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The Economic Impacts of Family Caregiving for Women in Academic Science, Technology, Engineering, STEMM: Driving an Evidence-Based Policy Response

Courtney Harold Van Houtven and Ngoc Dao, *Authors*

Corresponding Author:

Courtney Harold Van Houtven, PhD MSc

Population Health Sciences, Duke University, Research Career Scientist, Durham ADAPT, Durham VA Medical Center, Durham, NC 27705

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INTRODUCTION

Long-standing goals of the National Academies of Sciences, Engineering, and Medicine and other entities include increasing representation of women and diversity in academic science, technology, engineering, mathematics, and medicine (STEMM) (Hammonds et al., 2021). Efforts to support women entering STEMM, however, such as recruiting female students early in their educational journey, have produced modest improvements only (Colwell et al., 2020). A recent National Academies report has shown that underrepresentation of women in STEMM-based jobs remains prevalent across institutions in the United States, particularly for women of color. In 2019, women comprised 28 percent of STEM jobs (excluding medicine) (AAUW, 2023), including 27 percent and 29 percent of all civilian and federal government—based STEM jobs, respectively (Office of Federal Operations, 2019). This phenomenon persists outside STEMM with an underrepresentation of women observed in all high-status and high-income sectors (Cortés and Pan, 2020; Blau and Kahn, 2017; Bertrand, 2011).

Certain factors may influence women entering or remaining in academic STEMM, in both universities and hospital settings. Women, for example, are more likely to engage in adult and child family caregiving. National estimates for 2020 indicate that approximately 20 percent of all individuals in the United States were family caregivers for adults, the majority of whom were female with an average age of 55 years; in 2021, 40 percent of households included children less than 18 years (Census Bureau, 2021). Importantly, the COVID-19 pandemic substantially escalated the reliance upon family caregivers (Van Houtven et al., 2020) due to the increased number of individuals with disabilities, which included 34 million individuals aged 16 years and older (Boesch et al., 2021). Caregiving has a substantial economic impact on women. A lifetime income simulation model conducted at the Urban Institute recently estimated that women who engage in adult or child caregiving forgo nearly \$300,000 in lifetime earnings, due to a loss of direct earnings as well as public and private retirement earnings (Johnson et al., 2023). Further, an estimated structural model has shown that the welfare cost of caring for an older parent is

approximately \$165,000 over 2 years (Skira, 2015). Lifetime costs to women may therefore extend far beyond earnings and depend on the approach and definition of economic loss, as well as the time horizon.

The economic impact of caregiver responsibilities on women in academic STEM, however, is poorly understood, with limited empirical causal evidence for both female and male caregivers. A single longitudinal nationally representative survey previously reported that 43 percent of new mothers and 23 percent of new fathers left full-time STEM employment upon becoming parents, with new mothers more often moving to other work, part-time work, or exiting the workforce (Cech and Blair-Loy, 2019). A second longitudinal study found that male early-career physician parents were estimated to have 9 times higher odds of working full-time compared with similar females, with family factors cited as the main reason for this difference (Frank et al., 2019). A third longitudinal noncausal study found that women in STEM fields are substantially less likely to persist in STEM fields over time compared with women in other professional fields and that this can be explained by STEM women moving to non-STEM jobs at high rates and not due to labor force exits and family factors (Glass et al., 2013). So there appears to be something different about STEM within professional occupations. Results may differ in academic STEM-specific populations. Among female caregivers who remain in academic STEM, however, the impact of caregiving upon the ability to economically thrive at work is unclear. It is unknown if retention rates or markers of advancement in STEM, such as tenure, promotion, wage growth, and full-time work, are similar among women with caregiver responsibilities, women without these responsibilities, or men (Colwell et al., 2020).

Relatedly, wage and earnings gaps remain persistent among women in academic STEM compared with men, despite controlling for salary-influencing metrics such as experience, hours, specialty, and rank. Indeed, in 2019 the Equal Opportunity Commission documented a \$4,300 gap for women compared with men in STEM (Office of Federal Operations, 2019), while a 2016 study showed that women in academic medicine earn an average of \$16,000 less than their male counterparts (Freund et al., 2016). To date, women continue to earn 16 percent less than men, a slight improvement from the 20

percent documented 20 years ago (Aragão, 2023). Wages and earnings gaps, combined with the lower rate of women in higher paid STEMM occupations (e.g., computer science- or engineering-based roles), likely exacerbate difficulties for women in STEMM. Indeed, the financial burden of caregiving may prevent women in academic STEMM remaining or thriving at work. Should women in academic STEMM who become caregivers face negative economic work-related consequences, policies and supports will be necessary to accomplish the National Academies' goals for a robust and diverse STEMM workforce (Morgan et al., 2021).

This literature review aims to present causal evidence quantifying the effect of motherhood and family caregiving on work outcomes for women in STEMM, with a focus on economic thriving at work. Thriving was considered in terms of retention, advancement, and equity, factors considered critical by the National Academies for improving working conditions for women in STEMM, as well as recruitment, as some women report avoiding academia if they wish to become parents, due to a perception of hostility in academia toward mothers (Popescu, 2023). Evidence gaps are identified and suggestions are provided for research and policy evaluations required to minimize the negative economic effects on women in academic STEMM.

METHODOLOGY AND LAYOUT

Literature Review Methods

This literature review was conducted from May 1, 2023, to July 14, 2023, using Google Scholar (papers considered from 2000 onward); papers recommended by the National Academies' Committee on Policies and Practices for Supporting Family Caregivers Working in Science, Engineering, and Medicine; past evidence syntheses; book chapters on older adult caregiving (co-authored by the team); and conference or working papers identified via abstracts sourced across multiple professional associations over the last 5 years (Allied Social Sciences Association, Population Association of America, American

Society of Health Economists, National Bureau of Economic Research, and Association for Public Policy Analysis and Management). Citations located within identified papers were also considered, particularly those sourced from review articles and the most recent literature, including papers emerging post-COVID-19. U.S. studies were first considered due to the context of the U.S. social safety net (e.g., no universal paid sick leave or universal maternity leave, little collective bargaining, privately paid childcare as the norm), as well as international studies. This review focused on work and thriving at work outcomes, shown in Table 1.

TABLE 1 Work Outcomes
1. Labor force participation (any work)
2. Early retirement/labor market exit
3. Hours of work, part-time, full-time
4. Earnings, wages, wage penalties
5. Re-entry into labor force, return to work
6. Job/career opportunities: promotion, tenure or tenure denial, time in rank, moves off the tenure track
7. Occupational status/attainment
8. Productivity at work, work productivity and impairment index, number of publications, citations

Search terms were used to identify literature regarding older and disabled adult family caregiving (terms: informal car*, family caregiv*, unpaid care*, carer, and work outcomes [Table 1]) and child family caregiving (terms: parent*, mother*, father*, having child*, new mother*, birth, parenthood penalty, motherhood penalty, gender disparity, gender gap, and work outcomes [Table 1]). Parenthood literature was not limited by the age of children in the home, but instead focused on dependent minor children or disabled adult children in the home. Where possible, child and older or disabled adult caregiving are distinguished and the findings are integrated based on the preponderance of the evidence.

A focus was given to causal studies where possible: causal methods are crucial, as mothers may self-select into different occupations and fields where “non-pecuniary benefits related to motherhood are larger” (Simonsen and Skipper, 2006). Parenthood timing is also often a choice and depends on many unobserved and observed factors. Nonrandom selection of caregivers for adults may arise in several ways, including the choice of an older adult sibling to enter into caregiving based on the opportunity and time

cost for each sibling, comparatively. Identified high-quality studies are noted, such as those presenting longitudinal data or contributing unique data, but are correlational. Noncausal studies that may produce correlations are stated as such.

Review Layout

Causal evidence quantifying the effect of motherhood and family caregiving on work outcomes for women are presented, addressing the “motherhood penalty” and caregiving for older or disabled adults. Potential differences that could arise in findings should analyses isolate data specific to workers in academic STEM are discussed. Current policies to reduce economic impacts on working caregivers are next highlighted, focusing on thriving at work both nationally and internationally. To integrate findings, a summary of causal evidence for the impact of caregiving and remaining gaps in evidence for supporting policy formation for women in academic STEM is provided. An important consideration is the examination of direct economic impacts in academic STEM as well as spillovers (such as those caused by the impact of poor health upon work) and the macroeconomic effects and loss of innovation. Strategies to address these research gaps are discussed, including consideration of the need for better data and policy evaluation. Conclusions are presented at the end of the paper.

CAUSAL EFFECTS OF FAMILY CAREGIVING ON WORK OUTCOMES

Evidence-based policy formation require causal effects estimates of family caregiving on work outcomes in STEM. As academic STEM-based causal studies are sparse, however, national and international population-based studies must be used to estimate the treatment effects of caregiving upon work, accounting for the nonrandom selection into the caregiving role. Some studies focused on heterogeneity of caregiving treatment.

Caregivers of Dependent Children (in the Home) or the “Motherhood Penalty”

Studies primarily investigate the arrival of any child (often the first) and the number of children, with a focus on age of the women or children to determine the impact of different child-rearing phases (becoming a new parent, raising young children, raising school children) as well as the number of children and age of the mother. Limited literature was available from pediatric clinical journals regarding caring for children with a medical complexity (Foster et al., 2021). The sparse and descriptive nature of the data identified reflects a substantial negative association between caring for a medically complex child and remaining in the labor force, with 40 percent higher odds of quitting work. Evidence also suggests foregone earnings for those providing intensive family-provided medical care. Importantly, while literature regarding caregiving for children does not address academic STEM-specific effects, certain articles focused on academia. This review thus classified existing work outcomes into labor force participation, hours of work, job/career opportunities, earnings/wage penalties, and productivity.

Labor Force Participation

Beyond the above-mentioned survey study, showing the loss of full-time STEM workers among new mothers (43 percent) and new fathers (23 percent) (Cech and Blair-Loy, 2019), causal studies have supported findings that differential labor force exits occur among women but not men, upon becoming parents in the United States (Cortés and Pan, 2020; review article). The largest risk of labor force exit is the birth of a first child, and not the birth of subsequent children (Doren, 2019). Furthermore, having only one child makes one less likely to exit, especially among college-educated workers. Mothers are also more likely to exit male-dominated occupations if they work more than 50 hours per week (Cha, 2013), a phenomenon which was not observed among men or childless women. The author of this study concluded that the overworking norm in male-dominated workplaces combined with gender-based family beliefs,

strengthens disparities among women and men in the labor force. Internationally, a large and persistent negative causal effect of childbirth on female labor supply has been demonstrated in Germany (Boelmann et al., 2021), a country with generous maternity leave and job protection. This study showed that the effect lessens during the first 5 years post-childbirth but does not disappear over a longer time period (Boelmann et al., 2021). The inverse probability of treatment weights used, however, does not control for unobserved heterogeneity, and certainly, a heterogeneous effect on work may exist as more pronounced labor force exits have been shown among medium-earning mothers (Fitzenberger et al., 2013). In Denmark, a negative causal effect of motherhood on labor force exits was shown in the public sector and a positive but insignificant effect in the private sector (Simonsen and Skipper, 2006). The authors suggested that women are more willing to remain at public-sector jobs due to flexibility, even at a lower wage. Further international literature also indicates that delaying first birth may reduce labor force exits and increase retention, although this has not been consistent (Troske and Voicu, 2013; Miller, 2011).

Hours of Work

In Western Germany from 1985 to 2014, despite the declining gender gaps in human capital (e.g., increased productivity and education of women), increases in part-time work among women and the rising wage gap between part- and full-time work expanded the gender wage gap by approximately one-sixth (Schmitt and Auspurg, 2022). Indeed, a gender wage gap was observed both overall and in the public sector, although trends in overwork did not have a meaningful impact. The authors suggested that research efforts for family-work-based conflict and wage inequalities required higher consideration of working hours. A recent German study has also indicated that culture can influence changing work attachment for women. Previously, women in communist East Germany were encouraged to work full-time, while West Germany retained a male bread-winner culture model. This study showed that East German women who migrated to the West retained full-time work behaviors, while West German women

who migrated to the East adjusted their post-birth work behavior to that of the East (Boelmann et al., 2021).

Job/Career Opportunity (Occupational Status Including Moving Off the Tenure Track)

Evidence from lab, audit, and quasi-experimental studies suggests that, overall, mothers are discriminated against during the recruitment and hiring process. One audit study investigated the impact of gender and parental status on the likelihood that an applicant would be recalled, controlling for identical résumé and cover letter features (Correll et al., 2007; Bertrand and Mullainathan, 2003). Gender was ascertained by name. Parenthood was signaled by the applicant indicating on their résumé that they were “an officer in an elementary school parent-teacher association” versus a nonparent stating they were “an officer in a college alumni association.” Parenthood was also signaled by cover letters indicating the applicant was “relocating with my family.” Results showed that equally qualified childless women received twice the number of calls than mothers. Adjusted models revealed that a parenthood penalty was nonexistent, only a motherhood penalty.

Mothers may also experience slower advancement or promotion, including moving off the tenure track, although no causal studies investigating the relationship between family caregiving and moving off the tenure track were identified. A national faculty noncausal survey showed that women in academia are less likely to occupy leadership positions, are two-thirds less likely to reach the rank of professor, and one-third less likely to remain in academic medicine compared with men (Eversole et al., 2007). A U.K.-based study has suggested that mothers more often hold permanent positions, possibly due to postponing childbirth until receiving a secure contract, but take longer to reach top roles (e.g., professor). Uncommonly, this study found no disparity and uniquely surveyed 9,000 women in academia. The lack of causal methods used, however, makes drawing definitive conclusions difficult. Additionally, as noted among other related literature, this study did not consider the impact of family caregiving for older or disabled adults upon career advancement.

Understanding if women transfer to “easier” jobs upon becoming a parent is crucial for uncovering causes of gender earning disparities over time. One approach is to consider occupational status using the Hauser-Warren Socioeconomic Index, a composite measure of occupational prestige by earnings, among other factors. A higher score indicates higher occupational status (range: 0–80.5). One study revealed that although mothers initially lost ground in occupational attainment, this was regained later. The authors suggested that this reflects counterpressures experienced in later life, whereby women increase labor supply to meet the financial needs of children as they age. This study also found that the negative effects of motherhood substantially reduced during the ages in the 30s and 40s, leading to employed mothers of 50 years achieving an occupational attainment higher than those without children (Kahn et al., 2014).

Experiencing these occupational gains and recoveries, however, requires women to remain in the labor force. Certain international evidence shows that mothers are more likely to work at family-friendly workplaces compared with fathers during early parenthood, enabling them to remain in the labor force. In Denmark, becoming a mother is associated with moving from the private to the public sector (Pertold-Gebicka et al., 2016) possibly due to occupational characteristics including time pressure and convexity of pay (Cortés and Pan, 2020).

Earnings/Wage Penalties

A 2001 study using fixed effects regression and national longitudinal data (National Longitudinal Survey of Youth, or NLSY) found that motherhood incurs a wage penalty of 7 percent per child, with larger penalties for married women compared with unmarried women (Budig and England, 2001). The authors determined that women with more children have fewer years of job experience, explaining 2 percentage points of the wage penalty and resulting in a final penalty of 5 percent per child. After controlling for fixed effects in the longitudinal NLSY, an article in the *American Economic Review (AER)* has shown that the wage penalty differed by race (Anderson et al., 2002). Specifically, the overall penalty

for women was about 4 percent per child, with the least educated mothers facing no penalty. The authors estimated that Black mothers without a high school diploma earned more than non-mothers in some specifications. Number of children, however, was associated with a wage penalty for Black and white women alike. Overall, the study was unable to explain a significant portion of the wage penalty through observed characteristics. A third study using this NLSY dataset, with fixed effects regression and controls for changing work preferences, found that motherhood was “costly” to careers, with a substantial reduction in labor force participation. This effect was strongest among younger women and was eliminated by the 40s and 50s (Kahn et al., 2014).

Other observable factors may contribute to earnings gaps that are often considered residual or unexplained. While not specifically focused on motherhood, a 2014 *AER* article demonstrated earnings patterns by gender that may be important in academic STEM (Goldin, 2014). First, the gender earnings gap is small during early employment but differentially grows with age, based on occupation type. As established by this *AER* article, the science and technology field is more flexible than others (e.g., business, pharmacy), as there is lower face-to-face work, fewer working relationships, more independence in determining tasks, more time flexibility, and more specific projects with less discretion. Thus, gender wage gaps are lower in this field. By contrast, occupations requiring more interactions or time pressure demonstrate earning gaps. Higher gender earning parity may thus be expected in more flexible STEM fields. However, this article also established that gaps grow with age, likely due in part to parenthood.

A 2020 National Bureau of Economic Research working paper using microdata in a Panel Study of Income Dynamics (PSID) has shown that by the mid-2010s, almost two-thirds of the gender earnings gap could be attributed to child-related inequalities compared with other factors, with increases observed over the past four decades (Cortés and Pan, 2020). Importantly, the authors discount that wage gap findings are due to differing comparative advantage, because partnerships with higher-earning women (compared with their partners) also showed divergence in work behaviors and earnings upon having children (Cortés and Pan, 2020). This could occur if “women are more productive at home, value the

household good more, or households incur a utility penalty from women working in the market. Such gender differences in preference parameters could be generated by long-standing social norms regarding gender roles. If preferences and utility penalties exist when men take on more childcare, it will “make the road to gender equity even more challenging for modern cohorts of parents.”

Recently, a U.S. study focusing on adoption among heterosexual and same-sex couples reinforced the influence of discrimination, gender norms, and preferences upon the wage penalty, by largely discounting birthing and the advantage of the father in the labor market as factors (Andresen and Nix, 2022). The causal penalties in adopting heterosexual couples amounted to 20–25 percent of the mother’s earnings, while that of same-sex couples began at 10 percent and decreased over time. Five years after birth the penalty was no longer statistically significant for same-sex couples. This strongly suggests that pregnancy- and childbirth-related factors are likely not driving the child penalty, although short-term differences between mothers in same-sex couples potentially suggest a small role for the costs of birth during the first 2 years.

To put these findings in context, international literature on earnings penalties should be considered. In Denmark, the proportion of the earnings gap explained by the child penalty has ranged from 40 to 80 percent from 1980 to 2013 (Kleven, Landais, Sogaard et al., 2019), due to hours worked, participation in the labor force, and wage rates. Thus, depending on the country, between two-thirds and four-fifths of the earnings gap can be explained solely by having children. Similar results were shown in a study in the Netherlands, where most women work, but often part-time. Across all women, a 46 percent reduction in expected earnings upon childbirth was determined, while men experienced no reduction (Rabaté and Rellstab, 2022; Kleven, Landais, Posch et al., 2019). Evidence for a penalty for mothers varies across multiple European countries (Andresen and Nix, 2022; de Quinto et al., 2020; Kleven, Landais, Posch et al., 2019; Sieppi and Pehkonen, 2019), as shown by the threefold higher rate in Germany compared with Denmark (Rabaté and Rellstab, 2022; Kleven, Landais, Posch et al., 2019).

Indeed, the penalty ranges from a 20 percent reduction in Norway to a 60 percent reduction in Germany (Andresen and Nix, 2022).

A sole counterpoint to the association of motherhood with a wage penalty is shown by the results of a survey study that reported high work satisfaction and no wage gap for academic women in the United Kingdom (Troeger et al., 2020). The authors acknowledged that women may choose to achieve a particular stage of their career before becoming mothers, indicating that estimates may be influenced by reverse causality. This was addressed by finding individuals who were similar in the past and only differ on the choice to have children. As with other studies, propensity score methods and baseline matching cannot account for unobserved heterogeneity, potentially leading to a biased average treatment effect of having children upon wages.

Productivity

Several aspects of productivity gaps may explain the gender wage gaps. A 2021 analysis using causal methods and longitudinal data examined the effect of parenthood on early-career computer science, history, and business faculty in the United States and Canada (Morgan et al., 2021). Survey data collected included potential salary-influencing factors (faculty career age, timing of parenthood, research expectations). Parenthood was attributed to most of the gender productivity gap, due to lower short-term productivity of mothers, despite parents tending to be slightly more productive than nonparents. Productivity penalties for mothers was shown to reduce over time and were lower in more collaborative fields (Morgan et al., 2021), which may benefit women in more collaborative academic STEM fields. The authors thus conclude that a “small-to-modest” gender-based productivity gap remains unexplained and must be attributable to other effects, which may include bias in peer review, discrimination, differences in service loads, or research approaches. Productivity in terms of publications explains short-term gender disparities in academics only (Morgan et al., 2021). Uncovering the responsible factors is pivotal.

COVID-19–era papers are now emerging on productivity implications for women versus men (Stall et al., 2023). Early evidence shows a decrease in manuscript submissions to the Elsevier series of journals from female authors compared with male authors during the first 6 months of the COVID-19 pandemic, with more pronounced submission disparities for early-career women (defined as less than 20 years from degree) (Squazzoni et al., 2021). However, they show no differences in peer review completions, highlighting past evidence that service is borne by women in academia at rates disproportionate to men. A second study using causal difference-in-differences methods, which focused on basic medicine, biology, chemistry, and clinical medicine disciplines, showed that productivity was 17 percent lower among women prior to the pandemic, rising to 24 percent lower in 2020 (Madsen et al., 2022). Heterogeneity by key domains was also found, as the increasing gap was most pronounced among highly productive authors and among those in biology and clinical medicine. Early- and mid-career women both experienced this widening gap, suggesting this may not be due to having very young children. Conflicting evidence from a Nature-Springer journals analysis of published articles found no significant differences in the male-to-female ratio of the number of publications over 3 years (2019, 2020, 2021). Differences could be attributed to methods used or the higher volume of data available in the post-COVID-19 period in this last article (Jemielniak et al., 2022).

3.2. Caregivers of Older or Disabled Adults (in and outside of the Home)

While the causal link between family caregiving of adults and labor supply outcomes has been extensively studied, this literature is substantially smaller than that of the motherhood penalty. Overall, the effects on work are smaller than for new parents, especially regarding wage and earnings penalties. Mixed conclusions about the direction of this relationship have been drawn depending on outcome, while numerous empirical studies have documented a negative association between caregiving and labor market activities. This review classified work outcomes among caregivers for older adults according to labor

force participation, early retirement, hours of work, earnings/wage penalties, productivity, return to work, and job/career opportunities.

Labor Force Participation

A large portion of the literature examining family caregiving and labor force participation is descriptive, with a documented overall negative association, although effect sizes are modest or null, particularly among women (Reinhard et al., 2023; Wilcox and Sahni, 2022; Aughinbaugh and Woods, 2021; Fahle and McGarry, 2018; Bauer and Sousa-Poza, 2015, review article; Lee and Tang, 2015; Feinberg and Choula, 2012; Lilly et al., 2007, review article; Wakabayashi and Donato, 2005). However, causal studies on the relationship between family caregiving and labor force participation in the context of the United States is relatively limited compared with international studies, and the findings are mixed. For instance, several studies indicate that caregivers are slightly less often employed than non-caregivers; partly due to heterogeneity of the effects by gender and intensity of care provided, with females and intensive caregivers incurring the most significant labor impacts (Maestas et al., 2023; Jacobs et al., 2016; Butrica and Karamcheva, 2015; Jacobs, 2014; Van Houtven et al., 2013). Conversely, others have shown no significant effect on participation (Van Houtven et al., 2013; Stern, 1995; Wolf and Soldo, 1994).

Two recent working papers have expanded their analyses to include a younger population, which is a growing part of the family caregiving force, to observe the dynamic of the effects (Maestas et al., 2023; Truskinovsky and Maestas, 2018). Both studies utilize a longitudinal data structure to create an event-study style of approach, wherein outcome variables are compared before and after a caregiving period. However, findings from these studies differ. Truskinovsky and Maestas did not identify an overall significant impact, and only a modest decline in labor force participation among caregivers aged 40 years and older. In contrast, Maestas et al., using data from the Survey of Income and Program Participation linked to the Social Security Administration's earnings records, demonstrated employment reduction for both females and males (although the coefficient estimates were small), and that the impact of family

caregiving was persistent for at least 5 years after caregiving onset. Nevertheless, findings from these causal studies consistently document small effect sizes of adult caregiving on employment.

Early Retirement/Labor Market Exit

The link between caregiving for older and disabled adults and retirement has been less explored and findings have been mixed. Research suggests that these caregivers are more likely to retire, though the effects are small. However, certain papers have attempted to explore the casual effects of family caregiving on retirement decisions. Just two published papers examining the causal link between family caregiving and retirement in the United States were identified. These studies used instrumental variables estimation to account for nonrandom selection into the caregiving role and to minimize bias from unobserved heterogeneity.

The first study examining retirement status, using a pooled sample of both female and male middle-aged individuals from the Health and Retirement Study (HRS), observe a positive relationship only between caregiving for older parents and retirement decision among women. Women caregivers were 2 percentage points more likely to retire compared with female non-caregivers (Van Houtven et al., 2013). The second paper explored the effect of different care intensities on retirement decisions among women, using the American National Longitudinal Survey of Mature Women. Overall, an insignificant effect of caregiving on retirement was observed, although women who provided 20 hours or more of care per week were 3 percentage points more likely to retire (Jacobs et al., 2016). These findings, although limited, suggest that intensive caregiving increases the likelihood of retirement among female caregivers compared with nonintensive female caregivers. With an estimated 53 million caregivers for adults or children with special needs at some time (NAC and AARP, 2020), early retirement may pose more concerns about retirement insecurity, especially among women.

Hours of Work

Causal evidence consistently indicates that caregivers are more likely to work fewer hours than non-caregivers and to transition from full- to part-time work to meet care demands. The average effect size, however, is small and can depend upon certain caregiver characteristics (He and McHenry, 2016; Van Houtven et al., 2013; Johnson and Lo Sasso, 2000). For example, analysis of women aged 40–64 years from the Survey of Income and Program Participation estimated that working 10 percent more hours per week reduces the probability of providing care by approximately 2 percentage points, with larger effects among intensive caregivers or those who reside with care recipients (He and McHenry, 2016). Similarly, many studies have shown a significant inverse link between family caregiving and work hours among intensive female caregivers, although the definition of intensive care has ranged from 10 to 20 hours per week (Van Houtven et al., 2013; Johnson and Lo Sasso, 2000). One exception is a study published in 2015 that showed no statistically significant impact of caregiving on hours of work (Butrica and Karamcheva, 2015).

Earnings/Wage Penalties

The opportunity costs of family caregiving include changes in work status, work schedule, wages, and earnings. Family caregiving could be associated with a wage penalty through two possible channels. First, high-earning caregivers may face higher opportunity cost, meaning paid care (as a substitute for family- and friend-provided care) becomes more feasible and implicating a negative association between family caregiving and wages. Second, care duties might also reduce work hours, lower performance, and lower promotion, implicating a wage penalty (Bauer and Sousa-Poza, 2015). However, empirical studies in the United States and internationally investigating wage effects have drawn mixed conclusions. A U.S. study, for example, found no significant wage impact for women and men, with a marginal effect detected among women who help parents with chore care (e.g., instrumental activities of daily living). An estimated average of over \$5,000 per year was forgone from the combined effect of chore provision on

both hours and wages (Van Houtven et al., 2013). Similarly, a working paper assessing 1996–2010 HRS data with fixed-effect models showed that parent care has no impact on wages for men and a small, marginally significant impact for women (2.3 percent lower wage). Additionally, no wage impact was found for women and men among those who provide spousal care (Butrica and Karamcheva, 2015).

By contrast, analysis of 1994–2008 HRS data using an efficient method of moments approach to explore static and dynamic trade-offs between caring for mothers and labor activities among women aged 42–70 showed that women caregivers who ceased working due to care responsibilities would expect a 13 percent lower wage than similar non-caregivers. Additionally, part-time jobs were associated with lower wage offers if they returned to work (Skira, 2015). Similarly, estimates of the wage elasticity of caregiving to older parents using 1998 HRS data have suggested a negative wage effect on family caregiving, with a larger and significant effect for women but not for men. The findings indicated that a 10 percent increase in wages translates to an 18 percent decrease in average informal care provided by males and a 36 percent decrease by females, though these estimates seem to be an upper bound of the true elasticities (Nizalova, 2012). A recent working paper has shown significant downward effects on earnings among male and female caregivers after caregiving onset, with female caregivers estimated to return to nearly pre-caregiving earning levels at 5 years after onset, while male caregivers seemed not to recover. Additionally, younger female caregivers experienced larger earning shocks following onset compared with those who started caregiving aged 50 years or older (Maestas et al., 2023).

Productivity

Family caregiving may affect work productivity or performance. Only one study (a working paper) on the association between productivity loss and family caregiving for older adults using casual inference framework was identified. Most current studies focus on small and specific groups of care recipients, such as those with advanced-stage cancer. A study conducted using the Work Productivity and Activity Impairment Questionnaire, for example, observed a 22.9 percent caregiving-associated loss in

work productivity (Mazanec et al., 2011). Others have indicated that 32 percent of spousal caregivers of cancer patients receiving chemotherapy and 33.5 percent of family caregivers of patients with lupus report a reduction in job effectiveness due to care duties (Passik and Kirsh, 2005, Al Sawah et al., 2017). As these studies comprise care recipients with specific health conditions requiring highly intensive care, however, a large impact on productivity may be expected.

Understanding changes in work productivity for caregivers of individuals requiring daily and longer-term care is shown by a previously mentioned working paper. Using the National Health and Aging Trends Study data and National Study of Caregiving, the causal effect of intensive caregiving of older parents on work productivity were estimated, controlling for selection into work using a Heckman selection model (Kolodziej et al., 2023). Instrumental variables with widowhood of the parent care recipient identifies how adult children change work hours and work productivity to meet the demand as intensive caregivers. Work productivity was measured using the caregiver version of the work productivity and impairment measure (Wolff, 2016). Controlling for endogeneity of caregiving, the study found no reduction in work productivity among intensive caregivers compared to nonintensive caregivers but showed a negative 2-hour average reduction in weekly work hours among intensive caregivers. No causal studies were identified that examined caregivers versus non-caregivers, however, which was attributed to data not being available on work productivity in national household surveys.

Re-entry in Labor Force/Return to Work

No casual studies were identified to explain the return-to-work path among family caregivers, particularly in the United States. One descriptive study showed that helping spouses/partners with activities of daily living and instrumental activities of daily living reduces the odds of returning to work by 78 percent and 55 percent, respectively, compared with non-caregivers. No difference was found among those who provide similar care to parents (Passik and Kirsh, 2005). Although the study does not address if care responsibilities could lead to permanently exiting the labor force, especially when care

demand is temporary, it suggests the need to support caregivers to attain and/or return to work as a means to improve retirement security.

Job/Career Opportunities: Promotion, Tenure or Tenure Denial, Time in Rank, Moves Off the Tenure Track or Occupational Status/Attainment

Caregiving can interfere with opportunities at work, leading to fewer promotions, taking on a less demanding job, or turning down promotions. No papers were identified on job opportunities, occupational status or career changes in the causal literature of caregiving of older and disabled adults.

POLICY EFFORTS TO REDUCE ECONOMIC IMPACTS ON CAREGIVERS

Most of the promising practices implemented to increase representation of women in STEMM focus on promoting entry into academic STEMM and not retention (e.g., Position Statement on Equity of the Society of Women Engineers and the STEM Equity Alliance). As caregivers generally have worse economic outcomes than non-caregivers, there is also growing interest in national policy to support caregivers. Several national childcare policies have been proposed since 2020, though not enacted, including universal pre-K and childcare subsidies. To support adult caregivers, formulation of a National Caregiver Strategy was mandated by law through the Recognize, Assist, Include, Support, and Engage (RAISE) Family Caregivers Act and a report was released detailing hundreds of recommendations for better support.¹ The strategy implementation, importantly, has no appropriation of funds.

Aside from expanding paid family leave for caregivers of children and older and disabled adults, a handful of states have enacted direct payments to caregivers (e.g., Washington State or as Medicaid waivers), which can be used by caregivers of medically complex children with high care needs (e.g.,

¹ For more information, see [2022 National Strategy to Support Family Caregivers](https://acl.gov/sites/default/files/RAISE_SGRG/NatlStrategyToSupportFamilyCaregivers.pdf) at https://acl.gov/sites/default/files/RAISE_SGRG/NatlStrategyToSupportFamilyCaregivers.pdf.

intellectual and physical disabilities) and adults with high health-care needs (e.g., HIV) or disability (e.g., dementia, functional disabilities). While certain support policies and strategies may be accessed by all family caregivers, others are specific to care recipient type, such as universal kindergarten versus providing tax credits to caregivers of older and disabled adults. Importantly, in the United States and internationally, certain policies have demonstrated an economic impact, while others have not yet been enacted.

Paid Leave

State paid family leave policies are active in four states, and several more have been enacted and will be implemented in coming years. Evidence-based studies have mostly focused on the effects of these policies on new parents, with most demonstrating positive effects on infant and maternal health outcomes, increased sharing of care responsibilities from fathers, positive labor attachment, and increased return to the labor market among young mothers (Bana et al., 2020; Bullinger, 2019; Roy Choudhury and Polachek, 2021; Hamad et al., 2019; Pihl and Basso, 2019; Stanczyk, 2019; Bartel et al., 2018; Lichtman-Sadot and Bell, 2017; Baum and Ruhm, 2016; Byker, 2016; Klevens et al., 2016; Pal, 2016; Das and Polachek, 2015; Rossin-Slater et al., 2013; Chatterji and Markowitz, 2012; Lamb, 2004). Additionally, state paid leave policy increased returns to the labor market among young mothers (Bana et al., 2020, Stanczyk, 2019; Bartel et al., 2018; Baum and Ruhm, 2016; Byker, 2016; Das and Polachek, 2015; Rossin-Slater et al., 2013). Despite the range of significant benefits, one exception has been reported for paid leave policies in California and New Jersey, whereby no impact was identified on leave-taking, employment, or labor force participation compared with states with no paid leave policies (Yancey et al., 2016).

Regarding the causal link between state paid leave policy and care of older and disabled adults, four studies were identified in the literature which specifically addressed the link between California's state paid leave policy (the first enacting state) and care of older and disabled adults. This policy was

shown to increase the labor force participation of family caregivers by 8 percent after 2 years and by 14 percent after 7 years (Saad-Lessler and Bahn, 2017) and increase the chance of middle-aged potential caregivers working by approximately 4 percentage points. Effects were larger among those of early middle-aged, near poor, and with the highest level of education (Kang et al., 2019). Furthermore, using data from the 2001–2018 American Community Survey, California’s paid leave policy was shown to increase employment of women aged 45–64 years and with a disabled spouse by 1.4 percent, with smaller effects found among comparable men (Bartel et al., 2023). Similarly, analysis of 1998–2016 HRS data showed that this policy increased time spent by women caring for parents with personal care activities by 50 percent (relative to pre-policy periods), while an opposite pattern was observed for time spent caring for grandchildren. The impact was larger for middle-aged females (Abramowitz and Dillender, 2023). Examination of paid leave policies in New Jersey and California also revealed a dynamic decline in working, primarily among women, following spousal health shocks or disability onset (Anand et al., 2022). Women in states with paid leave policies were 4 percentage points more likely not to be working due to caregiving; and among employed caregivers, they were 3 percentage points less likely to reduce work hours, leading to a \$295 decrease in monthly earnings compared with states without paid leave policies. These findings, however, may not be generalizable because states with implemented paid leave policies (California and New Jersey) were compared with states with enacting, but not yet implemented, policies. One additional working paper found that, among individuals aged 18–64 years, the four enacted state paid family leave policies increased family caregiving of older or disabled adults and attachment to work, as well as lowered voluntary part-time work rates and use of social welfare (Dao and Van Houtven, under review). This analysis also found no reductions in wages or earnings, despite modest reductions in total hours worked. Finally, this study found differential effects for females compared with males according to age, education, race, and marital status. A summary of the impact of paid leave policies from this as yet unpublished study is provided in Table 2. Overall, studies are needed to investigate how paid leave affects women in academic STEM, given their high education, inability to often work part-time, and the frequent start of academic appointments for those aged 30 or more years, when childcare often

arises. Studies across all working ages would encapsulate dual duties arising—childcare and adult caregiving.

TABLE 2 State Paid Leave Policies and Impacts on Working-Age Adult Caregivers (American Time Use Study data)

	Females	Males	Overall
AVERAGE EFFECTS			
Family caregiving supplied	+	NS	+
Labor force attachment	+ (larger)	NS	+
Voluntary part time	-	- (larger)	-
Hours worked	NS	NS	NS
Wages	NS	+ (larger)	+
Earnings	NS	NS	NS
HETEROGENEITY			
Age			
<i>Family caregiving supplied</i>			
<i>Labor force attachment</i>	+ < 45 years old	NS	+ < 45 years old
<i>Voluntary part time</i>	- < 45 years old (larger)	- < 45 years old	- <45 and + 45–55 years
<i>Hours worked</i>	+ < 45 and 45–55; 55 plus	NS	- 55 plus
<i>Wages</i>	+ 45–55	+ 45–55 and 55 plus	+ 45–55 and 55 plus
Marital status			
<i>Family caregiving supplied</i>			
<i>Labor force attachment</i>	+ both, but larger for single	NS	+ single
<i>Voluntary part time</i>	- single	- both single and married	- single
<i>Hours worked</i>	- married	NS	NS
<i>Wages</i>	+ married	+ married	+ married
Race			
<i>Family caregiving supplied</i>			
<i>Labor force attachment</i>	+ white, Asian and other races	+ white and other races	+ white and other races
<i>Voluntary part time</i>	- black	- white and other races	- other races
<i>Hours worked</i>	- white; + black and Asian	+ other races	- white + black
<i>Wages</i>	+ other races	+ Asian	+ other races
EDUCATION			
Family caregiving			
Labor force attachment	+ high school graduates and some colleges	NS	+ high school and some college
Voluntary part time	NS	- college plus	NS
Hours worked	+ less than high school; some college	NS	NS
Wages	+ less than high school	+ less than high school	+ less than high school

NOTE: Summary from Dao and Van Houtven unpublished working paper, 2023. + indicates a positive marginal effect in the difference-in-difference results; - indicates a negative marginal effect; NS indicates a nonsignificant effect.

State Level – Universal Paid Leave Policy Enacted in Washington State in 2023

Caregiver leave policies are one policy recently recommended in *Promising Practices for Addressing the Underrepresentation of Women in Science, Engineering, and Medicine: Opening Doors*. (NASEM 2020). A universal caregiver leave policy has been adopted in Washington State with job protection for qualifying workers at firms with 50 or more employees.² Unlike most state paid leave policies which cover 6–8 weeks of leave, the WA Cares Fund offers up to 12 weeks coverage per year, extending to 16 weeks with approval. The only exception is New York’s policy, which began in 2021 and covers up to 12 weeks. Evaluating the impact of these policies on workers in academic STEM will be informative, starting from graduate students to postdoctoral fellows to all phases of professors.

Unpaid Leave

Although the United States does not have universal paid sick or maternity leave, one national policy may benefit caregivers of both children and older and disabled adults. Paid sick and maternity leave are likely available to academic STEM workers from their institutions (at least for faculty and full-time research staff). If that leave is exhausted by caregiving demands, however, up to 12 weeks of job-protected unpaid leave may be accessed by qualifying workers through the 1993 Family and Medical Leave Act (FMLA). FMLA was the first national “parental leave” policy in the United States, although unpaid leave has been used broadly over time for personal illness or for providing caregiving (Olivetti and Petrongolo, 2017). While FMLA has increased leave-taking, there has been little impact on employment and wages of eligible women (Waldfogel, 1999; Han et al., 2009; Baum, 2003; Cortés and Pan, 2020). Positive and negative impacts have been reported for FMLA. For example, modest increases in the change of employment status for women hired after the policy was introduced have been noted; however,

² For more information, see at <https://paidleave.wa.gov>.

these women were less likely to be promoted compared with those hired before the policy was introduced (Thomas, 2016; Han et al., 2009; Baum, 2003; Waldfogel, 1999). Although faculty members may be able to afford taking FMLA, as academic STEM is often conducted as team science, spillovers to team/lab functioning from the inability for research staff or postdoctoral fellows to take FMLA must be considered.

International Evidence of Paid Leave Policies

Many high-income countries offer universal paid leave to employees who need time off for family caregiving. Globally, 39 countries (including 16 Organization for Economic Co-operation and Development [OECD] countries) offer paid family medical leave (Heymann et al., 2010). The Canadian federal government, for example, guarantees 6 weeks over a period of 26 weeks for eligible workers to provide care for or support ill family members; most provinces further offer job protection for compassionate care leave. In Australia, employees can claim paid leave for personal illness, care responsibilities, and family emergencies. Leave duration depends on full- versus part-time work status but is generally 10 days per year. Australian workers are also eligible for two unpaid days of leave. Meanwhile in the United Kingdom, workers can file for paid leave, at the employer's discretion.

Medicaid Waivers That Allow Payment to Caregivers of Older and Disabled Adults or Children

In over half of U.S. states, Medicaid allows for consumer-directed care programs whereby care providers may be selected by families, rather than an agency, and may include family members or friends (Randi et al., 2021). However, this varies greatly in coverage by state, with certain important relationship limits (e.g., legally responsible individuals, such as parents, may not receive payment for caregiving) (Keim-Malpass et al., 2019; Teshale et al., 2021). Consumer-directed care has been shown to benefit the health gains of care recipients (e.g., Coe et al., 2019), as well as caregiver quality of life, financial strain, and interruptions to job performance (Foster et al., 2005). For example, subsequent paid work as an aide

may arise from the expertise gained as a paid family caregiver. Wages for family caregivers received from Medicaid are calibrated to a home health aide wage rate, which averages around \$12/hour. It is thus uncertain whether academic STEM workers would take up this role or delegate to another family member with a lower opportunity cost of time, or to an agency. However, academic faculty member eligibility (or an eligible family member needing care) for these programs could replace the need for caregiving during work hours. The impact on caregivers in academic STEM with medically complex children or disabled adults remains unknown.

Employer Benefits Supporting Caregivers of Children and Older or Disabled Adults

Employer policies and practices to promote work/life balance may strongly impact employees with family caregiving duties (Pitt-Catsouphes and Matz-Costa, 2008; McNamara et al., 2013). Analysis of the National Study of Employers in 2014 showed that 41 percent of employers provided access to information about needed services for older family members, compared with 31 percent in 2008, with 75 percent providing unpaid or paid job-protected time off (Matos and Galinsky, 2014). Comparisons of large and small firms (50 to 99 employees) indicated that larger firms have more resources to offer workplace flexibility. Importantly, in 2014 just 9 percent of employers reported that firm personnel policies and practices (e.g., penalties for unscheduled absences, onsite time requirements, strict headcount policies), were preventing the provision of workplace flexibility, versus 16 percent in 2008. However, a third of workers still have no ability to adjust work schedules due to inflexible workplace policy (Maestas et al., 2017).

A significant portion of employees continue to have no paid sick leave benefits, with a similar fraction among both men and women (Maestas et al., 2017). In 2022, paid sick leave was available to 77 percent of workers in the private industry, 38 percent of workers with an average wage in the lowest 10 percent, and 96 percent of those with an average wage in the highest 10 percent (Bureau of Labor Statistics, 2023). A report by the Kaiser Family Foundation recently revealed that 66 percent of women

who completed their Women's Health survey are offered sick paid leave and most are not offered parental paid leave (Ranji et al., 2021). Unique data from the Shift Project, which included 11,689 hourly service-sector workers across the United States, recently showed that workers who took paid leave reported significantly less financial difficulty and less hunger, were able to face utility payment hardship, and had better sleep quality than those without paid leave (Goodman and Schneider, 2021).

Though many employers expanded flexible work schedules for their employees during the COVID-19 pandemic, these benefits often favored working parents over working family caregivers of older adults due to a lack of understanding about care needs (Stovall et al., 2020). Limited studies have shown descriptively that family caregivers with access to workplace leave benefits are more likely to continue working (NAC and AARP, 2020). Further, parental leave policies vary across industries, locations, and firm size; technology companies are more likely than others to offer domestic partnership benefits (Davison and Rouse, 2010). Data from Fortune 500 companies has shown that technology firms, large firms, and those with headquarters in states with paid leave policies more often offer parental leave benefits (Kaufman and Petts, 2022). No studies were identified that addressed the impact of employer-provided parental leave on working caregiver outcomes.

Policies Supporting Caregivers of Dependent Children (in the Home)

Firm, University and NIH-Wide Policies Supporting Parents

Paid parental leave is not universal in the United States, depending on the employer, the state of residence, or a combination of each (Lalivie et al., 2014). Federal employees only started receiving parental leave in October 2020. This may have a large positive effect for certain women in academic STEM, as many female medical doctors are civil servants. Further, while most universities now have paid parental leave for faculty, this does not universally extend to postdoctoral fellows and graduate students in STEM.

Childcare benefits at the university level were not identified on a wide scale (Forry and Hofferth, 2011) for any worker type, despite their association with a lower likelihood of work interruptions. While certain universities have onsite childcare facilities that are accessible by postdoctoral fellows, no studies were identified that reported the volume of universities with these onsite facilities, the ability of fellows to access such care, nor the effects on work of such access. At a national level, recent progress on family supports for postdoctoral fellows has emerged following a letter written by three postdoctoral fellows at the Massachusetts Institute of Technology and Baylor University (and signed by many more) urging for better family support policies to prevent women from leaving the academic workforce (Guo et al., 2023). This letter detailed (1) the lack of paid parental leave, (2) the lack of support during the transition back to work, and (3) the high cost of childcare as barriers to remaining at work. Accordingly, the National Institutes of Health has implemented several reforms over the past 2 years. NRSA (National Research Service Award) postdoctoral fellows (F30, F31, F32) may now apply for up to \$2,500 per budget period to defray the costs of childcare. Notably, this amount would be expected to cover approximately 2 months of infant care at a childcare center,³ or just under 17 percent of average annual childcare costs for one infant. Nearly all applicants have received the benefit, with around 200 beneficiaries each year (\$500,000 cost each year total). Additionally, K99/R00 grant recipients, who receive a combined career development award with an R-01 grant mechanism over 5 years, or a “path to independence award,” now covers a 1-year extension for childbirth beginning in spring 2019. These awards already had a provision for family caregiving needs.⁴

In parallel, graduate students at multiple institutions have identified family support, such as childcare benefits and paid family medical leave, as a key needed benefit in their labor organizing efforts. Individual university collective bargaining agreements may now cover such supports on a growing but still small scale (about one in five graduate students are unionized, or up to 40 universities according to a

³ Child Care Cost by State. Available at <https://worldpopulationreview.com/state-rankings/child-care-costs-by-state>.

⁴ Details are available at <https://grants.nih.gov/grants/guide/notice-files/NOT-OD-20-011.html>.

recent report [Lauer, 2022]). For example, Harvard graduate students obtained a raise and funds to cover childcare arrangements.⁵

Also at the university level, tenure clock extensions for new parents have been recommended by Kossek and many others (see, e.g., Kossek et al., 2020). Evidence, however, suggests that gender-neutral stop clocking policies are harmful to women in the short-term, by decreasing tenure rates in top-50 economics departments, from 1980 to 2005 (Antecol et al., 2018). Long-term change in the probability of men or women eventually earning tenure in the profession, however, were not found. Analyses regarding changes in rank in academic STEM broadly are needed, with comparisons to departments of medicine specifically. Removing tenure clocks may benefit women in schools of medicine (e.g., Ph.D.'s in natural sciences or public health fields often are ineligible for tenure) or more clinical versus research roles. It may be easier to remain at work without the pressure of a tenure clock for women juggling caregiving, but there is no evidence that we could find either way.

State, U.S., or Country-Enacted Policies Supporting Parents

Women with extended maternity leave and job protection have been shown generally to have increased labor force attachment. The benefits accrued to lower-earning women widens gender earning gaps among higher-earning women. International evidence shows minor to no reductions in labor force participation with maternity leave; however, drops in labor force participation in Germany after the protection period indicates the structure of benefits matter (e.g., job protection or not) (Schönberg and Ludsteck, 2014).

A long history of U.S.-based studies have shown that subsidizing childcare modestly increases maternal employment. A recent study has shown that, conditional on working previously, federally funded childcare subsidies helped women remain in the labor force, with 98 percent of subsidy-receiving

⁵ See Harvard Graduate Students Union *Contract Summary* at <http://harvardgradunion.org/contract-summary/>.

married mothers remaining employed 4 years later compared with 91 percent of those without a subsidy. Furthermore, subsidy-receiving mothers earned a more equitable proportion of total household income: nearly 50 percent compared with just under 43 percent for those without the subsidy (Gurrentz, 2021). Additionally, using national Current Population Survey data from the Child and Dependent Care Credit (CDCC) program, a 10 percent increase in CDCC benefits was shown to cause a 4–5 percent increase in annual paid childcare participation among households with children aged less than 13 years. This study also showed an increased labor supply among married mothers, especially those with very young children, suggesting that CDCC benefits may generate long-run earnings gains by preventing labor force exits (Pepin, 2020).

At the state level, childcare subsidies supporting low-income families, which vary in coverage and generosity, are often linked to Temporary Assistance for Needy Families (TANF) benefits. Evidence from an endogenous switching model evaluating Minnesota’s childcare subsidy mirrored national evidence, whereby it was associated with a significant increase in the likelihood of employment, particularly full-time. Expansion of the childcare subsidy program could lead to increased employment among parents with young children in low-income households (Davis et al., 2018). Importantly, academic STEM graduate students and research staff may benefit from state programs targeting low-income households. Likely knowledge about eligibility for benefits like TANF is low, as indicated by its frequent underuse (Dreyfus, 2021).

Expansion of preschool and kindergarten policies have focused on the national and state experience in the United States (Pihl, 2022). Expansion of publicly funded kindergarten programs in the 1960s and 1970s generally increased maternal labor supply of single mothers, though not as notably for married mothers, possibly due to low participation rates among the latter in that era (Cortés and Pan, 2020). Access to universal pre-K in two southern states in the 1990s has previously been shown to increase preschool enrollment without affecting labor supply of most women (Fitzpatrick, 2012). By

contrast, a modest increase in the employment rate of less-educated mothers has been shown, with the strongest signal during the early years of the program's introduction (Cascio and Schanzenbach, 2013).

Head Start is a program for children from low-income families to improve school readiness. A national evaluation of Head Start's effect on indirect spillovers to women's work found that in the short term, single mothers worked less while some non-white mothers worked more (Pihl, 2022). After 10 years, both single and non-white mothers worked less. Overall, the largest effect of school entry on women's labor supply is found for single women (Barua, 2014; Fitzpatrick, 2012; Cascio, 2009).

Internationally, the 2009 expansion of an income-neutral childcare voucher subsidy in Luxembourg has shown significant but modest benefits on employment rates of mothers (Bousselin, 2022). As subsidies had been offered in limited provinces prior to 2009, this expansion increased formal childcare utilization, including before- and after-school care, allowing entry into the market of providers and easing capacity constraint. Analysis using a differences-in-differences approach of women aged 20–50 years, with a youngest child of 13 years or less versus a control group with no children or a youngest child aged 13–18 years, showed that this reform modestly increased employment by 3 percentage points and working time by 1 hour per week. Heterogeneity of effects show that mothers of younger children were more responsive to the reform than those with children in primary education. Importantly, these results are similar in magnitude to those reported following the expansion of subsidized childcare in the Netherlands and Spain (Bettendorf et al., 2015; Nollenberger and Rodriguez-Planas, 2015). A substantial childcare subsidy expansion in France also led to small but significant increases in female labor force participation overall, with a larger effect for those with large families (Bousselin, 2022). Finally, a reform for “daddy leave” in Sweden resulted in an increase in fathers taking leave for newborn children, but not in fathers taking leave to care for sick children and had no effect on earnings by gender (Ekberg et al., 2013). These studies generally provide valuable average effects and some heterogeneity of effects but do not address effects for women with the highest labor force attachment.

Policies Supporting Caregivers of Older or Disabled Adults (in and outside of the Home)

A handful of further policies are in place to support family caregivers of older or disabled adults, with variation at the state level (Miller et al., 2022). Few policies, however, are aligned with the National Academies' recommendations on policy supports for caregivers (Miller et al., 2022) and most are modest, have eligibility restrictions, and have not been evaluated for their impact on caregiver work outcomes. These policies include the National Family Caregiver Support Program, which is designed to train caregivers and match with respite care programs the state tax credits for full-time caregivers in certain states (for which workers rarely qualify as a full-time worker program), and the Veterans Affairs (VA) program, which provides a tax-free stipend for qualifying caregivers ranging from \$600–2,300 per month. The VA program was found to causally increase the care recipient's engagement in vocational rehabilitation; however, it is not known if family caregivers increased or decreased their work (Shepherd–Banigan et al., 2021). No studies were identified that evaluated the effects of these programs on caregiver work outcome. There is some traction to expand evidence-based programs to family caregivers of older adults, as recommended in the 2016 National Academies report *Families Caring for an Aging America* and subsequent recommendations from the National Caregiver Strategy that arose from the RAISE Act (ACL, 2022; NASEM, 2016). However, no analyses were identified quantifying the effects of factors such as support groups, trainings, better access to respite care, or adult day health care on labor market outcomes of family caregivers.

Indirect policies also affect caregiver activity, as spillovers of private long-term care insurance occur such that adult children are more likely to engage in work if their parent is insured (Coe et al., 2023). Thus, long-term care insurance expansion programs, such as through state partnership programs, could be considered indirect caregiver support policy.⁶

⁶ It will be important to track the long-term care insurance program enacted in Washington State (WA Cares) and launched July 1, 2023, whereby workers contribute \$0.58 per \$100 earned to their long-term care insurance fund. Future coverage can be up to around 1,000 hours of care, and it includes self-direction (e.g., paying a family member to provide care).

Given long-term care insurance in the United States is costly (\$2,000–5,000 per year depending on gender), it is possible that initiating university programs that subsidize long-term care insurance could also help future caregivers on faculty remain at work when disability of a parent arises. This seems an unlikely option, but as many private universities use tuition benefits to retain faculty, partially covering long-term care insurance would be a very attractive benefit to workers anticipating future caregiving demands. Internationally, Japan implemented public long-term care insurance, which was found to stimulate employment among family caregivers (Fu et al., 2017). Germany and the Netherlands allow for paying family caregivers versus home health aides, yet no evaluations on work outcomes were identified.

Policies or Employer Practices Proposed but Not Enacted

Removing incentives for firms to reward long hours and reward set scheduled hours may reduce gender earning gaps, such as through moving to more flexible work arrangements as was prescient given the arrival of the COVID-19 pandemic (Goldin, 2014). Multiple studies have shown that flexible work helped mothers preserve their working hours after childbirth (Chung and Van der Lippe, 2020; Chung and Van der Horst, 2018) and remain in time-intensive jobs despite intensive family demands (Fuller and Hirsh, 2019). Academic STEM allows for autonomy in scheduling with some exceptions (e.g., class, clinical medicine, clinic, and surgery schedules), so it is uncertain how added flexibility would influence this sector.

During the COVID-19 pandemic and the resulting loss of childcare, many academic women reported higher rates of working at night, whereby “second-shift” challenges juxtaposed increased boundary permeability, increasing workloads, and consistent ideal worker cultures (Kossek et al., 2020). Childcare availability also lessened once essential services restarted, with 16,000 centers closing in the first 2 years of the pandemic posing substantial challenges to working parents. Over the longer term, with a return of children to school, studies will need to examine if work flexibility in many high-income office jobs has been sustained or reverted, specifically for academic STEM.

A SUMMARY OF CAUSAL EVIDENCE FOR THE IMPACT OF CAREGIVING

The major finding from this literature review is that most studies did not focus on nor specifically examine causal evidence of the economic impacts of caregiving on workers in academic STEM. Women in academic STEM are a highly educated subset of the total female working population and may experience different economic impacts of caregiving than found in population-level studies. A summary of the causal findings identified is provided in Table 3.

Causal Findings for Caregiving in Academic STEM

Motherhood/parenthood penalty-based causal literature eclipsed that of caregiving for older and disabled adults by approximately threefold. Parenthood literature commonly compared new parents to nonparents using differences-in-differences or propensity score approaches and found substantial negative impacts of motherhood on work outcomes. By contrast, small but rigorous literature on caregiving of older or disabled adults showed modest reductions in work behavior for women and a modest wage penalty for those who continued working, with little impact on men. Child caregiving literature tended to focus on working-aged women or populations, whereas most adult caregiving literature focused on older workers or caregivers aged 65 years or more, with one exception examining caregivers of 18–64 years (Maestas et al., 2023). Caregiving literature for older and disabled adults did not focus on occupation nor occupational status, and a consensus on work productivity impacts of caregiving for adults has not yet been reached. Only one analysis examined academia, and none examined academic STEM.

The average economic impact on caregiving for children appears larger than for older adults, as new parents seem to adjust work more substantially. Although not specifically examined, it must also be noted that adult caregiving often commences in later working life (average age of 55 years) compared with new parents. Consistently, the Urban Institute’s simulation estimates on lifetime earnings losses of

caregiving have shown that adult care cost estimates are lower than childcare costs, as few women reduce work hours to provide adult care. Negative spillovers of parenthood on health were not found in new parent literature, while documented health effects in adult caregiving is growing in the United States and internationally.

Economic impacts of new parenthood are experienced by women only, while findings are variable for adult caregivers, with some weak evidence of negative effects on men. The preponderance of the evidence indicates heterogeneity of effects, in that women and individuals who provide intensive caregiving for older adults experience more negative economic impacts than nonintensive caregivers. Parenthood-based literature also addresses heterogeneity by public, private, computer science, or history sectors. Few analyses consider heterogeneity by intersectional identities.

TABLE 3 Summary of Family Caregiving Effects on Caregiver Work Outcomes Based on the Preponderance of Evidence Identified

	Caregiving of Children	Caregiving of Adults	Contextual Factors
Labor force participation	<p>Moderate negative effects for women</p> <p>Women in time-intensive/male-dominated fields more likely to leave</p> <p>Women in public sector less likely to leave</p> <p>No negative effects for men</p>	<p>Modest negative effects for women</p> <p>Stronger and persisting negative average effects for male and female workers of 40 years</p>	<p>Few studies on younger workers for caregiving of adults</p> <p>Few studies on older workers for parenthood (most address new parents only)</p>
Early retirement	NA	<p>One working paper showed caregiving for parents was associated with early retirement (Miller et al., 2022)</p>	<p>No available U.S. studies for the effect of family caregiving on early retirement, particularly for double-duty caregivers</p> <p>Reverse causal effects (i.e., if caregiving affects retirement decision or retirement decision affects caregiving) is unanswered</p>

Hours of work, part-time, full-time	Generally, new mothers move to less intensive work, with most evidence available from international literature	Generally, caregiving is associated with less work hours. Effect sizes are mostly small, with larger effects among those who provide intensive care intensively (20 hours/week) Caregivers are less likely to work full-time compared with non-caregivers	Few U.S. studies investigate full- to part-time employment transition once individuals are engaged in caregiving One study provides a description of employment status between caregivers and non-caregivers (Skira, 2015) International studies show caregivers are less likely to work full-time
Reentry into labor force, return to work	Overall, new mothers who exit return to less male-dominated/ time-intensive jobs, or to public sector jobs	No causal studies on return to work among caregivers who exited the labor force for care responsibilities One descriptive study shows caregivers return to work less often, especially those who take care of spouses with disabilities One study shows caregivers who return to work face a wage penalty (i.e., receive job offer with lower wage than that of the preretirement period), suggesting a lower probability of return (Skira, 2015)	NA
Job/career opportunities (promotion, tenure/tenure denial, time in rank, moves off tenure track)	Very few articles that are quasi-experimental Some papers evaluate policy measures to increase tenure rates for mothers, with perverse outcome, whereby the fathers are helped instead	NA	NA
Occupational status/ attainment	Some evidence that women make up for early losses in occupational status of new parenthood over the life course	NA	NA

Earnings, wages, wage penalties	Substantial wage penalties for new mothers Wage penalties not identified for new fathers	Modest wage penalties for older working women Wage penalties not identified for men	Robust U.S. literature on average effects, although few studies look beyond to intersectional identities (e.g., same-sex couples, workers racialized as Black, etc.)
Productivity at work, work productivity and impairment index, number of publications, citations	Robust literature shows a broad reduction in productivity for mothers compared with fathers, which narrows over time Some evidence indicates productivity does not differ by gender after 5 years of parenthood	One working causal study on work productivity was identified (Kolodziej et al., 2022) with no effects of intensive caregiving on work productivity compared to nonintensive caregivers	One article with a causal approach examined academia (one in the United Kingdom performed matching), and included a single academic STEM field, computer science (Morgan et al., 2021)

Expected Effects among Women in Academic STEM May Differ from Population-Level Studies

Findings related to all working mothers or those in nonacademic STEM may not directly translate to mothers in academic STEM, as these women often have higher labor force attachment than the general work population. Academic STEM-specific studies could potentially indicate lower labor force exit or switching. Gender earnings gaps are also well established in academic STEM (at least academic medicine). It will thus be important to examine if less flexible, in-person STEM fields such as medicine or those requiring on-site lab work are associated with lower wages for women, compared with fields more amenable to working from home (Goldin, 2014). Age difference patterns in academic STEM are also unclear, as positions beyond postdoctoral fellowships often occur after children are born, or children appear soon after a first assistant professor appointment (mean age of first birth is 33 years in STEM). Importantly, caregiving may particularly impact graduate students and postdoctoral fellows, as they are often not considered full-time employees and are ineligible for family support and economic resources, despite low earnings at this early-career stage. Thus, the ability to remain in academic STEM may be strongly inhibited for these individuals. Further, weekly hours are extremely difficult to observe in academic STEM but may be crucial to understand the role of work intensity on earnings gaps.

As a collaborative industry, new mothers in academic STEM fields may exhibit lower productivity loss than those in solo or small teams. Productivity depends on factors such as co-authorship team gender. Little evidence of bias in manuscript acceptance for all female scientific teams compared with mixed gender or male teams has been shown (Squazzoni et al., 2021). Female collaborators and minoritized faculty members, however, less often receive co-authorship recognition compared with male co-authors (Larson, 2021), which may be career damaging as institutions adopt citation counts and h-indices for promotion and tenure decisions. Certain universities, such as Duke School of Medicine, thus recommend that citation counts and h-indices are omitted from consideration. Overall, the marginal effect of motherhood on inequities in observed productivity and the likelihood of contribution recognition for new mothers in academic STEM fields has not been established, as related studies have not focused on STEM fields.

Evidence-based data on the economic impact of caregiving among women in academic STEM fields are scarce. Future studies are needed to drive evidence-based policy formation to support female academic STEM workers and to address the unique evidenced-based challenges faced by women in this sector.

Spillover Effects of Caregiving Contribute to the Full Economic Impacts of Caregiving

Estimates of caregiving economic impacts rarely include the negative spillovers to caregiver personal health (Coe and Van Houtven, 2009; Kolodziej et al., 2023). Health effects of parenthood were not examined in the motherhood penalty literature, although consideration was given to negative health spillovers in adult caregiving literature. Also, the overall impact of the COVID-19 pandemic on women in academic STEM is currently unknown, although lower academic paper submission rates were found for women than for men postpandemic. Additional exacerbations may also exist for women with children and/or other family caregiving duties that differ from effects on similar men.

An important spillover effect to consider may be the hindrance of economic growth caused by an underrepresentation of women in academic STEM. Understanding the macroeconomic effects of this underrepresentation will be required to detail the net societal benefits of supportive policy development for women in academic STEM. Reduced work among caregivers in academic STEM likely impedes economic growth and gross domestic product (GDP), meaning policies to preserve workers can enhance growth (Gibbs, 2022). Policymakers and scholars have also noted that the lack of women in STEM restricts scientific creativity and threatens innovation and economic competitiveness in the United States. Others have also established the harmful impact of misallocation of talent in the economy. Examination of economic growth between 1960 and 2010 showed that the increased number of female and Black male doctors and lawyers, shifting from an almost exclusively white male field, accounted for a growth of two-fifths in U.S. GDP per person, and a rise in labor force participation (Hsieh et al., 2019). Similar findings have been shown for entrepreneurship, where costly gender gaps reduce both income and aggregate productivity due to a reduction in average talent, leading to an average income loss of 15 percent in the OECD, 40 percent of which is due to entrepreneurship gaps (Cuberes and Teignier, 2016).

A small volume of literature has also shown reductions in inventions and innovation due to a lack of women in science. As just one in six patents are held by women, and as women are often faced with solving medical problems impacting women (Cox, 2021), this represents an innovation loss in the patents lost, as well as in women's health (Cech and Blair-Loy, 2019). Specifically, patents are 35 percent more likely to focus on women's health with all-female teams compared with all-male teams. Interestingly, certain literature also shows that diverse teams improve team functioning. Thus, advancing science necessitates incorporating women onto teams. This is likely true for historically underrepresented women also (e.g., racialized as Black); however, supporting literature was unavailable.

Collectively, these studies suggest that underrepresentation of women in STEM is costly to economic growth and innovation. However, gaining a full understanding will require quantification of economic growth effects of both underrepresentation and the individual economic impacts on women and

families in academic STEM. Economic growth consequence and population-level studies will need to consider the compounded negative work and economic growth effects arising from lack of diversity in academic STEM by race, gender, sexual orientation, and disability status.

GAPS IDENTIFIED IN THE EVIDENCE FOR CAREGIVING IMPACT ON ACADEMIC STEM

Epidemiologic studies are needed to establish the prevalence of both child and adult caregiving in academic STEM overall, according to demographic characteristics (e.g., gender, race, age, rank), and compared with other STEM fields and the national worker population. Studies are also required to assess selection into caregiving and the subsequent effects on occupational choice, as preexisting caregiving duties may prevent entry into academic STEM. Research is also needed to establish how individuals in academic STEM choose to commence caregiving, as data for caregiving for parents has indicated that, among siblings, the adult child with lower opportunity time costs will commence family caregiving (Engers and Stern, 2002). However, available empirical evidence to date has been inconclusive as preferences, cultural norms, and skill are not necessarily driven by opportunity costs. Research is particularly needed to investigate the selection of women in academic STEM into adult caregiving. A foundational descriptive working study reported evidence of substantial educational interruptions when children and young adults assume the caregiving role. Specifically, 4–5 percent of youth and young adults are engaged in caregiving and are less likely to enroll in school or spend significant time on educational activities than non-caregivers (Miller et al., 2022).

The overwhelming evidence on wage and productivity differences for women in motherhood/parenthood literature are not reflected in literature for caregiving of older and disabled adults. Focusing on late-career workers may help to fill this evidence gap by improving understanding of persistent (or narrowing) wage gaps at older ages when caregiving of older adults typically begins (age 55). Importantly, literature on parenthood and family caregiving of older and disabled adults do not

interact, nor do they address compounding causal effects of caring for multiple family members (children and older adults) or children with medical complexity. Quantifying sandwich generation effects will become increasingly important with delayed fertility and the tendency for female academic faculty to have children at older ages compared with the general population (Morgan et al., 2021; Evans et al., 2016). This integration should consider assessing if grandparent-provided care increases the ability of academic STEMM workers to thrive at work, as shown in a more general population (Zanella, 2017; Posadas and Vidal-Fernandez, 2013). The National Longitudinal Survey of Youth could be a vital source for such work.

Studies of new parent labor force exit tend to focus on individual behavior, despite fertility and labor force choices often occurring at the family level. This individualistic approach is an important gap in the literature, particularly given the understood value of joint labor market decisions of households and couples (e.g., joint retirement decisions) in the field of labor economics. Thus, controlling for labor force decisions of the partner and expanding datasets to understand the family dynamics behind changes in work for women in academic STEMM are vital. Although some studies have controlled for spouse work behavior and differential earnings within couples (Cech and Blair-Loy, 2019), further examination of dyadic characteristics outcomes could be illustrative. Flexible work for both members of the couple may alter work outcomes for women (as the marginal worker).

RESEARCH TOOLS AND STRATEGIES FOR FILLING THE IDENTIFIED GAPS IN

EVIDENCE

Better Data

To address the new research agenda highlighted previously, new datasets are required to quantify if women caregivers in STEMM are thriving or struggling economically, as current national data lack the

statistical power needed. The Current Population Survey (CPS), for example, does not allow for focus on academic STEM workers and omits caregivers of adults.

University-Based and Academically Affiliated Data

New data from universities and academically affiliated health systems are needed to evaluate the impact of caregiving both within and across STEM fields. As the largest national entity for training medical residents and an academically affiliated integrated health system employing more than 11,000 doctors, the VA is an important data source (Finnegan, 2017). The VA, however, does not provide an understanding of the prevalence of caregiving among its doctors. Employee surveys are thus vital for identifying the prevalence and associated work outcomes of child and adult caregiving in academic STEM.

Employer-Based Data

Examination of employer-side data would allow assessment of labor force exits and work hours among caregivers in academic STEM. Further, a detailed understanding of both research hours as a subset of all work hours (e.g., service, teaching, mentoring) and publication history is needed, given that promotion criteria are heavily weighted by grants and publication success. Currently, inexact time proxies such as article submission rates are available for work-hour analyses, while data-sharing consortiums across institutions allow for systematically assessing policies and supports at the university or medical center level. Importantly, including markers of discrimination in these databases would be instructive (Moors et al., 2022), although disclosure of this data may be protected in data use agreements at identifiable universities. Analyses of emerging trainee data may uncover leaky pipeline rates, such as the voluntary database that was built based on transparency of trainee experiences and outcomes across 39 participating institutions (Blank et al., 2017). Broad representation of institutions will be necessary to

ensure optimal data generalizability, as well as for secondary purposes such as profiling academia exit rates. These databases could inform future evidence-based policy formation to support women in academic STEM.

Public Data

Many nationally representative public datasets do not allow for adequate consideration of caregiver occupation and often neglect younger subpopulations of important family caregivers. The HRS, for example, is comprised of individuals aged 50 years and older. Further, while the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System national health survey includes family caregiver modules and covers younger caregivers, these modules are not available across all states and lack work variables. The Survey of Income and Program Participation is another nationally representative longitudinal dataset that provides occupation, employment, earning, welfare benefits, household demographics, and caregiving details (both childcare and adult care). The caregiving module, however, became unavailable after 2014, which complicates both child and adult caregiving studies. Importantly, the NLSY and PSID have been used effectively in parenthood-based literature, although not in adult caregiving literature. University-wide, health system, and national longitudinal survey data specific to individuals aged 18–64 years are needed to progress and ensure adequate representation of caregiving populations. Combined university administrative data and self-reported data would allow examination of how flexibility, fertility, age, work hours, publication counts, citation counts, rank, and field interact to explain gender earnings differences.

Relatedly, studies within academic STEM are needed to establish how intersectionality affects thriving at work and the extent to which systemic racism compounds factors for child and adult caregiving pressures. National analyses examining contextual factors among minoritized and marginalized populations, to inform potential heterogeneity of effects of parenthood in academic

STEMM, were not identified in the literature; all but one study focused on male-female couples (Andresen and Nix, 2022).

Qualitative Datasets

International evidence has shown that women in STEM receive both beneficial mentoring and harmful discrimination, with one study suggesting these women had “survived” their work environments through determination, resilience, and interest. Trusted qualitative research participation should thus be supported to establish similar trends in the United States, as women in academic STEMM may be guarded. Nevertheless, understanding how women in academic STEMM disclose or time births to minimize disruptions or appearances of disruptions at work is crucial. In medicine, for example, new mothers completing residency are permitted just 4 weeks of leave to prevent training disruptions. Others may choose to hide caregiving roles, although this may be easier for adult caregivers, than individuals who are pregnant. It is unknown whether new parents or caregivers of older adults hide their role due to discrimination fears. Mixed-methods study designs, such as those conducted by Prieto-Rodriguez and colleagues (2022) and Kossek and colleagues (2020), will be required to uncover specific experiences and compensating choices of women in academic STEMM. As women face gender discrimination and other compounding factors, women may refrain from using the few existing policies that have been designed for their support.

Better Policy Evaluations in the United States

Rigorous evaluation of current policies to determine those which have been effective for women in academic STEMM will inform the development of supports for women with additional caregiving responsibilities. Evidence for protective policies, such as for long-term wage penalties, however, has been

mixed. There are few national policies for adult caregivers, with paid family leave being the only option shown to protect female labor force participation.

Current Policies in Academic STEM

Across high-income countries, family-based policies associated strong reductions in gender disparities have focused on early childhood spending (both cross-country and microdata) and in-work benefits (microdata) (Olivetti and Petrongolo, 2017). Co-interventions and co-intervention effects, however, likely exist for women in academia. In the United Kingdom, generous maternity provisions and improved childcare availability have been associated with higher earnings, possibly due to reduced crowding of research activity (Troeger et al., 2020). Thus, a supportive work environment is critical for retention of women. Collectively, these findings suggest the need for a multifaceted policy response to motherhood penalties, and to consider both bundled and individual policy effects moving forward. Evidence suggests it is difficult to conclude which policies are “best” among comparisons of family policies in high-income countries, although subsidized childcare was concluded to have a somewhat stronger case than parental leave (Olivetti and Petrongolo, 2017). This may be because, particularly for longer durations of job protection and paid leave, parental leave policies often reinforce gender stereotypes and discourage hiring and promoting women. The net effects of an individual’s exposure to multiple policies is yet to be established and to guide evidence-based policy supporting women in academic STEM.

Workplace Policies

U.S.-based studies on productivity in new parenthood have concluded that policies providing more workplace flexibility for parents, such as accessible lactation rooms and affordable childcare, may lessen the impact of parenthood on research time (Morgan et al., 2021). Yet, the impact of flexible work

arrangements on caregivers thriving in academic STEM is poorly understood. Increased working from home, accelerated by the COVID-19 pandemic, may have aided caregiving academic women in STEM. In popular press reports and a report from an advocacy organization, family caregivers report that it is easier to fulfill work and caregiving duties from home (Cuadra, 2023; Mayslich and Blessing, 2023). However, if women remain at home while men return to the workplace, this may lead to decreased connections, visibility, and productivity that could exacerbate the motherhood penalty. A 2022 American Time Use Survey report showed that college-educated individuals were more likely to continue working from home, specifically 41 percent of female workers compared with 28 percent of male workers.

Policy evaluations will need to consider negative individual effects and spillovers, such as labor force exits and reduced tax revenues (Van Houtven et al., 2013), as well as spillovers to other public programs. For example, policies that increase labor force participation of women in academic STEM and reduce the ability to commence caregiving may increase tax revenue, while also increasing long-term care costs (e.g., to Medicaid) as the family member enters a nursing home. Cross-sectoral effects of policy remedies, therefore, need to be considered to assess net societal benefits and costs of increasing women in academic STEM across the working life course, or even extending that working life course.

Additional research on how preventing academic STEM exits due to caregiving may affect economic growth would quantify important societal impacts of caregiving, beyond the individual earnings and nonmonetary costs (such as health) to women in STEM, their families, and the government. Evaluations need to reveal average effects of policy remedies as well as heterogeneity of effects such as increasing the number of women with intersectional identities in academic STEM.

The Uptake of Benefits

Women and mother-centered studies will be needed to determine where policy supports are lacking, such as for fears surrounding job security or discriminations (Lovejoy and Stone, 2012). Exit

interviews from women who leave academic STEM, for example, would be extremely valuable to direct policy changes needed for progress. The same would be true in a non-STEM context for women who left professional careers with a plan to return to work, planned to return into a “traditionally female-dominated profession” due to negative experiences in family inflexible occupations, skill depreciation, and perceived age discrimination.

One promising employer-based practice would be enhancing work flexibility for academic faculty in STEM, such as through permanent online teaching and assigned office days. Importantly, evidence suggests that women spend more time on nonresearch activities such as teaching, leadership to advance diversity, equity, and inclusion, which are neither registered as article productivity nor rewarded in promotion evaluations. This is starting to change, such as shown by Indiana University-Purdue University Indianapolis explicitly rewarding an integrated case for diversity, equity, and inclusion advancement in its promotion criteria (Flaherty, 2021) with many universities adopting such changes, such as Virginia Tech in 2009 (Gasman, 2021)). This is not the norm nationally.

Increasing the uptake of benefits by men may be more possible for both child and adult caregiving, given higher rates and intensities of care by women compared with men. As shown in Germany, culture can affect work attachment (Boelman et al., 2021) and thus, if men take leave to care for children, this could alter the culture and increase women’s ability to work and productivity (Maume, 2016). The “daddy leave” policies in Denmark and Quebec showed mixed results, with some suggestion that longer-term care in the family tilted to a higher level of father-provided care. The COVID-19 pandemic may have accelerated cultural change, due to the initial economic downturn in female-related fields, followed by more women regaining work and more men being a primary caregiver of children (Alon et al., 2020). Longer-term evidence, however, will be needed.

Policies Affecting Research and Support Staff

Childcare subsidies may provide much higher value to lab-based research staff than extended maternity leave benefits, due to the high proportion of lower income families salaries that are spent on childcare (Horowitz et al., 2022). Keeping a stable research staff longitudinally can be vital for faculty productivity in team science. Within policy design, policy changes at the university and medical center level should follow Kossek's recommendation and be co-designed with academic STEM faculty, including postdocs and graduate students, who face the least policy support and are at heightened risk of exiting academia (Kossek et al., 2020). Engaging diverse academic STEM faculty will be vital due to the higher risk of negative work outcomes facing certain individuals and a need for user-centered and equitable policy designs and strategies (Hammonds et al., 2021).

CONCLUSIONS

Rich evidence exists that motherhood substantially interrupts work, with consequences for wages and productivity over the life course that make it very difficult to recover. Motherhood and work studies have focused on work overall or by occupation, with only a couple identified that assessed at academia and just one that included a single STEM field, computer science (Morgan et al., 2021). The parenthood-penalty literature generally examined a wide range of work outcomes, including job exit, job switching, and earnings penalties. A relatively smaller body of work has established that caring for older and disabled adults causally and modestly leads to reductions in work and hours at work and accompanying modest wage penalties. Both literatures found that effects on male caregivers are less pronounced or nonexistent, but one needs to consider that the null effects thus far for men may be at least partly due to the less intensive caregiving provided by males and the resulting lower statistical power available to detect effects. Policy supports in the United States thus far have been weak yet have shown some success retaining women at work. Indeed, some policies at the university level have helped parents but have had distortionary effects by helping men and not women gain tenure. Investing in early needs of

parenthood (childcare, universal pre-K programs, paid leave) as well as other initiatives to increase time flexibility and subsequently productivity would be an impactful direction for future policy experimentation, formation, and evaluation.

Gaps in the understanding of work effects from caregiving remain. Almost no empirical studies of family caregiving and work outcomes identified focused on academic workers, nor academic STEMM. Few of the caregiving of older and disabled adults and work studies included younger workers, and no studies examined the combined effect of sandwich generation caregiving on work outcomes. Thus, to fill gaps in the empirical literature, improved datasets and studies focusing on academic STEMM will provide a more precise picture of the extent to which women are thriving at work. Despite the high labor force attached among STEMM workers, few qualitative studies assess how women in academic STEMM and their families experience parenthood/onset of adult caregiving and adjust to remain at work following caregiving onset. Little university-level data or data across university consortiums that document implemented policies are available, thus employer data combined with individual worker data could advance the field. Moving forward, university, state, and national policies to help academic STEMM workers thrive at work must be women centered and evidence based where possible. Women face large work penalties from motherhood and relatively modest penalties from adult caregiving overall, but there are gaps in evidence on academic STEMM. Nevertheless, the evidence in this review suggests that policy remedies will very likely be necessary to support academic women in STEMM and thereby accelerate scientific innovation nationally by including voices of women and diverse individuals in academic STEMM fields.

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