SEX COMPOSITION OF THE WORKPLACE AND MORTALITY RISK

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ABSTRACT. This study uses Swedish registry data to examine whether imbalances in the adult sex ratio affect mortality risk. Using piece-wise constant exponential survival models to analyze occupational data from the Swedish administrative registries from 1995 to 2007, this paper examines how the proportion of men in administrative workplaces in the Swedish public service affects all-cause mortality risks amongst both males and females of working age. For males, a 1% increase in the proportion of males in the workplace was associated with a 1.1% increase in mortality risk (HR 1.011, 95% CI 1.005-1.017, P≤0.000), but no association was found for females (HR 1.005, 95% CI 0.998-1.013, P=0.180). Adjustments were made for age, family status, education, occupational status, occupational segregation by gender, the total number of individuals in the workplace, level of government, region, period, and variables reflecting the workplace structure by age, age by sex, occupation, and education. It is suggested that an increased proportion of males may be related to (i) an increased exposure to risky health behaviours such as alcohol consumption and unhealthy dietary patterns, (ii) a tendency towards sickness presenteeism, and (iii) an increase in the levels of several well-established emotional stressors in the workplace, including aggression, competition, and conflict, leading to an increased level of psychosocial stress. The findings and potential extensions of this research are discussed.

INTRODUCTION

A considerable volume of research has been conducted examining the impact that the proportion of males in a given specified context can have on a range of outcomes. These include marriage and divorce behaviour, and fertility behaviour, but also include outcomes that are suggested to be influenced by relative competition for a sexual partner, such as labour supply. However, relatively little research has been conducted examining whether imbalances in the adult sex ratio might have an impact upon health. Examples of the research that has been done include studies that have looked at whether the contextual sex ratio at the age of sexual maturity affects long-term mortality risk (Jin et al., 2010), studies investigating how occupational segregation by gender affects a range of factors, and whether the sex composition of the workplace affects health. However, studies investigating the effect of the sex ratio within the workplace have generally been limited by access to data. Subsequently, most research in this field has focused upon whether males and females have occupations that are male- or female-dominated, or whether these occupations fall within male- or female-dominated sectors of the economy (Alexanderson and Östlin, 2001).

Research into occupational segregation by gender has mainly used this measure as a proxy for the actual sex composition of the workplace at which an individual works (Mastekaasa,

2005; Leijon et al., 2004; Östlin et al., 2008). However, knowing that a male or female works in a male- or female-dominated occupation does not necessarily tell us very much about the sex ratio within her actual workplace, and thus is not a suitable proxy measure (Mastekaasa, 2005). Measures of occupational segregation by gender are also an attempt to capture the extent to which a job has, in broad terms, been designed to suit one gender or another (Leijon et al., 2004), leaving the minority gender at a systematic disadvantage. Past research on occupational segregation by gender has often found that men and women in occupations dominated by the opposite sex have poorer health, usually as measured by sickness absenteeism, or self-reports.

In this study I will use Swedish registry data to identify the sex ratio within discrete workplaces to investigate how the sex composition of one's work site may affect mortality risk. To my knowledge, only three studies have been conducted examining the relationship between the sex ratio within the actual worksite and health (Svedberg et al., 2009; Hensing and Alexanderson, 2004; Mastekaasa, 2005). Only one of these used administrative registry data (Mastekaasa, 2005), and all three examined morbidity, measured by self-reported health and/or sickness absenteeism. The studies conducted by Svedberg et al. (2009) and Hensing and Alexanderson (2004) both used survey data. Svedberg et al. (2009) found that sex segregation was associated with a wide range of self-reported ill-health symptoms for men, but not for women. Hensing and Alexanderson (2004) found that in general women working as metal workers at female-dominated work sites took more sick leave than women in the same occupation working at male-dominated work sites.

The study conducted by Mastekaasa (2005) used Norwegian administrative registry data and found that sickness absenteeism for men was largely unrelated to the workplace sex ratio, but sickness absenteeism for women was higher in female-dominated workplaces. Interestingly, the effect of occupational segregation by gender on health diminished substantially after controlling for the actual sex ratio within the workplace (Mastekaasa, 2005).To a certain extent, research on mortality avoids a number of the problems involved with investigating sickness absenteeism. Part of the theoretical analysis of how the gender composition of the workplace and occupational segregation by gender affects sickness leave is through changing individual norms regarding how and when they ought to take remedial steps to care for their own health, and how this will be affected by the behaviour in this regard of those around them. This is the absence culture hypothesis (Mastekaasa, 2005). For example, individuals in an environment where people tend to be stoical about illness may be less likely to take sick days themselves for minor problems. Likewise, in an environment where people take days off from work because they have a headache, the threshold for acceptable and legitimate absenteeism is considerably lower. Mortality in the working age population is rather different as individuals have less choice in regards to this outcome.

The only study of which I am aware that investigated the relationship between sex ratios and mortality was conducted by Jin, Elwert, Freese and Christakis (2010). In this study they focused upon whether the sex ratio at the age of sexual maturity would have a long-term effect on health. They found that a 1% increase in the sex ratio at the age of sexual maturity increased the hazard of mortality before the age of 65 by approximately 1% in males, though

no effect was found for females. They posited three potential mechanisms by which this effect might be operating: Imbalances in the adult sex ratio lead to delays in marriage and higher rates of non-marriage amongst members of the supernumerary sex, thus denying these individuals the cumulative health benefits of marriage; imbalances in the adult sex ratio mean that members of the supernumerary sex have to, on average, settle for a lower quality partner; and, imbalances in the adult sex ratio may lead to heightened levels of psychosocial stress for members of the supernumerary sex. This heightened level of psychosocial stress may be linked to competition for a sexual partner. However, widespread competition for sexual partners is less likely to be a factor in terms of the sex composition of the workplace and mortality risk, and different plausible mechanisms will be discussed below.

Sex Ratios in the Workplace: The Swedish Civil Service. In this study I have chosen to focus upon the Swedish civil administrative service (Vinde, 1970). There are two main reasons for this selection. The first is that it was judged important to consider a work environment that could neither be described as highly dangerous, nor unduly stressful in relative terms (Marmot, 2004). By the term Swedish civil service, I mean the public administrative bureaucracy. This group of workers within the public sector is not as clearly delineated in Sweden as it could be said to be in other EU countries such as the UK or Germany, but by identifying workplaces that are filled with white-collar administrative and managerial workers within the public sector, it can be argued that this study has identified a comparable group. The second reason for focusing upon the Swedish civil service is that it draws parallels with the Whitehall studies (Marmot et al., 1991), both of which were landmark research projects investigating the relationship between health, social status, and structural occupational factors.

The Swedish civil service consists of three different levels, which are ministries, agencies, and local government (Vinde, 1970; Pierre, 2010). Each level can be said to have a significant degree of autonomy, with relatively little top-down management (Pierre and Ehn, 1999; Pierre, 2010). The organization of the public bureaucracy in Sweden has been strongly resistant over time to macroeconomic fluctuations, cutbacks in public expenditure, and tax reductions; this is partly due to the decentralized nature of the Swedish civil service, but this decentralization has also been reinforced by these macro level changes (Pierre, 2010). A further advantage of focusing upon the Swedish civil service is that horizontal mobility is relatively low, and has been decreasing over time, both within the public bureaucracy, as well as between the public and private sector, and this is true for both junior and senior civil servants (Pierre and Ehn, 1999). The benefit of this is that the individuals in this study will, relatively speaking, be exposed to a similar environment over the time period that they are under risk, and should be less likely to be censored because of moving to a new job outside of the civil service.

Sex Ratios in the Workplace and Health: Potential Explanatory Mechanisms. There are several plausible mechanisms by which the sex composition of the workplace could be related to increased mortality risk. The following mechanisms will be discussed in detail

in the following section: peer effects; sickness absence culture; and, psychosocial stressors linked to the sex composition of the workplace.

Peer Effects. The sex composition of the workplace may be related to mortality risk as higher proportions of males in the workplace might lead to an increased exposure to risky health behaviours and unhealthy dietary patterns. Past research has suggested that since males are in general more likely to engage in risky activities, an increased proportion of males would increase social opportunities for these behaviours to take place, and increased opportunities might thereby lead to increased exposure to risk (Kraft et al., 1993). Indeed, males consume alcohol more frequently and in larger quantities than females, and are also more likely to engage in heavy drinking (Wilsnack et al., 2000; Vaez and Laflamme, 2003). Research conducted in Sweden has shown that females are more likely to engage in positive health behaviours, be more aware of health risks, and to have a stronger belief in the importance of engaging in healthy living than males (Näslund, 1997; Vaez and Laflamme, 2003; Von Bothmer and Fridlund, 2005). At the same time, daily smoking rates are now higher for females relative to males in Sweden (Ali et al., 2009). Past research looking at occupational segregation by gender in the United States and Finland has found that workers in male-dominated occupations consume significantly more alcohol than workers in female-dominated occupations (Kraft et al., 1993; Haavio-Mannila, 1992).

A study in Sweden using data from 1990 and 1995 found that, using gender balanced workplaces as the reference category, women in male-dominated occupations did not consume significantly more alcohol, but women in female-dominated occupations consumed significantly less alcohol (Savikko et al., 2008). One study looking at the sex composition of the workplace found a linear relationship between the proportion of males and alcohol consumption in females (Haavio-Mannila, 1992). There is a considerable volume of evidence in support of the importance of peer effects on health behaviours, both in adolescence and in adulthood (Rosenquist et al., 2010; Powell et al., 2005; Christakis and Fowler, 2008, 2007). Research in this field largely focuses upon three different explanations for why friends may exhibit similar behaviours, such as smoking. These three explanations are selection effects, or homophily, exposure to a common exogenous factor, and a genuine induction effect by which the behaviour of an individual's peers affect that individual's own behaviour. Empirical support for the influence of peer effects above and beyond selection effects and common exogenous factors is found consistently for a wide range of different behaviours, as well as in a wide range of different contexts, using both observational and experimental methodological approaches (Kremer and Levy, 2008; Lundborg, 2006; Gaviria and Raphael, 2001; Bot et al., 2005)

Peer effects can operate in a number of ways, such as by affecting the choice set available to a given individual, by affecting the preferences of an individual, and over the longer term affecting preferences not only in terms of behaviours but also in terms of the kind of alters that a given individual is likely to develop future relationships with (Kremer and Levy, 2008). It is difficult to know the extent to which peer effects might affect health outcomes; as the Whitehall studies indicated, while negative health behaviours do explain part of the increased

risk of suffering from cardiovascular disease, the variation that these behaviours account for is insufficient to explain differential cardiovascular disease incidence rates (Marmot et al., 1991). On the other hand, if the sex composition of an office is linked to the likelihood of a drinking culture developing, or is related to the probability of making healthier choices when going for lunch as a group, then it is certainly conceivable that these behaviour patterns repeated over an extended period of time would have an effect on health. It is possible to frame this both as male-dominated workplaces having a deleterious effect on health, and female-dominated workplaces having an ameliorative effect on health.

Sickness absence culture. As described earlier, two studies have examined how the sex composition of the workplace is related to sickness absenteeism (Hensing and Alexanderson, 2004; Mastekaasa, 2005). Hensing and Alexanderson (2004) found that females in a male-dominated occupation in Sweden, metal sheet workers, were more likely to be absent from work for sickness if the sex composition of the actual workplace was female- rather than male-dominated. Mastekaasa (2005) found that the sex composition of workplaces in Norway did not have a substantial effect on the sickness absenteeism of men, but that females working in a female-dominated workplace had higher sickness absenteeism relative to those working in a male-dominated workplace. The limited evidence available suggests that the sex composition of the workplace affects sickness absenteeism for females, but it is not possible to rule out any effect on males. Of course sickness absenteeism is not entirely a social behaviour - past research shows that absenteeism is closely linked to global health measures, as well as mortality risk (Marmot et al., 1995; Kivimäki, Head, Ferrie, Shipley, Vahtera and Marmot, 2003). This association is strongest when absences are for a longer period, and when an individual has frequent medically certified absences (Kivimäki, Head, Ferrie, Shipley, Vahtera and Marmot, 2003).

Sickness presenteeism refers to the behaviour of coming to work when sickness absence would be justifiable, though this is of course difficult to identify. The results of the two studies mentioned above could be providing not only an indicator of how absenteeism is related to the sex composition of the workplace, but also of how presenteeism is related to the sex composition of the workplace. Presenteeism is difficult to classify, and is for obvious reasons not recorded in the administrative registries. Employers assume that employees are not sick if they are at work. However, the lack of higher rates of sickness absenteeism in male dominated workplace allows for the possibility that there is a culture of presenteeism in these workplaces. Although absenteeism is also a social behaviour, refusing to take sick leave when one is actually ill, or presenteeism, is likely to have a deleterious effect on health, and the results of previous research allow for the possibility that this is more prevalent in male-dominated workplaces. Past research on presenteeism in Sweden suggests that there is no significant difference in this behaviour between males and females (Aronsson et al., 2003), but in general research on *absenteeism* both in the Nordic countries and across Europe has found that females are more likely to be absent, and to be absent for longer periods (Alexanderson et al., 1994; Laaksonen et al., 2008; Beemsterboer et al., 2009).

Psychosocial Stressors. There are a great number of factors that have the potential to increase stress within the workplace, and these include both physical and emotional stressors. von Onciul (1996) has presented a rather exhaustive list of these potential stressors, but here I will focus upon factors that increase emotional stress: fear (of sanctions); joy (about promotion); anger (over injustice); challenge (of a new position); shock (after sexual harassment or racial taunt); competition (with colleagues); conflicts (with subordinates or managers); contradictory instructions; negative thoughts; time pressure; structural changes; monotonous tasks; night shifts; and overtime (von Onciul, 1996). If these factors are linked to an increase in stress, then workplaces that are characterized by higher levels of these factors should have higher levels of morbidity and mortality related to psychosocial stress. The point at stake here is whether any of these factors should vary systematically by the sex composition of the workplace.

The theory of tokenism as developed by Kanter (1977) has played a prominent role in research into occupational segregation by gender. This theory suggests that the minority within a workplace should have higher levels of stress for several reasons. First of all, they are more visible. Because of this the actions that they take, and the contributions they make, will be relatively prominent, and this will lead to higher levels of pressure. Secondly, the theory holds that those in the minority are less likely to be recognized as individuals, and more likely to be recognized as representatives of the group to which they belong as a whole, and this leads to stereotyping. The third aspect of this is that the presence of the minority individual emphasizes the differences between the minority and majority group. This contrast may encourage in-group out-group distinctions by members of the majority group, thereby highlighting any form of deviancy by members of the minority group (Kanter, 1977). These three mechanisms within the theory of tokenism are plausible. Some empirical support has been found for this theory, though it has been related to occupational segregation by gender rather than looking at sex ratios within the workplace itself (Evans and Steptoe, 2002). Nevertheless, the implications are clear: according to tokenism theory, men working in female-dominated environments should experience higher levels of psychosocial stress, as should women working in male-dominated environments.

In terms of this study, tokenism theory would predict that the risk of mortality, and particular cardiovascular disease-related mortality, should be higher amongst individuals who are employed in workplaces in which they fall into the minority. Previous research suggests that the gender group in the minority, whether male or female, is more likely to suffer from sexual harassment. Females suffer from higher incidence rates of sexual harassment in the workplace than do males (Richman et al., 1999; Gruber, 1998), and less severe incidents of generalized abuse in one form or another are not uncommon for either men or women. However, it is unclear whether findings such as these reflect genuine patterns of harassment in the workplace, or whether males are less likely to report incidents of sexual harrasment. Whether or not this is true, the tendency for the gender in the minority to be more vulnerable to sexual harassment would suggest that being in the minority should increase the potential for suffering from psychosocial stress at work. Unsurprisingly, sexual harassment and

abuse in the workplace are linked to a very wide range of negative mental health outcomes (Richman et al., 1999).

Aside from tokenism theory, a small amount of research has been conducted to investigate how competitive and stressful interactions between males and females affects cardiovascular reactivity (CR), which refers to the responsiveness of the cardiovascular system to stress, for example in terms of heart rate or blood pressure fluctuations. The evidence cited here comes from a small number of studies, most of which have not set out to address this question directly. Subsequently it is difficult to draw strong conclusions, but since experimental research does exist in this area it is important to consider the implications that these findings might have for the current study. I will here give consideration to research that has addressed CR in terms of interactions between males and females in what can be described as a competitive or stressful context. A body of literature also exists examining the effect that spousal/partner support has on diminishing CR, but I would argue that this research is less relevant to the present study because spousal and partner relationships are fundamentally different from the relationships that most individuals have with their co-workers.

An experiment based around a competitive task conducted to investigate whether diastolic blood pressure (DBP) differs according to the sex of the opponent found that DBP reactivity increased for both males and females when they were competing against males (Holt-Lunstad et al., 2001). This result would suggest that a higher proportion of males in the workplace would have a negative impact on health for both men and women. A different study conducted by Glynn et al. (1999) measured the blood pressure reactivity of participants in response to performing an unprepared speech to either a supportive or unsupportive male or female confederate. The results of this study suggested that an audience of supportive females reduces CR for both males and females, in comparison to a non-supportive female audience. However, a supportive male audience did not decrease CR for males or females in comparison with a non-supportive male audience. The researchers also found weak support for inter-male interaction actually increasing blood pressure for males, though this effect was not observed in females (Glynn et al., 1999). Interestingly, in post-study surveys the participants were able to differentiate between supportive and non-supportive audiences, but this was simply not translated into a physiological response when the audience was male (Glynn et al., 1999). However, other studies with similar designs focusing on social support have found that gender does not play a substantial role (Lepore et al., 1993).

Some research has found that male-dominated workplaces have a higher incidence rate of workplace bullying or general conflict, resulting in the workplace being a more stressful environment (Brousse et al., 2008). Prolonged exposure to such an environment could be a plausible link between the proportion of males and psychosocial stress related health outcomes. Surveys suggest that male-dominated work environments have higher rates of minor abuse, and bullying, (Einarsen and Raknes, 1997). A series of surveys collected in Norway showed that larger workplaces, and workplaces with a higher proportion of males were more likely to have higher rates of bullying, and that males were more often the victims of bullying than women (Einarsen and Skogstad, 1996). In terms of social norms, male aggression and violence is more widely tolerated and perceived as natural than female aggression

(McCarry, 2010). Naturally workplace bullying also has a detrimental affect on women, and research has indicated that long-term exposure increases the risk of suffering from both depression and cardiovascular disease, and is also related to higher levels of sickness absenteeism (Kivimäki, Virtanen, Vartia, Elovainio, Vahtera and Keltikangas-Järvinen, 2003; Voss et al., 2001). These findings would point towards male-dominated environments being associated with higher levels of CR and stress responses than female-dominated environments, or alternatively, female-dominated environments having a positive effect on health.

DATA AND METHODS

Data. This study used Swedish registry data over the period 1995 to 2007. The Swedish occupational registers have considerably greater longitudinal depth than the 12 years under analysis in this study, but are limited in terms of the fact that occupation was not recorded before 1995. Previous research has demonstrated that occupation and occupational status play a very important role in influencing health, and this influence cannot be said to be entirely consistent with income levels (Marmot et al., 1991; Marmot, 2004). Although an analysis without occupation would have been possible from the period 1985 to 2007 for some of the occupational registers, the analysis would have been undermined by the absence of information on this crucial variable. The data used for this investigation have been drawn from the STAR (Sweden over Time: Activities and Relations) database. This database is a collection of administrative registers, and is maintained by the government body Statistics Sweden (Statistika Centralbyrån - SCB) for Swedish researchers.

Identification of Civil Service Workplaces. The Swedish government employs a large number of people, and the occupations held by these individuals cover a wide range. Compared to countries such as the United Kingdom and Germany, the equivalent Swedish civil administrative service is less clearly delineated. To accurately identify and classify workplaces as falling within the category of the administrative civil service I have used information in the database on the sector code for the workplace, as well as the occupations of individuals. The first step was to consider only those workplaces that were identified by the sector code as being within the central government (Statlig förvaltning), primary local government (Primärkommunal förvaltning), or county government (Landsting). Secondly, I classified as civil servants those individuals within these three sectors whose occupations were clerks or higher, as identified by the Swedish Standard Classification of Occupations (Svensk Yrkesklassificering - SSYK) occupational codes that are utilized in Sweden (SCB, 2011). In terms of the categories for occupation used, and described below, these are employees with occupations in categories I and II (SSYK codes 1000-4000).

Finally, I calculated the proportion of civil servants within each workplace. Only those individuals working within workplaces where the number of civil servants as a proportion of the total number of individuals in the workplace was 80% or higher are considered under risk for the analysis. The choice of 80% is arbitrary but the results to be presented below are robust to other specifications. I did not specify workplaces where the proportion of civil

servants was 100% because many of these workplaces also have a small number of support staff registered, such as office cleaners. Using the 100% specification meant that the sample size was drastically and unnecessarily reduced. Furthermore, only workplaces with more than 10 and less than 50 employees have been included in the analysis. This upper-limit restriction has been introduced so as to include only those workplaces where the employees clearly have the opportunity to interact with one another, as a small number of workplaces identifiers are linked to more than 500 individuals. These workplace identifiers may be linked to entire buildings of employees, or perhaps whole departments.

Censoring. Observations are censored when they leave a workplace designated as belonging to the Swedish civil service for any reason, for example if they are retiring, or changing job to another workplace outside the civil service. Observations who move to a different workplace within the civil service remain under risk. All observations are treated as being under risk if they are registered within a civil service workplace, including those who enter the civil service after 1995. If part-time employees are registered as working in the civil service they are also considered under risk. Any observations who may have left the civil service and later returned within the period 1995 to 2007 are considered under risk for the spells that they are registered at civil service workplaces.

Outcome Variable: Mortality. The outcome variable, mortality, has been drawn from the STAR database. The STAR database contains information on both the date of death, as well as the cause of death. The main focus of this study is all-cause mortality, but I will also conduct separate analyses for the major causes of death to ascertain what is driving the results for all-cause mortality. These deaths have been identified using the International Statistical Classification of Diseases and Related Health Problems (ICD). The current version of the ICD is the ICD-10. The transition of use from the ICD-9 to the ICD-10 took place in 1997 in Sweden, and I have taken this into account in my coding for the different sub-categories of causes of death.

Key Independent Variable of Interest: Proportion of Males in the Workplace. The proportion of males in the workplace has been calculated by dividing the total number of males in each workplace by the total number of people in each civil service workplace. Thus, this measure falls on a scale of 0 to 100. The reported hazard ratios will therefore refer to the increased or decreased hazard associated with a 1% increase in the proportion of males in the workplace. The histograms shown in figures 1(a) and 1(b) shows the percentage distribution of observations within five categories of the proportion of males in the workplace. These figures depict the distribution within the workplaces under analysis, not in Sweden as a whole. The majority of males work in workplaces where the proportion of males ranges from 41-60%, and fewer are employed in workplaces where the proportion of males is either less than 20% or greater than 80%. The majority of females work in workplaces where the proportion of males ranges from 21-40%, and, again, far fewer are employed in workplaces where the proportion of males is either less than 20% or greater than 80%. It is notable that the percentage of males working in female dominated work environments, and the percentage of females

working in male dominated work environments, are both very low. I will conduct analyses using both a linear and a categorical term for the proportion of males in the workplace, the categorical terms using the same groups as shown in figures 1(a) and 1(b).
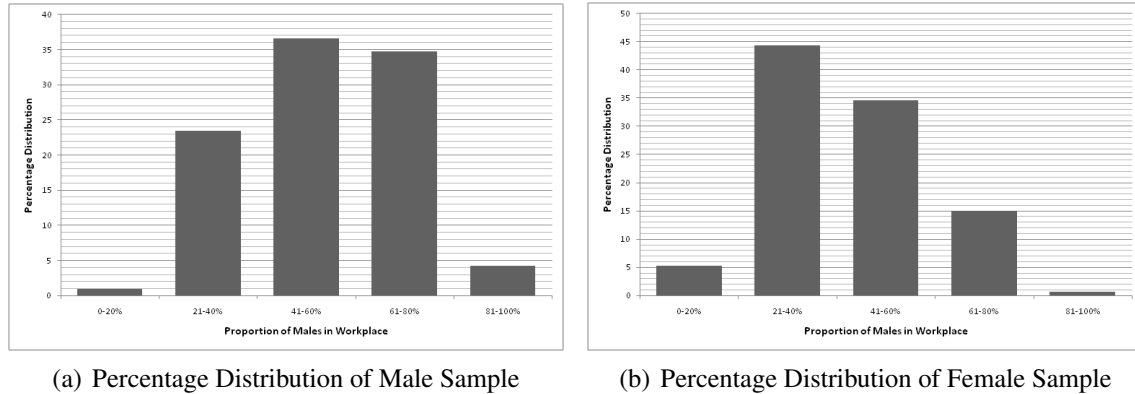

(a) Percentage Distribution of Male Sample

(b) Percentage Distribution of Female Sample

FIGURE 1. Percentage Distribution of Male and Female Samples within Workplaces

Covariates. The following variables have been drawn from, or calculated using, the STAR database:

- Age
- Family status
- Education
- Income
- Occupation
- Occupational segregation by gender
- Level of government

- Region by county (län)
- Period
- Age structure of workplace
- Age structure of workplace by sex
- Occupation structure of workplace
- Modal educational level at workplace
- Total number of individuals

To briefly comment on the other co-variates, it should be noted that the legal age of retirement in Sweden was 65 for the period over which this analysis is being conducted (Palme and Svensson, 1999), and this was enforced in the public sector. It follows that the sample for these analyses will consist of males and females of age 65 or younger. The categories in family status, unmarried, partnered, divorced, and widowed, combine both opposite-sex and same-sex partnerships. During the study period the Swedish registers did not contain data on cohabitation, and partnership is only recorded upon childbirth if the parents live together. Thus the partnered category includes both married individuals, and unmarried individuals who cohabit and have a child with their partner. Thus it is likely that a proportion of the individuals in the unmarried category cohabit with a partner as this is very common practice in Sweden. For occupation I have used the SSYK occupational codes (SCB, 2011), coding into five categories:

- I: Management, professional, and associate professional occupations
- II: Clerks, office, and administrative support occupations

- III: All workplace support occupations, e.g. cleaners, and security staff.

The variable 'Occupation Segregation' in the results tables below refers to the proportion of males within the occupation of a given individual in a given year, and this is a linear term. This has been calculated using all the data available in the occupational registers, and is not a calculation within the Swedish civil service alone. A number of variables have been calculated at the level of the workplace, and these include the structure of the workplace by age, age and sex, occupation, education, and the total number of workers at the workplace. The workplace structure variables for age, age and sex, occupation, education reflect the proportion of individuals in the workplace that fall into the sub-categories for these variables, with the same categories as have been used to code at the individual level.

Methods. I have used piece-wise constant exponential survival models to estimate the impact of the proportion of males in the workplace upon mortality risk, where:

$$\lambda_i(t \mid x_i) = \lambda_0(t) exp\{x_i'\beta\}$$

The piece-wise model splits the total period over which the subjects are under observation into several pieces; in this case, twelve month sub-periods. The baseline hazard is age. The total period of twelve years over which the subjects are under observation has been split into twelve twelve month, or yearly, sub-periods, because the occupational data registry is updated once each year, in November. These models have been estimated using cluster-adjusted standard errors to account for any potential intragroup correlation (Primo, Jacobsmeier and Milyo, 2007). The clusters in this study are the workplaces in which the individuals within the sample are employed.

RESULTS AND ANALYSIS

As can be seen in table 2, there is a positive and significant relationship between the proportion of males in the workplace and all-cause mortality risk for males, with a 1% increase in the proportion of males in the workplace associated with a 1.1% increase in the risk of mortality (HR 1.011, 95% CI 1.005-1.017, P≤0.000). However, in contrast to males, the proportion of males in the workplace is not significantly associated with all-cause mortality risk for females at the $p < .05$ level (HR 1.005, 95% CI 0.998-1.013, P=0.180). Looking at the results contained within table 2, we find some unusual results amongst the control variables for both the male and female analyses, and particularly in regards to education and occupation. The hazard ratios for females with a compulsory level education are lower than those with a gymnasium level education, though it is possible that this is due to the low proportion of the sample that work in the Swedish civil service with only a compulsory level education, as can be seen in table 1.

TABLE 1. Distribution of Time at Risk, Deaths, and Incidence Rates for Males and Females

Covariates	Categories	Males			Females		
		Time at Risk (%)	Deaths	IR(e^{-5})	Time at Risk (%)	Deaths	IR(e^{-5})
Age:	20-35	24.5	38	1.9	24.6	32	1.5
	36-45	24.5	101	5.1	25.4	87	4.1
	46-55	32.3	408	15.8	33.0	353	12.7
	56-65	18.6	525	35.4	16.9	368	25.9
	Total	100.0	1,072		100.0	841	
Family Status:	Unmarried	32.1	238	9.3	31.6	169	6.4
	Partnered	57.2	644	14.1	52.2	445	10.1
	Divorced	10.0	174	21.8	14.4	190	15.7
	Widowed	0.7	16	28.8	1.8	37	23.8
	Total	100.0	1,072		100.0	841	
Education:	Tertiary	81.8	807	12.4	57.9	352	7.2
	Gymnasium	15.8	209	16.6	24.6	380	13.1
	Compulsory	2.4	56	28.8	7.5	109	17.3
	Total	100.0	1,072		100.0	841	
Occupation:	I	93.7	965	12.9	78.8	584	8.8
	II	4.4	73	21.0	20.0	248	14.7
	III	1.5	29	23.9	0.9	8	11.1
	Total	100.0	1,072		100.0	841	

Source: Swedish administrative registry data, compiled by the author.

The unusual results for the occupational categories for males may also be due to the selection of the sample for this study. As the results in table 2 show, the relative risks of mortality are lower for those in occupational category I in comparison with occupational category II. This result is consistent with the incidence rates shown in table 1, and follows the usual pattern of those with higher occupational status having a lower mortality risk. The unusual results are to be seen in table 2 for category III, where the relative risk of mortality in these groups is lower than category II. However, it is important to remember that the workplaces under analysis were selected on the basis of having at least 80% of the employees registered there in categories I and II. As can be seen in table 1, the number of failures in category III is very small, and the proportion of the time spent under risk for members of this group was only 1.5%.

Looking at some of the other results, the estimates for occupational segregation by gender for females are also at odds with earlier research, as past findings have suggested that the higher the proportion of one's own gender in a given occupation, the lower the associated health risks should be. The results for occupational segregation by gender for males do fit the previously observed trend, as these results suggest that males have a decreased mortality risk when working in occupations that are dominated by males. However, neither of these results was statistically significant.

Table 3 is a frequency table for the major different sub-categories of causes of death amongst males, and shows that neoplasms and diseases of the circulatory system constituted the two largest causes of death amongst males in this sample. After running piece-wise constant survival models to find the association between the linear term of the proportion of

TABLE 2. Survival Analysis for Males and Females: All-cause Mortality

	Males				Females			
	HR	S.E.	95% CI	p-value	HR	S.E.	95% CI	p-value
Age								
20-35	0.077	0.035	0.031 - 0.189	0.000	0.106	0.049	0.042 - 0.262	0.000
36-45	0.207	0.064	0.113 - 0.379	0.000	0.401	0.154	0.189 - 0.849	0.017
46-55	1.000				1.000			
56-65	1.962	0.324	1.419 - 2.710	0.000	1.712	0.378	1.110 - 2.640	0.015
Family Status								
Unmarried	1.000				1.000			
Partnered	0.655	0.053	0.560 - 0.768	0.000	0.841	0.078	0.702 - 1.009	0.062
Divorced	0.869	0.091	0.707 - 1.068	0.183	1.039	0.109	0.846 - 1.276	0.718
Widowed	0.812	0.207	0.493 - 1.337	0.413	1.121	0.205	0.784 - 1.603	0.531
Education								
Tertiary	1.000				1.000			
Gymnasium	1.108	0.103	0.923 - 1.330	0.270	1.306	0.121	1.090 - 1.566	0.004
Compulsory	1.296	0.194	0.966 - 1.738	0.084	1.187	0.145	0.935 - 1.508	0.159
Occupation								
I	1.000				1.000			
II	1.655	0.543	0.870 - 3.150	0.125	1.014	0.381	0.485 - 2.117	0.971
III	1.121	0.402	0.556 - 2.263	0.749	1.651	0.773	0.659 - 4.134	0.284
Occupation Segregation	0.997	0.005	0.987 - 1.007	0.567	0.996	0.009	0.979 - 1.014	0.680
Total Workers	1.000	0.000	1.000 - 1.000	0.144	1.000	0.000	1.000 - 1.000	0.813
Proportion Male	1.011	0.003	1.005 - 1.017	0.000	1.005	0.004	0.998 - 1.013	0.180
n	120,362				136,225			
Clusters	4,151				3,877			
Deaths	1,072				841			

Source: Swedish administrative registry data

Note: Estimates not shown for level of government, period, region, and structure of workplace in regards to age, age by sex, occupation, and education.

TABLE 3. Males: Frequency Table for Causes of Death

Cause of Death	Frequency	Percentage (%)
Infectious and Parasitic Diseases	10	0.9
Neoplasms	473	44.1
Diseases of the Blood, Immunological Disorders	34	3.2
Endocrine, Nutritional, and Metabolic Diseases	19	1.7
Mental and Behavioural Disorders	14	1.3
Diseases of the Nervous System and the Sense Organs	17	1.6
Diseases of the Circulatory System	310	28.9
Diseases of the Respiratory System	12	1.1
Diseases of the Digestive System	25	2.3
Diseases of the Musculoskeletal System / Connective Tissue	6	0.6
Diseases of the Genitourinary System	3	0.3
Symptoms, Signs, Abnormal Findings, Ill-defined Causes	22	2.1
External Causes: Accidents	34	3.2
External Causes: Suicide, Homicide, Events of Undetermined Intent	93	8.7
Total	1,072	100.0

males in the workplace and mortality risk, I repeated the analysis with a categorical term for the proportion of males in the workplace, with categories 0-20%, 21-40%, 41-60%, 61-80%, and 81-100% males, so as to develop a clearer picture of this relationship. I also conducted these analyses for the major sub-categories of causes of death, adjusting for the same variables. The results for these categorical analyses are shown in figure 2.

I have included plots for all-cause mortality, as well as those sub-categories of causes of death that constitute 5% or more of the total number of deaths. This means that figure 2 shows plots for all-cause mortality, mortality related to neoplasms, diseases of the circulatory system, and external cause deaths that resulted from suicide, homicide, or events of undetermined intent. Furthermore, I have included a plot for external causes of death due to accidents, so as to make clear that these deaths are not responsible for the observation of a spurious relationship between the proportion of males in the workplace and all-cause mortality. As can be seen, the trend for all-cause mortality is in fact remarkably linear, meaning that it is possible to have confidence in the significant hazard ratio estimated for the linear term of the proportion of males in the workplace.

The two largest sub-categories of cause of death are neoplasms and diseases of the circulatory system, and it is clear that these two causes of death are strongly driving the all-cause mortality trend. With a gendered balanced workplace as the reference category, the association between the proportion of males in the workplace and death related to neoplasms is very much lower in workplaces with 0-20% males, and substantially elevated in workplaces where the proportion of males is higher than 61%. There is a similar trends for deaths related to diseases of the circulatory system. However, surprisingly, the relative risk of mortality within this category seems highest of all in workplaces with 0-20% males. The third largest contributor to the total number of mortalities is external causes related to suicide, homicide,
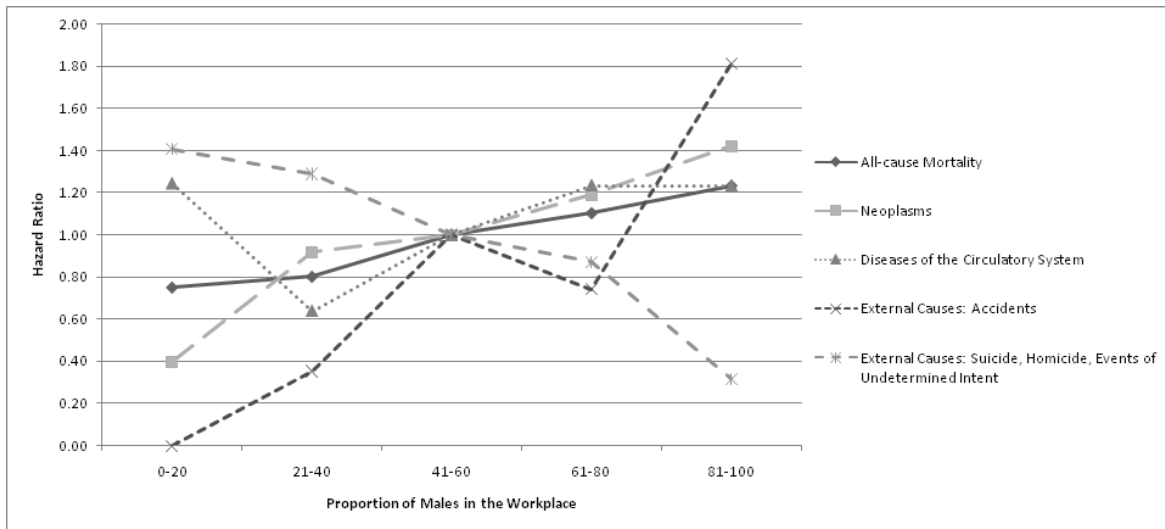
FIGURE 2. Relative Risks of Major Causes of Death for Males

or events of undetermined intent. This trend is quite the opposite to the other two discussed, with the relative risk of mortality decreasing as the proportion of males in the workplaces increases.

Finally, external causes of death due to accidents are lower in workplaces with a lower proportion of males, and are elevated in workplaces with a proportion of males greater than 80%. Given the relatively low number of deaths in this category (34), and the negative relationship between the proportion of males in the workplace and external causes of death due to suicide, homicide and events of undetermined intent, it is clear that external causes of death are not responsible for the association between the proportion of males in the workplace and all-cause mortality. I also ran separate analyses for the other causes of death shown in table 3. The majority of these causes of death were positively associated with the proportion of males in the workplace. However, due to the small number of mortalities in some of the categories, and because of the sample distribution across workplaces in terms of the proportion of males, in several cases no mortalities occurred in either heavily male- or female-dominated workplaces where the proportion of males was 81-100% or 0-20%, respectively.

Discussion and Conclusion

To briefly sum up the results, a higher proportion of males in the workplace was associated with a higher risk of all-cause mortality for males, but no significant relationship was observed for females. While past research on sickness absenteeism has suggested that the sex composition of the workplace affects sickness absenteeism behaviour in females but not in males, the only other research of which I am aware that has looked at sex ratios and mortality also found significant results for males but not for females (Jin et al., 2010). Given that the male sample group under analysis was individuals under the age of 65, almost all of whom

had medium to high occupational status and high levels of education, and who have stable jobs in the public sector, this finding is noteworthy. Although the focus of this study was all-cause mortality, figure 2 illustrates that the patterns for the largest categories of causes of death, neoplasms and diseases of the circulatory system, follow a similar pattern in relation to the proportion of males in the workplace. Furthermore, from the data shown in table 3 and figure 2, it is clear that external causes of death are not driving the all-cause mortality results.

In this study it has not been possible to distinguish between the different potential causes of the relationship between the sex composition of the workplace and all-cause mortality risk. It is possible that male dominated workplaces are characterized by higher levels of aggression, competition and conflict, or it may that when males are grouped together group polarisation may lead to an increase in the prevalence of risky health behaviours such as consuming unhealthy foods and alcohol. Alternatively, workplaces with a higher proportion of males may be characterized by a culture of sickness presenteeism, with males in these jobs less likely to take time of work for sickness even when that absence would be warranted. It is also possible that another unconsidered explanation could account for these results. The plots shown in figure 2 for neoplasms and diseases of the circulatory system mean that it is difficult to rule any of these explanations out, with all three mechanisms plausibly related to these outcomes.

While a large body of literature exists documenting the relationship between psychosocial stress and diseases of the circulatory system, these patterns of mortality risk could also clearly be explained by an increase in risky health behaviours if such behaviours are partially shaped by the sex composition of an individual's working environment. It is also likely that if sickness presenteeism is a prevalent behaviour in male-dominated workplaces, this could also be plausibly related to long-term risks in terms of diseases of the circulatory system. It is equally difficult to discern between the different potential mechanisms for the association between the proportion of males in the workplace and neoplasms. A recent review of the literature found that environmental psychosocial stress factors are linked to higher incidence rates of cancer in healthy populations, and higher mortality rates amongst those already diagnosed with cancer (Chida et al., 2008). The same review found that psychosocial stress factors are particularly important for incidence and mortality rates for breast, lung, head and neck, hepatobiliary, and lymphoid or hematopoietic cancers (Chida et al., 2008), and it may be possible to look within the category of neoplasms in further work.

However, medical research has also documented a causal relationship between both alcohol consumption and unhealthy dietary patterns and cancer (Boffetta et al., 2006; Boffetta and Hashibe, 2006; Lucenteforte et al., 2008; Benetou et al., 2008; Chan et al., 2011). Finally, any link between sickness presenteeism and increased cancer risk is likely to be weak if any such relationship exists at all, but it seems plausible that refusing to take the opportunity to recuperate when it is necessarily should have a general deleterious effect on the body. Of course it is possible that peer effects, sickness presenteeism, and psychosocial stress play simultaneous roles in regards to the relationship between the sex composition of the workplace and mortality risks. A surprising result was the negative relationship between the proportion

of males in the workplace and mortality attributable to external causes in terms of suicide, homicide, and events of undetermined intent. An attempt to explain this pattern would be speculative, but it is interesting and worthy of further investigation. If such a pattern persists in the larger population and in a more diverse range of workplaces it would be suggestive that these results may be related to something about work life that remains unclear at this point.

Although the only other study found that has investigated the relationship between sex ratios and mortality also found a significant association for males but not for females, it was still somewhat surprising, given the potential mechanisms that had been proposed, that no significant association was observed for females in this study. If peer effects or psychosocial stress are indeed the mechanisms underlying the observed association for males, it would seem reasonable that a similar effect would be observed for females. It should perhaps be noted that a smaller, but still positive, relationship was observed between the proportion of males in the workplace and all-cause mortality risk for females, but this was not significant at the $p < .05$ level. It is hoped that a clearer picture will emerge with further research. It might be added that even if the proposed mechanisms are plausible, the general trend that women engage in more positive health behaviours might be somewhat resistant to peer effects promoting a less healthy lifestyle. Alternatively, it is possible that the observed pattern that females tend to have higher levels of sickness absenteeism (Mastekaasa, 2005) may have an ameliorative effect on health that counteracts other negative influences.

Although the Swedish registry data that has been used for this study is impressive in many ways, I did not have access to detailed morbidity data. Access to data on morbidity would be extremely useful in further examining the relationship between the proportion of males in the workplace and health outcomes. It is likely that mortality outcomes before the age of 65, and particularly in the case of diseases of the circulatory system, will often describe rather sudden events such as a heart attack or stroke. Many individuals who have been suffering from severe hypertension or other chronic problems may instead opt for early retirement, or at least to an extended break from working life. In the analysis for this study, such individuals will have been censored because they would no longer have been registered as employees in the Swedish civil service. Clearly such data would allow for a much fuller and more extensive investigation of the current research question. Details on hospital visits for high blood pressure, or non-fatal myocardial infarction, for example, would provide a much more detailed picture of the situation under focus.

In the mean time, it will be possible to investigate the relationship between the proportion of males in the workplace and morbidity by looking at sickness absenteeism, extending the work of Mastekaasa (2005). The registry data on sickness absenteeism does not state the associated reason for taking time off work, so for every patient recovering from cardiovascular disease the data will also hold details on extensive periods away from work for those with broken legs, whiplash, or influenza. Nevertheless, such a study may help to fill in the picture, and sickness absenteeism is an outcome that is interesting in its own right. It should be noted that the collection of evidence for the relationship between the proportion of males in the workplace and mortality risk is at a very early stage; to my knowledge this study is the

only one of its kind. Further verification of these results, particularly in other countries and contexts, would provide further support to an important finding, and one that has challenging implications for public health policy.

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