

Revision Draft 11/22/2020

Boundaryless Work: The Impact of COVID-19 on Work-Life Boundary Management, Integration, and Gendered Divisions of Labor for Academic Women in STEMM

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Acknowledgements:

This paper was commissioned in November 2020 by an ad hoc committee of The National Academies of Sciences, Engineering, and Medicine and presents preliminary results as part of a [fast-track study focused on early indicators of the potential impact of the COVID-19 pandemic on the careers of women in academic science, technology, engineering, and mathematics, medicine \(STEMM\)](#). Opinions and statements in the paper are those of the authors and not necessarily adopted, endorsed or verified as accurate by the Committee. We would like to thank Dr. Kyung-Hee Lee at Purdue University for research assistance

* Both co-authors contributed equally in unique ways, author order alphabetical.

INTRODUCTION

“COVID-19 has prevented me from working face to face with students and colleagues, traveling for work, and working in the lab, all of which are critical to my work as an experimental astrophysicist.”

STEMM woman faculty member (rank unknown) on Covid-19 effects (1)

“Because I work from home I have to hole up in my bedroom for work meetings, and because my husband and I both work full time, jobs that require meetings with other people, we constantly have to switch back and forth between roles. I get an hour or two for some Zoom meetings, then it's my turn to play kindergarten teacher for two hours, then I might get another hour or two to work. The constant task switching is mentally challenging and makes it hard to dive deep into any work task or accomplish anything that requires sustained attention for a longer period of time.if I'm really lucky. There are no boundaries between personal and professional life anymore. I really miss going to my office for many reasons, but being able to compartmentalize work and homeis one of them.

STEMM woman Associate Professor (1)

As illustrated in the examples above, although COVID-19 is not responsible for the job-related disruptions and domestic labor challenges that increasingly impact the careers of academic scientists, it has exacerbated them and made women's work-life inequality as a growing form of job equality more visible (2,3). Women academic scientists, especially in STEMM (Science, Technology, Engineering, Mathematics, Medicine) fields where they are significantly under-represented, have long juggled unequal family caregiving and domestic demands, and faced gender discrimination prior to the pandemic (4).

Now scholars warn of a second epidemic related to the likely significant setbacks in gender representation and advancement in STEMM fields, or loss of, early career women academics, particularly those with children (5). Reports indicate that growing numbers of professional women, in general (6), and in academia, in particular (7), are considering cutting

back or leaving the workplace altogether due to family demands brought on by COVID-19. Mounting evidence suggests a need to be alarmed. Reports indicate that COVID-19 has had a significant negative effect on the research productivity of women academic scientists compared to men. Women in equipment-heavy “bench sciences” (e.g., biochemistry, biological sciences, chemistry, chemical engineering) report (8) a 40% decline in research activities when comparing their pre- and post-pandemic productivity to similar men. Publication output especially shows a substantial decline (9,10). The gap becomes even more evident when examining COVID-19 related research, because the studies were developed post-pandemic (11). In sum, the evidence is clear that the pandemic is harming the careers of women academic scientists more than those of men. Yet it is unclear whether academic institutions have effectively taken action to address how the forced home-working, blurred work-family boundaries, and heightened domestic demands have impacted women in academic STEM.

Report Goals and Structure: Given the above-described negative trends in STEM women’s careers and productivity, this report focuses on their experiences. Our commissioned report focused on these research questions: 1) How the COVID-19 pandemic has affected the personal-professional boundary interface and work-life issues?; 2) How have gendered expectations of domestic labor and caregiving responsibilities for children and elders shifted or impacted professional labor and well-being for women?; 3) What are emerging individual boundary management and family care coping strategies?; 4) What is the gap between current and desired organizational practices to support increasingly blurred work-life boundaries and preferences for integration and separation?; 5) What are suggestions for future research directions? We organized our report as follows in order to address these questions. In the

first half of our report, we conduct a literature review on the trends in the pre-pandemic literature regarding the relationships between work-life roles and their boundaries, and domestic labor and gender, particularly for women in academic STEMM. This is followed by a brief summary of recent empirical studies on the effects of the COVID-19 pandemic on academic women in STEMM.

Insert Table 1 about here.

Table 1 shows the search terms we used to develop the literature review. In deciding which studies to highlight on pre and post COVID-19-trends, we focused our review on data-based studies that were specific to academic women and especially those in STEMM. Since data was generally lacking on post-pandemic work life boundary and domestic labor issues specific to women in STEMM, in the second part of this report we present our findings from an original national faculty survey that we conducted in order to examine the effects of the COVID-19 pandemic on women STEMM academics. We conclude with future research directions.

PRE-COVID-19 PANDEMIC WORK-LIFE LITERATURE OVERVIEW

Our Pre-COVID 19 literature review is organized into two main parts. Part I provides a brief overview of work-life foundational concepts relevant to this paper including work-family-personal life conflict, enrichment, boundary management and their relationships. Part II examines the implications of these concepts for women’s careers in their academic social contexts, which have work structures and cultures that were largely developed before women increased their participation in STEMM fields. We selected the themes examined below as they

reflect how work-family dynamics play out in academic social contexts that increasingly can be characterized as not being very responsive to growing a growing mismatch between women faculty's career and personal life synthesis needs and the design of academic institutions. They are: 1) the paradox of a persistent second shift for women juxtaposed with prevailing ideal worker norms and overwork cultures; 2) the under-recognized critical importance of attending to intersectionality as it relates to organizational support for work-life needs; and 3) the design of work-life policies and academic cultures that are misaligned with the values and needs of an increasingly diverse faculty that is seeking significantly more opportunity to experience greater work-life balance over the life span. Below we discuss several core work-life concepts.

Foundational Concepts from Work-Life Literature

Work-Family Conflict, Enrichment and Gender

Work family conflict. Tensions between work and non-work lives, such as for women in academic STEM, can be understood from the individual and organizational psychological science behind role theory, and the associated concepts of role conflict and enrichment. All individuals have multiple roles in life (e.g., employee, parent, daughter, volunteer) (12). A role is defined as a position in a social system (e.g., group, organization), with accompanying responsibilities, rights and behavioral expectations (13). Role conflict occurs when an individual perceives incompatible time, strain or behavior-based demands between work and nonwork roles, and early research most often focused on work-family role relationships (13,14). For example, a tenure-track faculty member who is a parent may perceive that the behaviors she must carry out to care for children interfere with the high research, teaching, and service demands at a research university. During the pandemic, it is likely that these cross-role work-

nonwork demands may be increasingly at odds, such as when teleworking, one is scheduled to teach a Zoom class at the same time that a child needs help with on-line schooling.

Historical gender dynamics. Historically, work family research has suggested that women's work-family experiences can systematically differ from those of men. A seminal meta-analysis found that the relationships between job satisfaction and work-family conflict and life satisfaction and work-family conflict was stronger in a negative relationship for women than it was for men (15). Evidence from another meta-analysis that was recently conducted two decades later suggests men are also starting to report as much work-family conflict as women do, as some become more involved in household tasks (16). Yet these perceptions may not fully match data on actual household labor time allocation, which shows that women with children under 6 spend less time in the labor force and more time on household tasks than men, a trend that continues for school age children (17,18) and generally for elder care (19).

Work-family enrichment. Complementing the literature on work-family conflict, and a growing research stream is on work family enrichment, which is defined as the positive transfer of knowledges, skills and emotions from one domain to another (20). Work-family enrichment theory assumes that having multiple roles can be beneficial for well-being. This relationship is most likely to occur when one's work and nonwork cross-role demands can be carried out in ways that align with preferences for how one synthesizes work-nonwork roles, which can vary according to the salience of work and nonwork identities, and be influenced by the degree to which an organizational context supports enacting these preferences (21). Another seminal study suggests differential gendered work-family cross-role dynamics- this time for enrichment. While employed men reported positive *work to family enrichment* relationships in the transfer

of positive emotions and engagement from the work to family realms, women experienced *depletion* in the spillover from work to family roles. Men experienced no depletion effects. While women also experience enrichment, results showed that it was in the *opposite* direction from men from the *family role to the work role* (22). Given the importance of these cross-role relationships for well-being, let's turn to the concept of "boundary management."

Boundary Management Strategies, Control and Work-Family Conflict

Work-life boundary management. In recent decades, with the growth of virtual work and modern work-life policies, a body of research has emerged addressing "work-life boundary management." Work-life boundary management is defined as the organization of work and non-work roles to reinforce or weaken the boundary between them cognitively, physically, and emotionally (23,24, 25). Individuals vary in the ways that they prefer to organize and synthesize work and non-work roles to align with their career and family identities and task demands (23). Those with a preference for integration are comfortable removing or blurring boundaries between work and non-work, whereas those with a preference for segmentation prefer to keep boundaries between work and non-work more intact (23, 24, 25). Others cycle frequently through varying boundary styles as work and family role demands shift in peaks and valleys over time (26).¹

Research suggests that an individual's preferred alignment of work and non-work roles may shape his/her boundary management style -- the degree of integration and segmentation enacted (23). However, besides family structures, organizational policies, job structures, and

¹ For a visual depiction of different boundary management styles validated in several studies see Table 1 in the Appendix.

occupational norms may determine the extent that individuals have the ability to integrate or segment work and non-work roles, as well as their overall amount of control over the work/non-work boundary (24, 25, 26). Organizational contexts may also influence the degree to which one perceives the ability to access and customize work flexibility to manage boundaries, and the effectiveness of boundary management strategies (27, 28, 29)

Boundary control refers to the employee's ability to control how she manages the boundary between work and non-work roles and considers whether she can enact the boundary in alignment with their preferences (23, 30). When individuals lack boundary control, and the ability to choose the amount of work-nonwork segmentation, they have lower person-environment fit (31).

Boundaries and role conflict. In general, research shows that a more permeable work/non-work boundary is associated with increased work-family conflict, increased distress, higher turnover intentions, and work performance detriments (23,32,33). For example, interviews of navy personnel, their commanding officers, and family members, found that the use of cell phones and email while on duty resulted in distractions, interruptions, reduced productivity, and mistakes at work—resulting organizational policies restricting such work/non-work integration (34). Permeable boundaries can make employees feel as if they never truly leave work behind and they feel the burden of the expectation that they must be constantly available to meet work demands (35, 36). Continuous availability to work is associated with increased work-family conflict (37, 38), emotional exhaustion (39), and the inability to recover adequately from work (40).

For many professionals, such as STEM women, creating separation between professional identities and personal boundaries (41) can be challenging. Studies show that work-life boundaries can be more permeable for women than men, as they are likely to interrupt work for family demands (22). Thus, variation in boundary management strategies can result in varying effects on work-family conflict and employee well-being including outcomes such as engagement, stress, depressive symptoms, and exhaustion.

Women's Second Shift at Work and Home, Diverse Needs, and Ideal Worker Tensions

The Second Shift

The extra work and nonwork demands that women faculty face compared to their male counterparts are numerous. The term "second shift" is based on the classic work of Hochschild (42), who noted that employed mothers face a double day of work. After returning home from a day of paid work, most begin their second shift of unpaid work that includes childcare and housework. Decades later after the term "second shift" was coined, the gendered division of nonpaid labor remains (43). Specific to faculty, time expenditure studies show that women faculty spend more time caring for children than do their men counterparts (44, 45).

Elder and sandwiched care. Turning to elder care, which has a different life cycle and care dynamics than child care (89), although there are exceptions where one study of faculty found no gender differences in elder care involvement (45), this is not consistent with most studies. The majority of caregivers (61%) for elderly parents or other aging family members are women (46). Six in ten eldercare providers work while caregiving and most report that caregiving negatively impacts their work (46). Moreover, those who are caring for dependent children and an adult are referred to as "sandwich caregivers," which comprise 28% of

caregivers (47) About three in five sandwich caregivers are women and who are as a group are more racially or ethnically diverse than non-sandwich caregivers (48).

Gendered family structures. Differential family structures in marital status and household career configurations can privilege the caregiving resources available to male faculty who are more likely to be in family structures where the male career is primary in a couple. For example, reports indicate that in dual-academic couples, men faculty are four times more likely to have a partner who provides full time domestic care than are women faculty (49). Similar findings have been reported among STEM faculty. Jolly and colleagues (50) examined time spent on parenting and domestic work among physician recipients of a National Institutes of Health K08 or K23 award. Women were more likely than men to have spouses/domestic partners who were employed full time. Moreover, among married/partnered physicians with children, women spent 8.5 more hours per week on domestic activities than did men after controlling for work hours and spouse employment (50).

Care tasks at work. The gender differences associated with caring for others is not limited to home but women's care work roles extends into the work domain. Women professors report more teaching-related work and receive more special favor requests from students than do men professors (51). They also report spending more time on committee service work than do men faculty (52). Within the academy, this has been referred to as "taking care of the academic family." (53). Academic service responsibilities can be especially onerous for women of color who are fewer in number and, therefore, receive a disproportionate number of requests in an effort to have diverse representation on committees (52).

Academic Scientists as Overloaded Ideal Workers

Like other professional occupations, with the rise of personal electronic devices that blur work-life boundaries and rising workloads, many academic STEM professionals faced role overload. Similar to other professionals with a large investment in human capital, many STEM faculty are socialized to work long hours having invested years into earning a doctoral degree, and subsequently working to advance in their careers to tenure and beyond. Such work devotion continuously competes with nonwork passions (53).

Contributing to overwork pressures to generally prioritize work over personal life are norms encouraging adherence to ideal worker behaviors (54). Ideal workers inculcate masculine work norms following the myth that ensuring work and nonwork lives are “separate worlds” (55). They act to try to ensure that work commitments are not hindered by family or other nonwork matters (54). This behavior results in “overworking”, the idea of working more than is needed to perform one’s job to the detriment of one’s health and well-being (53, 54). Occupational cultures such as in academia often socialize members that in order to succeed, one must sacrifice personal life, which reinforces overworking (53,89). In academic STEM, faculty career success involves taking on a growing complexity of roles, including successfully writing and receiving large grants, running research labs -- sometimes 24-7, publishing in top journals, conducting service on many committees and engaging in public outreach, seeing patients if in medicine, and mentoring and teaching large sections of students (56). These job demands alone are challenging to carry out. Further, early career scientists are often juggling romantic relationships, partnering and/or starting a family, which can harm their future career

prospects (57). For example, a 2019 study showed that the rates of leaving the profession after the birth of a first child for academic STEM women were double the rates for men (58).

Intersectionality and Work-life Research

The work-life challenges of women faculty that are traditionally examined in research and practice often relate to maternity and child care work-life tensions as well as dual career – two-body location challenges (59). Granted, these issues are by no means resolved. However, there are a number of other important work-life issues facing women faculty, which have been given far less attention. Scholars have pointed to the growing relevance of diversity and inclusion concepts (60) and intersectionality theory to work-life research issues (61). Coined by Crenshaw (62), intersectionality theory emerged from her examination of legal discrimination cases that focused on gender or racial discrimination separately but overlooked how gender and race might intersect to create systems of marginalization within the power structures of these identity groups. For example, heterosexual white women historically have experienced greater privilege in representation in hiring and promotion in academia compared to women of color within the gender identity group (62).

Taking an intersectional approach is opening up new avenues for work-life research and policy. For example, the work-life issues of single minority women such as African Americans have been largely ignored by academic institutions that have often privileged work-life issues based on gender, and overlooked race issues that intersect with gender (63). It is important to examine intersectional work-life issues, because under-represented faculty, such as women of color, are more likely to report perceptions of work exclusion where they perceive that their personal and professional needs and values are not being addressed (61, 64). For example,

national data show that a black woman with a college degree between in her mid-thirties to mid-forties, is 15% less likely to be married than a white woman without a degree (65), and issue exacerbated in less racially diverse rural and small city college towns where many academic institutions are located (63). Such trends also carry over to motherhood. Creary notes that while statistics show that mothers as a whole are increasingly unmarried and women are generally waiting longer to have children, motherhood rates differ between never married white and black women, the latter of which have significantly higher rates than for white women (63, 66). Work-life preferences for employer support, intersect not only with race and gender, but other forms of difference such as parental status, disability, age and career stage (57, 60). Yet organizations and scholars have largely not attended to growing diversity and intersectionality in work-life needs (60, 61), which as we examine below can impact how work-life boundaries are managed in racial and gender imbalanced work units.

Boundary Management of Personal Identities in Gender & Racially-Imbalanced Contexts

Whereas most research has focused on role boundary management as a means to handle conflicting role demands, existing research also addresses the impact of boundaries on workplace relationships and employees' professional identities (41, 67). Employees not only attend to whether the tasks associated with their work and family roles conflict, but also whether aspects of their personal identities (e.g., being a parent, being an ethnic minority) conflict with the accepted or desired norms for professionalism in their workplace. When women work in men-dominated fields, such as many women in STEMM do, they report feeling that their gender is seen as incompatible with professional norms. So their boundary management practices take the form of concealing aspects of their personal lives that highlight

their gender or parental status if they are mothers (68,69,70). Similarly, work organizations often send the message to members of ethnic minority groups that their behavior must be altered to fit with professional norms (71). As a result, racial minorities are intentional in managing the boundary between their personal and professional lives to preserve workplace relationships with dissimilar others (67). For example African-Americans report refraining from disclosing personal information to their white coworkers due to concerns over career repercussions (72), or when they disclose personal information, they may be careful to share only what will enhance their status at work and downplay their racial or gender category (73,74). Hence, research also indicates that refraining from discussing personal information at work, or strategically downplaying one's demographic categories is also within the realm of managing the work/non-work boundary.

Work-Life Policies and Practices Traditionally Offered by Academic Institutions

Historically, while most academic institutions believe that they provide a work-life supportive environment through their policies and benefits, some scholars believe they generally fail to some degree (57, 60,75). Granted, a few innovative programs have emerged providing workload assistance to relieve time and face time pressure (76, 77), such as for physician scientists,. Programs have also emerged where faculty can share experiences and increase awareness of physician-scientists caregiving challenges (78). However, with the exception of some of these newer piloted studies, which are yet to be strongly integrated into academic institutions, far less attention has been devoted to using work-life policies to support the development of health work-life boundaries and cultures of well-being as a vehicle for faculty retention (60). The most common ways that academic institutions have responded to

faculty work-life needs are: 1) offering dual career hiring to attract and retain academic faculty, with less consistent support for hiring nonacademic spouses; 2) offering childcare centers on campus if available, however spaces are often limited with long waiting lists, particularly for infant care; 3) allowing faculty to extend the tenure clock with parental leave; and 4) offering help with realtors and school information for faculty with children when hired (48, 57, 60, 75,79). It is our belief that it is far less common for academic institutions to provide work flexibility, such as control over the timing of early morning or night classes to employees who are parents and those with elder care demands, although more evidence needs to be corroborate this view, and is being explored in a currently funded NSF study (56).

Supervisors and peer cultural support matters. As suggested by a long body of work on supervisor support for family and personal life, it is likely that much of the departmental support for how these family and personal life scheduling needs are accommodated is often determined on an ad-hoc decision-making basis by the department chair supervisor, resulting in wide variability (80,81). Evidence also showing the benefits of strong consistent leader and organizational cultural support for work-life issues is clear. Meta-analytic studies show that when individuals perceive their supervisors as social supportive of work and family/personal roles, they are more likely to experience less work-family conflict and perceive their organizations as work-life supportive (82). Yet universities have given relatively attention to leadership development interventions to promote family and work-life supportive supervisory behaviors, which has been shown to be effective in randomized control trial experiments in other settings (83,84). Regarding support for elder care and sandwiched care supports, given these are often outsourced to employee assistance firms and universities take a hands-off

approach, it is likely this support is also uneven in effectiveness, though once again this needs to be systematically investigated (79). Support for the tensions of juggling dual academic careers that may vary in job security or career progress or for single parents is also limited (85).

Systematic work- redesign and reduced-load work options overlooked. Not only have academic institutions seriously overlooked adopting work redesign and cultural interventions to increase organizational support for work-life issues as a form of support for diversity and inclusion (86); they often reactively respond with leaves of absence for immediate yet common work-life needs such as unexpected family care needs due to illness. It may be easier to offer faculty time off as a short term solution rather than experiment with redesigning occupational work cultures and reducing job demands. Yet this offer customized reduced-load work options to enable high talent employees to experience a more balanced life during career advancement is something that many private sector employers have done to foster sustainable careers, rather than force individuals to leave (87). Instead, faculty are largely expected to self-manage and know how to create their own healthy boundaries. Ideal worker models impact post child-birth norms of continuing highly career-focused, continuous full time employment after child birth, in up-or-out “tournament cultures” with ratcheting demands (54). Overall, many academic institutions have yet to move work-life issues from the margins to the mainstream of job design and talent management strategies (88).

The reality is that stepping out of the workforce for even a few years can risk career derailment and significantly decrease life time earnings with accrued pension effects from career gaps. Such trends have lead scholars to depict women’s careers as “the sagging middles”, the tendency of many women to decrease hours and work productivity or leave the

labor force after a first or second child (90). Indeed, a study of pay equity of faculty from 1980-2004 found that gender pay gaps can be attributed to career interruptions and declines in accumulated human capital due to stepping out of the workforce or cutting back for children (91). These effects vary within STEM disciplines. Women are highly under-represented in higher paid disciplines such as computer science or physics- fields where some scholars suggest women are stereotyped as not having the innate talent needed in order to excel (92)

Let's now turn to Post COVID 19 Trends and the second half of our report which includes these sections: Post-COVID 19 Literature Review on domestic labor and work-life boundaries focusing mainly on studies involving STEM faculty, then the national survey we conducted, followed by future directions for research.

POST COVID-19 PANDEMIC LITERATURE: CHANGES TO BOUNDARIES, CONTROL AND WELL-BEING

Given the lead-time for publishing academic articles, few published studies directly examine work-life challenges arising from the COVID-19 pandemic for women faculty in STEM. However, the common themes in the articles published so far are consistent with findings in foundational work-family literature and while not STEM specific the literature on the work-life challenges of academic motherhood (93).

Rise in child care and home school demands and increased partner tensions. As workplaces, schools, and childcare centers closed in response to the COVID-19 pandemic, many parents faced new and unusual dependent care and domestic demands, including the homeschooling of children. With children and working parents in the home all day, parents were required to reorganize caregiving time and working time. Several studies during the spring

and summer of the 2020 pandemic showed that caregiving time fell disproportionately to mothers than to fathers (94, 95, 96, 8). One of most well-known of these was by Myers and colleagues (8) which reported female scientists and those with young dependents were most impacted by COVID-19 in terms of their ability to devote time to their research. Specifically, female scientists reported a 5% larger decline in research time while scientists with at least one child 5 years old or younger experienced a 17% larger decline in research time. Based on a sample of faculty across eight different countries using data from 2020, including the U.S., this study found that women were significantly more likely than men to report that the pandemic had impacted their childcare routines between since the pandemic which began moving to remote teaching and research. Results showed significant reductions in research time as much as time as much as 17% for scientists who had to work and care for at least one child 5 years old or younger.

In another COVID- 19 specific study, scholars (97) analyzed data from the international society for stem cell research member survey, including responses of 762 scientists globally. Over half (55.72%) of respondents were academics. More than 85% of survey respondents reported increased caregiving, and almost 50% of these respondents indicated that the additional family responsibilities disrupted their work, a trend that was even greater among early-career faculty members, as 71% reported that their increased childcare responsibilities were hindering their work. The only reported home intervention for securing stretches of time to complete work was to trade-off working shifts with a partner.

Several studies have shown health and wellbeing implications. One recent study found that couples in which the wife was working remotely and taking on all of the childcare

responsibilities, women reported the lowest family cohesion, highest relationship tension, and lowest job performance. (96). Similarly, a study of the rates of anxiety among physician-mothers showed that 41% scored over the cut-of points for moderate or severe anxiety (98). Lower mental health of working mothers due to the pandemic has also been replicated in many studies (99). In order to cope with the additional caregiving demands, women are reducing their paid work hours. One study of dual-earner, married couples with children found that mothers scaled back their work hours by about five percent while fathers work hours remained stable. However, this same study found a significant gender gap among a subsample of parents in telecommuting-capable jobs with children between 1 and 5. For this group, the reduction in work hours was nearly 4.5 times larger for mothers than for father (100).

Using an international sample, another 2020 study of faculty affected by COVID-19, (101), researchers interviewed 80 academics who were mothers in the United States (U.S.) and Italy. Of the 80, 25 were in the U.S. These women reported reductions in their research productivity due in part, to the need to devote more attention to teaching online courses, which was very difficult with small children in the home. Both real-time and asynchronous online teaching were interrupted by children's demands, cries, or other background noise. Moreover, women reported a perceived cognitive deficit from managing the demands of children all day (101). These responses are consistent with research showing that blurred work-nonwork boundaries are associated with increased work-family conflict (102, 103).

Faculty of color COVID-19 work-life impacts. While we could not find refereed empirical scholarly literature on how the pandemic affected the work life challenges specific to STEMM women faculty of color, there were media reports of disparate negative health, career

and work-life impacts. Many news reports provided anecdotal evidence that the pandemic especially negatively affected the well-being of many faculty of color compared to their white counterparts, and we reviewed several examples here. Faculty of color were more likely to have or know a family member or friend who got ill or died from the virus than white faculty (104). The pandemic also made it difficult for more junior faculty hires to find housing which became more expensive and more difficult to secure during the pandemic (104). The tightening labor market, rescinding of some new hire positions, institutional layoffs and the dissolution or reorganization of departments to manage the decline in student enrollments disproportionately negatively affected the careers of faculty of color (105).

Given our literature search revealed relatively little research examining how COVID-19 was affecting work-life boundaries for academic women in STEMM, in October 2020 we designed and distributed a survey, the results of which we present below.

OCTOBER 2020 WOMEN IN STEMM FACULTY SURVEY ON WORK-LIFE EFFECTS OF COVID-19

Method

Survey Content, Distribution, and Sample.

We designed a survey to ask women in STEMM faculty to compare how COVID -19 has affected them over a 6 month period from March 2020 to October 2020. Using a mixed methods approach including qualitative and quantitative formats, the survey asked respondents to indicate their work-location preferences and boundary control, changes in work-life coping strategies, child and elder care and other domestic demands; and preferences for university support. The survey was publicized on the ADVANCE grant listserv and listservs of academic women in scientific specialties. We present here the results of 933 faculty who

identified themselves as STEMM faculty and provided usable data². We first present findings on the data from 733 tenured or tenure stream faculty. We focused our report on these results, since these individuals, on top of teaching and service roles, were juggling research demands that may have results in significant career setbacks that could harm tenure, research funding and implementation, and promotion. Then after reviewing these survey result, we include turn to the data from the 170 non-tenure steam respondents. Many of their concerns mirrored those of tenure stream faculty. Table 2 shows sample demographic breakouts.

Insert Table 2 about here.

Tenure track faculty sample description (Includes both untenured and tenured faculty). Nearly all (98%) of the 763 tenure -track or tenured women faculty in STEMM fields were from 202 institutions, and a small number (a little more than 2 % or n= 20) participants were from non-U.S. institutions. The survey was distributed on US listservs. About half the respondents or 326 people were from 77 R1 institutions.. The sample had representation from many disciplines with representation as follows: industrial, material, and general engineering, (n = 129, 16.9%); chemistry, chemical engineering, biology and biochemistry (n= 102, 13.9%) ; health sciences (n = 56, 7.3%), electrical & mechanical engineering (n = 48, 6.3%), mathematics and statistics (n = 27, 3.5%), Atmospheric, earth, & ocean sciences (n = 25, 3.3 %), agriculture & natural resources (n = 17, 2.2%), physics (n = 9, 1.2%), and other disciplines. For rank, the

² 763 represents the final sample. Other respondents omitted who were not women (25), not STEMM (190), or didn't indicate STEMM status (286) or had other incomplete data.

sample was evenly distributed with about 1/3 (34.1%) untenured assistant professors, 1/3, associate professors (31.2%), and 1/3 (34.7%) full professors. Approximately three-fourths of the sample was white (72.9%) and married or living with a romantic partner (86.5%). A little less than one-tenth (7.3%) of married women faculty lived apart from their spouse or one of the spouses lived far from work because of the other's work. More than half (58.2%) provided care for children under the age of 18, 10.4% provided eldercare, 3.9% provided sandwiched care (i.e., both child and elder care). Nearly one-fifth, or 17.8%, provided care for family members who do not live with them.

Analytical approach. Most of the survey responses were qualitative, and were analyzed using a content analysis method developed by Schreier (106). First, we created our main coding frame, challenges and coping strategies, for each topics (e.g., childcare, elder care, boundary management, work and nonwork and effects) based on the literature review. Next subcategories were created under each main category. They were defined to make sure each category was mutually exclusive, and continuously re-examined through discussion. After the coding was completed, we obtained final counts for each category.

The several quantitative items from the survey were analyzed using SPSS 26 (107). Means and standard deviations were obtained for the boundary control measure to assess changes in boundary control. Using paired t tests, we also compared changes in pre and post pandemic location preferences assessing the number of preferred and actual days working on and off campus over a 5 day week. In order to examine care responsibilities impacts on the changes in the numbers of days working at home and boundary management, we used a

general linear mixed model (108, 109) approach. The Appendix includes representative tables from the PowerPoint presentations for this analysis.

TENURE TRACK WOMEN IN STEMM: EFFECTS OF CHANGES DUE TO COVID-19

Survey Highlights: Pandemic Effects on Changes in Work-Life Boundaries

In this section we examine the effects of COVID-19 on changes in work-life boundaries with these issues, actual and preferred changes in work location, changes in boundary control, experiences of blurred work-home boundaries.

Changes in work location. We asked respondents to indicate their preferred and actual number of days working at home or on campus (in a typical work week, over 5 days) both pre- and post-pandemic.³ Regardless of family or personal demographics, overall women faculty were working at home far more than before the pandemic hit. Examination of the changes in work location between before and after the pandemic using paired-*t*-tests revealed that the number of days working at home significantly increased from .66 days to 3.90 days ($t = -45.67, p < .001$). This difference held regardless of tenure status (tenured vs. tenure track but not yet tenured), rank, racial minority status, and caregiving status (e.g., childcare, eldercare). We also examined the difference between the current and preferred number of days working at home. In general, the preferred number of days working at home was significantly lower than the current number of days working at home ($t = -31.03, p < .001$), across all respondents.

³ After the survey was distributed some respondents indicated that 5 days was too few, and should be changed to 7 days. Further during the pandemic, little travel or face to face data collection was conducted as field work was essentially stopped. Future research on boundaries control, preferences location control should add these considerations to measures.

Preferences and changes in number of days of working at home. Next, we examined the challenges conveyed by women faculty scientists with ($n = 444$) and without ($n = 311$) children under the age of 18. A key finding is that the increase in the number of days working at home post-pandemic was significantly greater for faculty with children than faculty without children. Ironically, although women faculty with childcare responsibilities worked at home significantly less than their counterparts before the pandemic ($t = 2.23, p < .05$; .57 and .77 days respectively), post-pandemic they worked at home significantly more than their counterparts without children ($t = -1.46, p < .05$; 4.02 and 3.72 days respectively). For many working parents this was far more days than they preferred.

Changes in boundary control. Recall that boundary control, defined as the ability to control the permeability and flexibility in time, location, and workload between work and non-work roles to align with identities, (23) is linked to important outcomes (e.g., work-family conflict, turnover). Using a five point Likert scale, where 1 is disagree and 5 is agree, we asked respondents about their perceptions of boundary control before and after the pandemic, and their preferred levels of boundary control. We adapted a 3-item boundary control measure (19) (e.g. "I am able to keep work and personal life separate"). Across the sample of women STEM faculty, all reported significantly lower levels of boundary control after the pandemic than before the pandemic ($t = 33.42, p < .001$; 3.98 and 2.33 respectively). Women faculty with childcare responsibilities reported significantly lower levels of boundary control than their women counterparts without children (including those with elder care or without care) after the pandemic ($t = 11.81, p < .001$; 1.95 and 2.86 respectively).

These quantitative changes were echoed by comments in the qualitative data . Twenty five percent of respondents wrote in comments pertaining to a *lack of boundary control* to prevent cross- border interruptions particularly when scheduling teaching or managing virtual meetings in videoconferencing. al meetings. One example of this related to the inability to control family boundaries interrupting work demands during synchronous teaching. As a full professor, married with children, bemoaned: “... my son had a meltdown 5 minutes before my Zoom class was supposed to start.” Another example of difficulties in managing boundary control involved trying to work and multitask caring for children, which women ended up doing more often than their men spouses. As one associate faculty member stated:

“I teach synchronously via Zoom. My husband is home and does the same thing. He and I have some classes that overlap, which means that I must frequently teach with my daughter in the room with me. She's too young to understand how much I need her to play independently during class time, and I have lost a lot of a sense of professionalism with my students, because they see me getting constantly interrupted with comments like ‘Mommy, I went poop!’”

Changes in blurring of work-life boundaries. Half of the respondents (51%) mentioned having problems managing boundaries between work and personal life since Covid-19. Over one-third of total respondents reported they were experiencing high boundary permeability as mentally and cognitively stressful to regulate.⁴ Examples included:

Blurred boundaries between work and family roles. An assistant professor married and managing childcare comments: “They are happening simultaneously: I am

⁴ For an example mirroring this issue in academic medicine see: Work-life balance in academic medicine: narratives of physician-researchers and their mentors. Strong EA, De Castro R, Sambuco D, Stewart A, Ubel PA, Griffith KA, Jagsi R.J 2013 *Gen Intern Med.* Dec;28(12):1596-603.

working, and I am caring for my one-year-old. I am answering emails while making dinner. I am recording lectures while he naps. There are no boundaries, as everything happens at the same time and in the same space.”

Many faculty, even those without children find it hard to manage boundaries between work and personal life as they *lack time buffers between role transitions*. A married assistant professor without children states: “Working from home, I log in and start looking at emails and responding to questions soon after waking up. The personal time that was earlier needed to get ready and commute to work provided the much-needed buffer between work and daily activities.”

Difficulties detaching from work. Many reported facing difficulty detaching from work, as an assistant married professor without care demands noted: “I’m always at home. Everything occurs at home. It’s harder to turn off at the end of the day because there is no longer an end of the day.

Limited space to create physical boundaries. Six percent of respondents simply did not have enough household space to accommodate a separate office to work and create physical boundaries. As an assistant married professor with no children stated:

“I don’t have a closed office at home, since we can’t afford a place that large. My husband has to work from home even without the pandemic, so he gets the one spare room. This means I have more distractions, kitchen noise, road noise, and a spouse who keeps walking into my ‘office’ at all hours. It is manageable, but psychologically is harder for me to keep the lines blurred, especially since I am just in my living room.”

Survey Highlights: Pandemic Effects on Work Productivity, Well-being, Child Care and Household Labor and Elder Care

In this section we examine the effects of COVID-19 on changes in productivity, well-being, child and elder care and domestic labor.

Negative productivity Impacts. We asked respondents how COVID -19 has affected their personal and professional work outcomes⁵. The majority of participants (72.34%⁶) mentioned the negative impact of COVID-19 on their work. The most commonly mentioned top negative impact was increased workload (27% of total responses) resulting from more meetings, longer hours, more emails and need for extended availability. As one partnered faculty member without children commented: "I feel like my workload has increased by 50%. I'm not able to keep up. I am worn out and tired of having to constantly apologize for being late." The second most common (25%) work impact was decreased work effectiveness. Examples include decreased productivity, efficiency, always being behind schedule, having tasks take much longer, and finding it hard to focus. As one married assistant untenured professor with children commented: "I'm constantly stressed that the lack of lab productivity will cause me to not get tenure." One fifth of respondents (20%) mentioned negative impacts on social interactions with peers and students. Another approximately 20% mentioned negative impact on teaching and negative impact on research. Other concerns were not having enough time to work and decreasing resources and support such as pay cuts, furloughs, worries about research funding, and tenure outcomes and delays.

Effects on personal well-being. Two-thirds or 66% reported a negative impact on personal well-being. A decline in psychological well-being was mentioned by 25% of the sample

⁵ See Table 2 in the Appendix for a visual depiction of COVID-19 effects on work productivity.

⁶ If people mentioned more than one negative or positive, only one key comment was counted per employee.

at all ranks and personal demographics. As a respondent who is a married full professor with no children commented: “(I have) enormous stress - from work, family, trying to figure out how to work remotely... coping with an ever-changing array of rules, protocols, scenarios, problems.”

Similarly an assistant professor who is living with a partner stated: “There’s a major increase in stress and anxiety as I feel like I’m working more/harder and accomplished less. This stress has taken a serious toll on my personal well-being.” A lack of sleep was mentioned by over 6% of respondents, including an assistant professor with children: “I am constantly stressed that the lack of lab productivity will cause me to not get tenure. I lose sleep over it. “

Effects on childcare and household labor. Three-fourths or 72 percent of faculty with children reported a negative impact of increased childcare demands.⁷ A key reason for this is 90% of women were handling a majority of school and child care demands. Only 9% of women reported that they shared child care demands equally with their spouse (50/50), and only 3% said they had help (e.g., babysitter, nanny, tutor) during COVID. Approximately 10% of the sample reported being the primary caregiver for children in their homes even if they were married to another professional.

Childcare feasibility, accessibility, and affordability. Due to the pandemic, many reported avoiding outside childcare due to concerns over the spread of the virus. A married assistant professor with young children shared,

“We are trying to stay in our bubble, so we don't have any childcare for our two kids. We don't want to bring in babysitters or have day care unless absolutely necessary. But this means the kids are with us all the time except about 10 hours of in-person school a week.”

⁷ See Table 3 in the Appendix for a visual depiction of trends in the effects of COVID-19 on Child care and Table 5 for household labor issues and coping strategies.

And those who desired to use outside childcare had difficulty finding it:

“This is bonkers. I cannot find childcare for my youngest (3 years old) and my older two children are remote learning for kindergarten and second grade. Babysitters/nannies in this area have raised their prices and now the starting rate is \$20/hr and for three kids with remote learning duties have been offering \$30-40/hour and still have not found someone to help. So since March, my husband and I have been simultaneously performing parenting full time and working full time. It is fundamentally exhausting.” – Associate Professor, Married with children

“My husband and I are both pre-tenure faculty and we have two young children at home. We are both trying to maintain jobs that want to demand 150% of our time when we are having to split shifts (2 hours in the home office then swap and two hours with the kids).” - Assistant professor

“My husband and I both work full time jobs, remotely. We live in an 800 sq ft apartment in XXX . My 5 year old is doing blended learning. We have to maintain our jobs and step in as kindergarten teachers (for a kid who absolutely does not want to do remote school work). There is so much more work to do to care for our kids (we lost our hired caregiver when the pandemic started) and only one adult can do work for their paid job at a time because the other has to watch our kids. In the spring, when this started, I had to stay up working very late into the night every single night to just barely keep my head above water and stay on top of my work.” – Associate professor

And some faculty reported an increased financial burden. Some women reported that they continued to pay for childcare spots in centers to prevent from losing their spaces, while they shouldered home schooling and childcare responsibilities themselves.

Home schooling and increase household labor stress. Over 41% reported that home schooling increased their workload and stress, and made it difficult to work. As an illustrative example of effect an associate professor juggling elder and child care commented:

“I am on the verge of a breakdown. I have three children doing virtual schooling full time who need my attention throughout the day; they all have different break schedules and seemingly interrupt me every 10 minutes. I want them to learn and thrive and I try to make these difficult circumstances for them as positive as possible, which means giving more of myself and my time to them. I try to wake up before them and work after they sleep, but this is hard given they

wake up at 7 AM for school and don't go to bed early (they are 13, 11, and 8). There are sports/activities, dinner, homework/reading, etc. All the things that keep my evenings busy when they were in school, but now it is all day.”

Over a third of the entire sample, regardless of caregiving demands or relationship status, reported strain from increased cooking, cleaning, and other domestic demands.

Children's heightened behavioral and academic needs and relational strain. Some respondents indicated that their children across all ages even into high school were not adjusting well to remote learning and the disruption in their regular schedules. Therefore, some children needed more academic assistance from their parents and others acted out, further disrupting the faculty members' ability to work. These challenges also put a strain on relations between children and parents, and children and spouses in the household.

“As a professional engineer working in academia, and single mother of three girls, the pandemic has radically changed everything. Although I spend more time with my girls, their mental health has deteriorated significantly with online school and very minimal contact with friends. Our social bubble with one other family (kids same age and gender) has been the only outlet. Even if there were enough hours in the day, I simply do not have the mental bandwidth to be a full time homeschooling mom, housekeeper, instructor, researcher, and family member (maintaining my family relationships from a distance - parents, sister, etc.).”

– Associate professor, single with children

“Being able to focus, and constantly shifting schedules to deal with kids and my husband's job. My 7-year old is struggling with being home all the time and having a baby at home. So on top of the scheduling challenges, she is having way more behavioral problems than normal, which makes it even harder to work.

– Assistant professor, married with young children

“On the negative side, I have children in school attempting to do virtual learning; this has been very difficult to manage while still trying to work myself. I have had to spend anywhere between 1 and 3 hours per day managing their virtual school activities. My husband does not feel as obligated and does not perform these

tasks related to checking their schoolwork. I have lost sleep trying to make up for these lost working hours after the kids are in bed.”

– Assistant professor, married with children

“My son, although fairly independent as a high school student, is not adjusting well to virtual learning. His grades do not at all indicate his understanding of the content of his classes. He is finding it difficult to understand what the teachers are looking for through his virtual interactions with them. This has produced the need for frequent difficult family conversations that did not exist pre-COVID.”

– Full professor, married with children

“I also feel like I'm being put in the role of a mean mommy telling them they have to work extra at the end of the school day because they didn't get their work done during the day. I know that if they were physically in the classroom, the teachers would see them not being focused and the teachers could be the one encouraging them to work more efficiently. I guess I'm concerned about how online schooling is impacting my relationship with my kids.”

– Associate professor, married with children

Positive effects. We should note that a small subgroup, a little more than one-tenth of the sample 13.3% (n=100) of respondents women mentioned positive effects of COVID-19 on family life, such as enjoying more family time together, ease in managing work-family demands, not having to dress for work, and a shorter commute – but they were in the minority.

Effects on Elder and Sandwiched Care.

Over half of the faculty (56%) reported increased elder care demands.⁸ Nearly one-fourth (22 %) of those with elderly relatives reported increased stress from not being able to visit them. Responses generally reflected three issues: demands associated with moving the family member from their initial care facility either to another facility or to have their parents

⁸ See Table 4 in Appendix for a visual depiction of these eldercare trends and coping strategies.

move in with them in order avoid exposure to COVID-19, the need to provide increased domestic support such as household cleaning or ordering groceries to minimize elder's risks to COVID-19 or the loss of paid support, and concern over distance from the family member , for the family member's well-being. As an example of distance challenges: One respondent with parents in another country found it very difficult to help her parents during one of her parent's heart operation.

Other illustrations of the above challenges are below. As one married assistant professor with both child and elder care ("sandwich" care) responsibilities noted, "I need to shop, cook, and provide all support for healthcare visits for both parents, one who died unexpectedly in July and has left us grieving on top of all this. Now mom is at home alone and needs more support and love in the middle of all this."

Another associate professor faculty member noted, she was constantly stressed by the "inability to be able to fly back home to take care of [her parent] (or if bad things happened later). The anxiety of being stuck far away and not even knowing if I can attend the funeral on time is too high." A full professor who is unmarried reported that her parents are also exhibiting increased stress, due to "cancelled doctor appointments, more difficulty getting them care, multiple hospitalizations, move to facility, no visitation at facility, more mood disorder, isolation, unable to get services to home due to fear of COVID."

Survey Highlights- Coping Strategies For Blurred Boundaries and Domestic Labor

In this section we share findings regarding how faculty are coping to manage boundaries using boundary management tactics and other approaches. ⁹

⁹ For a visual depiction of boundary management tactics and other coping strategies see Table 6 in the Appendix.

Separation tactics: technological and spatial. Many faculty actively used separation tactics to manage the boundary between work and home. The most popular separation tactic involved the use of technology to hide the home space (40% of the 763 respondents), whereby faculty set up teleconferencing video meeting backgrounds to protect home privacy. As an assistant professor with children commented: “I ... have my webcam background blurred so people don't know I'm in a bedroom.”

A full professor with sandwiched care noted that not all platforms enable this separation tactic: “Zoom backgrounds are critical to blocking out private visuals about one's home, kids, what room you are in, etc. Not all platforms allow that and I think those that do not are not fair or equitable, as they intrude into people's privacy and showcase their socioeconomic situation, too. Background availability should be mandatory for remote work.”

The second most common separation strategy used by nearly one-third of respondents was having a separate office at home if space permits, such as “turning my dining room into a designated office and try(ing) to only use the desk there for work.” Another stated, “I have a computer set up in a guest room so I can shut the door when I'm on a call or recording a lecture.” However, some had spaces non-conducive for work and sometimes needed to manage boundaries with family in ways children may not fully understand. As a married assistant professor with young children shares:

“I have a workspace set up in my walk-in closet, and I purchased a folding screen to put behind me so others can't see my dirty laundry or items all over the floor. I'll shut the door to the closet so the cats and kids stay out when I'm 'at work.' But if I need an extra level, the closet door leads into the bathroom so I'll close the bathroom door, which has a lock on it for extra assurance. However, my 5 year old has figured out how to stick a bobby pin into the knob to pop the lock open when she's desperate.”

A third separation strategy used by about 25% of respondents involved email boundary management as a means to limiting availability for work communications on devices during non-work times. Some professors mentioned physically removing or turning off work emails from their smartphones. As one faculty member stated: “I deleted my Outlook app on my phone so I can't physically check work email unless I walk into the office and boot up my computer.” Some of these strategies also were combined with temporal boundaries such as, “I am not checking my email over weekends,” or “I will not respond to emails after 9 PM and before 5:30 AM.”

A fourth strategy mentioned by about 7% entailed using separate technological devices. Examples include using the work computer only for work, and using a personal laptop only for personal use. Some of these physical technology boundaries were combined with spatial boundaries. One faculty member commented: “I put my work computer in my desk in my room. I don't do any personal stuff on it at that desk, and I don't do work outside that space.”

Individual temporal strategies to manage working time. Since most academic institutions did not have any policies or approaches in place to culturally prevent faculty overwork, many faculty had to individually self-regulate and triage new ways of coping with managing work and nonwork boundaries, given their workload increased exponentially. Those with children in particular had to self-manage and engage in significant time restructuring in order to be able to manage their heavier workload with child care. The most common coping strategy, particularly for those with children, was working outside of standard hours (26.1%) (and around children's schedules) which resulted in extended availability to work, and long hours. Some respondents reported getting up very early in the morning and working late at

night when children are sleeping, and to a lesser degree, just sleeping less. As one associate professor with children commented, she and her spouse now “go ‘back to work’ after the children are in bed and it is still not enough time to keep on top of everything.” Another assistant professor with children commented on the demands of juggling childcare/elearning: “I can’t get work done productively during the day, so work bleeds over until late evening. Regularly work from 9-midnight and start at 3 AM now.”

Another temporal strategy for those with children involved setting up *a coordinated work schedule with a partner* (16%), with periods of integration and separation to cover shared caregiving. An associate professor explains: “We’ve taken the team approach, so 1/2 the time we are ‘free’ to work and 1/2 the time we juggle work with family responsibilities.” Others organize their household with shared calendars with a spouse, if married. As one associate faculty member explained, “My husband and I try to set up a schedule where we trade off being the “on call” parent for school/supervision while the other works. I have started trying to go to my work office one half-day a week and, for a few hours, one weekend day in order to get some focused work done, when this is feasible.”

Another time separation strategy involved simply *blocking off time* for schooling when they are not available to work. An assistant professor with children commented:

“My children have one remote learning day a week in their K-12 public school. I blocked off this time on my work calendar as a private appointment. I wanted to keep this time free to be available to help my children. As they settle into their remote learning routine, I find that I can work next to them. I am so glad I thought ahead to block off this time so that I am not torn between sitting with my children or being in another room occupied with a video meeting.”

A number of (14%) faculty followed separation temporal strategies that involved *not working on the weekends* to allow for recovery. For some faculty, enforcing this break was not

easy to do. As one assistant professor faculty member with children stated: “I force myself not to work for at least one day over the weekend.” The need to separate from work is not limited to those with care demands. As a widowed full professor with no care demands stated: “I have finally started saying ‘no’ more during weekends. It took me 6 months to realize that I needed to separate work from my personal life.”

Reducing time allocated for self-care. Given limited time, many faculty are putting their family’s well-being ahead of their own. As one faculty member commented: “My most productive hours are when family is sleeping. In fact, about 6% sacrifice their well-being noting *giving up time for self* (n= 39). Many mentioned that they have no time for self and a lack of social support. For example, one respondent stated: “I find I am always trying to hide to get work done and never have enough personal time without kids.” As one professor noted: “I have two small children to care for, but many of my colleagues don't seem to understand/care. I have no time for myself.” While some (9%) of respondents did mention self-care strategies such as taking walks, exercising, and meditation, many reported unhealthy strategies. As one married assistant professor with children explained, “I have had to reduce my sleep to a bare minimum (2-3 hours), forgo exercise or time to myself, and endure significant stress and anxiety.”

SURVEY HIGHLIGHTS: ACTUAL VS. DESIRED UNIVERSITY ACCOMMODATIONS POST COVID-19

Faculty respondents reported three main ways that academic institutions helped manage challenges associated with COVID-19.¹⁰ First, many (but not all) academic institutions gave faculty an option to fully choose *remote work* (n=76). The second most common support

¹⁰ For a visual depiction of faculty write in comments on current and desired organizational supports, see Table 7 in the Appendix.

was extending the tenure clock (n=74). The third form of support was that many academic institutions let faculty choose their preferred teaching mode (n = 47), such as whether to teach online, remote, hybrid, or face-to-face. Although some academic institutions did not give faculty members any choice in teaching mode, many did not pressure faculty who are in higher-risk brackets for COVID to teach in-person, and provided resources for faculty who need to teach from home.

Given the sudden, unprecedented onset of COVID-19 challenges, some faculty reported that most academic institutions focused on testing and health issues (110) but did not have a plan or clear policies in place to help faculty working remotely. For example, there was no infrastructure for childcare, school, or ways to continue research or reduce teaching demands. Switching to online dramatically increased faculty members' workload. For example, faculty members needed to learn new technologies and redesign entire classes for remote learning almost overnight, something that is likely to change higher education for decades (111). Further, due to variance in student internet access and schedule control from home, faculty needed to deliver content both synchronously and asynchronously, resulting in the need for additional measures, such as recording lectures and remaining available for student interaction outside of normal class time or office hours (111).

Lack of Caregiving and School Support

When asked how their academic institutions could improve in their handling of COVID-19, some faculty stated their academic institutions could have done a much better job of providing childcare, school help, and actual financial support. These were the supports faculty most wanted, but few academic institutions provided them. As one assistant professor faculty

commented: “To be honest, unless they come over to my house and clean up and take care of the kids, nothing is going to be of help.” Most academic institutions took a hands off approach.

As an assistant professor with children states:

“Many faculty were expected to manage childcare demands by themselves. We were told to have back up childcare this semester in case schools closed (they are virtual part time), but they haven’t offered any options or financial support for this in a town where daycares already had a >12 month] waiting list pre-COVID, and they stopped allowing kids on campus.”

Moreover, some academic institutions have under-invested in childcare support for years, placing little priority on improving the quality and supply of childcare, which became painfully apparent when COVID hit. As one faculty member with children commented:

“Our on-campus childcare situation is terrible, too little capacity and historically not high quality care. With the onset of the pandemic, it was closed and some schools at the university stepped up and provided additional childcare subsidies to families who needed them, but it was not centralized or universal across the university. HR is now being entirely restructured so perhaps it will end up being more comprehensive, inclusive, and proactive. There is in general an utter lack of proactive care of people's needs.”

Finally, a handful of faculty commented that their academic institutions were not very culturally supportive of family life. As one faculty member stated: “My university does not care about families. They don't even mention issues with childcare in messaging and blamed the lack of affordable childcare on ‘community partners’. It has always been a problem here, which is probably why we have so few women as professors.” Such comments suggest that maybe COVID-19 could be a catalyst for institutions to reinvest in new solutions to foster gender equality (112).

Workload Reduction

Another suggestion raised by about 5% of all respondents was workload reduction in teaching and service demands for those with child and elder care, as well as modified research expectations for tenure given the pandemic. As one associate professor with childcare demands noted: "It is not clear they are helping with reducing workload - mostly it seems like they want us to magically adapt and do more work, and there is no mention yet how research productivity decreases and corresponding funding decreases will be accounted for." A number of respondents stated that they didn't feel a tenure clock extension was very effective. As an assistant professor stated: "I don't think we need an extension of the tenure clock as much as we need an acknowledgement that these years will result in much lower productivity -- therefore lowering the expectations for tenure."

NON-TENURE TRACK FACULTY: HIGHLIGHTS

Although the intent of the survey was to focus on tenure track faculty members whose research was largely stopped by the pandemic, in this section we offer some highlight as non-tenure track faculty also faced difficult career challenges during COVID-19. Most of these faculty members were lecturers and clinical professors thus they bore the burden of heavy course revision to a virtual format.

Non-Tenure track sample description. The sample of women faculty in STEMM fields who are not on the tenure track included 170 participants predominantly from 62 US institutions. The survey population was comprised of faculty (91.2%), researchers (5.9%), and postdocs (2.9%). Three-fourths were white (76.3%) and most (82.4%) were married or living with a romantic partner. A little less than one-tenth (7.7%) of married women faculty lived

apart from their spouse or one of the spouses lived far from work because of the other's work. More than half (57.1%) provided care for children under the age of 18, 10% provided eldercare, 7% provided sandwiched care (i.e., both child and elder care). Nearly one-fifth, or 18.8% provided care for family members who do not live with them. While most of the concerns of non-tenure track faculty mirrored those of tenured and tenure-track faculty, we did notice some unique challenges which we focus on here.

Negative Work Impact on Nontenure Track Women Faculty in STEMM

Similar to the women faculty who are tenured or on the tenure-track, about three-fourths (75.3%) of nontenure track faculty mentioned the negative impact of COVID-19 on their work productivity. While the top two most mentioned negative impacts on work productivity were increased workload (42.4%) and decreased work effectiveness (24.7%) which were similar to the same top concerns of tenure track and tenured faculty. While the academic tenure and tenure track faculty's third most common concern was on the negative impacts of COVID-19 on social interactions with peers and students, for non-tenure track faculty, the third most common concern mentioned by one fifth of the faculty was a negative impact on teaching (18.8%). Key concerns included a tremendous increase in workload and stress due to technology problems, having to offer multiple format to students, developing new content, and lack of clear directions from administrators on decisions that could help planning. Here are three sample illustrative comments highlighting these issues:

"I feel like I am not as effective at instructing students as I was pre-pandemic or even during the quarantine period of the pandemic. Currently, with offering flexible solutions for students, I am pulled in too many directions and spend 2-3 times the amount of prep time on lectures and materials. Trying to deliver

content to students in class AND online has been a tremendous challenge and I feel like I waste about 20 minutes out of every 75-minute lecture just trying to get the technology to work properly. I'm working at least 12 hours a day either developing materials for both types of instruction or trying to get caught up on grading assignments and providing adequate feedback to students. Even my weekends are now rarely my own, since this is the only time I can record content for some of my courses."

– Senior instructor, married with children

"Added much more STRESS to life. Working more hours at home than I would ordinarily put into my day when I went to campus. Had to learn technology quickly and by myself for the most part (adult children were helpful too). Spring I tried asynchronous instruction which was a LOT of work and students were not pleased at all. Changed to synchronous instruction in Summer and currently and overall a much more pleasant and satisfying solution to the problem. Had to figure out on-line labs in Spring which was a total disaster and most unsatisfactory for both me and the students. As a program, we did not offer labs in summer until we were able to meet face-to-face beginning in July. Labs are face to face this Fall so only issues are that some students are quarantined and miss at least 2 labs minimum, and yet must be counted as "excused.""

– Senior lecturer, married without caregiving responsibilities

"Early in the pandemic (March and April), there was so much communication (much of it contradictory) from department, college, and university level admin that we were jerked every which way almost every day. Admin seemed to think you could totally redesign your course on a dime in the middle of the semester, and sent us ads from 3rd party vendors, as well as constantly changing policy edicts and requests for information. This pushed me to work 10-12 hours per day, 7 days per week, and resulted also in very unhappy students. The stress was unbearable, and by June I was in ICU with a stroke. Thankfully I have recovered sufficiently to keep working. But I fault the university for the amount of stress they caused."

– Anonymous, married with eldercare

Finally, compared to less than 1% (0.4) of women faculty who are tenured or on the tenure-track, 4.1% of women faculty who are not on the tenure-track mentioned worrying about job security because their job is dependent on contract renewal or funding:

"Our institution is facing mandatory 10% budget reductions. I am in a vulnerable position as a non-tenured academic lecturer (despite 25+ years' experience at

this institution, women faculty member in STEM field). So, who knows. I try to be grateful I have a job, a job I enjoy, and I am healthy.”

- Senior lecturer, married without caregiving responsibilities

“There is no guarantee whether I can have a postdoc in the next 6 months because it all depends on my supervisor and the funding agency. There is no fallback in these times of pandemic.”

- Postdoc, married with children

Non-Tenure Stream Faculty Desired University COVID-19 Organizational Supports

In general, the views non-tenure track faculty on how academic institutions were helping women faculty manage challenges associated with COVID-19 and how their academic institutions could improve were similar to those mentioned by women faculty who are tenured or on the tenure-track. However, some nontenure stream women faculty noted that some of the accommodations that their academic institutions are offering such as extending the tenure clock, simply did not apply to them because of their employment status. They may be at risk for burnout given a heavy teaching load with grading can be a 7 days a week commitment.

I'm not feeling my institution is encouraging work-life integration as a whole. My immediate supervisor is very supportive of my decision to work exclusively from home. A few attaboys are tossed by the Provost to thank faculty for their flexibility with coping with challenging times, but no real differences implemented EXCEPT allowance to take 2 personal days this semester. That's nice BUT the semester is already one week longer than in the past. And, if you teach every day, which day am I to take off??”

– Senior lecturer, married without caregiving responsibilities

“In reality, the flexible work schedules, reduced schedules, job/sharing and alternate work duties options they offer simply do not apply to teaching faculty, especially those that rely on their income to support their family.”

- Assistant professor of practice, married without caregiving responsibilities

While there was no consensus on the further practices academic institutions could adopt to help non-tenure stream faculty beyond the same workload reduction and child care recommendations that some tenure stream faculty wanted, it appears that extra teaching support for grading and technology and converting course to a virtual format might allow nontenure stream faculty have respite from their higher teaching loads.

Survey Limitations

Because our survey was developed and disseminated within a ten days of being commissioned to write the report, notwithstanding the strengths of speed to market, conducting an anonymous national survey with a rapid turnaround time. means that our dataset may have some limitations. First, we may not be able to do some more nuanced analysis of subgroup differences within women, as lack data for background variables (e.g., age and number of children, and elders.) which could also provide a more fine grained analysis of caregiving demand levels. We only know if one was currently providing care for a child under 18 or an elder at least 3 hours a week, which has been a reliable measure of in other studies (83, 84). By measuring are you providing care at least 3 hours a week, rather than measuring “do you have children or an elder”, this measure assesses caregiver role involvement as opposed to just measuring parental status but not necessarily responsibility for care. Second, we are not able to conduct strong within STEMM subgroup analysis on SES, and nor on intersectionality between race and gender and family status as we could not break out smaller groups due to the need to preserve confidentiality. Yet it may be that some of these subgroup differences were not significant. For example, we did not find major differences in the between tenured and tenure stream faculty, nor by institution type. We also did no find significant

differences for our coding categories by rank except assistant professors and associates were juggling more child and school concerns and full professors were handling more elder care challenges. However, the use of largely open-ended responses permitted us to gain a person-oriented perspective on the challenges women faculty were facing, but did not permit the type of quantitative comparisons that allow for a lot of significance testing. Moreover, we cannot make inferences with regard to cause and effect. These variables were omitted from the survey in order to secure the fastest possible institutional review board approval to conduct the research. Let's now turn to future research recommendations.

FUTURE RESEARCH RECOMMENDATIONS

Identify and Pilot Evidence-Based Work-Life Organizational Policies Using Bottom Up Design

The evidence is clear that women faculty in STEMM faced unique challenges due to COVID-19 related to juggling growing second shift challenges juxtaposed with increased boundary permeability, rising workloads, and persistent ideal worker cultures. Yet, currently there is little guidance regarding institutional policies- both structural and cultural- that can be most helpful. Tenure clock extensions have been the most widely implemented immediate policies to address COVID-19 productivity challenges. However, these have been implemented without addressing the disparities in increased caregiving and job-related workload that women faculty across all ranks and job status are facing. For tenure stream faculty, this means that tenure clock extensions may not have a positive impact on women's careers, and may have an adverse impact on women's tenure achievement and the retention of women faculty. Previous research suggests that gender-neutral tenure clock stop policies actually reduce women's

tenure rates while increasing men's tenure rates (113). Previous research suggests the value of comparing the effectiveness of piloting different types and organizational levels of work-life supports and interventions that are customized to organizational contexts (114, 115). Based on the findings of our survey, it is clear that some faculty believe that tenure clock extensions alone will not be sufficient to help pre-tenure faculty manage the negative career impacts of the pandemic, quasi-experimental field experiments could be conducted comparing the effectiveness of tenure clock-only interventions with initiatives that combine tenure clock extensions with other types of support – including childcare assistance, work redesign, workload reduction, cultural interventions to address ideal worker norms and overworking, and workload reduction to account for women's extra care workloads. In order to identify and rapidly design interventions, academic institutions might engage with STEM women faculty groups to rapidly co-design new practices for evaluation and experimentation using work redesign organizational change scientists. Interventions also need to be developed to address nontenure stream faculty's massively heavier workloads, as the core policy most universities adopted- increasing the tenure clock, doesn't even apply to nontenure stream faculty.

Consider Disparate Gender Impact of Using Accommodations and the Rise of 24-7 Ideal Work

We know from prior research that men who take leave time increase their productivity whereas women often do not (113). This highlights a need for research that considers gender-specific productivity effects of organizational policies and the unintended consequences of COVID-related work-family policy use and beyond. Similarly, research is needed to identify the conditions under which using forced remote work will benefit women's careers and well-being, and when it does not. Remote work can be a double-edged sword for women's careers (114).

For example, while it can facilitate the management of work-family roles, it also increases multi-tasking, process losses from switching frequently between tasks, and interruptions and extended work availability that may harm health, families and lead to burnout and occupational turnover. Concerted effort is needed to test and evaluate various policies and interventions, and scale up those that are effective. Studies are also needed to address the special needs of faculty subgroups, such as women faculty who are single parents, women of color, single faculty members, those partnered with other women, those who share custody of children, those juggling extended caregiving, and parents of children with special needs across ranks.

Compare Boundary Management Strategies in Team, Job & Economic and Identity Contexts

Extending the prevailing literature, our data identified many different strategies that women faculty use to manage role boundaries during the pandemic. Future research should examine the effectiveness of novel strategies that have emerged by faculty and institutions specifically to cope with the pandemic. Studies might examine boundary shifts in not only domestic contexts focusing on micro work-home boundaries, but also the impact of shifts in cross-national and personal career boundaries which have also shifted as the pandemic closed borders and halted scientific face to face research collaboration (115,116), as well as the ability to care or see family living abroad. At a domestic household level, if some families have adjusted by sharing caregiving in the home more equitably, perhaps these faculty may have improved gender balance in both caregiving and career outcomes. However, such adjustments may vary within organizational disciplinary cultures and institutions as well as across national and international cultural borders.

Remote Work's Paradox: Advancing (or Harming) Gender Equality and Dual Careers?

A key question for future research is whether this potential shrinkage of the gender gap for a small subgroup of faculty (as only 10% of couples in our sample equitably shared child care and domestic labor) will be maintained and perhaps even continue to shrink post-pandemic, particularly as higher education undergoes an economic shakeout and becomes increasingly corporatized. Narrowing the domestic labor gap could help level the future playing field for women faculty. Moreover, one silver lining of the pandemic may be that individuals developed new skills in setting technological, temporal, and spatial adjustments to manage boundaries. These new skills in boundary management may continue to be useful to their career development long-term. Adjustments due to the pandemic present the opportunity to compare the benefits and detriments of different boundary management styles. Multi-level studies might explore how and whether academic institutions have learned how to support increasing diversity in faculty preferred boundary management styles such as learning how to support faculty members' ability to control boundaries to align with their role preferences, and could open up more opportunities for dual career and cross-national faculty members to be able to live and work remotely post pandemic as a two-body career solution.

Survey results also highlight the impact of role boundaries on multiple aspects of employees' life domains. Respondents reported outcomes related to personal well-being and those of their children and partners. Although the work-family research increasingly shows that work and nonwork well-being is increasingly intertwined as entangled strands, we need more studies holistically assessing the impact of STEMM faculty work on nonwork stakeholders such as elders, spouses, children and partners as well as the traditional studied faculty career outcomes. Finally, it will be important to study the downstream career effects of

shifting work-life boundaries to manage childcare, and elder care and other domestic labor more intensively during COVID-19. To what extent will there be higher occupational turnover and lower career ambition due to the overwhelming workload during this unique time period?

Pilot Healthy Occupational, Leader, and Team Cultural Boundary Management Interventions

We recommend conducting research exploring the creation of healthy work group cultures. Showing organizations and teams how to respect others' management of work life boundaries, and to preserve others' needs for boundary control may help prevent burnout. Team gender demography – which may be linked to variation in discipline gender representation, may be another important factor in shaping more feminine or masculine ideal worker work-life cultures, and are important to assess as a contextual influence. Studies are needed to help identify how to increase organizational understanding of how to create cultures that encourage members to view work-life issues as a diversity and inclusion issue, as well as benefits for the institution from doing so (57). Leaders might be trained in how to better manage their units to provide jointly greater predictability in face time and team work as well as increasing faculty's ability to customized scheduling, workload, boundaries (119).

Increase Social Support for Jointly Excelling in the Nonwork Domain Comparing the Effectiveness Of Individual, Peer and Family Support

While the mental health of most employees has been taxed during the pandemic, it is affecting women disproportionately. Research that compares the effectiveness of different types of social support – both at work and outside of work – can be helpful. Work support interventions, such as greater administrative help in managing the added demands associated with learning new technology platforms for online teaching are critical in reducing stress. These

types of interventions may dovetail well with family support interventions that help faculty with managing schooling and childcare demands. Further, it may be helpful to consider peer support network interventions, given that working from home is reducing interaction and connection between colleagues, increasing social isolation, and may have reduced mentoring opportunities. These factors affect both the psychological well-being and career outcomes of women faculty. Some exemplary work is now being conducted with social media peer groups for physician mothers (120)

Study COVID -19 Cohort Career Turnover and Career Success within Subgroups of Women

Finally, future research should examine career outcomes for early-career women to further understand those whose careers are thriving. What can we learn from comparing those whose careers were derailed to those who are more successful? There are likely key differences at many levels. In other words, beyond individual differences, what are differences in the departmental supervisor, disciplinary and university context around overwork culture and boundary norms? How does intersectionality come into play comparing the lived experiences of women of color faculty during the pandemic versus similar white faculty women and then to compare different family demands and rank differences within. Such studies should examine how the work life, gender and racial climate of the organization intersect with how the pandemic has been experienced in terms of disparate turnover, pay, tenure and performance outcomes, as well as preventative remedies to learn how to manage faculty well-being of diverse identity groups during the next economic downturn. At the individual level, analyzing occupational and career self-efficacy (121), as well as authenticity empowerment (122) during COVID -19 will also be helpful, as well as the effects of differential access to nonwork supports

across diverse identities and career stages,. Of particular importance is considering how many women quit academic science altogether, and/or consider quitting, or adjust their career path/goals and life ambitions.

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Table 1: Search Terms

Few papers were empirical papers focused specifically on covid-19 and women in STEMM)

Kossek Search Terms

	Psychinfo	Academic search complete		
COVID-19 and Leadership	51	367		
COVID-19 and HR	6	72		
COVID-19 and organizational support	2	3		
COVID-19 and faculty	148	21		
COVID-19 and women faculty	2	4		
COVID-19 and university	1175	108		
COVID-19 and higher education	22	24		
COVID-19 and professors	11	0		
COVID-19 and coping	108	1		
COVID-19 and faculty stress	1	0		
COVID-19 and faculty well-being	0	0		
COVID-19 and faculty coping	0	0		
COVID-19 and faculty elder care	0	0		
COVID-19 and faculty childcare	2	0		
COVID-19 and faculty parenting	0	0		
COVID-19 and faculty sandwiched care	0	0		
COVID-19 and elder care	5	0		
COVID-19 and childcare	20	21		
COVID-19 and STEM	10	122		
COVID-19 and STEMM	0	0		
Total	1563	743	769	3075

Chronicle of Higher Education COVID 19 USED AS SEARCH TERM

1. Dumas Search
2. "Covid-19" "women" "faculty" "stem" Yielded 3,290 results
3. "Covid-19" "women" "faculty" "stem" "U.S." 2,890 results
4. Allen Search:
5. Search keywords USF library:
6. covid-19 AND academic women
7. covid-19 AND academic women AND division of labor
8. covid-19 AND STEM
9. covid-19 AND STEMM
10. SocArXIC Papers website:
11. COVID academic women
12. <https://osf.io/preprints/socarxiv/discover?q=Covid%20academic%20women>

Table 2- Sample Description for October Survey of Women in Academic Science STEMM Faculty

		Tenured or on the Tenure Track (n = 763) N (%)				Non-Tenure-Track (n = 170) N (%)				Study Sample
Characteristics		Assistant (n = 258, 34.1%)	Associate (n = 236, 31.2%)	Full (n = 263, 34.7%)	Total (n = 763)	Faculty (n = 155, 91.2%)	Researcher (n = 10, 5.9%)	Postdocs (n = 5, 2.9%)	Total (n = 170)	Total (n = 933)
Ethnicity	White	172 (66.7)	171 (72.5)	209 (88.9)	556 (72.9)	116 (74.8)	10 (100)	2 (40.0)	128 (75.3)	684 (73.3)
	Hispanic	20 (7.8)	17 (7.2)	13 (4.9)	50 (6.6)	12 (7.7)	0	1 (20.0)	13 (7.6)	63 (6.8)
	Black	6 (2.3)	4 (1.7)	1 (0.4)	11 (1.4)	7 (4.5)	0	0	7 (4.1)	18 (109)
	Asian/Pacific Is.	31 (12.0)	23 (9.7)	16 (6.1)	70 (9.2)	7 (4.5)	0	1 (20.0)	8 (4.7)	78 (8.4)
	Multi-Racial/Other	11 (4.3)	8 (3.4)	9 (3.4)	28 (3.7)	7 (4.5)	0	1 (20.0)	8 (4.7)	36 (3.9)
Relationship	Married	198 (76.7)	183 (77.5)	215 (81.7)	601 (80.2)	120 (77.4)	7 (70.0)	3 (60.0)	130 (76.5)	731 (78.3)
	Living with a Romantic Partner	23 (8.9)	16 (6.8)	9 (3.4)	49 (6.3)	9 (5.8)	0	1 (20.0)	10 (5.9)	59 (6.3)
	Single	28 (10.9)	34 (14.4)	33 (12.5)	95 (12.9)	24 (15.5)	3 (30.0)	1 (20.0)	28 (16.5)	123 (13.2)
	Widowed	1 (0.4)	1 (0.4)	3 (1.1)	5 (0.7)	1 (0.6)	0	0	1 (0.6)	6 (0.6)
	Long-Distance Married Relationship	18 (7.0)	14 (5.9)	12 (4.6)	44 (5.8)	8 (5.2)	2 (20.0)	0	10 (5.9)	54 (5.8)
	Long-Distance Romantic Relationship	5 (1.9%)	1 (0.4)	0	6 (0.7)	1 (0.6)	0	0	1 (0.6)	7 (0.8)
Care	Childcare	148 (57.4)	168 (71.2)	124 (47.1)	444 (58.2)	89 (41.3)	5 (50.0)	3 (60.0)	97 (57.1)	541 (58.0)
	Eldercare	23 (8.9)	24 (10.2)	32 (12.2)	79 (10.4)	14 (9.0)	3 (30.0)	0	17 (10.0)	96 (10.3)
	Sandwiched care	10 (3.9)	12 (5.1)	9 (3.4)	31 (3.9)	5 (3.2)	2 (20.0)	0	7 (4.1)	38 (4.1)
	Long-Distance care	39 (15.1)	36 (15.3)	60 (22.8)	136 (17.8)	28 (18.1)	3 (30.0)	1 (20.0)	3 (18.8)	139 (14.9)

Appendix: Highlights of Presentation Slides from Nov 9, 2020 Webinar

Table 1: Types of Work-Nonwork Boundary Management Interruption Styles

Types of Work-Nonwork Boundary Management Interruption Styles		
Integrators		Individuals manage boundaries to fit identities; Work group, Organizational cultures and structures shape boundary control context
Separators		
Work Firsters		
Family/Personal Life Firsters		
Cyclers		

Sources: Kossek, Ruderman, Brady, Hannum, JVB, 2012; Kossek & Lautsch, 2012

Commented [KEE1]: I am not sure the slides should be included in the paper but since they were asked for I include them here and refer to them in the paper where appropriate in footnotes which would be easy to remove if needed.

Table 2: The Impact of COVID-19 on the Productivity of Academic Science Women in STEMM

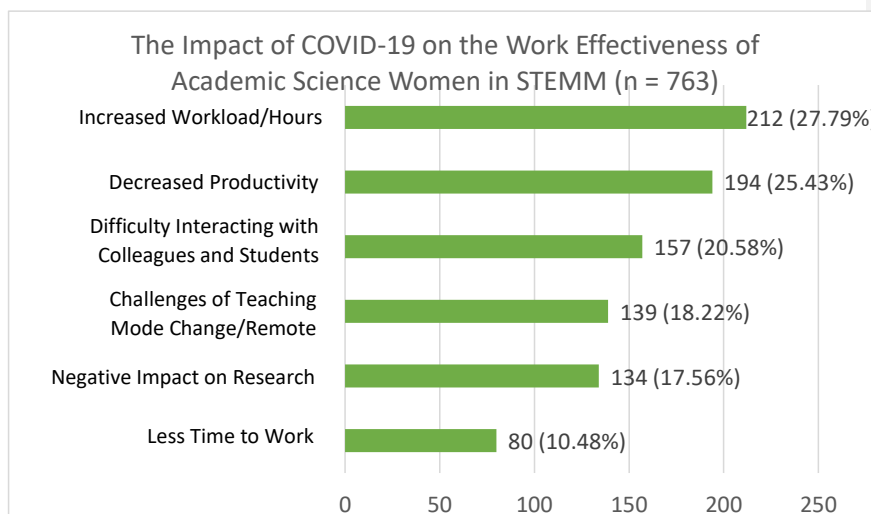


Table 3: The Impact of COVID-19 on the Child Care Demands of Academic Science Women in STEMM

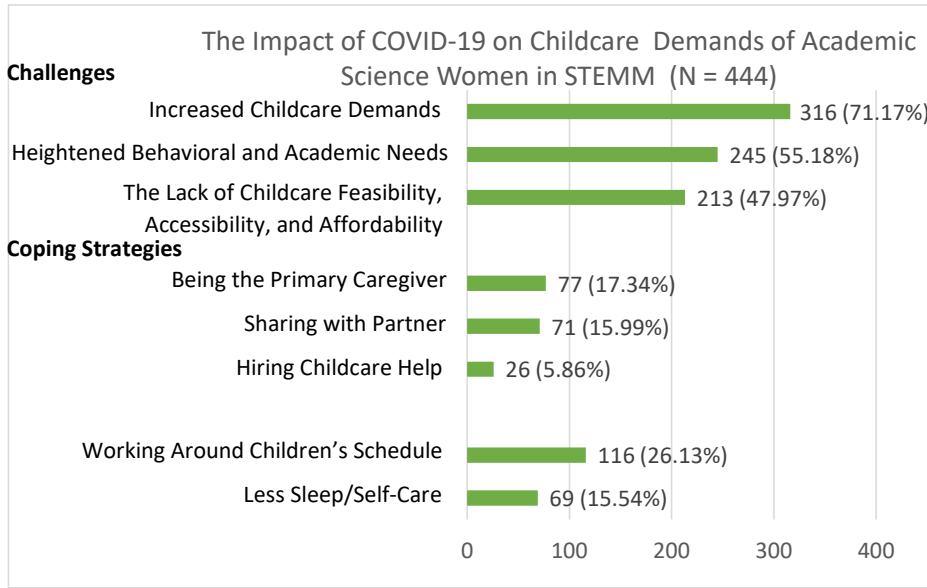


Table 4: The Impact of COVID-19 on the Elder Care Demands of Academic Science Women in STEMM

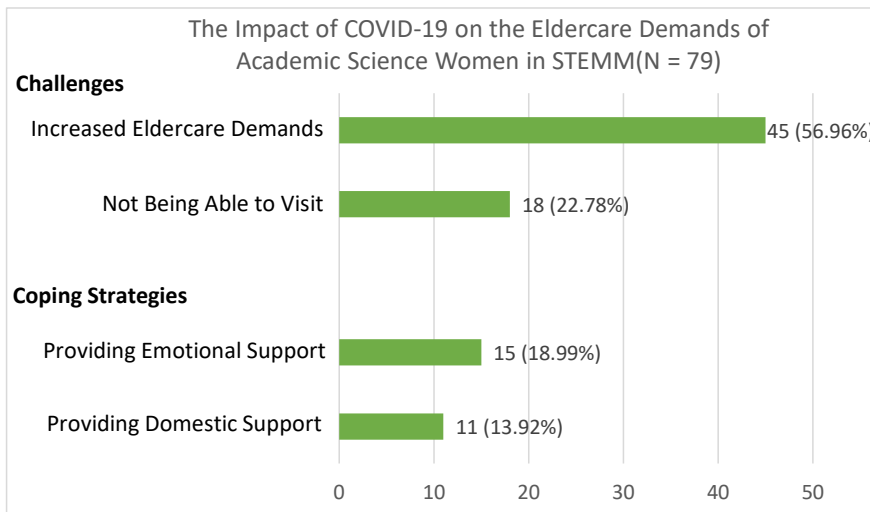


Table 5: The Impact of COVID-19 on the Housework Demands of Academic Science Women in STEMM

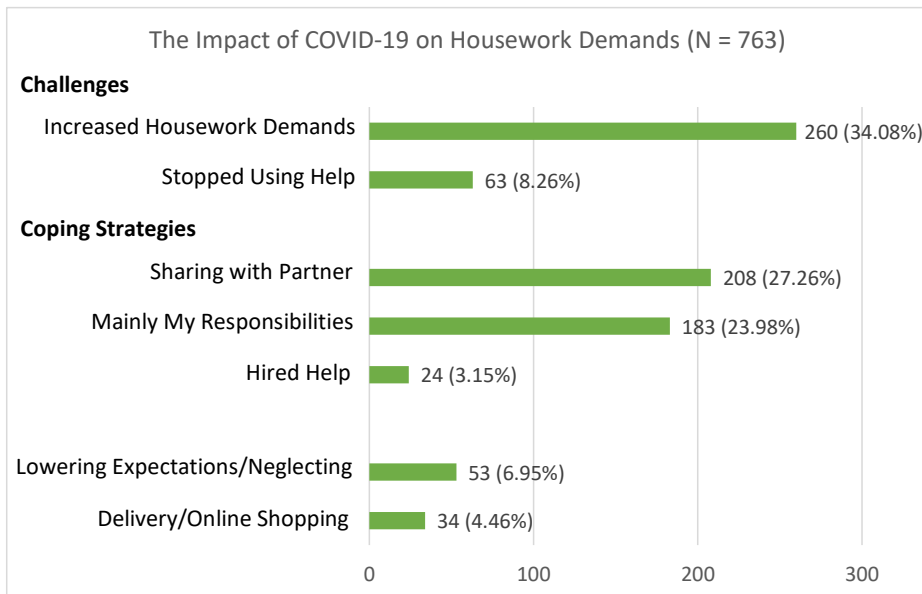


Table 6 The Boundary Management Tactics of Academic Science Women in STEMM

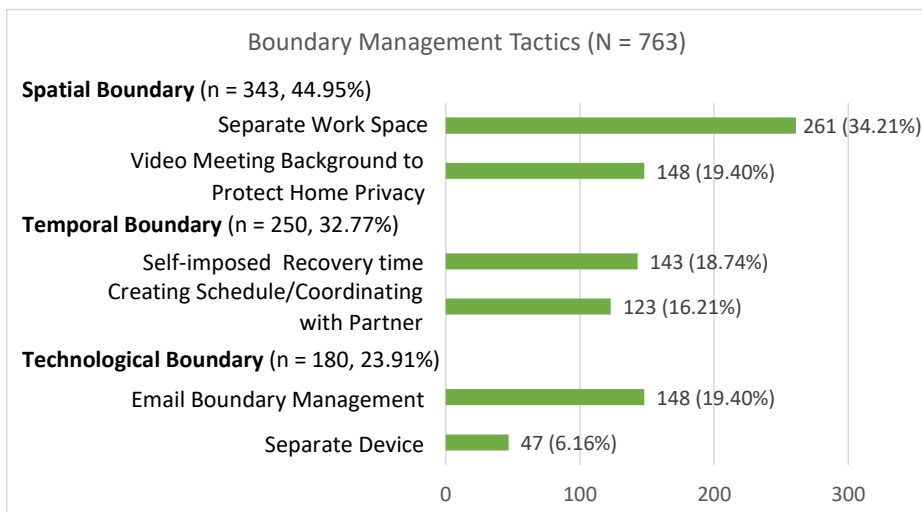


Table 7 Write in Comments on Current and Desired Institutional Support by Academic Science Women in STEMM

