psychologist Jos Akkermans [9] describes the pandemic as a career shock. Career shock means an event that occurs unexpectedly and suddenly, interrupts one's previous working life, and causes intense reflection on one's career. A career shock involves a dynamic interplay of individual and contextual factors that produces different effects and changes depending on the career and life stage. The authors distinguish between short- and long-term consequences and believe that even a negative career shock can show positive consequences in the long run [9]. Similarly, Cui and colleagues [10] refer to the COVID-19pandemic as an "exogenous shock" that would have a substantial impact on academic work. Teaching and research activities have to be reorganized in parallel with household activities and care work, while business travel is cancelled and meetings organized online. All this may impact on wellbeing and productivity differently in different persons and under different conditions, and may have impact on post-corona times [10–12].

1.2. Gender-publication gap in science during the COVID-19 pandemic

An analysis of the most widely used open access repository for social sciences in America shows that ten weeks after the first lockdown, publication productivity increased by 35% overall in North America. But, the productivity of female scientists fell by 13.2% compared to their male colleagues during this period. This finding is especially true for postdocs (assistant professors) and at top-ranking universities [10]. Postdocs (assistant professors) are under great pressure to publish, especially at top-ranking universities, and at the same time are at an age when families are being started and there are children to care for. The study points out that female postdocs would show the sharpest drop in their research productivity after lockdown compared to male junior scientists [10]. Other studies support these findings: While male scientists have stable or increased number of papers, the productivity of female scientists with children and care time experienced a loss which supports the existing gender gap [10; 13–15]. In Germany, 37% of male and 57% of female senior scientists (professors) reported submitting fewer than planned for publication [16].

1.3. Attitudes towards scientific career

Beside gender inequalities and publication changes, the COVID-19 pandemic appears to have brought changes in career attitudes. In a qualitative interview study with 25 professionals who were mid-career and had experienced career shocks, it was found that any career shock can result in different voluntary or involuntary changes in professional perspectives [17].

In a U.S. study 329 second- and fifth-year doctoral students were asked about their career aspirations and priorities. Fifth year PhDs appeared more interested in non-academic careers than second year PhDs. Job security and salary appear to have become more important to them, especially after the initial peak of the pandemic March-May 2020 [18]. The way universities support their students through the pandemic and, for example, promote good communication, may have an impact on the attitudes of doctoral students [18].

Building on these findings, our aim was to investigate scientists' behaviors and attitudes by considering publication behavior, prioritizing of scientific career, and family situation (children, care time) together. Research questions are as follows:

1. Which family and academic characteristics explain the current self-reported priority of the scientific career and the publication outcome of young scientists?
2. Are there different priority groups in scientists, e.g. scientists who strongly prioritize either their family (F), or their career (C), or both (FC), or none (NN)?

2. Method

2.1. Procedure

By means of an anonymous online survey, the situation of young scientists from a German technical university was investigated in April 2021.

Table 1
Characteristics of scientists at different career stages and of different gender. Mean values (standard deviations) or frequencies are reported.

Social and scientific situation	Doctorate candidates $N=251$	Post-Docs $N=89$	Prof without tenure $N=4$	Prof with tenure $N=2$	Significance of groups differences (X^2 or ANOVA)	Men $N=211$	Women $N=128$	Significance of groups differences (X^2 or T-Test)	All $N=346$
Age	30.52 (4.76)	38.00 (6.15)	40.00 (5.71)	48.00 (9.90)	0.000 (ANOVA)	32.64 (6.01)	32.42 (6.09)	0.749 (T-Test)	32.65 (6.27)
% Women	34.7%	46.1%	0.0%	0.0%	0.000 (X^2)				37.0%
% with high priority for family	64.9%	82.0%	100%	50.0%	0.011 (X^2)	67.8%	74.2%	0.036 (X^2)	69.7%
% with high priority for scientific career	53.8%	69.7%	100%	100%	0.024 (X^2)	59.2%	57.0%	0.286 (X^2)	58.7%
% with limited contract	99.6%	83.0%	75.0%	100%	0.000 (X^2)	94.3%	96.1%	0.841(X^2)	95.1%
Care time					0.001(X^2)			0.076 (X^2)	
none	58.0%	33.3%	25.0%	0.0%		56.4%	42.5%		50.8%
up to 6 hours daily	29.6%	30.4%	50.0%	100%		31.4%	33.3%		32.6%
more than 6 hours daily	12.4%	28.4%	25.0%	0.0%		12.2%	24.2%		16.6%
Children in need for care in one's own household	28.6%	58.8%	75.0%	50.0%	0.000 (X^2)	33.3%	43.7%	0.672 (X^2)	36.6%
Interest in scientific career					0.564 (X^2)			0.379	
Decreased	34.2%	28.6%	50.0%	0.0%		28.9%	37.8%		32.6%
unchanged	57.8%	67.5%	50.0%	100%		63.9%	56.8%		60.6%
increased	8.0%	3.9%	0.0%	0.0%		7.2%	5.4%		60.7%
Publications in comparison to year before					0.064 (X^2)			0.630	
Decreased	26.7%	40.8%	50.0%	100%		30.7%	31.2%		31.4%
unchanged	63.1%	48.7%	25.5%	0.0%		60.7%	55.0%		58.1%
increased	10.3%	10.5%	25.0%	0.0%		8.6%	13.8%		10.5%
Reviews in comparison to year before					0.005 (X^2)				
Decreased	8.0%	22.7%	25.0%	50.0%		9.4%	17.3%		12.6%
Unchanged	86.2%	66.7%	50.0%	50.0%		81.9%	76.9%		79.9%
Increased	5.9%	10.7%	25.0%	0.0%		8.8%	5.8%		7.4%

Note: There were 3 diverse, and 4 missings concerning the variable gender, thus the sample size is slightly smaller for the gender comparison.

All scientists from the university who were below the level of full professor (i.e. young scientists) were invited for participation. Content-valid items on scientific work and on the burden of care work were created.

The data analysis was carried out with SPSS 26. Frequencies and distributions were examined descriptively. Chi²-tests, *t*-tests or ANOVA were calculated to investigate group differences.

2.2. Instruments

Participants were first asked to report their gender, age, career stage, to which degree they prioritize their scientific career or their family life, whether in the past year their interest in scientific career, and their publication outcome have changed (Table 1). Items were formulated as a kind of checklist (not a psychometric scale).

The contents of the questionnaire and the items have been developed by scientists who know the scientific setting in all career stages. Items have then been checked for content validity by another heterogenous group of experts and scientific employees from different faculties of the university prior to the beginning of the study. For this study there is no need of a psychometric questionnaire, as there are no psychological constructs in the stricter sense measured (such as behavioral or internal processes, or emotional aspects). Instead, it was necessary to assess demographic facts (e.g. number of children), and situation-related facts such as publication activity, career status, hours of care time and global priorities by categories (family, career).

2.3. Participants

Table 1 shows the characteristics of the 346 participants, also stratified by different career groups, as well as the gender comparison. Data on professors ($n=6$) cannot be interpreted statistically due to small group sizes, we only report them for descriptive purpose and empirical completeness.

Table 2
Variance explanations by different accompanying characteristics for priority of scientific career and change in the number of publications compared to the previous year

Social and scientific situation	Priority of scientific career (0 = low 1 = high priority)		Number of publications in comparison to year before (decreased, unchanged, increased)	
	Beta	*p*-value	Beta	*p*-value
Age	–0.050	0.530	0.052	0.505
Gender (men, women)	0.075	0.223	–0.118	0.052
Work contract limited, unlimited	–0.011	0.868	0.097	0.122
Doctorate candidate, Post-Doc, Assistant Prof	0.282	0.000	–0.072	0.327
Care time				
None, up to 6 hours daily, more than 6 hours daily	0.075	0.360	–0.074	0.358
Number of children in need for care in one's own household	–0.129	0.172	–0.288	0.002
Priority of family	–0.106	0.108	0.053	0.416
Number of publications in comparison to year before (decreased, unchanged, increased)	0.098	0.122		
Priority of scientific career			0.095	0.122

The participating scientists from all disciplines were on average 33 years old and 36.9% female. Thus, the sample is similar to the population of junior scientists at this technical university (31% female in 2019).

Post-Docs were older which is in line with their higher career stage. They were more likely to have children and more extensive care work than doctoral students. Post-Docs had greater variance in changes in publication activity, and they were more likely than doctoral students to report high prioritization of both career and family. Women were more likely to have high prioritization for family and more likely to have longer care times than men, but the same publication development.

3. Results

3.1. Priority for scientific career and publication activities

Most of men and women similarly ranked scientific career as a priority (59.2% and 57.0%, Table 1). Postdocs were more likely to assign a high priority to the career (69.7%) as compared to doctorate candidates (53.8% of them reported high priority for career, Table 1).

The higher the career status (doctorate – post-doc – assistant professor), the higher was the priority for scientific career (beta = 0.202, $p < 0.001$, Table 2). Family priority, number of children, and amount of care time were not significant in explaining career priority (Table 2). Similarly, gender, contract, and age did not play a role concerning career prioritization (Table 2).

Although career level was found to explain variance in the self-reported importance of the scientific career, family priority was also growing with higher career level (doctorates 64.9%, postdocs 82%, Table 1).

Growth or constancy in publication activities during the COVID-19 pandemic year was explained by having no or few children (beta = –0.288, $p = 0.002$, Table 2), but not by family prioritization in general (beta = 0.053, $p = 0.416$, Table 2). Women reported consistency (55.0%) or growth (13.8%) in publications similarly as compared to men (60.7%, 8.6%, Table 1).

3.2. Comparison of young scientists with different priorities concerning family and scientific career

Most often the young scientists reported high priority for both family and science (38.8%), followed by family priority (31.6%), career priority (19.4%), and least often no priority (10.1%, Table 3). Gender distribution is overall similar in all the four priority groups (about 29–41% women).

In the group who prioritize both family and career (FC), there are proportionally more post-docs or assistant professors (41.0%, Table 3). This group reported most frequently changes in their publication activity, i.e. either increases (15.4%) or decreases (35.6%, Table 3).

The scientist with high prioritization of career (C, FC) most often expressed unchanged high

Table 3
Comparison of scientists with different priorities of the life domains family and scientific career. Means (standard deviations) and/or frequencies are reported ($N = 345$)

Social and scientific situation	No high priority (NN) $N = 35$ (10.1%)	High priority family (F) $N = 109$ (31.6%)	High priority scientific career (C) $N = 67$ (19.4%)	High priorities for career and family (FC) $N = 134$ (38.8%)	Significance of group differences ANOVA or X^2
Age	32.00 (7.24)	32.83 (5.87)	30.68 (5.44)	33.65 (6.55)	0.016 (ANOVA)
% Women	28.6%	41.3%	34.3%	37.3%	0.056 (X^2)
% Persons with limited work contract	97.0%	95.0%	98.0%	93.0%	0.289 (X^2)
% Doctorate candidates (vs. Post-Docs, Assistant Profs)	88.6%	78.9%	80.6%	59.0%	0.002 (X^2)
Care time					0.000 (X^2)
None	80.0%	42.3%	72.6%	39.7%	
Up to 6 hours daily	13.3%	32.7%	25.8%	41.4%	
More than 6 hours daily	6.7%	25.0%	1.6%	19.0%	
Number of children in need of care at home	0.16 (0.63)	0.98 (1.06)	0.05 (0.27)	0.80 (0.98)	00.000 (ANOVA)
0	91.2%	46.7%	97.0%	53.1%	00.000 (X^2)
1	2.9%	17.8%	1.5%	20.3%	
2-4	5.8%	35.5%	1.5%	26.6%	
Interest in scientific career	0.69 (0.54)	0.67 (0.63)	0.82 (0.54)	0.77 (0.54)	0.355 (ANOVA)
Decreased	34.6%	41.9%	24.6%	28.6%	0.234 (X^2)
Unchanged	61.5%	49.5%	68.4%	65.7%	
Increased	3.8%	8.6%	7.0%	5.7%	
Publications in comparison to year before	0.84 (0.55)	0.74 (0.55)	0.83 (0.61)	0.80 (0.69)	0.798 (ANOVA)
Decreased	24.0%	31.2%	27.8%	35.6%	0.202 (X^2)
Unchanged	68.0%	63.5%	61.1%	49.0%	
Increased	8.0%	5.4%	11.1%	15.4%	
Reviews in comparison to year before	1.00 (0.41)	0.92 (0.38)	1.02 (0.50)	0.92 (0.48)	0.502 (ANOVA)
Decreased	8.0%	11.4%	11.3%	15.7%	0.389 (X^2)
Unchanged	84.0%	85.2%	75.5%	76.5%	
Increased	8.0%	3.4%	13.2%	7.8%	

(65.7–68.4%) or even increasing interest (5.7–7.0%, Table 3) in career. Thus, also scientists who had children and reported frequent and long care periods (FC) were still focusing on their academic goals. Accordingly, correlation analysis shows that prioritization of academic career was independent from prioritization of family life (Spearman correlation $r = 0.021$, $p = 0.676$).

4. Discussion

Overall, our findings show some similarities but also differences as compared to other (international) studies: Internationally, two thirds of the young scientist reported or expected negative impacts on their career [7], and about one fourth said they were impaired in publication activities [7]. In our sample, about 27% of doctorates and 41% of post-docs reported decreased publication activities during the pandemic year. In the international survey 2020 [7], 43% said that "writing" (scientific publications) became easier during the down time, whereas in our German study sample (2021), only 10% of doctorates and postdocs evaluated their publication activities in the past (pandemic) year as increased. The seemingly worse publication outcome of the German university might reflect some differences in international settings, but it may be that the time point of investigation (summer 2020 [7] versus early 2021) impacts on the findings: in the beginning of the pandemic 2020 an international sample of post-docs gave their current perception and expectations, in 2021 the German sample reported about their real publication outcome from one pandemic year.

Our study shows that several aspects must be considered together when discussing the impact of the COVID-19 pandemic on scientific outcome.

4.1. Priority for scientific career and publication activities

Concerning the specific research questions of our study, the data show that *family and scientific career*

are independent priorities. In our unselected sample, we found scientists with high priorities for both life domains (work and family: 38.8%), scientists with only family priority (31.6%), those with only scientific priority (19.4%), and some with no priority (10.1%). These groups partly have different characteristics concerning their career level and family situation, but not in scientific interest or outcome.

We found that a *priority of scientific career was more established among post-docs than among doctoral students*. This is opposite to findings which report decreasing interest in scientific career in post-docs, whereas doctoral students remained interested even during the COVID-19 period [18]. It may be that context factors play a role for the development of scientific career priority, e.g. support from the university, or the national scientific systems as such, and perspectives of reaching a fixed position becoming more realistic with advance in career. In Germany, doctorates and post docs usually remain on temporary contracts, and only entering one of the rather rare professorships results in an unlimited contract. However, university system is changing in Germany as well. Presently there is an increase in private universities and colleges which offer additional professorships. This development may increase the individual (post-doc) candidate's chances for getting an unlimited position when continuing scientific career.

Care times and the *number of care-intensive children impact on scientific publication productivity*. This supports finding who reported that scientists with older children or no children (but not those with smaller children aged 0–5 years) reported stable productivity or increases [13]. Our data show that *this effect occurs in both women and men.* Our findings show that not gender as such may be the problem, but the question who does the care time for children and whether care time is distributed, e.g. between the caring persons or external support for child care.

4.2. *Young scientists with different priorities concerning family and scientific career*

Losses of scientific productivity occurred in all groups, independently from the priority orientation. Thereby it must be considered that publication problems may occur rather in cases of family and children care [13], and publication losses affect both women and men [14]. The individual situations of the scientists are important to consider in respect to potential support activities: A doctorate beginner may need different support (e.g. mentoring for perspective taking towards scientific career of other professional paths) as compared to a post-doc with two children (e.g. child care support for ensuring continuation of scientific activities). Research findings make hope that individual support is given when possible: In the international survey, six out of ten post-docs reported problems to discuss their research with their supervisors or colleagues during the pandemic, but more than half of the post-docs believed that their supervisor had at least done everything s/he could do to give support to their junior scientists [7].

Our data show that young scientists with *priority for scientific career seem to be rather stable* concerning this wish. This is similar to findings [18] from a survey in the USA in spring 2020. There was little evidence that the pandemic caused substantial shifts in doctoral students' aspirations and priorities. Some senior students expressed a greater interest in non-academic career paths. Contrary to expectation, the authors found evidence that the pandemic even improved some students' perceptions of their academic departments.

Despite this rather stable prioritization of scientific career, some of our investigated young scientists perceived *losses in publication outcome* during the pandemic year. This is a hint that the conditions impact on scientific activities. Despite this fact, 68% of the here investigated young scientists reported no deterioration in scientific outcome or interest during the COVID-19 period. Seemingly, in most cases research activities could be continued during the pandemic or even newly initiated, such as specific timely corona-related research.

4.3. *Limitations*

The sample investigated here was a natural unselected and heterogenous sample of young scientists covering all faculties and groups of junior scientists (especially doctorate candidates, post docs) at a German technical university. This study has been conducted in a German-speaking context. Different experiences can have been made in other regions or even other universities within the national context.

5. Conclusion

Family and scientific career may be independent priorities in young scientists.

Two thirds (68%) of the young scientists reported no deterioration in scientific outcome.

Care times and the number of children impact on scientific productivity measured in publication outcome. This is true for both women and men.

If in need of support, young scientists need *individual* support, according to their concrete career level and life situation, and their priorities: family or career or both. Especially care support for children could be of merit in order to safe parents-scientists time slots for scientific work. Care support might even be useful in post-pandemic times.

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Conflict of interest

The authors declare that there are no conflicts of interest.

Ethics statement

Data have been collected anonymously. Participants filled in an online questionnaire anonymously, with informed consent, free-willingly, without expense-allowance. Scientific exploitation of the survey was approved by the ethics committee of the faculty of life sciences of the Technische Universität Braunschweig, approval number FV_2021-09.

Author contributions

U.W. initiated the survey and designed the survey questionnaire, A.S. collected the data, B.M. added to the questionnaire, analyzed the data and wrote the manuscript.

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