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# Gender Inequality in Research and Service amongst Natural Sciences and Engineering Professors in Canada

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## ABSTRACT

Little is known about gender inequality in Canadian professors' workloads in particular whether or not women perform more service than men. To address this gap, we explore the distribution of research and service work amongst Natural Sciences and Engineering (NSE) professors from the Atlantic and Prairie provinces. We further investigate whether women are disproportionately responsible for activities intended to improve gender equity (for example, youth recruitment targeting girls to account for women's underrepresentation in NSE); and ascertain the professional and personal effects of heavy service demands. Statistical analyses of a cross-sectional online workplace experiences survey indicated that men spent significantly more time on research than women, while women spent significantly more time on service than men. Women reported significantly more time spent on professional development and outreach activities than men, specifically. Women's heavier service load was associated with decreased research productivity, longer terms as assistant professors; and below average salaries, as compared to men of similar rank and experience. Moreover, women's well-being was negatively affected by heavy service. Accordingly, women's disproportionate responsibility for service is an obstacle to gender equity in academic NSE in Canada; and suggests that initiatives intended to improve gender equity in NSE may be detracting from women's research time.

## KEYWORDS

STEM, gender, research, service, academia, Canada

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## INTRODUCTION

There is some evidence of structural gender inequality in natural sciences and engineering (NSE) departments in Canada which suggests that women's careers are undermined, while men are better positioned for achievement such as promotion from assistant to associate and, finally, full professor. Specifically, women are underrepresented amongst the Canadian NSE professoriate (for example comprising less than 25% of full-time faculty members in engineering and computer science); are less likely than men to be full professors; and spend a significantly longer time as assistant professors than men (Canadian Association of University Teachers, 2014; Ornstein et al., 2007; Perreault et al., 2017; CAUT, 2018).

Yet, compared to the United States, there is a lack of data examining gender inequalities within the Canadian professoriate. Aside from informative reports (for example Canadian Council of Academies, 2012; Perreault et al., 2017), the reasons underlying women's seemingly delayed career progression in NSE have remained largely unexplored. However, research with U.S. science, technology, engineering, and mathematics (STEM) professors suggests that an inequitable distribution of research and service between men and women may be a key reason for women's underrepresentation amongst (or slower ascension to) associate and full professor, specifically (Misra et al., 2011).

Research success is essential for promotion and tenure in Canada. Consequently, research activities such as obtaining funding and publishing in journals are the most highly valued and rewarded, followed by teaching and service (Acker et al., 2012; Dengate, Farenhorst, & Peter, 2019). Service may include an array of internal and external activities (Guarino & Borden, 2016). Internal service is undertaken within one's university including hiring and promotion/tenure committees, but may also include administrative roles, such as Department Head/Chair; and, depending on the university, may even encompass professional development activities[1]. External service is based outside of one's university. It may involve community-, national-, and international-level activities, such as being an editor for an academic journal or a member of a scientific board (such as the International Union of Pure and Applied Chemistry).

Some U.S. and Canadian scholars argue that women's disproportionate responsibility for service and care labour at work, such as helping students with personal problems, detracts from their research time (Acker & Feuerverger, 1996; Bellas, 1999; Bird et al., 2004; Dengate, Peter, & Farenhorst, 2019). Men's lighter service loads, in contrast, allow men to spend significantly more time on research than women and later reap the rewards of greater research productivity (Bellas & Toutkoushian, 1999; Bird et al., 2004; Park, 1996). Thus, gender-based workload inequality (i.e., women spending more time on "low-value" service and less time on "high value" research than men) can lead to structural gender inequity throughout

universities, wherein men may be expected to hold a disproportionate share of the senior positions relative to women, for example (Acker, 1990).

It is presently unclear whether women and men professors in Canada engage equally in the amount of research and service they do, as analyses of time allocation and research and teaching orientations have not reported gender comparisons (Gopaul et al., 2016; Jones et al., 2012). Accordingly, we add to the literature by exploring gender inequality in Canadian NSE professors' scholarly activities. We ask, how is research and service time distributed between women and men at each faculty rank (assistant, associate, and full professor), including differentiating between types of service both internal and external; and how are professors impacted professionally and personally by heavy service demands?

## LITERATURE REVIEW

The literature review is limited to research on Canadian and U.S. academics, given the cultural similarities between these two countries, including similarities in university systems, such as neoliberal policies that have promoted a market-based approach to post-secondary education (Acker et al., 2012). Nevertheless, we acknowledge there are important contextual differences, such as the pervasiveness of union membership amongst the Canadian professoriate and greater homogeneity amongst Canadian universities than US universities (Acker & Webber, 2017). Canadian and U.S. professors generally engage in three core scholarly activities: research, teaching, and service. Again, research is the most highly valued and rewarded, followed by teaching and service (Acker et al., 2012; Acker & Webber, 2017).

We begin the literature review by discussing what is known about Canadian professors' workloads. We then describe the extent of gender and rank differences in research and service for pooled samples of multidisciplinary professors in the U.S., followed by the workload distribution of STEM professors. Finally, we discuss cultural and organizational reasons why women may perform more service/less research.

### Canadian Professors' Workloads

Some women professors in Canada have reported having a greater responsibility for service and tending to students' emotional needs than men (Acker & Feuerverger, 1996; Dengate, Peter, & Farenhorst, 2019). Service and care labour in the workplace can divert women's time away from research, which may affect their advancement prospects and exact a personal toll, such as increased stress (Acker & Feuerverger, 1996; Armenti, 2004; Dengate, Peter, & Farenhorst, 2019). Indeed, Weinrib and colleagues (2013) found women professors were significantly more likely than men to report that their job was a source of considerable personal strain. However, service loads were not examined.

Analyses of the Changing Academic Profession (CAP) survey found that assistant professors in Canada reported similar working conditions and job satisfaction as their associate and full professor colleagues (Jones et al., 2012, p. 197). During teaching terms, assistant professors performed more weekly hours of research

(16.3 vs. 15.7 hours); teaching (22.4 vs. 18.9 hours); and service (4.0 vs. 3.8 hours) than their more senior colleagues, but their total number of weekly hours were nearly identical. Assistant professors logged a total of 48.4 hours, compared to 47.5 hours for associate and full professors, with associate and full professors spending more time on administrative duties than assistant professors (Jones et al., 2012).

A slightly higher percentage of assistant professors reported high or very high levels of job satisfaction, as compared to associate and full professors (80% vs. 73%), but gender and/or rank differences in work hours were not reported (Jones et al., 2012).

**Gender and Rank Differences in Research & Service**

Some U.S. research using multidisciplinary samples of professors, including STEM professors, has found that men spend significantly more time on research than women, which bolsters men's research output, such as journal publications (Bellas & Toutkoushian, 1999). Male associate professors in the U.S. spent an additional seven-and-a-half hours per week on research than female associate professors. On average, these men devoted an additional 12% of their time to research than women (37% vs. 25%) (Misra et al., 2011)

In contrast, women performed 1.28 more service activities per year than men; and nearly all of the gender difference was the result of women's greater internal service participation, such as committee work (Guarino & Borden, 2016). Similarly, while only minor differences in women's and men's committee time were found, Porter (2007) noted that women at doctoral institutions spent 15% more hours engaged with committees than men.

With respect to rank, some U.S. research found that associate professors performed the most service, while assistant professors did the least (Guarino & Borden, 2016; Misra et al., 2011). Misra and colleagues (2011) refer to the associate rank as the "mid-career service gully," with 75% of female associate professors reporting heavy service duties, compared to 50% of male associate professors (p. 24). Specifically, women associate professors spent five more hours a week on service than their male counterparts; and, on average, women devoted 27% of their time to service, compared to 20% for men. In addition, women associate professors serving as undergraduate program directors took five years longer to be promoted to full professor than male undergraduate directors (twelve vs. seven years). Further, women were more likely than men to serve as undergraduate program directors (33% vs. 17%), suggesting that women's career progression may be disproportionately slowed by service roles (Misra et al., 2011).

After earning tenure (generally received while one is an assistant or associate professor), the focus on research may become relatively less vital, enabling associate and full professors to spend more time on service and teaching (Link et al., 2008). Associate and full professors' service time may also increase due to protections afforded to assistant professors. Universities may have rules prohibiting assistant professors from sitting on tenure and promotion committees; or employ

an election process which increases the likelihood of well-known, senior professors being nominated (Porter, 2007). Informally, department heads and colleagues may also shield assistant professors from service to allow them to focus on research, which is more important for promotion and tenure (Pyke, 2011).

Yet, full professors' seniority may also empower them to refuse service (Misra et al., 2011). Indeed, full professors reported more service than assistant professors, but completed fewer service hours than associates (Guarino & Borden, 2016). Compared to their assistant-level colleagues, full professors performed more external service. However, female full professors outpaced their male counterparts in community and national service (Guarino & Borden, 2016).

**STEM Professors' Research & Service**

The U.S. evidence describing STEM professors' workloads is somewhat mixed. Some scholars found that men spent significantly more time on research than women, who performed more service (Blackwell et al., 2009; Link et al., 2008; Misra et al., 2011). Indeed, Misra and colleagues (2011) found gender differences in research and service time to be most pronounced amongst STEM professors. Yet, Carrigan and colleagues (2011) found that men engaged in more research *and* service than women, overall. Increased research time was associated with greater workload satisfaction for women, whereas more time in service decreased women's workload and job satisfaction (Carrigan et al., 2011). However, gender differences were mediated by a critical mass of women. Specifically, women in STEM departments with at least 15% women professors spent more time on research and graduate teaching, and less time on undergraduate instruction, compared to departments with fewer women. Yet, women in departments with a critical mass of women also did more service than women with fewer women colleagues. Carrigan and colleagues (2011) surmised that women with more female colleagues could be channelling the time that they gained from reduced undergraduate teaching into more service.

With respect to rank, assistant science and engineering professors spent the majority of their time on research, with male assistant professors devoting three more hours per week to research than female assistant professors (Link et al., 2008).

After receiving tenure, women and men in science and engineering spent less time on research, but the decline was greater for women (Link et al., 2008). Similarly, Misra and colleagues (2011) found men associate STEM professors spent 42% of their time engaged in research, compared to 27% for their female counterparts. Women associate STEM professors devoted 25% of their time to service, compared to 20% for their male colleagues (Misra et al., 2011). Some research found that service demands tended to increase during the first 20 years of science and engineering professors' careers, with women full professors spending the most time on service (Link et al., 2008). However, specific service activities were not distinguished, allowing for the possibility that women full professors spent more time on particular types of service. Differentiating service activities may be relevant to fully understanding inequalities in STEM professors' workloads; for example,

Jackson (2004) found no difference in research activity or committee hours amongst engineering professors but noted that white women performed more external service than white men.

**Reasons for Gender Inequality in Service**

Many women professors value service (Acker & Feuerverger, 1996). Indeed, women in the U.S. associated service with numerous benefits, including advocacy opportunities, understanding how the university works, expanding professional networks, feeling less isolated, gaining allies in administration, and increasing their decision-making power (Bird et al., 2004; O'Meara, 2016).

Yet, gender differences in time spent on service do not appear to reflect women preferring research less than men. Winslow (2010) found that male professors in the U.S. preferred to spend approximately 25% of their work week engaged in research, whereas women preferred 20%. Instead, gender differences in service time are influenced by a combination of cultural and organizational factors that constrain men's and women's scholarly "preferences" and time allocation (Winslow, 2010).

*Cultural Expectations*

Professors may feel pressure to allocate their time in "gender-appropriate" ways; performing tasks that are consistent with their culture's understanding of what men and women "are like" and "should" do (West & Zimmerman, 1987). For men, this may mean prioritizing research (i.e., work requiring analytical skills). For women, it may mean accepting service requests and, by doing so, taking care of their department's/university's needs.

Indeed, O'Meara (2016) found that some U.S. professors engaged in gendered thinking about service. Men were more likely than women to characterize service "as a distraction or burden that could hurt your ability to do the 'real work' of research," unless it could be leveraged to meet career goals (p. 20). Accordingly, men's approach to service was individualistic and more likely to include boundary setting (p. 20). Women were more likely than men to see service as a collective responsibility. Some women noted that they "had to" take on this work because there was no one else who could do it (or do it well); that refusing service might mean particular groups could not accomplish goals; and that junior colleagues would be burdened with extra responsibilities (O'Meara, 2016, p. 16). Thus, to avoid violating expectations of "proper" feminine support and collegiality, women may feel pressured to accept service requests (Pyke, 2011). Similarly, as men are not expected to be as agreeable and helpful as women, men may not face criticism for limited service participation.

However, professors' construction of their own gender identities at work (including whether to accept or refuse a service request) occurs within the organizational structure of their universities. As such, occupying particular positions requiring different credentials and having different duties; and the application of workplace policies also influences professors' time allocation.

*Organizational and Structural Factors*

Women in the U.S. were found to have greater mismatches between their preferred and actual time allocations than men; women spent less time in research than they wanted (Winslow, 2010). However, women's relative inability to match their time allocation to preferences were largely attributed to their education and rank. Women were less likely than men to hold doctorates and more likely to be instructors and lecturers (which are often temporary, teaching-focused contract positions and/or ineligible for tenure). Consequently, women in some teaching-focused roles or at teaching-focused institutions may have fewer opportunities to prioritize research (Winslow, 2010).

Yet, educational differences cannot explain gender inequality in research amongst women and men professors who hold doctorates and have tenure-track (or tenured) positions, as research is expected in these roles. One explanation is the interaction between gendered cultural expectations and university service roles. Students may prefer to have a woman undergraduate advisor, for example, assuming them to be warmer and more empathetic than men, increasing the time they spend with students/on service, and detracting from research (Mottarella et al., 2004; Nadler & Nadler, 1993).

In addition, the practice of shielding junior professors from service may be gendered. O'Meara (2016) found that men were more likely than women to be shielded from service by colleagues. Similarly, equity and diversity policies may require women to be represented on committees, increasing pressure for women to accept service requests (Acker & Feuerverger, 1996; Pyke, 2011). These policies may greatly influence women NSE professors' service loads, as there are likely few women to share committee responsibilities to begin with, due to their underrepresentation in NSE units (Blackwell et al., 2009).

In sum, the literature on U.S. academia suggests that men face fewer cultural and organizational constraints on their time than women. Gendered cultural assumptions linking service to "feminine" communality (being a helpful teammate) and the institutional devaluation of service may lead men to avoid or limit service or be protected from it by others (O'Meara, 2016). Conversely, women may encounter more pressure to accept service, especially if universities require that women are represented on committees (Blackwell et al., 2009; Pyke, 2011). To the extent that pressure/requests to take on service result in women shouldering heavier service loads, women may spend significantly less time in research than men; and experience negative consequences, such as anxiety, promotion delays, and reduced job satisfaction (Acker & Feuerverger, 1996; Carrigan et al., 2011; Misra et al., 2011).

Accordingly, we expect women will spend significantly more time on service than men at every rank; and men to engage in significantly more research than women at every rank. Yet, we anticipate heavier service loads will be associated with negative professional outcomes for both women and men, as we expect service to be negatively correlated with research time (Bellas & Toutkoushian, 1999).

## METHODOLOGY

### Data and Sample

We administered a cross-sectional workplace experiences survey to NSE professors from 12 Canadian universities located across the Prairie provinces of Alberta, Saskatchewan, and Manitoba; and the Atlantic provinces of Newfoundland and Labrador, Nova Scotia, New Brunswick, and Prince Edward Island. The sample included medical/doctoral universities (broad range of doctoral programs, including medical degrees); comprehensive universities (significant research activity, offer professional degrees and wide range of undergraduate and graduate programs); and undergraduate universities (few graduate programs and students) of varying sizes (Maclean's, 2019). The sampling frame was generated from university websites. After receiving ethics approval, professors were emailed an invitation with a link to access the survey online. The Prairie data were collected between September-November, 2017; and the Atlantic data were collected between April-June, 2018.

Our final sample included 686 cases, representing a response rate of 22%. Nearly two-thirds (63.7%) of the sample identified as men and 36.3% as women. Nearly half are full professors (46.7%) and the mean age is 49.4 years old (SD = 10.02; Md = 48). Associate and assistant professors constitute 26.4% and 16.5% of the sample, respectively, and 10.5% are teaching stream faculty. Women in our sample are more likely than men to be instructors/lecturers (17.4% vs. 6.0%) and assistant professors (17.4% vs. 13.7%). Men are more likely than women to be associate (28.4% vs. 25.3%) and full professors (51.9% vs. 40.0%).
Most (59.7%) are in science faculties, 20.3% work in engineering or related disciplines, and 20% are from agriculture, forestry, ocean/fisheries or other fields. The majority have tenure (75.3%) and most are white (86.0%), with 14.0% reporting a racialized identity.

### Measures

The survey covered a number of topics expected to influence workplace climate, including workload density, harassment/discrimination, and experiences with students. The main independent variables are gender (male, female, transgender, and non-binary) and rank (lecturer, instructor I, instructor II, senior instructor, assistant professor, associate professor, and full professor). Less than 2% of respondents identified as transgender or non-binary, making it impossible to conduct robust statistical analyses. Therefore, we use a dichotomous measure of gender (0 = man, 1 = woman), excluding the transgender/non-binary cases. All levels of instructors and lecturers were grouped together into one category. In addition, all teaching stream faculty and instructors/lecturers were excluded from research-specific analyses (n = 71, 10.5%).

*Research and Service Activities*

Research was assessed with two items. Respondents were asked to estimate the amount of time they spent on research activities and the extent of their publication record (0 = well below average, 4 = well above average). A Pearson's correlation indicated a strong association but not enough to suggest multicollinearity (r = .66). Service was measured with four items, asking professors how much time they

spent on professional development, on internal service (such as committees), on outreach work/youth engagement, and on service external/outside of the university (0 = well below average, 4 = well above average). Respondents were free to interpret the term "professional development". The Cronbach's alpha coefficient of scale reliability indicated relatively good internal consistency between the four service items (α = .62).

*Perceptions and Consequences of Workload Density*
The workload density items were used as both outcome and explanatory measures. Respondents were asked if they have too many research projects, teaching responsibilities, and service to do them all well. In addition, respondents indicated whether or not they feel emotionally drained from work; and used up at the end of the workday (0 = strongly disagree, 4 = strongly agree).

*Professional Outcomes*
Career satisfaction was assessed with a four-item index (0 = strongly disagree, 4 = strongly agree) (α = .80), adapted from the Career Satisfaction Scale (Greenhaus et al., 1990). Respondents were also asked whether or not they feel valued for their research-related service outside of the university (0 = strongly disagree, 4 = strongly agree). Similarly, respondents indicated how their salaries compared to other faculty members in their department/unit of similar rank and experience (0 = well below average, 4 = well above average). We also calculated the length of time to promotion, asking what year respondents started as assistant professors, followed by the years they were promoted to associate and full professor (if applicable). Higher scores indicate longer times to promotion. Finally, intent to leave the university was measured with a three-item index asking if respondents have been actively looking for employment at another university, outside of academia, and if they planned on leaving their current university within the next 2 years (0 = strongly disagree, 4 = strongly agree). Those who were planning to retire within the next 2 years were excluded from the index (n = 40, 5.8%).

**Analytic Procedures**
All statistical analyses used SPSS (v.25). We calculated gender and rank differences in research and service (individual items) using chi-square tests, including Cramer's V analyses of effect size and strength of association; and independent samples t-tests of mean differences. Pearson's correlations were used to assess the relationship between service/research and research productivity, years as an assistant professor, and career satisfaction. In order to aid interpretation, all indices were standardized with a mean of zero and a standard deviation of 1. Positive index scores indicated above average research/service workloads, career satisfaction, and intent to leave the university, whereas negative scores indicated below average workloads, satisfaction, and intent to leave the university. Analysis of variance (ANOVA) tests were run to test the associations between heavy service demands (0 = neutral/do not have too many service demands, 1 = too many service demands); and the career satisfaction and intent to leave indices.

Finally, we preformed two logistic regressions to investigate the independent impact of gender and service on self-reported salary (0 = average or above average, 1 =

below average); and whether or not professors feel used up at the end of the work day (0 = disagree/neutral, 1 = agree). Interactions between research, teaching, and service responsibilities and gender were included as separate independent variables.

## RESULTS

### Research and Service Time

As expected, men spent significantly more time on research and reported a greater publication record than women. Specifically, 38.9% of women reported above average research time, compared to 52.9% of men ($X^2$ (2, 469) = 8.57, p <.05, V = .14). Indeed, at each rank, men were more likely to devote more time to research than women (Table 1). However, gender-rank differences were only significant amongst full professors, with men (61.8%) being more likely to report above average research time than women (42.1%) ($X^2$ (2, 249) = 13.05, p <.01, V = .23).

Table 1 *Gender and rank differences in 'above average' research activities*

| | Time spent on research activities | | Publication record | |
|---|---|---|---|---|
| | Female | Male | Female | Male |
| Total | 38.9% | 52.9%* | 45.5% | 57.4%* |
| Assistant professor | 36.4% | 43.2% | 34.4% | 54.4% |
| Associate professor | 35.4% | 41.1% | 41.7% | 37.9% |
| Full professor | 42.1% | 61.8%*** | 52.6% | 69.0%* |

*Note.* *p<.05; **p<.01; ***p<.001

Slightly more than 45% of women reported an above average publication record, as compared to 57% of men ($X^2$ (2, 466) = 6.09, p <.05, V = .11) (Table 1). Again, the only significant gender differences in publication record were found for full professors: 69% of male full professors reported an above average record, compared to 52.6% of female full professors ($X^2$ (2, 932) = 7.36, p <.05, V = .17). Men reported below average service time expenditures, whereas women spent an above average amount of time on service (M = -.13, SD = 1.00 vs. M =.22, SD = .97; t (501) = -3.73, p <.001, d = .35). Specifically, women were more likely to spend an above average amount of time on professional development (46.2% vs. 26.7%) ($X^2$ (2, 504) = 19.94, p <.001, V = .20); and on outreach (such as youth engagement) than men (43.4% vs. 30.9%) ($X^2$ (2, 492) = 14.07, p <.01, V = .17) (Table 2).

At each rank, women were more likely than men to spend an above average time on professional development. Women lecturers/instructors spent significantly more time on professional development than men lecturers/instructors (57.6% vs. 21.1%) ($X^2$ (2, 52) = 10.34, p <.01, V = .45); as did female associate professors, compared to their male counterparts (45.5% vs. 14.3%) ($X^2$ (2, 135) = 15.61, p <.001, V = .34) (Table 2). In contrast, female assistant professors reported significantly more outreach time than their male counterparts (60.0% vs. 23.8%) ($X^2$ (2, 72) = 10.18, p <.01, V = .38); as did female associate professors,

compared to male associate professors (52.3% vs. 31.2%) ($X^2$ (2, 137) = 6.89, p <.05, V = .22). We found no gender differences in the amount of time spent on internal or external service. Thus, women's greater involvement in professional development and outreach appears to be driving gender inequality in service for our sample.

Table 2

*Gender and rank differences in 'above average' service activities*

| | Professional development | | Outreach | |
|---|---|---|---|---|
| | Female | Male | Female | Male |
| Total | 46.2%*** | 26.7% | 43.4%** | 30.9% |
| Instructor/Lecturer | 57.6%** | 21.1% | 48.1% | 63.2% |
| Assistant professor | 48.5% | 30.2% | 60.0%** | 23.8% |
| Associate professor | 45.5%*** | 14.3% | 52.3%* | 31.2% |
| Full professor | 41.9% | 33.1% | 30.1% | 28.4% |

*Note.* *p<.05; **p<.01; ***p<.001

Rather than a "mid-career service gully" for women associate professors (Misra et al., 2011, p. 24), we found gender differences in service amongst assistant and full professors. Women assistant professors spent more time on service than their male counterparts (M = .11, SD = .76 vs. M = -.38, SD = .98) (t (71) = -2.31, p <.05, *d* = .56). Likewise, female full professors devoted more time to service than male full professors (M = .30, SD = 1.01 vs. M = -.09, SD = 1.0) (t (501) = -2.81, p <.01, *d* = .40).

**The Impact of Service**

We found an inverse correlation between the service and research indices for women (r = -.16, p < .05). Moreover, the association was strongest for women at the assistant (r = -.383, p < .05) and full professor ranks (r = -.26, p <.05). We also found a positive association between service and years spent as an assistant professor (r = .19, p < .05): women who spent an above average amount of time on service took longer to be promoted to associate professor.

To assess whether or not women benefitted from service, we tested the association between above average service time and feeling valued for outreach/youth engagement. The correlation was insignificant ($X^2$ (4, 155) = 3.97, p =.41, V = .11), indicating women did not feel valued for these efforts. The association between service and career satisfaction was insignificant for women (r = -.01, p = .93), but was significant and positive for men (r = .12, p <.05). In contrast, time spent on research was positively associated with both men's (r = .20, p <.001) and women's (r = .28, p <.001) career satisfaction.

Finally, logistic regression analyses indicated that women who spent an above average amount of time on service were nearly twice as likely (1.87 times) to report below average compensation as men of similar rank and experience (Table 3).

Table 3
*Logistic regression results for female faculty's below average salary*

| Variables | *b* | SE | Odds Ratio |
|---|---|---|---|
| Constant | -1.15 | .20 | .32 |
| Service | .62** | .19 | 1.87 |

*Note.* * p<.05; ** p<.01; *** p<.001

In summary, women did not appear to benefit from spending significantly more time on service than men. Service was negatively correlated with research productivity, contributed to delayed promotion to associate professor, and was linked to below average salaries. Moreover, women reported a disproportionate responsibility for outreach, but did not feel valued for it; and their career satisfaction was not positively associated with service. In order to further explore the impact of service, we examined the effect of dense/heavy service workloads on both women and men.

**The Impact of Heavy Service Demands**

Women were significantly more likely than men to conclude they have too many research (50.6% vs. 40.3%) ($X^2$ (1, 482) = 4.72, p <.05, V = .10); teaching (39.2% vs. 25.9%) ($X^2$ (1, 518) = 9.98, p <.01, V = .14); and service demands (45.4% vs. 27.2%) ($X^2$ (1, 516) = 17.63, p <.001, V = .19) to do them all well. Female assistant professors (57.6%) were more likely than male assistant professors (34.8%) to feel overburdened with research ($X^2$ (1, 79) = 4.05, p <.05, V = .23) (Table 4). Women lecturers/instructors (50%) were more likely than their male counterparts (21.1%) to feel overloaded with service ($X^2$ (1, 49) = 4.10, p <.05, V = .29). Likewise, women full professors (47.3%) were more likely than their male counterparts (28.2%) to report too much service ($X^2$ (1, 244) = 8.35, p <.01, V = .19).

Table 4
*Workload density by rank and gender*

| | Lecturer | | Assistant | | Associate | | Full | |
|---|---|---|---|---|---|---|---|---|
| | Female | Male | Female | Male | Female | Male | Female | Male |
| Too much research | -- | -- | 57.6%* | 34.8% | 56.5% | 41.9% | 46.6% | 41.2% |
| Too much teaching | 57.6% | 35.0% | 45.2% | 26.1% | 37.5% | 27.4% | 30.6% | 24.3% |
| Too much service | 50.0%* | 21.1% | 40.6% | 21.7% | 44.7% | 29.5% | 47.3%** | 28.2% |
| Feel drained | 66.7% | 75.0% | 69.7%** | 39.1% | 70.2% | 54.7% | 72.4%*** | 36.6% |
| Feel used up | 81.8% | 75.0% | 78.8%** | 48.9% | 79.2%* | 61.1% | 72.4%*** | 42.4% |

*Note.* *p<.05; ** p<.01; *** p<.001

Women were more likely to feel emotionally drained from work than men (70.7% vs. 44.3%) ($X^2$ (1, 525) = 34.0, p <.001, V = .25); and were significantly more

likely than men to feel used up at the end of the work day (77.1% vs. 50.5%) ($X^2$ (1, 523) = 35.98, p <.001, V = .26). Mirroring the distribution of service, female assistant professors were significantly more likely than male assistant professors to feel used up at the end of the work day (78.8% vs. 48.9%) ($X^2$ (1, 78) = 7.19, p <.01, V = .30); as were female full professors relative to their male counterparts (72.4% vs. 42.4%) ($X^2$ (1, 246) = 18.95, p <.001, V = .28) (Table 4). Moreover, amongst professors who asserted they have too many service responsibilities to do them all well, women were significantly more likely than men to feel used up at the end of the work day (90.5% vs. 74.2%) ($X^2$ (1, 173) = 7.82, p <.01, V = .21). The moderating effect of gender on heavy service and "feeling used up" was further supported by logistic regression analyses (Table 5, Figure 1). Women who reported above average service demands were significantly more likely to feel used up at the end of the work day than men with above average service demands. Thus, service appears to affect women's well-being to a greater degree than men's; however, the slope appears steeper for men, suggesting that men may have a stronger reaction to heavy service.

Table 5

*Logistic regression results for "feeling used up at the end of the day"*

| Variables | *b* | SE | Odds Ratio |
|---|---|---|---|
| Constant | .04 | .12 | 1.04 |
| Gender (Female) | 1.37*** | .25 | 3.93 |
| Service | .33** | .12 | 1.38 |
| Research | -.10 | .12 | .90 |
| Teaching | .02 | .12 | .84 |
| Service*Gender | -.63** | .25 | .53 |
| Research*Gender | -.24 | .24 | .79 |
| Teaching*Gender | .28 | .24 | 1.32 |

*Note.* * p<.05; ** p<.01; *** p<.001

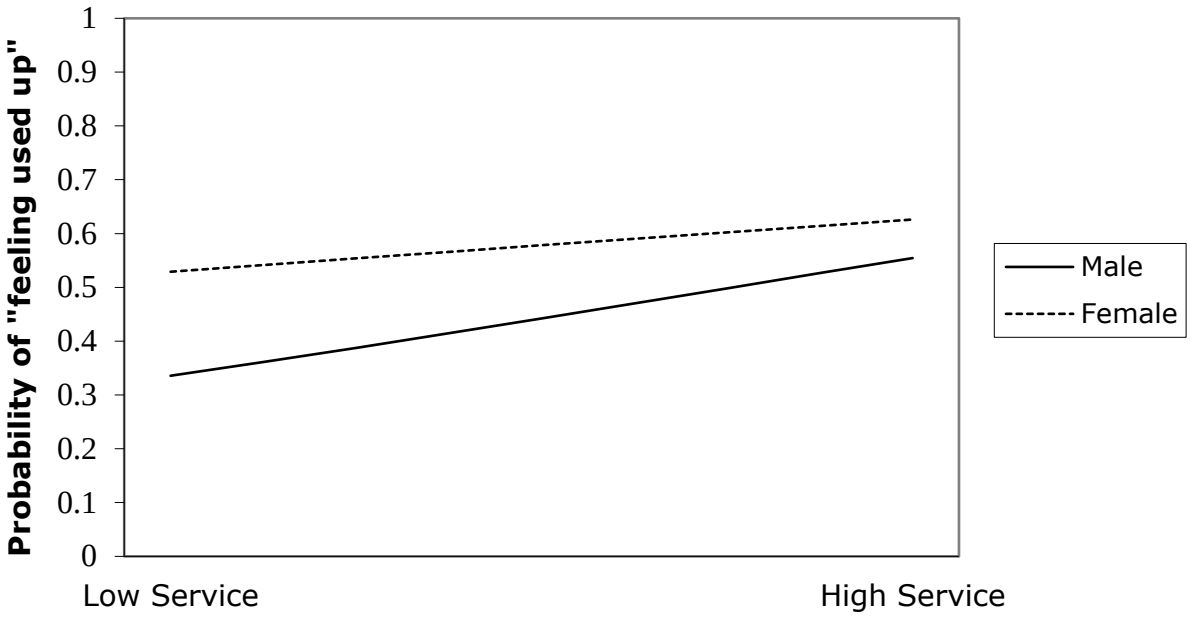


*Figure 1.* Relationship between service and "feeling used up at the end of the day," moderated by gender.

ANOVA results indicated that men with too many service demands were less satisfied with their careers than men who either held a neutral opinion of their service demands or did not feel they had too many service responsibilities (M = -.16, SD = 1.1 vs. M = .16, SD = 0.9) (F (1,331) = 7.19, p <.01). We found no significant differences in women's career satisfaction related to service workload density (M = -.08, SD = .99 vs. M = -.07, SD = 1.05) (F (1, 185) = .003, p =.96). Thus, women's career satisfaction appears less affected by excessive service, even when they feel that they have too many service duties.

Men with too many service demands were also significantly more likely to consider leaving their university, as compared to men who either held a neutral opinion of their service load or did not feel they have too many service responsibilities (M = .44, SD = 1.13 vs. M = -.06, SD = .99) (F (1, 295) = 14.34, p <.001). Again, we found no significant differences in women's intent to leave their jobs related to service workload density (M = -.09, SD = .88 vs. M = -.11, SD = .97) (F (1, 172) = .03, p =.86). Thus, men's career plans may be more sensitive to heavy service demands than women's, even though women appear more likely to experience other negative consequences associated with service such as delayed promotion.

## DISCUSSION

Our results about Canada are generally consistent with U.S. studies that find men spend more time on research, whereas women spend more time on service (Guarino & Borden, 2016; Misra et al., 2011); and that service detracts from women's research time and productivity (Bellas & Toutkoushian, 1999). We add to

this literature by establishing that women NSE professors in Canada spend more time on professional development and outreach than men; two activities that are, ironically, intended to help ameliorate gender inequity in STEM fields.

Women's greater involvement with professional development and outreach is understandable, given their persistent underrepresentation in NSE units relative to men, including amongst full professors (Perreault et al., 2017; CAUT, 2018). To support their own advancement, women may feel it is important to participate in professional development activities, such as leadership development workshops or conferences that provide networking opportunities (Yen et al., 2007). Similarly, women may value the chance to encourage young girls/women to pursue STEM education (Stout et al., 2011; Weber, 2011). Nevertheless, these activities may also be exacerbating women's total service loads, detracting from their research time, and increasing the time they spend at the assistant professor rank.

Consequently, women's greater responsibility for outreach and participation in professional development appears to be contributing to overall structural gender inequity in Canadian NSE units, with men being better positioned for success and advancement (Ornstein et al., 2007; Perreault et al., 2017).

Contrary to a "mid-career service gully" for associate professors (Misra et al., 2011, p. 24), we find women assistant and full professors performed significantly more service than their male counterparts. With respect to women assistant professors' significantly greater reports of outreach, junior women professors may be assumed to better "relate" to younger girls/women and be recommended for outreach activities. Similarly, as junior faculty members, women assistant professors may consider professional development particularly important for their career success. Women full professors, in contrast, are tenured and likely have established research programmes, which may afford them more time for service (Link et al., 2008). They may also receive more requests/nominations to serve if they are well-known and respected senior professors (Porter, 2007).

*Limitations & Future Research*

Our sample is not representative of NSE professors in Canada, as it only includes professors from two geographic regions. Moreover, our sample did not include sufficient numbers of marginalized identity professors to examine differences in research and service related to racialized, minority sexual orientation, non-binary gender, and physical/mental health identities. These analyses are important, as bias against women is only one expression of inequality in academic STEM (Tucker & Horton, 2018; Yoder & Mattheis, 2016). A representative national survey of NSE professors in Canada is needed to fully investigate the distribution of research and service labour. Analyses of intersectional differences are particularly important (Purdie-Vaughns & Eibach, 2008) given evidence of greater risk of bias and mistreatment for multiple marginalized identity individuals (e.g., Black women) in STEM workplaces (Clancy et al., 2017; Williams et al., 2016)

Gender differences in research and service may not be unique to NSE units (Britton et al., 2012). Yet, because women are underrepresented in NSE units, they may be

more likely to be suggested for outreach work and encouraged to participate in professional development opportunities than women from other departments. Consequently, some workload differences may be unique to NSE units. A representative survey including multidisciplinary professors in Canada would enable comparisons of different Faculties (for example Arts vs. Science) and different STEM departments. This research should distinguish between types of service (for example outreach vs. senior administration); and between types of professional development (for example teaching workshops vs. leadership development workshops for women) to better ascertain if women NSE professors' research is inhibited by initiatives intended to reduce gender inequity.

Finally, our survey data only allowed us to describe whether women or men spent a greater amount of time on particular scholarly activities. We can only speculate as to professors' thought processes – how they feel about research/service, including different types of service; and the ways in which time spent on research/service may be one way that professors construct and reproduce their own gender identities at work. Future research employing in-depth interviews would enable a direct examination of the reasons why women and men may perform more or less research/service; and why heavy service appears to affect men and women differently including greater intent to leave as opposed to well-being impacts.

Interviews would be particularly useful in uncovering how intentions to quit amongst men with heavy service loads may be related to assumptions that service is "women's work" (Bird et al., 2004; Park, 1996). It is possible that having heavy "feminine" service demands conflicts with men's expectations of a "masculine" academic career (O'Meara, 2016). Accordingly, mismatches between these men's activity preferences and their actual workloads may be one reason we observed increases in their career dissatisfaction and intent to leave their university. Similarly, interviews would allow men to discuss their opinions about relatively more/less prestigious service (such as Department Head vs. committees) to shed light on the associations we observed between service demands and career satisfaction for men. Perhaps men's career satisfaction is more likely to be undermined if they have heavy, less prestigious service demands, as opposed to a demanding but prestigious administrative role (O'Meara, 2016).

Likewise, interviews can examine whether or not women expect they will be asked to perform service because of their gender; if aligning with such expectations helps explain why heavy service loads are not associated with lower career satisfaction; and if women's career satisfaction is bolstered by other benefits, such as enhanced networks (Bird et al., 2004; O'Meara, 2016). Similarly, interviews also allow for an in-depth exploration of how women NSE professors' caregiving and housework demands interact with their scholarly duties and may exacerbate "feeling used up at the end of the work day". The latter question is important, as a lack of work-life balance remains a persistent barrier to women advancing in academic STEM careers (Brue, 2019; Rosser, 2004).

## CONCLUSION

Our analyses suggest that service demands are a greater impediment to women NSE professors' career progress than men's career progress; preventing women from participating equally in research activities and delaying their promotion to the associate professor rank. Moreover, we conclude that labour associated with improving women's representation in STEM fields (i.e., youth outreach and professional development) may be disproportionately falling on women's shoulders. Accordingly, NSE units working towards gender equity must review the distribution of specific workload tasks between men and women, not just their total service times. Until service is fairly distributed amongst men and women in NSE and/or the value of service is elevated to encourage more professors to serve, women will continue to be systemically disadvantaged relative to men.

## ENDNOTE:

1. Performance review documents, for example, may ask professors to list professional development activities under service. However, the authors acknowledge that whether or not professional development is considered separate from service depends on one's university.

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