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Sex differences in behavior and the morbidity-mortality paradox

By

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ABSTRACT

Objective: To analyze if gender-specific health behavior can be one explanation why women outlive men while at the same time have worse morbidity outcomes, known as the morbidity-mortality or gender paradox.

Setting: The working population in Sweden.

Participants: 30% random sample of Swedish women and men aged 40-59 with a hospital admission in the period 1993-2004 . The analysis sample consist of 233,274 individuals (115,430 men and 117,844 women) and in total 1 867,013 observations on sickness absence.

Intervention: Hospital admission.

Main outcome measures: Sickness absence (morbidity) and mortality. Longitudinal data at the individual level allows us to study how the sickness absence change after the hospital admission for men and women.

Results: Women increase their sickness absence by around five more days per year than the males (95% confidence interval 5.25 to 6.22). At the same time men have higher risk of mortality for the eighteen diagnosis categories analyzed. The pattern of more sickness absence of the women is the

same across seventeen different diagnosis categories. For neoplasm on the other hand, with a 57% higher risk of death for the men (54.18% to 59.89 %) the results depend on the imputation method of sickness for those deceased. By using the pre mortality means of sickness absence men have an additional 14.47 (12.64 to 16.30) days of absence but with the zero imputation women have an additional 1.6 days of absence (0.05 to 3.20). Analyses with or without covariates reveals a coherent picture.

Conclusions: The pattern of increased sickness absence (morbidity) and lower mortality in women provides evidence of more pro-active and preventive behavior of women than that of men, which could thus explain the morbidity-mortality paradox.

Article summary

Morbidity measures are used as measures of the health in the population as well as inputs to adjust for the remuneration when health care is paid by capitation. Ideally, these measures should not be affected by patients' preferences for health care. If these morbidity measures do not reflects real health the design of increasing public health can be misleading and inefficient.

The present study, focus on the differences between the genders and to what extent that gender differences in observed morbidity outcomes reflects differences in behavior rather than differences in health. We test this hypothesis using mortality data and a novel difference-in-difference design on a morbidity measure (sickness absence) on the total Swedish population of working people (115,430 men and 117,844 women). The morbidity-mortality or gender paradox has been studied by numerous of researchers. However we are only aware of three papers, with conflicting results, aiming at testing if this observed phenomena stems from differences in preferences between the sexes, that is a more proactive behavior of women then of men (1-3). In the present study we use the strategy previously suggested by two of the authors in a more methodologically oriented article (3), and test the hypothesis in a much larger population.

Strengths and limitations of this study

- The empirical analyze is based is based on a difference-in-differences design commonly used in social science and increasingly applied in medical science.
- The longitudinal characteristic of our data allows us to condition on group differences in health, working conditions, and other time-invariant factors (e.g. differences in household duties) which might confound the relation between absenteeism and gender-specific health behavior.
- Results based on observational data can however always suffer from confounding bias.
- All displayed results are not sensitive to the inclusion of observed covariates or not. This result is to be expected from the design of the study.
- If anything the adjustment for covariates increase, rather than decrease, the magnitude of the. Hence, given that the inclusion of these covariates to some extent captures health before the hospital admission, this empirical pattern indicates that women have, on average, better pre-admission health than men do. The implication would then be that the observed gender differences in sickness absence after a hospital admission is a lower bound of the more proactive and preventive behavior of women in contrast to that of the men.

INTRODUCTION

In many countries, women are relatively more absent for health reasons than men [1]. Furthermore, similar gender differences exist in other common measures of morbidity such as medical care utilization and self-reported health [2]. Yet, while most commonly used observed health measures show an over-representation of women, there is one major exception to this rule – the remaining life expectancy. One of the most known stylized facts of gender differences is that women outlives men. In fact, the remaining life expectancy is higher for women than for men in all ages and in nearly all parts of the world. The global average gender difference in life expectancy was about four years in 2010 and has been persistently so for a long time [3]. This has led some scholars to label the relationship the *morbidity-mortality or gender paradox [4]*.

One suggested explanation for this apparently inconsistent pattern has been the existence of gender differences in health behavior, where women use common measures of morbidity proactively in order to keep healthier, which would then prolong their lives relative to men (cf. [4], [5], [6], [7]). This particular explanation for the so-called morbidity-mortality paradox was discussed already in the 17th century; the English demographer John Graunt [8] observed that both the birth and death rates of men were higher than for women while at the same time "[Physicians] have two women patients to one man".

This conjecture of behavioral differences have support in experimental studies in social science (cf. [9]). In particular, it has often been noted that women, in general, act more proactively in matters regarding their own and other family members' health and that women tend to be more risk averse than men. The implication is that if women pay more attention to potential future illnesses, by more frequent use of medical services or health insurance, poor health can be detected at an earlier stage, remediated, and, consequently, increase their relative life expectancy in relation to men. The large cross-country variation is life expectation (see e.g. [10]) also suggests that the general picture of

women outliving men to some extent stems from gender-specific health behavior based on differences in cultural norms.

This article empirically tests for gender differences in behavior as a factor in understanding the morbidity-mortality paradox by using the evolution of morbidity (sickness absence) and mortality of men and women after a hospital admission (i.e. an adverse health shock). If women act more proactively than men do, we should find that women are more sickness absent after a comparable health shock compared to men while, at the same time, do not experience higher mortality rates. Thus, if we find such a pattern in our data, this supports the conjecture that the morbidity-mortality conundrum is driven by a more proactive health behavior among women. On the other hand, if we find an increase in sickness absence and that women's mortality rate is higher after the health shock, we would conclude that it is likely that actual health differentials between men and women are causing the increase in sickness absence.

Since measures of morbidity are almost exclusively discussed from an adverse standpoint, it is an important question for health policy whether and to which extent gender differences in observed outcomes reflects differences in behavior rather than differences in health. Therefore, our aim is to study the morbidity-mortality paradox and analyze if gender-specific health behavior can be one explanation why women outlive men while at the same time have worse morbidity outcomes.

METHODS

Study design and participants

Our empirical analysis exploits micro-data originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. The data on socioeconomic variables covering the entire Swedish (16-65) population for years 1993-2004 were obtained from Statistics, Sweden. We linked these data to information on sickness absence and

inpatient care over the same time period using registers at the Swedish Social Insurance Agency and the Swedish National Board of Health and Welfare, respectively. The information about sickness absence covers all individual spells of paid sick leave from the statutory sickness insurance in Sweden. The National Patient Register covers all inpatient medical contacts in public hospitals. The diagnoses, made by physicians, are classified according to the World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD-10).

The analysis was performed using a 30 percent random sample of the population of employed individuals 40-59 years of age in 1993 who were hospitalized at some point between years 1994-2004. We make use of the first hospital admission only. For sampled individuals with their first hospital admission in 1999, we hence observe their sickness absence five years before and five years after the admission. For other years we do not observe the complete number of leads and lags, leading to an unbalanced panel. To account for potential sample composition effects, we include factors (or fixed effects) for years and age in our empirical specification

The reason for the age and employment restrictions prior to the hospital admission is that sickness absence is only a valid morbidity measure if individuals are eligible for sickness benefits, i.e. have employment (or searching for a job but with previous employment). Eligibility is tied to being in the labor force and below the mandatory retirement age of 65. As individuals in general leave the labor force before the age of 65 we restrict the analysis to individuals younger than 60.

Statistical analyzes

In the analyses we make use of regression analysis and adjust for age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and a factor for whether the individual or the spouse had earnings above the sickness insurance cap and factors for year of the admission, occupational sector and disease category.

The difference-in-difference design allows us to adjust for unobserved confounders of importance for sickness absence that may differ between men and women before the admission to the hospital. Adjusting for pre-admission gender differences, we then estimate the relative effect from the admission of women compared to men using an ordinary least squares estimator. As deceased individuals will otherwise be right-censored after death and thus not show up in sickness absence records, we keep all deceased by imputing the sickness absence the year before the death for each year after their death. If men have a higher mortality rate than women, this strategy is conservative as a means to test for more pro-active behavior of women compared to men. On the other hand if men and women have similar mortality rates imputing zero days of absence for each year after their death provides a conservative test for more pro-active behavior of women. Both imputation methods will be used in the analysis however the first results take use of the mean imputation. Furthermore, the sickness and disability insurance are integrated parts of the social insurance system and therefore interrelated. An individual on full time disability benefits cannot receive sickness benefits but part time disabled persons can. In the analysis, we therefore define days on sickness absence as number of days on sickness benefits and/or days on disability benefits in a given year.

In the mortality analyses, we make use of daily data and estimate discrete time Cox proportional hazard regression models using maximum likelihood.

The study was approved by the Regional Ethical Review Board in Uppsala (approval number 2005:126).

Patient and Public Involvement.

Patients were not involved in the design or conduct of this large observational register-based study. It will not be possible to disseminate the results directly to the individuals involved since all analyses were done on depersonalized data. Hence, the results will be disseminated to the public through publication in scientific and popular scientific journals.

RESULTS

Sickness absence in relation to gender

Figure 1 shows the average number of days of sickness absence of men and women before and after hospitalization. The left panel shows the overall difference while the right panels displays the average for four large disease categories; neoplasms (ICD-10 = C00-D48), circulatory diseases (ICD-10 = I00-I99), musculoskeletal diseases (ICD-10 = M00-M99) and mental and behavioral disorders (ICD-10 = F00-F99).

From the left panel we can see that the sickness absence for both men and women increase in the years prior to the hospital admission, but also that this increase is greater for women. In the period after the hospital admission, we see a sharp increase in sick leave for both men and women, but the increase is much greater for women. The right panel of Figure 1 shows the same pattern before the hospital admission for the four large diseases categories. After the hospital admission, however, there are some differences across these categories. For neoplasms sickness absence is higher for men one two –four years after the admission. For the other diseases women have higher sickness absence than men for the whole follow up period. For circulatory diseases this difference is small the admission year while for the two other the gender differences is initially large but then taper off.

Mortality in relation to gender

Figure 2 reports disease-specific share of men and women who died within five years after the hospitalization separated into mortality within yearly follow-up categories for in total eighteen different disease categories. It shows a remarkable pattern; for all disease categories, men have a higher probability of dying (also within follow-up categories) after the hospitalization.

For neoplasms, the risk of dying in the five-year follow-up period is 22 percentage points higher for the men than for the women (42% compared with 20%). For circulatory diseases, mental and behavioral (mental in the following) disorders and musculoskeletal diseases, there is a corresponding

4 (14% to 10%), 4 (12% to 8%) and 1.5 (6% to 4.5%) percentage points increased risk for the men, respectively.

For the sickness absence data, we imputed the sickness absence the year before the death for the deceased. The gender differences in mortality could thus possibly explain some of the post-hospital admission pattern regarding sickness absence. This explanation is most likely to be the most important for neoplasms.

Results from regression estimation

Table 1 presents the results from regression analyses of gender differences in sick leave and mortality for the five years follow-up period after the hospital admission. The results on both sickness absence and mortality are in line with the previous results reported in Figures 1 and 2. From column (3) in panel A of Table 1, we see that women use a statistically significant 5.73 additional days of sickness absence than men per year over the five-year post-hospitalization sampling window (95% confidence interval 5.25 to 6.22). For a hospital admission for a neoplasm, circulatory disease, musculoskeletal disease, and mental disorder, the corresponding gender differences are -14.47, 7.44, 5.77, and 5.30 days, respectively (-16.30 to -12.64, 5.91 to 8.96, 3.63 to 7.91 and 1.96 to 8.64). Finally, from column (3) in panel B, we see that women have around 27% ($\approx 100(1-\exp(-.314))$ lower post-hospitalization mortality risk than men (24.18% to 29.62%). For the neoplasm, circulatory, musculoskeletal, and mental diseases, the corresponding figures are, 57%, 38% 27% and 45% lower mortality risks (54.18% to 59.89%, 30.73% to 43.94%, 13.02% to 38.40% and 33.89% to 54.98%)

Results from analyses on sickness absence for the eighteen disease categories are provided in Table 2. The general conclusion from these analyses is the same as in the overall gender-difference analysis: women increase their absence more for all categories (statistically significant for twelve of these) except for neoplasm five years after the hospital admission than men.

Table 1. Results (standard errors within parenthesis) from regressions (linear and Cox) of gender difference in sickness absence (for the deceased we impute the sickness absence the year before the death for all years after the death) and mortality after a hospitalization, by disease type. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission(see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
A: Linear regressions (difference-in difference design on gender difference in effect of health shock on days of sickness absence			
All	5.728***	4.963***	5.738***
N =1,867,013[%]	(0.252)	(0.250)	(0.246)
Circulatory (ICD-10 = I00-I99)	7.102***	6.621***	7.436***
N=255,687	(0.792)	(0.780)	(0.777)
Neoplasms (ICD-10 = C00-D48)	-9.365***	-15.082***	-14.471***
N =223,875	(0.935)	(0.941)	(0.935)
Musculoskeletal (ICD-10 = M00-M99)	3.149***	4.165***	5.772***
N =149,846	(1.116)	(1.105)	(1.091)
Mental (ICD-10 = M00-M99)	4.109**	3.584**	5.305***
N =63,065	(1.718)	(1.705)	(1.704)
B: Cox PH regressions on gender difference in post-shock mortality			
All	-0.279***	-0.226***	-0.314***
N = 233,274	(0.018)	(0.018)	(0.019)
Circulatory (ICD-10 = I00-I99)	-0.449***	-0.400***	-0.473***
N =31,838	(0.053)	(0.053)	(0.054)
Neoplasms (ICD-10 = C00-D48)	-0.918***	-0.752***	-0.847***
N =27,781	(0.031)	(0.033)	(0.034)
Musculoskeletal (ICD-10 = M00-M99)	-0.197**	-0.253***	-0.312***
N =18,875	(0.086)	(0.086)	(0.088)
Mental ICD-10 = M00-M99)	-0.578***	-0.559***	-0.606***
N =8,236	(0.095)	(0.095)	(0.098)
Covariates[#]		√	√
Factors[¤]			√

*** p<0.001, ** p<0.05

[%] N is the sample size. In the sickness absence analysis this is the number of individuals time the number of time periods they are included in the analysis while in the mortality analysis it is the number of individuals.

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap..

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

Table 2. Results from linear regression (difference-in difference model) of gender difference in sickness absence (for the deceased we impute the sickness absence the year before the death for all years after the death) after a hospitalization for 18 disease categories. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission(see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
Accident, N=201,273[%]	5.033***	6.541***	7.653***
Blood, N = 9,973	7.613**	3.717	3.768
Congenital, N =5,530	5.365	3.116	3.924
Digestive, N = 219,619	7.861***	7.628***	8.447***
Ear, N = 25,660	4.459**	4.559**	5.952***
Endocrine, N =40,538	-0.871	-0.964	0.157
Eye, N = 22,685	4.086**	4.648**	5.248***
Factors, N =55,136	-0.147	2.113	3.633***
Genitourinary, N =168,659	4.273***	0.667	0.860
Circulatory (ICD-10 = I00-I99), N = 255,687	7.102***	6.621***	7.436***
Infection, N =40,946	3.555**	3.380**	3.660**
Mental ICD-10 = M00-M99) N =63,065	4.109**	3.584**	5.305***
Neoplasms (ICD-10 = C00-D48), N = 223,875	-9.365***	-15.082***	-14.471***
Nerve, N = 44,075	9.461***	10.397***	11.395***
Respiratory, N = 81,981	7.952***	7.819***	8.688***
Skin, N = 14,040	-0.219	0.983	2.355
Symptoms, N = 244,425	10.072***	9.972***	10.752***
Covariates[#]		√	√
Factors[¤]			√

*** p< 0.001, ** p< 0.05, p<0.10

[%] N is the sample size. This is the number of individuals time the number of time periods included in the analysis (i.e. 10).

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap..

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

In order to find out the importance of the mean imputation method we present the results when we imputed zero for those deceased after their death in Table 3. The overall results is basically unaffected but now we find statistical significant increase in sickness absence for the women in

sixteen disease categories, including neoplasm. For this disease women increase their absence by 1,6 days more than the men after the admission over the five-year follow up period (0.05 to 3.20).

Table 3. Results from linear regression (difference-in difference model) of gender difference in sickness absence (imputing zero days of absent for all years after a death for those deceased) after a hospitalization for 18 disease categories. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission(see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
All, N = 1,867,013	5.156***	4.392***	5.126***
Accident, N=201,273[%]	5.175***	6.693***	7.771***
Blood, N = 9,973	16.757***	12.188***	12.320***
Congenital, N =5,530	5.940	3.660	4.458
Digestive, N = 219,619	7.569***	7.349***	8.137***
Ear, N = 25,660	4.068**	4.190**	5.567***
Endocrine, N =40,538	0.240	0.122	1.212
Eye, N = 22,685	5.576***	6.132***	6.717***
Factors, N =55,136	0.641	2.662*	4.150***
Genitourinary, N =168,659	5.230***	1.570**	1.759**
Circulatory (ICD-10 = I00-I99), N = 255,687	7.385***	6.900***	7.779***
Infection, N =40,946	4.349***	4.153***	4.411***
Mental ICD-10 = M00-M99) N =63,065	5.474***	4.947***	6.713***
Musculoskeletal (ICD-10 = M00-M99), N = 149,846	2.981***	4.009***	5.592***
Neoplasms (ICD-10 = C00-D48), N = 223,875	6.097***	1.108	1.626**
Nerve, N = 44,075	9.607***	10.469***	11.461***
Respiratory, N = 81,981	7.317***	7.294***	8.061***
Skin, N = 14,040	0.114	1.342	2.710
Symptoms, N = 244,425	9.487***	9.419***	10.173***
Covaraites[#]		√	√
Factors[¤]			√

*** p< 0.001, ** p< 0.05, p<0.10

[%] N is the sample size. This is the number of individuals time the number of time periods included in the analysis (i.e. 10).

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap..

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

There exits previous studies of gender differences in the mortality after an inpatient care visit for an acute myocardial infarct (AMI), see e.g. [14], [15] and [16]. For this reason additional analyses on

the AMI inpatient care visits were made. We re-estimated our models using the AMI sample on (1) total five years mortality, (2) in-hospital death (i.e., where the patient dies before discharge), (3) one year follow-up period (conditional on discharge) and (4) a follow up period of 1-5 years after the inpatient care visit. We estimate the total effects but also separately for the age groups 40-44, 45-49, 50-54 and 55-59.

Table 4 provides the results from the regressions where we adjust for the same variables as in the previous analyses. From column (1) we see that men in this population have higher risk of dying within five years and that men in the oldest cohort is primarily driving this effect. For the other outcomes, we find no statistically significant gender differences.

Table 4: Results (standard errors within parenthesis) from Cox regressions of gender difference in mortality after acute myocardial infarct hospitalization by "timing of death" and age categories

	(1) Total	(2) In-hospital	(3) Post-discharge (<1year)	(4) Post-discharge (1 to 5 years)
All	-0.030**	-0.007	-0.009	-0.013
N = 3,545[%]	(0.014)	(0.006)	(0.005)	(0.011)
Age cohorts				
40-44	-0.054	-0.011	-0.032	-0.010
N = 211	(0.044)	(0.018)	(0.025)	(0.033)
45-49	-0.016	-0.004	-0.003	-0.009
N = 604	(0.033)	(0.014)	(0.013)	(0.028)
50-54	-0.005	-0.013	-0.008	0.016
N = 1,175	(0.024)	(0.011)	(0.009)	(0.020)
55-59	-0.050**	-0.003	-0.009	-0.038**
N = 1,555	(0.022)	(0.009)	(0.009)	(0.018)
Covariates and factors[#]	√	√	√	√

[%] N is the number of individuals.

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap, indicators for calendar year, occupational sector and disease category (where feasible).

** p<0.05

DISCUSSION

Measures of morbidity are often used as measures of the health in the population as well as inputs to adjust for the remuneration when health care is paid by capitation. . Ideally, these measures should not be affected by patients' preferences for health care. If these morbidity measures do not reflects real health the design of increasing public health can be misleading and inefficient. For instance a recently published study shows that among fee-for-service Medicare beneficiaries, there is an inverse relationship between the regional frequency of diagnosis and the case-fatality rate for chronic conditions [17]. The present study focus on the differences between the genders and to what extent that gender differences in observed morbidity outcomes reflects differences in behavior rather than differences in health. We test this hypothesis using a novel design made possible by the supply of longitudinal data on a morbidity measure (sickness absence) on the population of working men and women (115,430 men and 117,844 women). We found that women extracted relatively more sickness absence and simultaneously had a lower mortality risk than men both before, but in particular after, the hospitalization. This provides strong evidence of more proactive and preventive behavior of women than that of the men.

Case and Paxson (2005) [11] and [12] could not confirm the hypothesis of differences in preferences between the sexes, that is a more proactive behavior of women than of men or a [13, p. 2251] "greater stoicism among men and a greater willingness among women to use health services, report health problems and factor in less-serious ailments when assessing their own health". As a morbidly measure [11] focused on self- assessed health while [12] used self-rated health, longstanding illness, respiratory illness, sickness absence, hypertension and CHD prevalence. The lack of systematic statistical significant differences in association between mortality and the morbidity measures are taken as evidence against the theory. One should, however note that there are patterns in both studies that supports the theory. For example 8 of 11 morbidly measures have a stronger association to mortality for men than for women and for one (sickness absence) is this difference

statistically significant. In [11] men with respiratory cancer, cardiovascular disease, and bronchitis are found to have higher incidence of hospital episodes and mortality than women who suffer from the same self-reported conditions. This suggest that this theory may be one explanation for the observed gender pattern but that the sample size needs to be large and that one potentially need methods not sensitive to unmeasured confounders. The strategy used in this paper was originally suggested in [13] who applied the method to a sample of working Swedish men and women aged 40-45.They could not reject the hypothesis of behavior differences between men and women. This paper extend on [13] by studying a larger population and by a more elaborate analysis over diagnosis codes.

Our results on mortality after a hospital admission are somewhat in contrast to studies on gender differences in AMI mortality after a hospital admission. For example [14], [15] and [16] found a higher risk of mortality after an inpatient care visit for an AMI for younger (less than or equal to 65 or less than or equal to 75) women, compared to men. However, these analyses are based on hospital discharge data, implying that mortality is conditional on patient admission and that death occurred before leaving the hospital. Both [18] and [19] show that female AMI patients have on average longer hospital stays than men. The implication is that, if women have longer length of hospital stays (e.g. due to differences in preferences) given a certain health condition, then this could explain women's higher mortality. An advantage of our analysis is that it is not restricted to death in the hospital. In order to shed light on this potential issue, we re-estimated our analyses on the subsample of AMI patients. This sub-analysis could not confirm the results in [14], [15] and [16].

LIMITATIONS

Results based on observational data can always suffer from confounding bias. We empirically analyze changes in sickness absence after a hospital admission for men and women in a difference-in-differences design commonly used in social science and increasingly applied in medical science [20].

The longitudinal characteristic of our data allows us to condition on group differences in health, working conditions, and other time-invariant factors (e.g. differences in household duties) which might confound the relation between absenteeism and gender-specific health behavior. In this respect, we need to stress that all displayed results are not sensitive to the inclusion of observed covariates or not. This result is to be expected from the design of the study. If anything the adjustment for covariates increase, rather than decrease, the magnitude of the effects (compare column (1) with no adjustment to column (3)) in Tables 1, 2 and 3. Hence, given that the inclusion of these covariates to some extent captures health before the hospital admission, this empirical pattern indicates that women have, on average, better pre-admission health than men do. The implication would then be that the observed gender differences in sickness absence after a hospital admission is a lower bound of the more proactive and preventive behavior of women in contrast to that of the men.

IMPLICATIONS

Using morbidity measures in the design of increasing public health can be misleading and inefficient. A more efficient strategy may instead be of affecting attitudes and norms on risks for groups with high mortality. One such strategy that might save many lives would be to inform men to imitate female behavior, rather than the opposite.

a. Daniel Avdic made all analyses and interpreted the data together with the coauthors. He had approved the version of the manuscript to be published.

   Pathric Hägglund interpreted the data together with the coauthors and drafted the manuscript. He had approved the version of the manuscript to be published.

   Bertil Lindahl interpreted the data together with the coauthors, drafted parts of the manuscript and revised the manuscript for important intellectual content. He had approved the version of the manuscript to be published.

   Per Johansson designed the study and interpreted the data together with the coauthors and

drafted the manuscript of data. He had approved the version of the manuscript to be published.

b. None of the authors has any conflict of interest relevant in relation to the present article to report.

c. The corresponding author acknowledge funding from the Swedish Research Council for Heath, Working life and Welfare (FORTE).

d. The data used in this analysis are drawn from Swedish administrative registers and are confidential. The data can be obtained for replication by contacting IFAU by email ifau@ifau.uu.se. The data is personal data and are therefore governed by the ethical principles set up by the Swedish government. The data may be transferred to a third country in one of the following situations:

- If there is an adequate level of protection (see * below) in the recipient country (for instance according to decisions by the EU Commission).
- When the data subject has given his/her consent to the transfer.
- In certain specific situations enumerated in section 34 of the Personal Data Act.
- If it is permitted in some other way according to regulations or specific decisions by the Government or the Data Inspection Board with reference to that there are adequate safeguards with respect to the protection of the rights of the data subjects. Such safeguards may result from:
  - Standard contractual clauses approved by the EU Commission.
  - Binding Corporate Rules (BCR).

The processing of personal data that takes place in Sweden must still comply with the rules of the Personal Data Act. This means that data may only be transferred if the data controller in Sweden has complied with the other requirements of the Personal Data Act, for instance the fundamental requirements regarding processing of personal data and the rules about when such processing is permitted on the whole.

*In the Personal Data Act (and in the EC Directive on data protection) there are guidelines on what you have to consider when assessing the level of protection for personal data. All circumstances surrounding the transfer shall be considered. Particular consideration shall be given to the nature of data, the purpose of the processing, the duration of the processing, the country of origin, the country of final destination and the rules that exist for the processing in the third country.
The EU Commission has analyzed the data protection rules of a few countries and decided that the level of protection in these countries is adequate. The decisions concern: Argentina, Bailiwick of Guernsey, Faroe Islands, Isle of Man Jersey, Switzerland
Furthermore the EU Commission has assessed that the level of protection is adequate within certain sectors or under certain conditions in the following countries:

- Canada (if their legislation on protection of personal data in the private sector is applicable on the recipient´s processing of personal data)
- U.S.A. (if the recipient has adhered to the so called Safe Harbor principles)

The decisions of the EU Commission are enumerated in an annex to the Personal Data Ordinance. In the ordinance it is explicitly stated that transfers are permitted in these cases.
The self harbor principle is a set of voluntary rules on privacy and data protection elaborated and decided by the US Department of Commerce (DoC). Organizations in the US can notify the DoC that they adhere to these rules. The EU Commission has assessed that the rules (including accompanying questions and answers) constitute an adequate level of protection. Thus it is permitted to transfer personal data from EU/EEA to organizations in the US who have adhered to the rules.

On the website of the US DoC there is a list of companies and organizations that have adhered to the Safe Harbor principles. For further information see http://www.datainspektionen.se/in-english/in-focus-transfer-of-personal-data/

REFERENCES

1. Mastekaasa A, Olsen, K. Gender, Absenteeism and Job Characteristics: A Fixed Effects Approach. *Work and Occupations*. 1998; 25: 195-2228.
2. Sindelar, J L. Differential Use of Medical Care by Sex. *Journal of Political Economy*. 1982; 90: 1003-1019.
3. Lee, C. Gender, Health and Health Behaviors. In J. Chrisler and D. R. McCreary (eds.), Handbook of Gender Research in Psychology. Springer Science, 2010; 20: 471-493.
4. Nathanson, C. Illness and the Feminine Role: A Theoretical Review. *Social Science and Medicine*. 1975;9: 57-62.
5. Verbrugge, L M. Sex Differentials in Health. *Public Health Report*. 1982; 97: 417-437.
6. Stronegger, W J, Freidl, W, Rasky, V. Health Behaviour and Risk Behaviour: Socioeconomic Differences in an Austrian Rural County. *Social Science and Medicine*. 1997;44: 423-426.
7. Uitenbroek, D. G., Kerekovska, A, Festchieva, N. Health Lifestyle Behaviour and Socio-Demographic Characteristics. A Study of Varna, Glasgow and Edinburgh. *Social Science and Medicine*. 1996;43:367-377.
8. Graunt, J. Natural and Political Observations Mentioned in a Following Index and Made Upon the Bills of Mortality. London: Tho: Roycroft, for John Martin, James Allestry, and Tho: Dicas, 1662, London: Martin, Allestry and Dicas.
9. Bertrand, M. New Perspectives on Gender. In O. Ashenfelter and D. Card (eds.), Handbook of Labor Economics 4b, Elsevier Ltd. 2010: 1545-1592.
10. CIA factbook, 2011. https://www.cia.gov/library/publications/the-world-factbook/index.html
11. Case A, Paxson C. Demography. 2005 May;42(2):189-214. Sex differences in morbidity and mortality.
12. Singh-Manoux A, Guéguen A, Ferrie J, Shipley M, Martikainen P, Bonenfant, S, Goldberg M, Marmot, M Association Between Morbidity and Mortality Among Middle-Aged Men and Women Am J Public Health. 2008; 98: 2251–2257.
13. Avdic D, Johansson P. Absenteeism, Gender and the Morbidity–Mortality Paradox. *Journal of Applied Econometrics*. 2017; 32: 440-462.
14. Vaccarino V, Parsons L, Every NR, Barron HV, Krumholz HM.; National Registry of Myocardial Infarction 2 Participants. Sex-based differences in early mortality after myocardial infarction. *N Engl J Med*. 1999;341(4):217-225.
15. Vaccarino V, Krumholz HM, Yarzebski J, Gore JM, Goldberg RJ. Sex differences in 2-year mortality after hospital discharge for myocardial infarction. *Ann Intern Med*. 2001;134(3):173-181.
16. Canto JG, Rogers WJ, Goldberg RJ, et al. Association of Age and Sex With Myocardial Infarction Symptom Presentation and In-Hospital Mortality. *JAMA*. 2012;307(8):813-822. doi:10.1001/jama.2012.199.
17. Welch GH, Sharp SM, Gottlieb DJ, Skinner JS, Wennberg JE. Geographic Variation in Diagnosis Frequency and Risk of Death Among Medicare Beneficiaries. JAMA. 2011;305(11):1113-1118. doi:10.1001/jama.2011.307

18. Every N R, Spertus J, Fihn SD, Hlatky M, Martin JS, Weaver WD. Length of hospital stay after acute myocardial infarction in the Myocardial Infarction Triage and Intervention (MITI) Project registry. *J Am Coll Cardiol.* 1996;28(2):287-93.
19. Kinjo K1, Sato H, Nakatani D, Mizuno H, Shimizu M, Hishida E, Ezumi A, Hoshida S, Koretsune Y, Hori M; Osaka Acute Coronary Insufficiency Study (OACIS) Group. Predictors of Length of Hospital Stay After Acute Myocardial Infarction in Japan. *Circ J.* 2004; 68: 809– 815.
20. Dimick J B, Ryan A M. Methods for evaluating changes in health care policy: the difference-in-differences approach. *JAMA.* 2014; 312(22):2401-2. doi: 10.1001/jama.2014.16153.

Legends Figures

Figure 1. Number of days of absence for men and women before and after a (first) hospital admission for the population of employed (prior to the hospital admission) individuals 40-59 years of age in 1993 to 2004. Left panel average. Right panel conditional on a cancer, myocardial infarction, musculoskeletal and mental diseases.

Figure 2. Five-year mortality risk for men and women after a hospital admission by diagnosis category for the population of employed (before the hospital admission) individuals 40-59 years of age in 1993 to 2004.

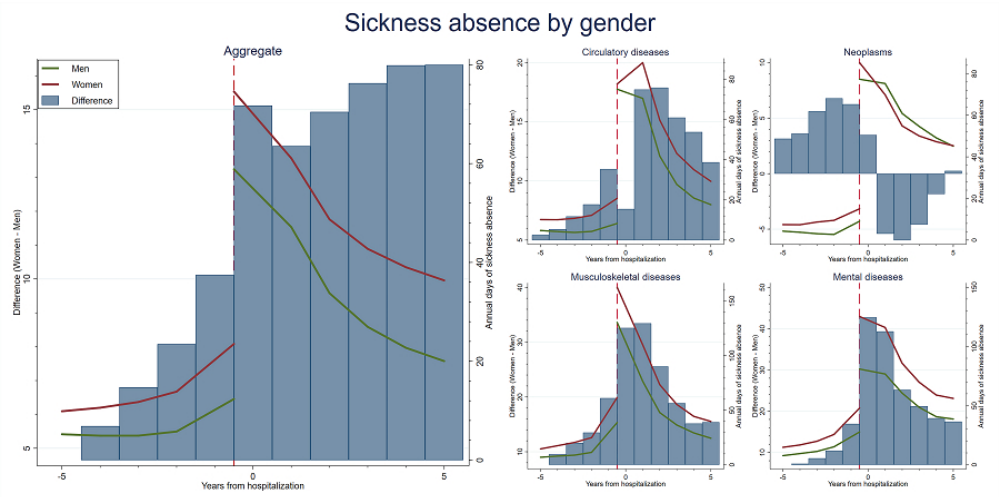

Figure 1. Number of days of absence for men and women before and after a (first) hospital admission for the population of employed (prior to the hospital admission) individuals 40-59 years of age in 1993 to 2004. Left panel average. Right panel conditional on a cancer, myocardial infarction, musculoskeletal and mental diseases.

76x38mm (300 x 300 DPI)

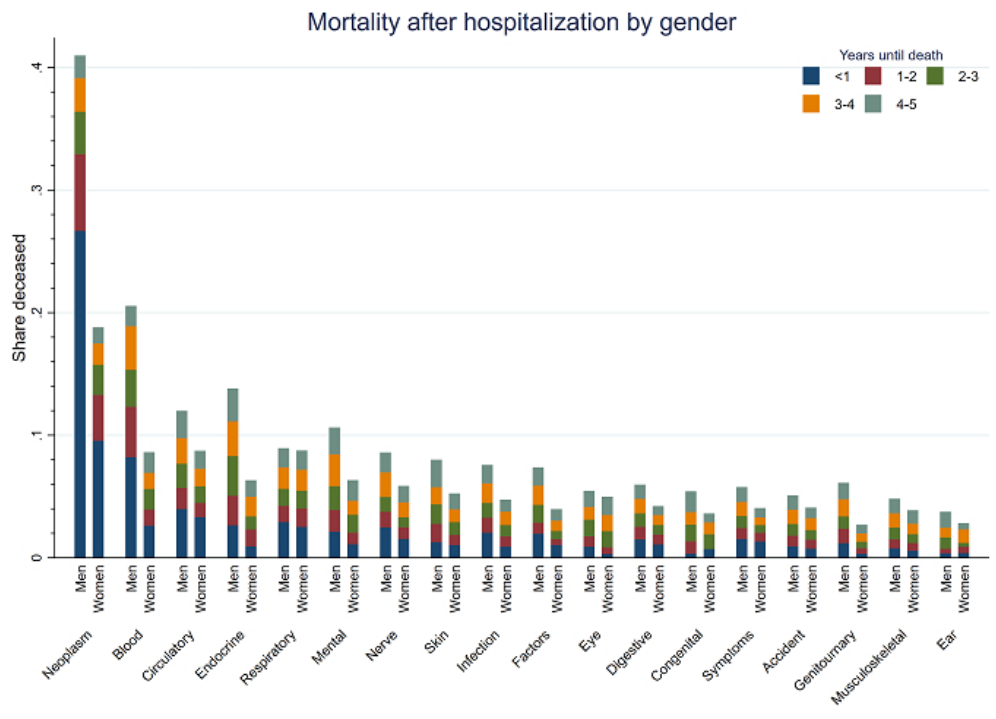

Figure 2. Five-year mortality risk for men and women after a hospital admission by diagnosis category for the population of employed (before the hospital admission) individuals 40-59 years of age in 1993 to 2004.

57x42mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	Longitudinal data at the individual level and using a difference-in-differences design for the analysis on sickness absence (before and after a hospital admission)..
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1	Women increase their sickness absence by around five more days per year than the males (95% confidence interval 5.25 to 6.22 (mean) and 4.66 to 5.60 (zero)). At the same time men have higher risk of mortality for the eighteen diagnosis categories analyzed.
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2	The global average gender difference in life expectancy was about four years in 2010 and has been persistently so for a long time [3]. This has led some scholars to label the relationship the morbidity-mortality or gender paradox [4].

Objectives	3	State specific objectives, including any prespecified hypotheses	1	To analyze if gender-specific health behavior can be one explanation why women outlive men while at the same time have worse morbidity outcomes, known as the morbidity-mortality or gender paradox.
Methods				
Study design	4	Present key elements of study design early in the paper	4	The difference-in-difference design allows us to adjust for unobserved confounders of importance for sickness absence that may differ between men and women before the admission to the hospital
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2-3	Our empirical analysis exploits micro-data originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. Sweden
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	2-3	The data on socioeconomic variables covering the entire Swedish (16-65) population for years 1993-2004 were

		Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants		obtained from Statistics Sweden
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*3*	
Bias	9	Describe any efforts to address potential sources of bias	12-13	
Study size	10	Explain how the study size was arrived at	12	

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Sex differences in behavior and the morbidity-mortality paradox

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Sex differences in behavior and the morbidity-mortality paradox

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ABSTRACT

Objective: To analyze if gender-specific health behavior can be one explanation why women outlive men while at the same time have worse morbidity outcomes, known as the morbidity-mortality or gender paradox.

Setting: The working population in Sweden.

Participants: 30% random sample of Swedish women and men aged 40-59 with a hospital admission in the period 1993-2004 . The analysis sample consist of 233,274 individuals (115,430 men and 117,844 women) and in total 1 867,013 observations on sickness absence.

Intervention: Hospital admission across eighteen disease categories.

Main outcome measures: Sickness absence (morbidity) and mortality. Longitudinal data at the individual level allows us to study how the sickness absence change after the hospital admission for men and women in a difference-in-difference regression analysis. Cox regression models are used to study differences in mortality after the admission.

Results: Women increase their sickness absence by around five more days per year than the males (95% confidence interval 5.25 to 6.22). At the same time men have higher risk of mortality for the

eighteen diagnosis categories analyzed. The pattern of more sickness absence of the women is the same across seventeen different diagnosis categories. For neoplasm on the other hand, with a 57% higher risk of death for the men (54.18% to 59.89 %) the results depend on the imputation method of sickness for those deceased. By using the pre mortality means of sickness absence men have an additional 14.47 (12.64 to 16.30) days of absence but with the zero imputation women have an additional 1.6 days of absence (0.05 to 3.20). Analyses with or without covariates reveals a coherent picture.

Conclusions: The pattern of increased sickness absence (morbidity) and lower mortality in women provides evidence of more pro-active and preventive behavior of women than that of men, which could thus explain the morbidity-mortality paradox.

Article summary

Morbidity measures are used as measures of the health in the population as well as inputs to adjust for the remuneration when health care is paid by capitation. Ideally, these measures should not be affected by patients' preferences for health care. If these morbidity measures do not reflects real health the design of increasing public health can be misleading and inefficient.

The present study, focus on the differences between the genders and to what extent that gender differences in observed morbidity outcomes reflects differences in behavior rather than differences in health. We test this hypothesis using mortality data and a novel difference-in-difference design on a morbidity measure (sickness absence) on the total Swedish population of working people (115,430 men and 117,844 women). The morbidity-mortality or gender paradox has been studied by numerous of researchers. However, we are only aware of three papers, with conflicting results, aiming at testing if this observed phenomena stems from differences in preferences between the sexes, manifested as behavior differences in morbidity measures (17-18). In the present study we use sickness absence as the morbidity measure. This strategy was previously suggested by two of the authors in a more methodologically oriented article (19), and test the hypothesis in a much larger population.

Strengths and limitations of this study

- The empirical analysis is based on a difference-in-differences design commonly used in social science and increasingly applied in medical science.
- The longitudinal characteristic of our data allow us to condition on group differences in health, working conditions, and other time-invariant factors (e.g. differences in household duties) which might confound the relation between absenteeism and gender-specific health behavior.
- The conclusion of a larger increase in sickness absence for women than for men after an hospital admission is not depending on covariate adjustment.
- If anything the adjustment for covariates increase, rather than decrease, the magnitude of the difference. Hence, given that the inclusion of these covariates to some extent captures health before the hospital admission, this empirical pattern indicates that women have, on average, better pre-admission health than men do. The implication would then be that the observed gender differences in sickness absence after a hospital admission is a lower bound of the more proactive and preventive behavior of women in contrast to that of the men.

INTRODUCTION

In many countries, women are relatively more absent for health reasons than men [1]. Furthermore, similar gender differences exist in other common measures of morbidity such as medical care utilization and self-reported health [2]. Yet, while most commonly used observed health measures show an over-representation of women, there is one major exception to this rule – the remaining life expectancy. One much-quoted fact of gender differences is that women outlives men. In fact, the remaining life expectancy is higher for women than for men in all ages and in nearly all parts of the world. The global average gender difference in life expectancy was about four years in 2010 and has been persistently so for a long time [3]. This has led some scholars to label the relationship the *morbidity-mortality or gender paradox* [4].

One suggested explanation for this apparently inconsistent pattern has been the existence of sex differences in health behavior. Differences in behavior could be with regard to smoking, drinking, diet etcetera, but it can also be manifested in common measures of morbidity. Women may for example proactively make more use of the health care and to be more sick absent from work in order to keep healthier, which would then prolong their lives relative to men (cf. [4], [5], [6], [7]). This particular explanation for the so-called morbidity-mortality paradox was discussed already in the 17th century; the English demographer John Graunt [8] observed that both the birth and death rates of men were higher than for women while at the same time "[Physicians] have two women patients to one man".

This conjecture of behavioral differences have support in experimental studies in social science (cf. [9]). In particular, it has often been noted that women, in general, act more proactively in matters regarding their own and other family members' health and that women tend to be more risk averse than men. The implication is that if women pay more attention to potential future illnesses, by more frequent use of medical services or health insurance, poor health can be detected at an earlier stage,

remediated, and, consequently, increase their relative life expectancy in relation to men. The large cross-country variation in life expectancy (see e.g. [10]) also suggests that the general picture of women outliving men to some extent stems from gender-specific health behavior based on differences in cultural norms.

This article empirically tests for sex differences in behavior as a factor in understanding the morbidity-mortality paradox by using the evolution of morbidity (sickness absence) and mortality of men and women after a hospital admission. If women act more proactively than men do, we should find that women are more sickness absent after a comparable health change compared to men while, at the same time, do not experience higher mortality rates. Thus, if we find such a pattern in our data, this supports the conjecture that the morbidity-mortality conundrum is driven by a more proactive health behavior among women. On the other hand, if we find an increase in sickness absence and that women's mortality rate is higher after the hospital admission, we would conclude that it is likely that actual health differentials between men and women are causing the increase in sickness absence.

Since measures of morbidity are almost exclusively discussed from an adverse standpoint, it is an important question for health policy whether and to which extent gender differences in outcomes reflects differences in behavior rather than differences in health. Therefore, our aim is to study the morbidity-mortality paradox and analyze if sex-specific health behavior can be one explanation why women outlive men while at the same time have worse morbidity outcomes.

METHODS

Study design and participants

Our empirical analysis exploited micro-data originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. The data on

socioeconomic variables covering the entire Swedish population in the age interval 16-65 for years 1993-2004 were obtained from Statistics, Sweden. These data were linked to information on sickness absence and inpatient care over the same time period using registers at the Swedish Social Insurance Agency and the Swedish National Board of Health and Welfare, respectively. The information about sickness absence covers all individual spells of paid sick leave from the statutory sickness insurance in Sweden. The National Patient Register covers all inpatient medical contacts in public hospitals. The diagnoses are made at discharge by by the responsible senior consultant and classified according to the World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD-10).

The analyses were performed using a 30 percent random sample of the population of employed individuals 40-59 years of age in 1993 who were hospitalized at some point between years 1994-2004. The sample consist of in total 233,274 individuals of which 49.5 percent are men. The fraction of individual in the age strata 40-44, 45-49, 50-54 and 55-59 are 20, 25, 28 and 27 percent, respectively. This sample constitutes around 37 percent of the employed individual in this age span. In comparison to those not hospitalized during the same period the age distribution are comparable but they have somewhat lower income. Descriptive statistics for the 30 percent sample of both population (hospitalized and non-hospitalized) is provided in Table 1 and 2 in the appendix. We made use of the first hospital admission only. For sampled individuals with their first hospital admission in 1999, we hence observed their sickness absence five years before and five years after the admission. For other years we do not observe the complete number of leads and lags, leading to an unbalanced panel. To account for potential sample composition effects, factors (or fixed effects) for years and age were included in our empirical specification.

The reason for the age and employment restrictions prior to the hospital admission was that sickness absence is only a valid morbidity measure if individuals are eligible for sickness benefits, i.e.

have employment (or searching for a job but with previous employment). Eligibility is tied to being in the labor force and below the mandatory retirement age of 65. As individuals in general leave the labor force before the age of 65 we restrict the analysis to individuals younger than 60.

Statistical analyzes

In the analyses we made use of regression analysis and adjusted for age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and a factor for whether the individual or the spouse had earnings above the sickness insurance cap and factors for year of the admission, occupational sector and disease category.

The regression analysis can be denoted a differences-in-differences design. The idea was proposed, already, in 1855 by John Snow [11] who used the fact that Lambeth Company in London moved its water work upriver, relatively free from sewage, as a means to empirically test the theory of water quality affecting cholera. He compared the change in occurrence of cholera in people served by Lambeth Company before and after the move of the water work against the change in occurrence of cholera during the same time period in people served by another company who did not change their location. By making use of the two differences over time (i.e. difference-in difference) he controlled for the fact that the change of the water quality was not randomly assigned. For an easy assessable discussion of this idea for the analysis of health care policies see [12] .

The difference-in-difference design allowed us to adjust for unobserved confounders of importance for sickness absence that may differ between men and women before the admission to the hospital. Adjusting for pre-admission gender differences, we then estimated the relative effect from the admission of women compared to men using an ordinary least squares estimator. We imputed the sickness absence for the deceased the year before the death for each year after their death. If men have a higher mortality rate than women, this strategy is conservative as a means to test for more pro-active behavior of women compared to men. On the other hand, if men and

women have similar mortality rates imputing zero days of absence for each year after their death provides a conservative test for more pro-active behavior of women. Both imputation methods was used in the analysis. However the first results take use of the mean imputation strategy. Furthermore, the sickness and disability insurance are integrated parts of the social insurance system and therefore interrelated. An individual on full time disability benefits cannot receive sickness benefits but part time disabled persons can. In the analysis, we therefore defined days on sickness absence as number of days on sickness benefits and/or days on disability benefits in a given year.

In the mortality analyses, we made use of daily data and estimated discrete time Cox proportional hazard regression models using maximum likelihood.

The study was approved by the Regional Ethical Review Board in Uppsala (approval number 2005:126).

Patient and Public Involvement.

Patients were not involved in the design or conduct of this large observational register-based study. It will not be possible to disseminate the results directly to the individuals involved since all analyses were done on depersonalized data. Hence, the results will be disseminated to the public through publication in scientific and popular scientific journals.

RESULTS

Sickness absence in relation to gender

Figure 1 shows the average number of days of sickness absence of men and women before and after hospitalization. The left panel shows the overall difference while the right panels displays the average for four large disease categories; neoplasms (ICD-10 = C00-D48), circulatory diseases (ICD-10 = I00-I99), musculoskeletal diseases (ICD-10 = M00-M99) and mental and behavioral disorders (ICD-10 = F00-F99).

From the left panel it can be seen that the sickness absence for both men and women increase in the years prior to the hospital admission, but also that this increase is greater for women. In the period after the hospital admission, a sharp increase in sick leave for both men and women can be seen, but the increase is much greater for women. The right panel of Figure 1 shows the same pattern before the hospital admission for the four large diseases categories. After the hospital admission, however, there are some differences across these categories. For neoplasms sickness absence is higher for men one to four years after the admission. For the other diseases women have higher sickness absence than men for the whole follow up period. For circulatory diseases this difference is small the admission year while for the two other the gender differences are initially large but then taper off.

Mortality in relation to gender

Figure 2 reports disease-specific share of men and women who died within five years after the hospitalization separated into mortality within yearly follow-up categories for in total eighteen different disease categories. A remarkable pattern is shown; for all disease categories, men have a higher probability of dying (also within follow-up categories) after the hospitalization.

For neoplasms, the risk of dying in the five-year follow-up period is 22 percentage points higher for the men than for the women (42% compared with 20%). For circulatory diseases, mental and behavioral (mental in the following) disorders and musculoskeletal diseases, there is a corresponding 4 (14% to 10%), 4 (12% to 8%) and 1.5 (6% to 4.5%) percentage points increased risk for the men, respectively.

For the sickness absence data, we imputed the sickness absence the year before the death for the deceased. The gender differences in mortality could thus possibly explain some of the post-hospital admission pattern regarding sickness absence. This explanation is most likely to be the most important for neoplasms.

Results from regression estimation

Table 1 presents the results from regression analyses of gender differences in sick leave and mortality for the five years follow-up period after the hospital admission. The results on both sickness absence and mortality are in line with the previous results reported in Figures 1 and 2. From column (3) in panel A of Table 1, it can be seen that women use a statistically significant 5.73 additional days of sickness absence than men per year over the five-year post-hospitalization sampling window (95% confidence interval 5.25 to 6.22). For a hospital admission for a neoplasm, circulatory disease, musculoskeletal disease, and mental disorder, the corresponding gender differences are -14.47, 7.44, 5.77, and 5.30 days, respectively (-16.30 to -12.64, 5.91 to 8.96, 3.63 to 7.91 and 1.96 to 8.64). Finally, from column (3) in panel B, it can be seen that women have around 27% ($\approx 100(1-\exp(-.314))$ lower post-hospitalization mortality risk than men (24.18% to 29.62%). For the neoplasm, circulatory, musculoskeletal, and mental diseases, the corresponding figures are, 57%, 38% 27% and 45% lower mortality risks (54.18% to 59.89%, 30.73% to 43.94%, 13.02% to 38.40% and 33.89% to 54.98%)

Results from analyses on sickness absence for the eighteen disease categories are provided in Table 2. The general conclusion from these analyses is the same as in the overall gender-difference analysis: women increase their absence more for all categories (statistically significant for twelve of these) except for neoplasm five years after the hospital admission than men.

Table 1. Regression (linear and Cox) slope parameter (standard errors within parenthesis) of gender difference in sickness absence (for the deceased we impute the sickness absence the year before the death for all years after the death) and mortality five years after a hospital admission, by disease type. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission (see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
A: Linear regressions (difference-in difference design on gender difference in effect of an admission on days of sickness absence)			
All	5.728***	4.963***	5.738***

N =1,867,013[%]	[5.25 – 6.22]	[4.47 – 5.45]	[5.26 – 6.22]
Circulatory (ICD-10 = I00-I99)	7.102***	6.621***	7.436***
N=255,687	[5.55 – 8.65]	[5.09 – 8.15]	[5.91 – 8.96]
Neoplasms (ICD-10 = C00-D48)	-9.36***	-15.082***	-14.471***
N =223,875	[-11.12 – -7.53]	[-16.93 – -13.24]	[-16.30 – -12.64]
Musculoskeletal (ICD-10 = M00-M99)	3.149***	4.165***	5.772***
N =149,846	[0.96 – 5.33]	[2.00 – 6.33]	[3.63 – 7.91]
Mental (ICD-10 = M00-M99)	4.109**	3.584**	5.305***
N =63,065	[0.74 – 7.48]	[0.24 – 6.93]	[1.96 – 8.64]
B: Cox PH regressions on gender difference in post-admission mortality			
All	-0.279***	-0.226***	-0.314***
N = 233,274	[-0.31 – -0.24]	[-0.26 – 0.19]	[-0.35 – -0.28]
Circulatory (ICD-10 = I00-I99)	-0.449***	-0.400***	-0.473***
N =31,838	[-0.55 – -0.34]	[-0.50 – -0.30]	[-0.58 – -0.37]
Neoplasms (ICD-10 = C00-D48)	-0.918***	-0.752***	-0.847***
N =27,781	[-0.98 – -0.86]	[0.82 – -0.69]	[-0.91 – -0.78]
Musculoskeletal (ICD-10 = M00-M99)	-0.197**	-0.253***	-0.312***
N =18,875	[-0.37 – -0.03]	[-0.42 – -0.08]	[-0.484 – -0.140]
Mental ICD-10 = M00-M99)	-0.578***	-0.559***	-0.606***
N =8,236	[-0.764 – -0.39]	[-0.74 – -0.37]	[-0.80 – -0.41]
Covariates[#]		√	√
Factors[¤]			√

*** p<0.001, ** p<0.05

[%] N is the sample size. In the sickness absence analysis this is the number of individuals time the number of time periods they are included in the analysis while in the mortality analysis it is the number of individuals.

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap.

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

Table 2. Linear regression slope parameter, that is the difference-in difference estimate of gender difference in sickness absence five years after a hospital admission (for the deceased we impute the sickness absence the year before the death for all years after the death) for 18 disease categories. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission (see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
Accident, N=201,273[%]	5.033***	6.541***	7.653***
Blood, N = 9,973	7.613**	3.717	3.768
Congenital, N =5,530	5.365	3.116	3.924

Digestive, N = 219,619	7.861***	7.628***	8.447***
Ear, N = 25,660	4.459**	4.559**	5.952***
Endocrine, N =40,538	-0.871	-0.964	0.157
Eye, N = 22,685	4.086**	4.648**	5.248***
Factors, N =55,136	-0.147	2.113	3.633***
Genitourinary, N =168,659	4.273***	0.667	0.860
Circulatory (ICD-10 = I00-I99), N = 255,687	7.102***	6.621***	7.436***
Infection, N =40,946	3.555**	3.380**	3.660**
Mental ICD-10 = M00-M99) N =63,065	4.109**	3.584**	5.305***
Neoplasms (ICD-10 = C00-D48), N = 223,875	-9.365***	-15.082***	-14.471***
Nerve, N = 44,075	9.461***	10.397***	11.395***
Respiratory, N = 81,981	7.952***	7.819***	8.688***
Skin, N = 14,040	-0.219	0.983	2.355
Symptoms, N = 244,425	10.072***	9.972***	10.752***
Covariates[#]		√	√
Factors[¤]			√

*** p< 0.001, ** p< 0.05, p<0.10

[%] N is the sample size. This is the number of individuals time the number of time periods included in the analysis (i.e. 10).

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap.

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

In order to find out the importance of the mean imputation method an analysis where we imputed zero for those deceased after their death was conducted. Results from this sensitivity analyses is presented in Table 3. The overall results is basically unaffected but now we find statistical significant increase in sickness absence for the women in sixteen disease categories, including neoplasm. For this disease women increase their absence by 1,6 days more than the men after the admission over the five-year follow up period (0.05 to 3.20).

Table 3. Linear regression slope parameter, that is the difference-in difference estimate of gender difference in sickness absence five years after a hospital admission (imputing zero days of absence for all years after a death for those deceased) for 18 disease categories. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission (see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
All, N = 1,867,013	5.156***	4.392***	5.126***
Accident, N=201,273[%]	5.175***	6.693***	7.771***
Blood, N = 9,973	16.757***	12.188***	12.320***
Congenital, N =5,530	5.940	3.660	4.458
Digestive, N = 219,619	7.569***	7.349***	8.137***
Ear, N = 25,660	4.068**	4.190**	5.567***
Endocrine, N =40,538	0.240	0.122	1.212
Eye, N = 22,685	5.576***	6.132***	6.717***
Factors, N =55,136	0.641	2.662*	4.150***
Genitourinary, N =168,659	5.230***	1.570**	1.759**
Circulatory (ICD-10 = I00-I99), N = 255,687	7.385***	6.900***	7.779***
Infection, N =40,946	4.349***	4.153***	4.411***
Mental ICD-10 = M00-M99) N =63,065	5.474***	4.947***	6.713***
Musculoskeletal (ICD-10 = M00-M99), N = 149,846	2.981***	4.009***	5.592***
Neoplasms (ICD-10 = C00-D48), N = 223,875	6.097***	1.108	1.626**
Nerve, N = 44,075	9.607***	10.469***	11.461***
Respiratory, N = 81,981	7.317***	7.294***	8.061***
Skin, N = 14,040	0.114	1.342	2.710
Symptoms, N = 244,425	9.487***	9.419***	10.173***
Covariates[#]		√	√
Factors[¤]			√

*** p< 0.001, ** p< 0.05, p<0.10

[%] N is the sample size. This is the number of individuals time the number of time periods included in the analysis (i.e. 10).

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap.

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

Previous studies have reported of gender differences in the mortality after an inpatient care visit for an acute myocardial infarct (AMI), see e.g. [13], [14] and [15]. For this reason, additional analyses on the AMI inpatient care visits were made. We re-estimated our models using the AMI sample on (1) total five years mortality, (2) in-hospital death (i.e., where the patient dies before discharge), (3) one year follow-up period (conditional on discharge) and (4) a follow up period of 1-5 years after the inpatient care visit. We estimated the total effects but also separately for the age groups 40-44, 45-49, 50-54 and 55-59.

Table 4 provides the results from the regressions where we adjusted for the same variables as in the previous analyses. From column (1) it can be seen that men in this population have higher risk of dying within five years and that men in the oldest stratum is primarily driving this effect. For the other outcomes, we found no statistically significant gender differences.

Table 4: Cox regression slope parameters (standard errors within parenthesis). The gender difference in mortality after acute myocardial infarct hospitalization by "timing of death" and age categories

	(1) Total	(2) In-hospital	(3) Post-discharge (<1year)	(4) Post-discharge (1 to 5 years)
All	-0.030**	-0.007	-0.009	-0.013
N = 3,545[%]	[-0.057 – -0.003]	[-0.019 – 0.005]	[-0.019 – 0.001]	[-0.035 – 0.009]
Age cohorts				
40-44	-0.054	-0.011	-0.032	-0.010
N = 211	[-0.140 – 0.032]	[-0.046 – 0.024]	[-0.081 – 0.017]	[-0.075 – 0.055]
45-49	-0.016	-0.004	-0.003	-0.009
N = 604	[-0.081 – 0.049]	[-0.031 – 0.023]	[-0.028 – 0.022]	[-0.064 – 0.046]
50-54	-0.005	-0.013	-0.008	0.016
N = 1,175	[-0.052 – 0.042]	[-0.035 – 0.009]	[-0.026 – 0.010]	[-0.023 – 0.055]
55-59	-0.050**	-0.003	-0.009	-0.038**
N = 1,555	[-0.093 – -0.007]	[-0.021 – 0.015]	[-0.027 – 0.009]	[-0.073 – -0.003]
Covariates and factors[#]	√	√	√	√

[%] N is the number of individuals.

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap, indicators for calendar year, occupational sector and disease category (where feasible).

** p<0.05

DISCUSSION

Measures of morbidity are often used as measures of the health in the population as well as inputs to adjust for the remuneration when health care is paid by capitation. Ideally, these measures should not

be affected by patients' preferences for health care. If these morbidity measures do not reflects real health the design of increasing public health can be misleading and inefficient. For instance a recently published study shows that among fee-for-service Medicare beneficiaries, there is an inverse relationship between the regional frequency of diagnosis and the case-fatality rate for chronic conditions [16]. The present study focuses on the differences between the sexes and to what extent that sex differences in observed morbidity outcomes reflect differences in behavior rather than differences in health. We test this hypothesis using a novel design made possible by the supply of longitudinal data on a morbidity measure (sickness absence) on the population of working men and women (115,430 men and 117,844 women). We found that women extracted relatively more sickness absence and simultaneously had a lower mortality risk than men both before, but in particular after, the hospitalization. This provides strong evidence of more proactive and preventive behavior of women than that of the men.

Case and Paxson (2005) [17] and [18] could not confirm the hypothesis of differences in preferences between the sexes, that is a more proactive behavior of women than of men or a [13, p. 2251] "greater stoicism among men and a greater willingness among women to use health services, report health problems and factor in less-serious ailments when assessing their own health". As a morbidly measure [17] focused on self- assessed health while [18] used self-rated health, longstanding illness, respiratory illness, sickness absence, hypertension and CHD prevalence. The lack of systematic statistically significant differences in association between mortality and the morbidity measures are taken as evidence against the theory. One should, however note that there are patterns in both studies that supports the theory. For example, 8 of 11 morbidly measures have a stronger association to mortality for men than for women and for one (sickness absence) is this difference statistically significant. Men with respiratory cancer, cardiovascular disease, and bronchitis were found to have higher incidence of hospital episodes and mortality than women who suffer from the

same self-reported conditions in the study by Case and Paxson [17]. This suggest that this theory may be one explanation for the observed gender pattern but that the sample size needs to be large and that one need methods not sensitive to unmeasured confounders. The strategy used in this paper was originally suggested in [19] who applied the method to a sample of working Swedish men and women aged 40-45. This paper extends on this study by studying a larger population and by a more elaborate analysis over diagnosis codes. The results from the two papers are however in agreement.

Our results on mortality after a hospital admission are somewhat in contrast to studies on sex differences in AMI mortality after a hospital admission. For example, some previous studies [13-15] have found a higher risk of mortality after an inpatient care visit for an AMI for younger (less than or equal to 65 or less than or equal to 75) women, compared to men. However, these analyses are based on hospital discharge data, implying that mortality is conditional on patient admission and that death occurred before leaving the hospital. Furthermore, other studies show that female AMI patients have on average longer hospital stays than men [20,21]. The implication is that, if women have longer length of hospital stays (e.g. due to differences in preferences) given a certain health condition, then this could explain women's higher mortality. An advantage of our analysis is that it is not restricted to death in the hospital. In order to shed light on this potential issue, we re-estimated our analyses on the subsample of AMI patients. This sub-analysis could not confirm the results in the previous studies [13-15].

LIMITATIONS

Results based on observational data can always suffer from confounding bias. We empirically analyze changes in sickness absence after a hospital admission for men and women in a difference-in-differences design commonly used in social science and increasingly applied in medical science [12]. The longitudinal characteristic of our data allows us to condition on group differences in health,

working conditions, and other time-invariant factors (e.g. differences in household duties) which might confound the relation between absenteeism and gender-specific health behavior. In this respect, we need to stress that all displayed results are not sensitive to the inclusion of observed covariates or not. This result is to be expected from the design of the study. If anything the adjustment for covariates increase, rather than decrease, the magnitude of the effects (compare column (1) with no adjustment to column (3)) in Tables 1, 2 and 3. Hence, given that the inclusion of these covariates to some extent captures health before the hospital admission, this empirical pattern indicates that women have, on average, better pre-admission health than men do. The implication would then be that the observed sex differences in sickness absence after a hospital admission is a lower bound of the more proactive and preventive behavior of women in contrast to that of the men.

Another limitation is that our results reflect the findings from a representative sample of employed Swedish individuals aged 40-59 with a hospital visit in 1991. It is not clear that these results would apply to other populations.

IMPLICATIONS

Using morbidity measures in the design of increasing public health can be misleading and inefficient. A more efficient strategy may instead be of affecting attitudes and norms on risks for groups with high mortality. One such strategy that might save lives in Sweden would be that of informing Swedish men of making more use of medical services pro-actively.

a. Daniel Avdic made all analyses and interpreted the data together with the coauthors. He had approved the version of the manuscript to be published.

   Pathric Hägglund interpreted the data together with the coauthors and drafted the manuscript. He had approved the version of the manuscript to be published.

   Bertil Lindahl interpreted the data together with the coauthors, drafted parts of the manuscript and revised the manuscript for important intellectual content. He had approved

the version of the manuscript to be published.

Per Johansson designed the study and interpreted the data together with the coauthors and drafted the manuscript of data. He had approved the version of the manuscript to be published.

b. None of the authors has any conflict of interest relevant in relation to the present article to report.
c. The corresponding author acknowledge funding from the Swedish Research Council for Heath, Working life and Welfare (FORTE).
d. The data used in this analysis are drawn from Swedish administrative registers and are confidential. The data can be obtained for replication by contacting IFAU by email ifau@ifau.uu.se. The data is personal data and are therefore governed by the ethical principles set up by the Swedish government. The data may be transferred to a third country in one of the following situations:
   - If there is an adequate level of protection (see * below) in the recipient country (for instance according to decisions by the EU Commission).
   - When the data subject has given his/her consent to the transfer.
   - In certain specific situations enumerated in section 34 of the Personal Data Act.
   - If it is permitted in some other way according to regulations or specific decisions by the Government or the Data Inspection Board with reference to that there are adequate safeguards with respect to the protection of the rights of the data subjects. Such safeguards may result from:
     - Standard contractual clauses approved by the EU Commission.
     - Binding Corporate Rules (BCR).

   The processing of personal data that takes place in Sweden must still comply with the rules of the Personal Data Act. This means that data may only be transferred if the data controller in Sweden has complied with the other requirements of the Personal Data Act, for instance the fundamental requirements regarding processing of personal data and the rules about when such processing is permitted on the whole.

*In the Personal Data Act (and in the EC Directive on data protection) there are guidelines on what you have to consider when assessing the level of protection for personal data. All circumstances surrounding the transfer shall be considered. Particular consideration shall be given to the nature of data, the purpose of the processing, the duration of the processing, the country of origin, the country of final destination and the rules that exist for the processing in the third country.
The EU Commission has analyzed the data protection rules of a few countries and decided that the level of protection in these countries is adequate. The decisions concern: Argentina, Bailiwick of Guernsey, Faroe Islands, Isle of Man Jersey, Switzerland
Furthermore the EU Commission has assessed that the level of protection is adequate within certain sectors or under certain conditions in the following countries:

- Canada (if their legislation on protection of personal data in the private sector is applicable on the recipient´s processing of personal data)
- U.S.A. (if the recipient has adhered to the so called Safe Harbor principles)

The decisions of the EU Commission are enumerated in an annex to the Personal Data Ordinance. In the ordinance it is explicitly stated that transfers are permitted in these cases.
The self harbor principle is a set of voluntary rules on privacy and data protection elaborated and decided by the US Department of Commerce (DoC). Organizations in the US can notify the DoC

that they adhere to these rules. The EU Commission has assessed that the rules (including accompanying questions and answers) constitute an adequate level of protection. Thus it is permitted to transfer personal data from EU/EEA to organizations in the US who have adhered to the rules. On the website of the US DoC there is a list of companies and organizations that have adhered to the Safe Harbor principles. For further information see http://www.datainspektionen.se/in-english/in-focus-transfer-of-personal-data/

REFERENCES

1. Mastekaasa A, Olsen, K. Gender, Absenteeism and Job Characteristics: A Fixed Effects Approach. *Work and Occupations*. 1998; 25: 195-2228.
2. Sindelar, J L. Differential Use of Medical Care by Sex. *Journal of Political Economy*. 1982; 90: 1003-1019.
3. Lee, C. Gender, Health and Health Behaviors. In J. Chrisler and D. R. McCreary (eds.), Handbook of Gender Research in Psychology. Springer Science, 2010; 20: 471-493.
4. Nathanson, C. Illness and the Feminine Role: A Theoretical Review. *Social Science and Medicine*. 1975;9: 57-62.
5. Verbrugge, L M. Sex Differentials in Health. *Public Health Report*. 1982; 97: 417-437.
6. Stronegger, W J, Freidl, W, Rasky, V. Health Behaviour and Risk Behaviour: Socioeconomic Differences in an Austrian Rural County. *Social Science and Medicine*. 1997;44: 423-426.
7. Uitenbroek, D. G., Kerekovska, A, Festchieva, N. Health Lifestyle Behaviour and Socio-Demographic Characteristics. A Study of Varna, Glasgow and Edinburgh. *Social Science and Medicine*. 1996;43:367-377.
8. Graunt, J. Natural and Political Observations Mentioned in a Following Index and Made Upon the Bills of Mortality. London: Tho: Roycroft, for John Martin, James Allestry, and Tho: Dicas, 1662, London: Martin, Allestry and Dicas.
9. Bertrand, M. New Perspectives on Gender. In O. Ashenfelter and D. Card (eds.), Handbook of Labor Economics 4b, Elsevier Ltd. 2010: 1545-1592.
10. CIA factbook, 2011. https://www.cia.gov/library/publications/the-world-factbook/index.html
11. Snow, John (1855). On the Mode of Communication of Cholera (2nd ed.). London: John Churchill.
12. Dimick J B, Ryan A M. Methods for evaluating changes in health care policy: the difference-in-differences approach. *JAMA*. 2014; 312(22):2401-2. doi: 10.1001/jama.2014.16153.
13. Vaccarino V, Parsons L, Every NR, Barron HV, Krumholz HM.; National Registry of Myocardial Infarction 2 Participants. Sex-based differences in early mortality after myocardial infarction. *N Engl J Med*. 1999;341(4):217-225.
14. Vaccarino V, Krumholz HM, Yarzebski J, Gore JM, Goldberg RJ. Sex differences in 2-year mortality after hospital discharge for myocardial infarction. *Ann Intern Med*. 2001;134(3):173-181.
15. Canto JG, Rogers WJ, Goldberg RJ, et al. Association of Age and Sex With Myocardial Infarction Symptom Presentation and In-Hospital Mortality. *JAMA*. 2012;307(8):813-822. doi:10.1001/jama.2012.199.

16. Welch GH, Sharp SM, Gottlieb DJ, Skinner JS, Wennberg JE. Geographic Variation in Diagnosis Frequency and Risk of Death Among Medicare Beneficiaries. JAMA. 2011;305(11):1113-1118. doi:10.1001/jama.2011.307
17. Case A, Paxson C. Demography. 2005 May;42(2):189-214. Sex differences in morbidity and mortality.
18. Singh-Manoux A, Guéguen A, Ferrie J, Shipley M, Martikainen P, Bonenfant, S, Goldberg M, Marmot, M Association Between Morbidity and Mortality Among Middle-Aged Men and Women Am J Public Health. 2008; 98: 2251–2257.
19. Avdic D, Johansson P. Absenteeism, Gender and the Morbidity–Mortality Paradox. *Journal of Applied Econometrics*. 2017; 32: 440-462.
20. Every N R, Spertus J, Fihn SD, Hlatky M, Martin JS, Weaver WD. Length of hospital stay after acute myocardial infarction in the Myocardial Infarction Triage and Intervention (MITI) Project registry. *J Am Coll Cardiol*. 1996;28(2):287-93.
21. Kinjo K1, Sato H, Nakatani D, Mizuno H, Shimizu M, Hishida E, Ezumi A, Hoshida S, Koretsune Y, Hori M; Osaka Acute Coronary Insufficiency Study (OACIS) Group. Predictors of Length of Hospital Stay After Acute Myocardial Infarction in Japan. *Circ J*. 2004; 68: 809– 815.

Legends Figures

Figure 1. Number of days of absence for men and women before and after a (first) hospital admission for the population of employed (prior to the hospital admission) individuals 40-59 years of age in 1993 to 2004. Left panel average. Right panel conditional on a cancer, myocardial infarction, musculoskeletal and mental diseases.

Figure 2. Five-year mortality risk for men and women after a hospital admission by diagnosis category for the population of employed (before the hospital admission) individuals 40-59 years of age in 1993 to 2004.

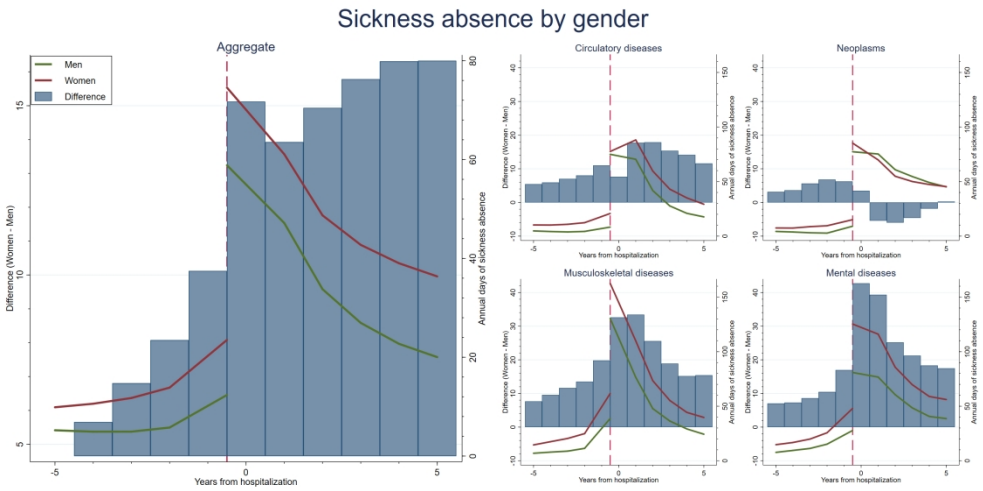

Figure 1. Number of days of absence for men and women before and after a (first) hospital admission for the population of employed (prior to the hospital admission) individuals 40-59 years of age in 1993 to 2004. Left panel average. Right panel conditional on a cancer, myocardial infarction, musculoskeletal and mental diseases.

254x127mm (300 x 300 DPI)

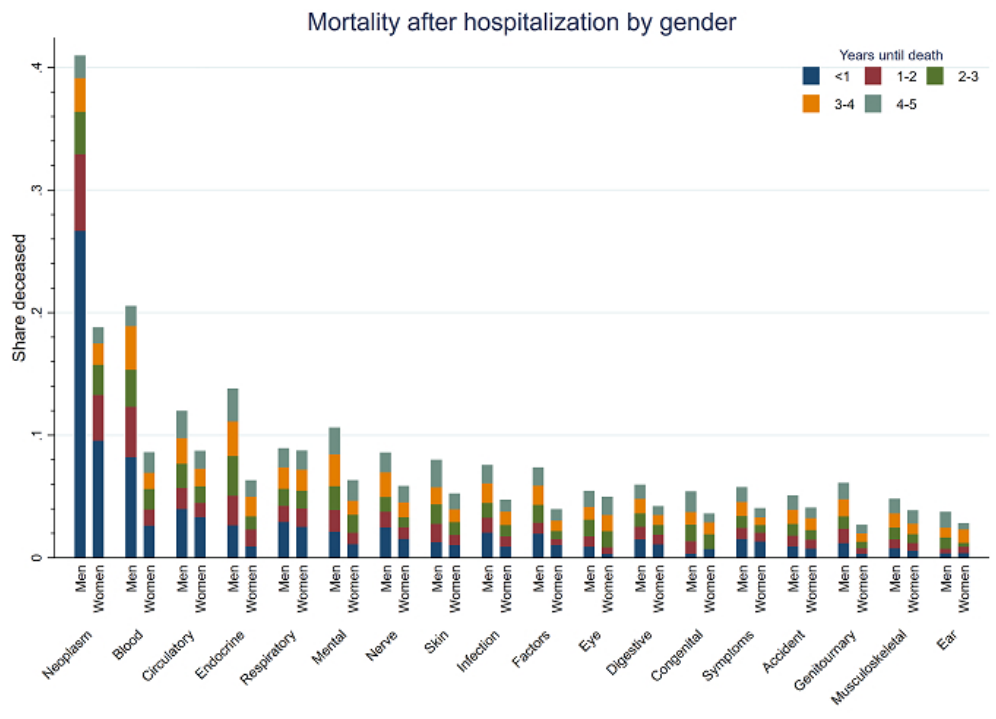

Figure 2. Five-year mortality risk for men and women after a hospital admission by diagnosis category for the population of employed (before the hospital admission) individuals 40-59 years of age in 1993 to 2004.

57x42mm (300 x 300 DPI)

Appendix: Descriptive statistics

Table 1: Sample summary statistics

	(1) Total	(2) Male	(3) Female
Age 40-44	46,581	22,778	23,803
Share of total	0.200	0.098	0.102
Age 45-49	57,069	27,654	29,415
Share of total	0.245	0.119	0.127
Age 50-54	66,545	32,701	33,844
Share of total	0.285	0.140	0.145
Age 55-59	63,079	32,297	30,782
Share of total	0.269	0.138	0.131
Total	233,274	115,430	117,844
Share of total	1.000	0.495	0.505

30 percent random sample of the population of employed individuals 40-59 years of age in 1993 who were hospitalized at some point between years 1994-2004.

Table 2: Sample summary statistics

	Hospitalized Men		Hospitalized Women		Non-hospitalized Men		Non-hospitalized Women	
Variable	(1) mean	(2) sd	(3) mean	(4) sd	(5) mean	(6) sd	(7) mean	(8) Sd
Age	52.477	7.195	51.906	7.078	51.571	7.662	52.161	7.826
Earnings	6.845	5.152	4.694	2.732	7.497	6.166	5.035	3.319
Non-labor income	3.741	29.641	4.535	19.479	4.041	30.506	5.028	25.609
Household earnings	10.586	30.201	9.230	19.799	11.538	31.264	10.062	25.987
Infection	0.024	0.154	0.019	0.138				
Neoplasm	0.062	0.242	0.175	0.380				
Blood	0.003	0.056	0.007	0.084				
Endocrine	0.019	0.138	0.025	0.155				
Mental	0.041	0.199	0.030	0.169				
Nerve	0.026	0.159	0.020	0.139				
Eye	0.013	0.115	0.011	0.104				
Ear	0.014	0.118	0.013	0.114				
Circulatory	0.186	0.389	0.088	0.284				
Respiratory	0.048	0.213	0.041	0.198				
Digestive	0.125	0.331	0.110	0.313				
Skin	0.008	0.090	0.007	0.085				
Musculoskeletal	0.082	0.275	0.080	0.271				
Genitourinary	0.049	0.216	0.131	0.338				
Congenital	0.003	0.050	0.004	0.059				
Symptoms	0.145	0.352	0.116	0.320				
Accident	0.123	0.328	0.092	0.289				

Factors	0.028	0.165	0.032	0.176		
# Individuals	115,430		117,844		205,762	198,992

30 percent random sample of the population of employed individuals 40-59 years of age in 1993 who were hospitalized at some point between years 1994-2004 and not-hospitalized during the same period. Earning and Non-labor income and both measure as price base (PBA) amounts in 1992 (one PBA is 33,700 SEK (= £2,9452 in December 2018)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	Longitudinal data at the individual level and using a difference-in-differences design for the analysis on sickness absence (before and after a hospital admission)..
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1	Women increase their sickness absence by around five more days per year than the males (95% confidence interval 5.25 to 6.22 (mean) and 4.66 to 5.60 (zero)). At the same time men have higher risk of mortality for the eighteen diagnosis categories analyzed.
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2	The global average gender difference in life expectancy was about four years in 2010 and has been persistently so for a long time [3]. This has led some scholars to label the relationship the morbidity-mortality or gender paradox [4].

Objectives	3	State specific objectives, including any prespecified hypotheses	1	To analyze if gender-specific health behavior can be one explanation why women outlive men while at the same time have worse morbidity outcomes, known as the morbidity-mortality or gender paradox.
Methods				
Study design	4	Present key elements of study design early in the paper	4	The difference-in-difference design allows us to adjust for unobserved confounders of importance for sickness absence that may differ between men and women before the admission to the hospital
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2-3	Our empirical analysis exploits micro-data originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. Sweden
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	2-3	The data on socioeconomic variables covering the entire Swedish (16-65) population for years 1993-2004 were

		Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants		obtained from Statistics Sweden
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3	The information about sickness absence covers all individual spells of paid sick leave from the statutory sickness insurance in Sweden. The diagnoses, are made at discharge by the responsible senior consultant and classified according to the World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD-10).
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*3*	Information on sickness absence were obtained using a register at the Swedish Social Insurance Agency. Data on discharge diagnosis was obtained from the National Patient Register covers all inpatient medical contacts in public hospitals at the Swedish National Board of Health and Welfare.
Bias	9	Describe any efforts to address potential sources of bias	3-4	In the analyses we made use of

				regression analysis and adjusted for age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and a factor for whether the individual or the spouse had earnings above the sickness insurance cap and factors for year of the admission, occupational sector and disease category. The difference-in-difference design allowed us to adjust for unobserved confounders of importance for sickness absence that may differ between men and women before the admission to the hospital.
Study size	10	Explain how the study size was arrived at	12	No formal sample size calculation was performed. That data from the whole country were used.

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	2-3	Our empirical analysis exploited micro-data originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. The data on socioeconomic variables covering the entire Swedish (16-65) population in the age interval 16-65 for years 1993-2004 were obtained from Statistics, Sweden. These data were linked to information on sickness absence and inpatient care over the same time period using registers at the Swedish Social Insurance Agency and the Swedish National Board of Health and Welfare, respectively.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	3-5	
		(*b*) Describe any methods used to examine subgroups and interactions		
		(*c*) Explain how missing data were addressed		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		
		(*e*) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6	We have included a supplementary table with the number of men and women at different age strata. for potential online publication

		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6	We have included a supplementary table with descriptive statistics for potential online publication.
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		Table1-4
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures		
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		Table 1-4
		(*b*) Report category boundaries when continuous variables were categorized		
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		
Discussion				
Key results	18	Summarise key results with reference to study objectives	13	We found that women extracted relatively more sickness absence and simultaneously had a lower mortality risk than men both before, but in particular after, the hospitalization. This provides strong evidence of more proactive and preventive behavior of women than that of the men.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15	
Generalisability	21	Discuss the generalisability (external validity) of the study results	15	
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based		

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Sex differences in sickness absence and the morbidity-mortality paradox: A longitudinal study using Swedish administrative regis-ters

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Sex differences in sickness absence and the morbidity-mortality paradox: A longitudinal study using Swedish administrative registers

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ABSTRACT

Objective: To analyze whether gender-specific health behaviors constitute an explanation for why women outlive men while simultaneously have worse health outcomes; the sex morbidity-mortality paradox.

Setting: The working population in Sweden.

Participants: 30% random sample of the Swedish working population aged 40-59 with a hospital admission between 1993 and 2004. The analysis sample consist of 233,274 individuals (115,430 men and 117,844 women) and a total of 1,867,013 sickness absence observations.
Intervention: Hospital admission across eighteen disease categories.
Main outcome measures: Sickness absence (morbidity) and mortality. Longitudinal data at the individual level allows for studying sex differences in sickness absence in relation to a hospital admission using a difference-in-differences analysis. Cox regression models are used to study differences in mortality after the admission.
Results: Women increase their sickness absence by around five additional days per year than the men (95% confidence interval 5.25 to 6.22). At the same time, men have higher risk of mortality for the eighteen diagnosis categories analyzed. The pattern of higher sickness absence for women is consistent across seventeen different diagnosis categories. For neoplasms, we observe a 57% higher mortality risk for men (54.18% to 59.89%), depending on the imputation method of sickness absence for the deceased. Using pre-mortality averages values of sickness absence, men have an additional 14.47 (12.64 to 16.30) days of absence while women have an additional 1.6 days of absence (0.05 to 3.20) when zero imputation is used. Analyses with and without covariate adjustment yield coherent results.

Conclusions: The empirical pattern of higher sickness absence (morbidity) and lower mortality in women after an adverse health episode provides suggestive evidence that more proactive and preventive health behavior among women could be a contributing factor in explaining the morbidity-mortality paradox.

Article summary

Morbidity is used both as a general measure of health in the population and as an input to adjust for provider remuneration when healthcare is financed by capitation. Ideally, these measures should not be affected by patients' preferences for healthcare consumption. If measures of morbidity do not reflect true health, policy designs aimed at increasing public health may be mistargeted and inefficient. The present study explores to what extent observed sex differences in morbidity reflect differences in health behavior, rather than differences in health. Although the sex morbidity-mortality paradox has previously been extensively studied, we are only aware of three papers with the aim of exploring this hypothesis (17-19). We test this hypothesis using morbidity (sickness absence) and mortality data from the entire Swedish working population in a difference-in-differences empirical design (115,430 men and 117,844 women). This strategy was previously suggested by two of the authors of this article in a methodologically oriented article (19), and tested in a significantly larger population.

Strengths and limitations of this study

- The empirical analysis is based on a difference-in-differences design for causal inference, commonly used in social science and increasingly applied also in the field of medicine.
- The longitudinal characteristics of our data allow us to condition on group differences in health, working conditions, and other time-invariant factors (e.g. sex differences in household work) which might confound the relation between sickness absence and health behaviors.
- The finding of a greater increase in sickness absence for women relative to men after a hospital admission is not conditional on covariate adjustment.

INTRODUCTION

In many countries women are significantly more absent from work for health reasons than men [1]. Sex differences also exist in many other common measures of morbidity, such as medical care utilization and self-reported health [2]. Yet, while most commonly used measures of health show an overrepresentation of women, the remaining life expectancy is higher for women in all ages and in nearly all parts of the world. The global average life expectancy gap between men and women is about four years and has been persistently so for a long time [3]. This seemingly conflicting pattern has led some scholars to label the observation the *sex morbidity-mortality paradox* [4].

One suggested explanation for the morbidity-mortality paradox has been the existence of sex differences in health behaviors, such as the use of tobacco or alcohol, but it can also be manifested in common measures of morbidity. As an example, women may be more prone to utilize healthcare and sickness insurance systems proactively in order to prevent the onset of a disease or to seek care at an early stage of an illness to avoid more serious conditions. If such preventative action is effective, women would, as a consequence, prolong their lives relative to men (cf. [4-7]). This particular rationalization of the morbidity-mortality paradox was discussed already in the 17th century by the English demographer John Graunt [8] who observed that both the birth and death rates of men were higher than for women while, at the same time, "[physicians] have two women patients to one man".

The conjecture of sex differences in behavior have support from experimental studies in social science (cf. [9]). In particular, it has often been noted that women act more proactively in matters regarding their own and other family members' health, and that women tend to be more risk averse than men. The large cross-country variation in life expectancy (see e.g. [10]) also suggests that sex differences in life expectancy are to some extent malleable with respect to variation in cultural norms and perception of what constitutes male and female behavior.

This article empirically tests for sex differences in behavior as a factor in understanding the morbidity-mortality paradox by studying the evolution of morbidity (sickness absence) and mortality of men and women after they experienced a hospital admission. Our conjecture is simple: If women are more prone to conduct proactive health measures than men, we should find that women take up more sickness absence, while not experiencing higher mortality risks, relative to men after the hospital admission. Alternatively, if we find that women have both a relative greater increase in sickness absence *and* a higher mortality risk after the hospital admission, we would conclude that it is more likely that actual sex differentials in health are the primary cause for the relatively higher sickness absence among women.

Since measures of morbidity are almost exclusively discussed from an adverse standpoint, it is an important topic for health policy to understand the extent to which sex differences in morbidity reflect differences in health *behaviors* in contrast to differences in health. Our aim is therefore to study to which extent the morbidity-mortality paradox can be explained by variation in behavior between men and women. Such information can be used to support the implementation of policies that take into account the dual aspects of morbidity measures, such as sickness absence and healthcare visits.

METHODS

Study design and participants

Our empirical analysis exploited microdata originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. The data on socioeconomic variables, covering the entire Swedish population aged 16-65 for years 1993-2004, were obtained from Statistics, Sweden. These data were linked to information on sickness absence (including all paid sick leave spells from the statutory sickness insurance) and hospital care (including all inpatient medical contacts in public hospitals) over the same time period using registers at the

Swedish Social Insurance Agency and the Swedish National Board of Health and Welfare, respectively. The inpatient diagnoses are made at discharge by the responsible senior consultant and classified according to the World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD-10).

The analyses were performed using a 30 percent random sample of the population of employed individuals 40-59 years of age in 1993 who were hospitalized at some occasion between years 1994 and 2004. The motivation for the age and employment restrictions was that sickness absence is only a valid morbidity measure if individuals are eligible for sickness benefits, which is tied to their employment. Eligibility is tied to being in the labor force and below the mandatory retirement age of 65. As individuals generally leave the labor force before the age of 65, we restrict the analysis to individuals younger than 60.

The sample consist of in total 233,274 individuals with roughly equal proportions of men and women. The fraction of individuals in the age strata 40-44, 45-49, 50-54 and 55-59 are 20, 25, 28 and 27 percent, respectively, and constitutes around 37 percent of the employed Swedish population in this age span. Descriptive statistics for our analysis sample and for a comparable 30 percent random sample of the non-hospitalized population are provided in Table A.1 and A.2 in the Appendix. In comparison with the non-hospitalized population, our hospitalization sample have a similar age distribution but somewhat lower incomes. For sampled individuals whose first hospital admission occurred in 1999, we observed their sickness absence five years before and five years after the episode. For other years we do not observe the complete number of leads and lags, leading to an unbalanced panel. To account for potential spurious sample composition effects, factors (or fixed effects) for years and age were included in our empirical specification.

Statistical analyses

We used regression analysis to account for confounding factors, adjusting for age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and factors for whether the individual or the spouse had earnings above the sickness insurance cap, year of the admission, occupational sector and disease category.

Our empirical approach for causal analysis is commonly known as difference-in-differences (DiD) in social science research. The idea for DiD was proposed in 1855 by John Snow [11] who used the fact that the London-based Lambeth Company moved its water work upriver, which was relatively free from sewage, as a strategy to empirically test the hypothesis whether water quality is a determinant for cholera. He compared the change in the incidence of cholera in people served by Lambeth Company before and after the relocation of the water work against the contemporaneous change in cholera incidence in people served by another company who did not change their location. By analyzing the change in the difference in cholera incidence across the groups of individuals served by the two water works over time (i.e. the difference-in-differences) he controlled for the fact that water quality was not randomly assigned to the analysis population. For an easy assessable discussion of this idea for the analysis of healthcare interventions, see [12].

Implementation of the DiD design in our context allowed for adjustment of unobserved confounders of sickness between men and women prior to the hospital admission by estimation of relative effects of the admission on sickness absence using an ordinary least squares (OLS) estimator. Sickness absence was imputed for the deceased for each subsequent year after their death using the observed days of sickness absence in the year prior to their death. This strategy is conservative as a means to test for more proactive behavior of women compared to men if men have a higher mortality rate than women. On the other hand, if men and women have similar mortality rates, zero imputation of sickness absence provides a conservative test for more proactive behavior of women. We used both imputation methods in the analysis.

The sickness and disability insurance are both parts of the social insurance system in Sweden and therefore highly interconnected. Specifically, an insured individual receiving full-time disability benefits are not eligible for sickness benefits, while part-time disabled individuals are able to receive benefits from both insurance systems. We therefore defined days of sickness absence as the combined number of days receiving sickness benefits and disability benefits in a given year. In the analyses of mortality, we used data on the daily level to estimate discrete time Cox proportional hazard regression models by maximum likelihood.

The study was approved by the Regional Ethical Review Board in Uppsala (approval number 2005:126).

Patient and Public Involvement

Patients were not involved in the design or conduct of this register-based study. Since all analyses were performed on deidentified data, it is not possible to relate results directly to particular individuals comprising the analysis sample. Results are expected to be disseminated to the public through publication in scientific and popular scientific journals.

RESULTS

Sex differences in sickness absence

Figure 1 shows the average annual number of days of sickness absence in our sample by sex, before and after a hospital admission. The left panel shows the overall difference pooled across all diseases, while the right panel shows the difference for the four most frequently occurring disease categories; neoplasms (ICD-10 = C00-D48), circulatory diseases (ICD-10 = I00-I99), musculoskeletal diseases (ICD-10 = M00-M99) and mental and behavioral disorders (ICD-10 = F00-F99). The left panel shows that, while sickness absence for both sexes increase in years prior to the hospital admission,

this increase is more pronounced for women. Similarly, a sharp increase in sickness absence is visible after the hospital admission for both men and women, but the increase is again more pronounced for women. Turning to the right panel of Figure 1, some variation in the relative response in sickness absence after the hospital admission can be discerned across disease categories. While absence is higher for men for neoplasms one to four years after the hospital admission, women have consistently higher levels of post-admission absence for the other three disease categories. For circulatory diseases, the sex difference in sickness absence is relatively small during the year of admission, while it is initially large and subsequently tapering off for musculoskeletal and mental and behavioral diseases.

Sex differences in mortality

Figure 2 reports category-specific mortality shares by year up to five years after hospitalization for eighteen different disease categories. Quite remarkably, men have a higher mortality risk after the hospitalization for all disease categories and for all follow-up years. For neoplasms, the five-year mortality risk is 22 percentage points higher for men than for women (42% and 20%, respectively). For circulatory diseases, mental and behavioral disorders and musculoskeletal diseases, the corresponding figures are 4 (14% to 10%), 4 (12% to 8%) and 1.5 (6% to 4.5%) percentage points. Due to the imputed values of sickness absence, the sex differences in mortality could possibly explain parts of the post-admission sickness absence pattern, in particular for neoplasms

Results from regression analysis

Table 1 presents regression analysis results for sex differences in sickness absence and mortality after a hospital admission. The results for both outcomes corresponds closely to the descriptive pattern displayed in Figures 1 and 2. In particular, column (3) in panel A of Table 1 suggests that women use

a statistically significant 5.73 additional days of sickness absence than men per year over the five-year post-hospitalization sampling window (95% confidence interval 5.25 to 6.22). For hospital admissions due to neoplasms, circulatory, musculoskeletal, and mental diseases, the corresponding sex differences are -14.47, 7.44, 5.77, and 5.30 days, respectively (-16.30 to -12.64, 5.91 to 8.96, 3.63 to 7.91 and 1.96 to 8.64). Finally, from column (3) in panel B of Table 1, women have an estimated 27% ($\approx 100(1-\exp(-.314))$ lower post-hospitalization mortality risk than men (24.18% to 29.62%). For neoplasms, circulatory, musculoskeletal, and mental diseases, the corresponding figures are 57%, 38% 27% and 45% lower mortality risks for women (54.18% to 59.89%, 30.73% to 43.94%, 13.02% to 38.40% and 33.89% to 54.98%)

Separate regression results on sickness absence for the eighteen disease categories are provided in Table 2. The general conclusion from these category-specific analyses is that they closely resembles the results from the pooled sex difference analysis: women increase their absence more than men for all categories (statistically significant for twelve) except for neoplasm after the hospital admission.

Table 1. Regression (linear and Cox) slope parameter (standard errors within parenthesis) of sex difference in sickness absence (for the deceased we impute the sickness absence the year before the death for all years after the death) and mortality five years after a hospital admission, by disease type. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission (see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
A: Linear regressions (difference-in difference estimates of a hospital admission on sex difference in days of sickness absence)			
All	5.728***	4.963***	5.738***
N =1,867,013%	[5.25 – 6.22]	[4.47 – 5.45]	[5.26 – 6.22]
Circulatory (ICD-10 = I00-I99)	7.102***	6.621***	7.436***
N=255,687	[5.55 – 8.65]	[5.09 – 8.15]	[5.91 – 8.96]
Neoplasms (ICD-10 = C00-D48)	-9.36***	-15.082***	-14.471***
N =223,875	[-11.12 – -7.53]	[-16.93 – -13.24]	[-16.30 – -12.64]
Musculoskeletal (ICD-10 = M00-M99)	3.149***	4.165***	5.772***
N =149,846	[0.96 – 5.33]	[2.00 – 6.33]	[3.63 – 7.91]
Mental (ICD-10 = M00-M99)	4.109**	3.584**	5.305***
N =63,065	[0.74 – 7.48]	[0.24 – 6.93]	[1.96 – 8.64]

B: Cox PH regressions on gender difference in post-admission mortality			
All	-0.279***	-0.226***	-0.314***
N = 233,274	[-0.31 – -0.24]	[-0.26 – 0.19]	[-0.35 – -0.28]
Circulatory (ICD-10 = I00-I99)	-0.449***	-0.400***	-0.473***
N =31,838	[-0.55 – -0.34]	[-0.50 – -0.30]	[-0.58 – -0.37]
Neoplasms (ICD-10 = C00-D48)	-0.918***	-0.752***	-0.847***
N =27,781	[-0.98 – -0.86]	[0.82 – -0.69]	[-0.91 – -0.78]
Musculoskeletal (ICD-10 = M00-M99)	-0.197**	-0.253***	-0.312***
N =18,875	[-0.37 – -0.03]	[-0.42 – -0.08]	[-0.484 – -0.140]
Mental ICD-10 = M00-M99)	-0.578***	-0.559***	-0.606***
N =8,236	[-0.764 – -0.39]	[-0.74 – -0.37]	[-0.80 – -0.41]
Covariates[#]		√	√
Factors[¤]			√

*** p<0.001, ** p<0.05

[%] N is the sample size. In the sickness absence analysis this is the number of individuals time the number of time periods they are included in the analysis while in the mortality analysis it is the number of individuals.

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap.

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

Table 2. Linear regression slope parameter, that is the difference-in difference estimate of sex difference in sickness absence five years after a hospital admission (for the deceased we impute the sickness absence the year before the death for all years after the death) for 18 disease categories. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission (see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
Accident, N=201,273[%]	5.033***	6.541***	7.653***
Blood, N = 9,973	7.613**	3.717	3.768
Congenital, N =5,530	5.365	3.116	3.924
Digestive, N = 219,619	7.861***	7.628***	8.447***
Ear, N = 25,660	4.459**	4.559**	5.952***
Endocrine, N =40,538	-0.871	-0.964	0.157
Eye, N = 22,685	4.086**	4.648**	5.248***
Factors, N =55,136	-0.147	2.113	3.633***
Genitourinary, N =168,659	4.273***	0.667	0.860
Circulatory (ICD-10 = I00-I99), N = 255,687	7.102***	6.621***	7.436***
Infection, N =40,946	3.555**	3.380**	3.660**
Mental ICD-10 = M00-M99) N =63,065	4.109**	3.584**	5.305***

Neoplasms (ICD-10 = C00-D48), N = 223,875	-9.365***	-15.082***	-14.471***
Nerve, N = 44,075	9.461***	10.397***	11.395***
Respiratory, N = 81,981	7.952***	7.819***	8.688***
Skin, N = 14,040	-0.219	0.983	2.355
Symptoms, N = 244,425	10.072***	9.972***	10.752***
Covariates[#]		√	√
Factors[¤]			√

*** p< 0.001, ** p< 0.05, p<0.10

[%] N is the sample size. This is the number of individuals time the number of time periods included in the analysis (i.e. 10).

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap.

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

In order to study the influence of the choice of imputation method for deceased individuals, we re-estimated the regression model for sickness absence by instead imputing zero for years after the death of an individual. Results from this sensitivity analysis are presented in Table 3. The overall conclusion remains qualitatively unchanged although we now find statistically significant post-admission relative increases in sickness absence for women in sixteen out of the eighteen disease categories, including neoplasm. For neoplasms, women increase their absence by an additional 1.6 days compared to men after the admission (0.05 to 3.20).

Table 3. Linear regression slope parameter, that is the difference-in difference estimate of gender difference in sickness absence five years after a hospital admission (imputing zero days of absence for all years after a death for those deceased) for 18 disease categories. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission (see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
All, N = 1,867,013	5.156***	4.392***	5.126***
Accident, N=201,273[%]	5.175***	6.693***	7.771***
Blood, N = 9,973	16.757***	12.188***	12.320***
Congenital, N =5,530	5.940	3.660	4.458
Digestive, N = 219,619	7.569***	7.349***	8.137***
Ear, N = 25,660	4.068**	4.190**	5.567***
Endocrine, N =40,538	0.240	0.122	1.212

Eye, N = 22,685	5.576***	6.132***	6.717***
Factors, N =55,136	0.641	2.662*	4.150***
Genitourinary, N =168,659	5.230***	1.570**	1.759**
Circulatory (ICD-10 = I00-I99), N = 255,687	7.385***	6.900***	7.779***
Infection, N =40,946	4.349***	4.153***	4.411***
Mental ICD-10 = M00-M99) N =63,065	5.474***	4.947***	6.713***
Musculoskeletal (ICD-10 = M00-M99), N = 149,846	2.981***	4.009***	5.592***
Neoplasms (ICD-10 = C00-D48), N = 223,875	6.097***	1.108	1.626**
Nerve, N = 44,075	9.607***	10.469***	11.461***
Respiratory, N = 81,981	7.317***	7.294***	8.061***
Skin, N = 14,040	0.114	1.342	2.710
Symptoms, N = 244,425	9.487***	9.419***	10.173***
Covariates[#]		√	√
Factors[¤]			√

*** p< 0.001, ** p< 0.05, p<0.10

[%] N is the sample size. This is the number of individuals time the number of time periods included in the analysis (i.e. 10).

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap.

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

Previous studies have reported sex differences in mortality after an inpatient care visit for acute myocardial infarctions (AMI), see e.g. [13-15]. For this reason, we re-estimated our Cox regression models using the AMI sample on (1) total five years mortality, (2) in-hospital death (i.e., where the patient dies before discharge), (3) one year follow-up period (conditional on discharge) and (4) a follow up period of up to five years after the inpatient care visit. We estimated both overall mortality and separately for age groups 40-44, 45-49, 50-54 and 55-59.

Table 4 reports regression results including the same control variables in the model as in our previous analysis. Estimates from Column (1) suggest that men, primarily in the oldest age stratum, have a significantly higher mortality risk than women after being admitted to a hospital with an AMI. For the other outcomes we found no statistically significant sex differences in AMI mortality.

Table 4: Cox regression slope parameters (standard errors within parenthesis). Sex differences in mortality after a hospitalization for an acute myocardial infarct by time of death and age category

	(1) Total	(2) In-hospital	(3) Post-discharge (<1year)	(4) Post-discharge (1 to 5 years)
All	-0.030**	-0.007	-0.009	-0.013
N = 3,545[%]	[-0.057 – -0.003]	[-0.019 – 0.005]	[-0.019 – 0.001]	[-0.035 – 0.009]
Age cohorts				
40-44	-0.054	-0.011	-0.032	-0.010
N = 211	[-0.140 – 0.032]	[-0.046 – 0.024]	[-0.081 – 0.017]	[-0.075 – 0.055]
45-49	-0.016	-0.004	-0.003	-0.009
N = 604	[-0.081 – 0.049]	[-0.031 – 0.023]	[-0.028 – 0.022]	[-0.064 – 0.046]
50-54	-0.005	-0.013	-0.008	0.016
N = 1,175	[-0.052 – 0.042]	[-0.035 – 0.009]	[-0.026 – 0.010]	[-0.023 – 0.055]
55-59	-0.050**	-0.003	-0.009	-0.038**
N = 1,555	[-0.093 – -0.007]	[-0.021 – 0.015]	[-0.027 – 0.009]	[-0.073 – -0.003]
Covariates and factors[#]	√	√	√	√

[%] N is the number of individuals.

[#] Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap, indicators for calendar year, occupational sector and disease category (where feasible).

** $p<0.05$

DISCUSSION

Measures of morbidity are often used as measures of the health in the population as well as inputs to adjust for the remuneration when health care is paid by capitation. Ideally, these measures should not be affected by patients' preferences for health care. If these morbidity measures do not reflects real health the design of increasing public health can be misleading and inefficient. For instance a recently published study shows that among fee-for-service Medicare beneficiaries, there is an inverse relationship between the regional frequency of diagnosis and the case-fatality rate for chronic conditions [16]. The present study focuses on the differences between the sexes and to what extent that sex differences in observed morbidity outcomes reflect differences in behavior rather than differences in health. We test this hypothesis using a novel design made possible by the supply of longitudinal data on a morbidity measure (sickness absence) on the population of working men and

women (115,430 men and 117,844 women). We found that women extracted relatively more sickness absence and simultaneously had a lower mortality risk than men both before, but in particular after, the hospitalization. This provides strong evidence of more proactive and preventive behavior of women than that of the men.

Case and Paxson (2005) [17] and [18] could not confirm the hypothesis of differences in preferences between the sexes, that is a more proactive behavior of women than of men or a [13, p. 2251] "greater stoicism among men and a greater willingness among women to use health services, report health problems and factor in less-serious ailments when assessing their own health". As a morbidly measure [17] focused on self- assessed health while [18] used self-rated health, longstanding illness, respiratory illness, sickness absence, hypertension and CHD prevalence. The lack of systematic statistically significant differences in association between mortality and the morbidity measures are taken as evidence against the theory. One should, however note that there are patterns in both studies that supports the theory. For example, 8 of 11 morbidly measures have a stronger association to mortality for men than for women and for one (sickness absence) is this difference statistically significant. Men with respiratory cancer, cardiovascular disease, and bronchitis were found to have higher incidence of hospital episodes and mortality than women who suffer from the same self-reported conditions in the study by Case and Paxson [17]. This suggest that this theory may be one explanation for the observed gender pattern but that the sample size needs to be large and that one need methods not sensitive to unmeasured confounders. The strategy used in this paper was originally suggested in [19] who applied the method to a sample of working Swedish men and women aged 40-45. This paper extends on this study by studying a larger population and by a more elaborate analysis over diagnosis codes. The results from the two papers are however in agreement.

Our results on mortality after a hospital admission are somewhat in contrast to studies on sex differences in AMI mortality after a hospital admission. For example, some previous studies [13-15]

have found a higher risk of mortality after an inpatient care visit for an AMI for younger (less than or equal to 65 or less than or equal to 75) women, compared to men. However, these analyses are based on hospital discharge data, implying that mortality is conditional on patient admission and that death occurred before leaving the hospital. Furthermore, other studies show that female AMI patients have on average longer hospital stays than men [20,21]. The implication is that, if women have longer length of hospital stays (e.g. due to differences in preferences) given a certain health condition, then this could explain women's higher mortality. An advantage of our analysis is that it is not restricted to death in the hospital. In order to shed light on this potential issue, we re-estimated our analyses on the subsample of AMI patients. This sub-analysis could not confirm the results in the previous studies [13-15].

LIMITATIONS

Results based on observational data always suffer the risk of confounding bias. We empirically analyze changes in sickness absence after a hospital admission for men and women in a difference-in-differences design commonly used in social science and increasingly applied in medical science [12]. The longitudinal characteristic of our data allows us to condition on group differences in health, working conditions, and other time-invariant factors (e.g. differences in household duties) which might confound the relation between absenteeism and gender-specific health behavior. In this respect, we need to stress that all displayed results are not sensitive to the inclusion of observed covariates or not. This result is to be expected from the design of the study. If anything the adjustment for covariates increase, rather than decrease, the magnitude of the effects (compare column (1) with no adjustment to column (3)) in Tables 1, 2 and 3. Hence, given that the inclusion of these covariates to some extent captures health before the hospital admission, this empirical pattern indicates that women have, on average, better pre-admission health than men do. The implication

would then be that the observed sex differences in sickness absence after a hospital admission is a lower bound of the more proactive and preventive behavior of women in contrast to that of the men.

Another limitation is that our results reflect the findings from a representative sample of employed Swedish individuals aged 40-59 with a hospital visit in 1991. It is not clear that these results would apply to other populations.

IMPLICATIONS

Using morbidity measures in the design of increasing public health can lead to mistargeted interventions. A potentially more efficient strategy could be to implement policies which affect attitudes and norms on risks for groups with risky health behaviors. One such strategy in the context of Sweden would be to promote information which would make Swedish men more aware of the proactive use of medical services.

A. Contributor ship statement

Daniel Avdic made all analyses and interpreted the data together with the coauthors. He had approved the version of the manuscript to be published.

Pathric Hägglund interpreted the data together with the coauthors and drafted the manuscript. He had approved the version of the manuscript to be published.

Bertil Lindahl interpreted the data together with the coauthors, drafted parts of the manuscript and revised the manuscript for important intellectual content. He had approved the version of the manuscript to be published.

Per Johansson designed the study and interpreted the data together with the coauthors and drafted the manuscript of data. He had approved the version of the manuscript to be published.

B. Competing interests

Daniel Avdic – None declared
Pathric Hägglund – None declared

Bertil Lindahl – None declared
Per Johansson – None declared

C. Funding

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D. Data sharing statement

The data used in this analysis are drawn from Swedish administrative registers and are confidential. The data can be obtained for replication by contacting IFAU by email ifau@ifau.uu.se. The data is personal data and are therefore governed by the ethical principles set up by the Swedish government. The data may be transferred to a third country in one of the following situations:

- If there is an adequate level of protection (see * below) in the recipient country (for instance according to decisions by the EU Commission).
- When the data subject has given his/her consent to the transfer.
- In certain specific situations enumerated in section 34 of the Personal Data Act.
- If it is permitted in some other way according to regulations or specific decisions by the Government or the Data Inspection Board with reference to that there are adequate safeguards with respect to the protection of the rights of the data subjects. Such safeguards may result from:
- Standard contractual clauses approved by the EU Commission.
- Binding Corporate Rules (BCR).

The processing of personal data that takes place in Sweden must still comply with the rules of the Personal Data Act. This means that data may only be transferred if the data controller in Sweden has complied with the other requirements of the Personal Data Act, for instance the fundamental requirements regarding processing of personal data and the rules about when such processing is permitted on the whole.

*In the Personal Data Act (and in the EC Directive on data protection) there are guidelines on what you have to consider when assessing the level of protection for personal data. All circumstances surrounding the transfer shall be considered. Particular consideration shall be given to the nature of data, the purpose of the processing, the duration of the processing, the country of origin, the country of final destination and the rules that exist for the processing in the third country.
The EU Commission has analyzed the data protection rules of a few countries and decided that the level of protection in these countries is adequate. The decisions concern: Argentina, Bailiwick of Guernsey, Faroe Islands, Isle of Man Jersey, Switzerland
Furthermore the EU Commission has assessed that the level of protection is adequate within certain sectors or under certain conditions in the following countries:

- Canada (if their legislation on protection of personal data in the private sector is applicable on the recipient´s processing of personal data)
- U.S.A. (if the recipient has adhered to the so called Safe Harbor principles)

The decisions of the EU Commission are enumerated in an annex to the Personal Data Ordinance. In the ordinance it is explicitly stated that transfers are permitted in these cases.
The self harbor principle is a set of voluntary rules on privacy and data protection elaborated and decided by the US Department of Commerce (DoC). Organizations in the US can notify the DoC

that they adhere to these rules. The EU Commission has assessed that the rules (including accompanying questions and answers) constitute an adequate level of protection. Thus it is permitted to transfer personal data from EU/EEA to organizations in the US who have adhered to the rules. On the website of the US DoC there is a list of companies and organizations that have adhered to the Safe Harbor principles. For further information see http://www.datainspektionen.se/in-english/in-focus-transfer-of-personal-data.

REFERENCES

1. Mastekaasa A, Olsen, K. Gender, Absenteeism and Job Characteristics: A Fixed Effects Approach. *Work and Occupations*. 1998; 25: 195-2228.
2. Sindelar, J L. Differential Use of Medical Care by Sex. *Journal of Political Economy*. 1982; 90: 1003-1019.
3. Lee, C. Gender, Health and Health Behaviors. In J. Chrisler and D. R. McCreary (eds.), Handbook of Gender Research in Psychology. Springer Science, 2010; 20: 471-493.
4. Nathanson, C. Illness and the Feminine Role: A Theoretical Review. *Social Science and Medicine*. 1975;9: 57-62.
5. Verbrugge, L M. Sex Differentials in Health. *Public Health Report*. 1982; 97: 417-437.
6. Stronegger, W J, Freidl, W, Rasky, V. Health Behaviour and Risk Behaviour: Socioeconomic Differences in an Austrian Rural County. *Social Science and Medicine*. 1997;44: 423-426.
7. Uitenbroek, D. G., Kerekovska, A, Festchieva, N. Health Lifestyle Behaviour and Socio-Demographic Characteristics. A Study of Varna, Glasgow and Edinburgh. *Social Science and Medicine*. 1996;43:367-377.
8. Graunt, J. Natural and Political Observations Mentioned in a Following Index and Made Upon the Bills of Mortality. London: Tho: Roycroft, for John Martin, James Allestry, and Tho: Dicas, 1662, London: Martin, Allestry and Dicas.
9. Bertrand, M. New Perspectives on Gender. In O. Ashenfelter and D. Card (eds.), Handbook of Labor Economics 4b, Elsevier Ltd. 2010: 1545-1592.
10. CIA factbook, 2011. https://www.cia.gov/library/publications/the-world-factbook/index.html
11. Snow, John (1855). On the Mode of Communication of Cholera (2nd ed.). London: John Churchill.
12. Dimick J B, Ryan A M. Methods for evaluating changes in health care policy: the difference-in-differences approach. *JAMA*. 2014; 312(22):2401-2. doi: 10.1001/jama.2014.16153.
13. Vaccarino V, Parsons L, Every NR, Barron HV, Krumholz HM.; National Registry of Myocardial Infarction 2 Participants. Sex-based differences in early mortality after myocardial infarction. *N Engl J Med*. 1999;341(4):217-225.
14. Vaccarino V, Krumholz HM, Yarzebski J, Gore JM, Goldberg RJ. Sex differences in 2-year mortality after hospital discharge for myocardial infarction. *Ann Intern Med*. 2001;134(3):173-181.
15. Canto JG, Rogers WJ, Goldberg RJ, et al. Association of Age and Sex With Myocardial Infarction Symptom Presentation and In-Hospital Mortality. *JAMA*. 2012;307(8):813-822. doi:10.1001/jama.2012.199.
16. Welch GH, Sharp SM, Gottlieb DJ, Skinner JS, Wennberg JE. Geographic Variation in Diagnosis Frequency and Risk of Death Among Medicare Beneficiaries. JAMA. 2011;305(11):1113-1118. doi:10.1001/jama.2011.307

17. Case A, Paxson C. Demography. 2005 May;42(2):189-214. Sex differences in morbidity and mortality.
18. Singh-Manoux A, Guéguen A, Ferrie J, Shipley M, Martikainen P, Bonenfant, S, Goldberg M, Marmot, M Association Between Morbidity and Mortality Among Middle-Aged Men and Women Am J Public Health. 2008; 98: 2251–2257.
19. Avdic D, Johansson P. Absenteeism, Gender and the Morbidity–Mortality Paradox. *Journal of Applied Econometrics*. 2017; 32: 440-462.
20. Every N R, Spertus J, Fihn SD, Hlatky M, Martin JS, Weaver WD. Length of hospital stay after acute myocardial infarction in the Myocardial Infarction Triage and Intervention (MITI) Project registry. *J Am Coll Cardiol*. 1996;28(2):287-93.
21. Kinjo K1, Sato H, Nakatani D, Mizuno H, Shimizu M, Hishida E, Ezumi A, Hoshida S, Koretsune Y, Hori M; Osaka Acute Coronary Insufficiency Study (OACIS) Group. Predictors of Length of Hospital Stay After Acute Myocardial Infarction in Japan. *Circ J*. 2004; 68: 809– 815.

Legends Figures

Figure 1. Number of days of absence for men and women before and after a (first) hospital admission for the population of employed (prior to the hospital admission) individuals 40-59 years of age in 1993 to 2004. Left panel average. Right panel conditional on a cancer, myocardial infarction, musculoskeletal and mental diseases.

Figure 2. Five-year mortality risk for men and women after a hospital admission by diagnosis category for the population of employed (before the hospital admission) individuals 40-59 years of age in 1993 to 2004.

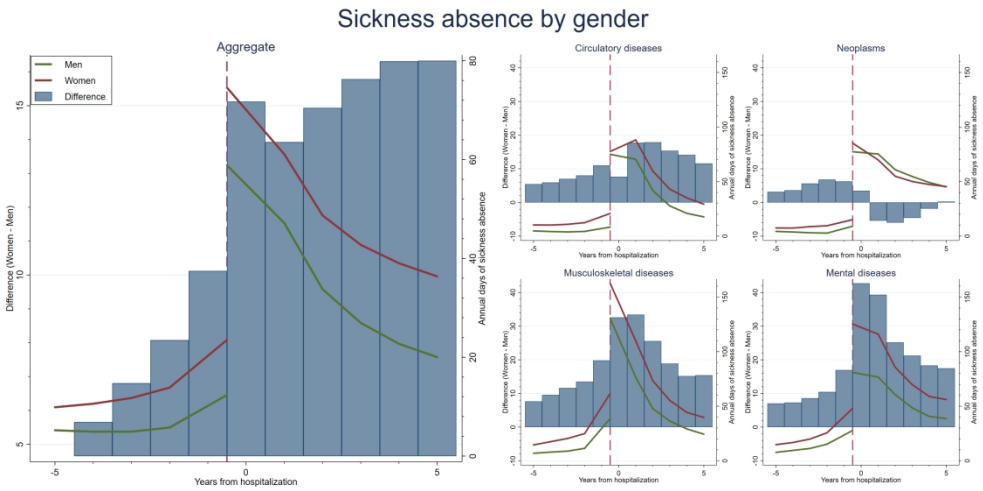

Figure 1. Number of days of absence for men and women before and after a (first) hospital admission for the population of employed (prior to the hospital admission) individuals 40-59 years of age in 1993 to 2004. Left panel average. Right panel conditional on a cancer, myocardial infarction, musculoskeletal and mental diseases.

254x127mm (300 x 300 DPI)

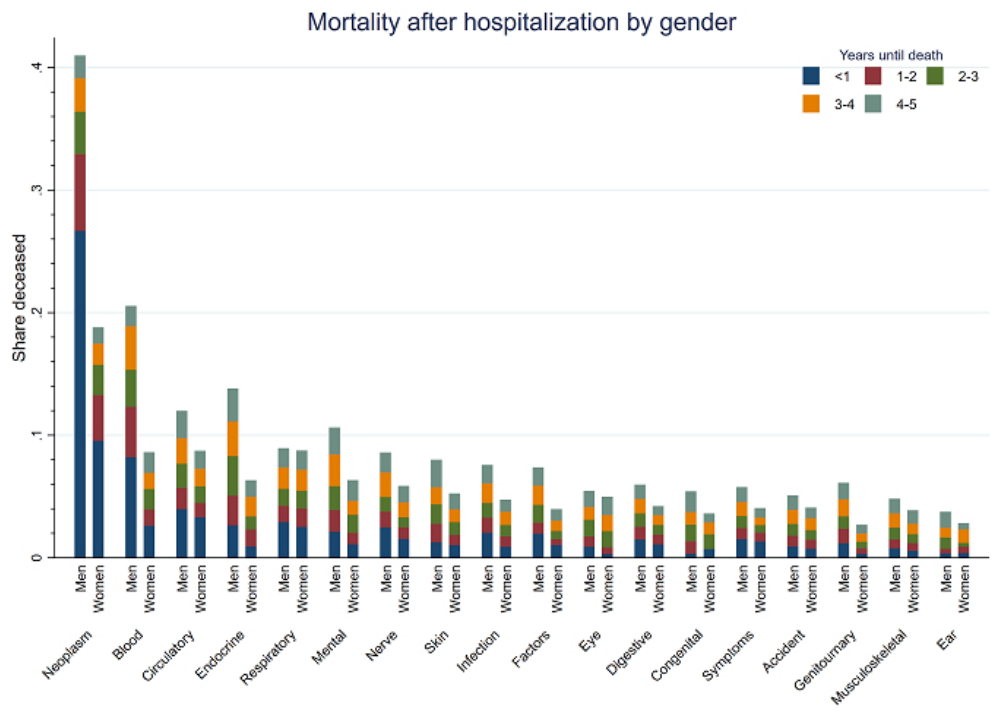

Figure 2. Five-year mortality risk for men and women after a hospital admission by diagnosis category for the population of employed (before the hospital admission) individuals 40-59 years of age in 1993 to 2004.

57x42mm (300 x 300 DPI)

Appendix: Descriptive statistics

Table 1: Sample summary statistics

	(1) Total	(2) Male	(3) Female
Age 40-44	46,581	22,778	23,803
Share of total	0.200	0.098	0.102
Age 45-49	57,069	27,654	29,415
Share of total	0.245	0.119	0.127
Age 50-54	66,545	32,701	33,844
Share of total	0.285	0.140	0.145
Age 55-59	63,079	32,297	30,782
Share of total	0.269	0.138	0.131
Total	233,274	115,430	117,844
Share of total	1.000	0.495	0.505

30 percent random sample of the population of employed individuals 40-59 years of age in 1993 who were hospitalized at some point between years 1994-2004.

Table 2: Sample summary statistics

	Hospitalized Men		Hospitalized Women		Non-hospitalized Men		Non-hospitalized Women	
Variable	(1) mean	(2) sd	(3) mean	(4) sd	(5) mean	(6) sd	(7) mean	(8) Sd
Age	52.477	7.195	51.906	7.078	51.571	7.662	52.161	7.826
Earnings	6.845	5.152	4.694	2.732	7.497	6.166	5.035	3.319
Non-labor income	3.741	29.641	4.535	19.479	4.041	30.506	5.028	25.609
Household earnings	10.586	30.201	9.230	19.799	11.538	31.264	10.062	25.987
Infection	0.024	0.154	0.019	0.138				
Neoplasm	0.062	0.242	0.175	0.380				
Blood	0.003	0.056	0.007	0.084				
Endocrine	0.019	0.138	0.025	0.155				
Mental	0.041	0.199	0.030	0.169				
Nerve	0.026	0.159	0.020	0.139				
Eye	0.013	0.115	0.011	0.104				
Ear	0.014	0.118	0.013	0.114				
Circulatory	0.186	0.389	0.088	0.284				
Respiratory	0.048	0.213	0.041	0.198				
Digestive	0.125	0.331	0.110	0.313				
Skin	0.008	0.090	0.007	0.085				
Musculoskeletal	0.082	0.275	0.080	0.271				
Genitourinary	0.049	0.216	0.131	0.338				
Congenital	0.003	0.050	0.004	0.059				
Symptoms	0.145	0.352	0.116	0.320				
Accident	0.123	0.328	0.092	0.289				

Factors	0.028	0.165	0.032	0.176		
# Individuals	115,430		117,844		205,762	198,992

30 percent random sample of the population of employed individuals 40-59 years of age in 1993 who were hospitalized at some point between years 1994-2004 and not-hospitalized during the same period. Earning and Non-labor income and both measure as price base (PBA) amounts in 1992 (one PBA is 33,700 SEK (= £2,9452 in December 2018)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	Longitudinal data at the individual level and using a difference-in-differences design for the analysis on sickness absence (before and after a hospital admission)..
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1	Women increase their sickness absence by around five more days per year than the males (95% confidence interval 5.25 to 6.22 (mean) and 4.66 to 5.60 (zero)). At the same time men have higher risk of mortality for the eighteen diagnosis categories analyzed.
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2	The global average gender difference in life expectancy was about four years in 2010 and has been persistently so for a long time [3]. This has led some scholars to label the relationship the morbidity-mortality or gender paradox [4].

Objectives	3	State specific objectives, including any prespecified hypotheses	1	To analyze if gender-specific health behavior can be one explanation why women outlive men while at the same time have worse morbidity outcomes, known as the morbidity-mortality or gender paradox.
Methods				
Study design	4	Present key elements of study design early in the paper	4	The difference-in-difference design allows us to adjust for unobserved confounders of importance for sickness absence that may differ between men and women before the admission to the hospital
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2-3	Our empirical analysis exploits micro-data originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. Sweden
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	2-3	The data on socioeconomic variables covering the entire Swedish (16-65) population for years 1993-2004 were

		Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants		obtained from Statistics Sweden
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3	The information about sickness absence covers all individual spells of paid sick leave from the statutory sickness insurance in Sweden. The diagnoses, are made at discharge by the responsible senior consultant and classified according to the World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD-10).
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*3*	Information on sickness absence were obtained using a register at the Swedish Social Insurance Agency. Data on discharge diagnosis was obtained from the National Patient Register covers all inpatient medical contacts in public hospitals at the Swedish National Board of Health and Welfare.
Bias	9	Describe any efforts to address potential sources of bias	3-4	In the analyses we made use of

				regression analysis and adjusted for age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and a factor for whether the individual or the spouse had earnings above the sickness insurance cap and factors for year of the admission, occupational sector and disease category. The difference-in-difference design allowed us to adjust for unobserved confounders of importance for sickness absence that may differ between men and women before the admission to the hospital.
Study size	10	Explain how the study size was arrived at	12	No formal sample size calculation was performed. That data from the whole country were used.

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	2-3	Our empirical analysis exploited micro-data originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. The data on socioeconomic variables covering the entire Swedish (16-65) population in the age interval 16-65 for years 1993-2004 were obtained from Statistics, Sweden. These data were linked to information on sickness absence and inpatient care over the same time period using registers at the Swedish Social Insurance Agency and the Swedish National Board of Health and Welfare, respectively.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	3-5	
		(*b*) Describe any methods used to examine subgroups and interactions		
		(*c*) Explain how missing data were addressed		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		
		(*e*) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6	We have included a supplementary table with the number of men and women at different age strata. for potential online publication

		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6	We have included a supplementary table with descriptive statistics for potential online publication.
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		Table1-4
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures		
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		Table 1-4
		(*b*) Report category boundaries when continuous variables were categorized		
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		
Discussion				
Key results	18	Summarise key results with reference to study objectives	13	We found that women extracted relatively more sickness absence and simultaneously had a lower mortality risk than men both before, but in particular after, the hospitalization. This provides strong evidence of more proactive and preventive behavior of women than that of the men.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15	
Generalisability	21	Discuss the generalisability (external validity) of the study results	15	
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based		

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Sex differences in sickness absence and the morbidity-mortality paradox: A longitudinal study using Swedish administrative registers

By

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ABSTRACT

Objective: To analyze whether gender-specific health behavior can be an explanation for why women outlive men, while having worse morbidity outcomes, known as the morbidity-mortality or gender paradox.

Setting: The working population in Sweden.

Participants: Thirty percent random sample of Swedish women and men aged 40-59 with a hospital admission in the period 1993-2004. The analysis sample consist of 233,274 individuals (115,430 men and 117,844 women) and in total 1 867,013 observations on sickness absence.

Intervention: Hospital admission across eighteen disease categories.

Main outcome measures: Sickness absence (morbidity) and mortality. Longitudinal data at the individual level allows us to study how the sickness absence change after a hospital admission in men and women in a difference-in-difference regression analysis. Cox regression models are used to study differences in mortality after the admission.

Results: Women increased their sickness absence after a hospital admission by around five more days per year than males (95% confidence interval 5.25 to 6.22). At the same time, men had higher mortality in the eighteen diagnosis categories analyzed. The pattern of more sickness absence in women was the same across seventeen different diagnosis categories. For neoplasm on the other hand, with a 57% higher risk of death for men (54.18% to 59.89 %) the results depended on the imputation method of sickness for those deceased. By using the pre mortality means of sickness absence men had an additional 14.47 (12.64 to 16.30) days of absence but with the zero imputation women had an additional 1.6 days of absence (0.05 to 3.20). Analyses with or without covariates revealed a coherent picture.

Conclusions: The pattern of increased sickness absence (morbidity) and lower mortality in women provides evidence of more pro-active and preventive behavior in women than in men, which could thus explain the morbidity-mortality paradox.

Strengths and limitations of this study

- The empirical analysis is based on a difference-in-differences design commonly used in social science and increasingly applied in medical science.
- The longitudinal characteristic of our data allow us to condition on group differences in health, working conditions, and other time-invariant factors (e.g. differences in household duties) which might confound the relation between absenteeism and gender-specific health behavior.
- The conclusion of a larger increase in sickness absence in women than in men after an hospital admission is not depending on covariate adjustment.

INTRODUCTION

In many countries, women are relatively more absent for health reasons than men [1]. Furthermore, similar gender differences exist in other common measures of morbidity such as medical care utilization and self-reported health [2]. Yet, while most commonly used observed health measures show an over-representation of women, there is one major exception to this rule – the remaining life expectancy. One much-quoted fact of gender differences is that women outlives men. In fact, the remaining life expectancy is higher in women than in men in all ages and in nearly all parts of the world. The global average gender difference in life expectancy was about four years in 2010 and has been persistently so for a long time [3]. This has led some scholars to label this relationship as the *morbidity-mortality or gender paradox* [4].

One suggested explanation for this apparently inconsistent pattern has been the existence of sex differences in health behavior. Differences in behavior could be with regard to smoking, drinking, diet etcetera, but can also be manifested in common measures of morbidity. Women may for example proactively make more use of health care and be more sick absent from work in order to keep healthier, which would then prolong their lives relative to men (cf. [4], [5], [6], [7]). This particular explanation for the so-called morbidity-mortality paradox was discussed already in the 17th century; the English demographer John Graunt [8] observed that both the birth and death rates of men were higher than for women while at the same time "[Physicians] have two women patients to one man".

This conjecture of behavioral differences have support in experimental studies in social science (cf. [9]). In particular, it has often been noted that women, in general, act more proactively in matters regarding their own and other family members' health and that women tend to be more risk averse than men. The implication is that if women pay more attention to potential future illnesses, by more frequent use of medical services or health insurance, poor health can be detected at an earlier stage,

remediated, and, consequently, increase their relative life expectancy in relation to men. The large cross-country variation in life expectancy (see e.g. [10]) also suggests that the general picture of women outliving men to some extent stems from gender-specific health behavior based on differences in cultural norms.

This article empirically tests for sex differences in behavior as a factor for understanding the morbidity-mortality paradox by using the evolution of morbidity (sickness absence) and mortality of men and women after a hospital admission. If women act more proactively than men do, we should find that women are more sickness absent after a comparable health change compared to men, while, at the same time, women do not experience higher mortality rates. Thus, if we find such a pattern in our data, this supports the conjecture that the morbidity-mortality conundrum is driven by a more proactive health behavior among women. On the other hand, if we find an increase in sickness absence and that women's mortality rate is higher after the hospital admission, we would conclude that it is likely that actual health differentials between men and women are causing the increase in sickness absence.

Since measures of morbidity are almost exclusively discussed from an adverse standpoint, it is an important question for health policy whether and to which extent gender differences in outcomes reflects differences in behavior rather than differences in health. Therefore, our aim was to study the morbidity-mortality paradox and analyse whether gender-specific health behaviour can be an explanation for why women outlive men, while having worse morbidity outcomes

METHODS

Study design and participants

Our empirical analysis exploited micro-data originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. The data on

socioeconomic variables covering the entire Swedish population in the age interval 16-65 for years 1993-2004 were obtained from Statistics, Sweden. These data were linked to information on sickness absence and inpatient care over the same time period using registers at the Swedish Social Insurance Agency and the Swedish National Board of Health and Welfare, respectively. The information about sickness absence covers all individual spells of paid sick leave from the statutory sickness insurance in Sweden. The National Patient Register covers all inpatient medical contacts in public hospitals. The diagnoses are made at discharge by the responsible senior consultant and classified according to the World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD-10).

The analyses were performed using a 30 percent random sample of the population of employed individuals 40-59 years of age in 1993 who were hospitalized at some point between years 1994-2004. The sample consists of in total 233,274 individuals of which 49.5 percent are men. The fraction of individual in the age strata 40-44, 45-49, 50-54 and 55-59 are 20, 25, 28 and 27 percent, respectively. This sample constitutes around 37 percent of the employed individual in this age span. In comparison to those not hospitalized during the same period the age distribution are comparable but they have somewhat lower income. Descriptive statistics for the 30 percent sample of both population (hospitalized and non-hospitalized) is provided in Table 1 and 2 in the appendix. We made use of the first hospital admission only. For sampled individuals with their first hospital admission in 1999, we hence observed their sickness absence five years before and five years after the admission. For other years, we did not observe the complete number of leads and lags, leading to an unbalanced panel. To account for potential sample composition effects, factors (or fixed effects) for years and age were included in our empirical specification.

The reason for the age and employment restrictions prior to the hospital admission was that sickness absence is only a valid morbidity measure if individuals are eligible for sickness benefits, i.e.

have employment (or searching for a job but with previous employment). Eligibility is tied to belonging to the labor force and being below the mandatory retirement age of 65. Thus, as individuals in general leave the labor force before the age of 65 we restricted the analysis to individuals younger than 60.

Statistical analyzes

In the analyses we made use of regression analysis and adjusted for age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and a factor for whether the individual or the spouse had earnings above the sickness insurance cap and factors for year of the admission, occupational sector and disease category.

The regression analysis can be denoted a differences-in-differences design. The idea was proposed, already, in 1855 by John Snow [11] who used the fact that Lambeth Company in London moved its water work upriver, relatively free from sewage, as a means to empirically test the theory of water quality affecting cholera. He compared the change in occurrence of cholera in people served by Lambeth Company before and after the move of the water work against the change in occurrence of cholera during the same time period in people served by another company who did not change their location. By making use of the two differences over time (i.e. difference-in difference) he controlled for the fact that the change of the water quality was not randomly assigned. For an easy assessable discussion of this idea for the analysis of health care policies see [12] .

The difference-in-difference design allowed us to adjust for unobserved confounders of importance for sickness absence that may differ between men and women before the admission to the hospital. Adjusting for pre-admission gender differences, we then estimated the relative effect from the admission of women compared to men using an ordinary least squares estimator. We imputed the sickness absence for the deceased the year before the death for each year after their death. If men have a higher mortality rate than women, this strategy is conservative as a means to

test for more pro-active behavior of women compared to men. On the other hand, if men and women have similar mortality rates imputing zero days of absence for each year after their death provides a conservative test for more pro-active behavior of women. Both imputation methods was used in the analysis. However the first results take use of the mean imputation strategy. Furthermore, the sickness and disability insurance are integrated parts of the social insurance system and therefore interrelated. An individual on full time disability benefits cannot receive sickness benefits but part time disabled persons can. In the analysis, we therefore defined days on sickness absence as number of days on sickness benefits and/or days on disability benefits in a given year.

In the mortality analyses, we made use of daily data and estimated discrete time Cox proportional hazard regression models using maximum likelihood.

The study was approved by the Regional Ethical Review Board in Uppsala (approval number 2005:126).

Patient and Public Involvement.

Patients were not involved in the design or conduct of this large observational register-based study. It will not be possible to disseminate the results directly to the individuals involved since all analyses were done on depersonalized data. Hence, the results will be disseminated to the public through publication in scientific and popular scientific journals.

RESULTS

Sickness absence in relation to gender

Figure 1 shows the average number of days of sickness absence of men and women before and after hospitalization. The left panel shows the overall difference while the right panels displays the average for four large disease categories; neoplasms (ICD-10 = C00-D48), circulatory diseases (ICD-

10 = I00-I99), musculoskeletal diseases (ICD-10 = M00-M99) and mental and behavioral disorders (ICD-10 = F00-F99).

From the left panel it can be seen that the sickness absence for both men and women increase in the years prior to the hospital admission, but also that this increase is greater for women. In the period after the hospital admission, a sharp increase in sick leave for both men and women was seen, but the increase was much greater for women. The right panel of Figure 1 shows the same pattern before the hospital admission for the four large diseases categories. After the hospital admission, however, there are some differences across these categories. For neoplasms sickness absence was higher for men one to four years after the admission. For the other diseases women had higher sickness absence than men for the whole follow up period. For circulatory diseases this difference was small the admission year while for the two other the gender differences were initially large but then taped off.

Mortality in relation to gender

Figure 2 reports disease-specific share of men and women who died within five years after the hospitalization separated into mortality within yearly follow-up categories for in total eighteen different disease categories. A remarkable pattern was shown; for all disease categories, men had a higher probability of dying (also within follow-up categories) after the hospitalization.

For neoplasms, the risk of dying in the five-year follow-up period was 22 percentage points higher in men than in women (42% compared with 20%). For circulatory diseases, mental and behavioral (mental in the following) disorders and musculoskeletal diseases, there was a corresponding 4 (14% to 10%), 4 (12% to 8%) and 1.5 (6% to 4.5%) percentage points increased risk in men, respectively.

For the sickness absence data, we imputed the sickness absence the year before the death for the deceased. The gender differences in mortality could thus possibly explain some of the post-hospital

admission pattern regarding sickness absence. This explanation is most likely to be the most important for neoplasms.

Results from regression estimation

Table 1 presents the results from regression analyses of gender differences in sick leave and mortality for the five years follow-up period after the hospital admission. The results on both sickness absence and mortality were in line with the previous results reported in Figures 1 and 2. From column (3) in panel A of Table 1, it can be seen that women used a statistically significant 5.73 additional days of sickness absence than men per year over the five-year post-hospitalization sampling window (95% confidence interval 5.25 to 6.22). For a hospital admission for a neoplasm, circulatory disease, musculoskeletal disease, and mental disorder, the corresponding gender differences were -14.47, 7.44, 5.77, and 5.30 days, respectively (-16.30 to -12.64, 5.91 to 8.96, 3.63 to 7.91 and 1.96 to 8.64). Finally, from column (3) in panel B, it can be seen that women had around 27% ($\approx 100(1-\exp(-.314))$ lower post-hospitalization mortality risk than men (24.18% to 29.62%). For the neoplasm, circulatory, musculoskeletal, and mental diseases, the corresponding figures were, 57%, 38% 27% and 45% lower mortality risks (54.18% to 59.89%, 30.73% to 43.94%, 13.02% to 38.40% and 33.89% to 54.98%)

Results from analyses on sickness absence for the eighteen disease categories are provided in Table 2. The general conclusion from these analyses is similar as from the overall gender-difference analysis: women increased their absence more for all categories (statistically significant for twelve of these) except for neoplasm five years after the hospital admission than men.

Table 1. Regression (linear and Cox) slope parameter (standard errors within parenthesis) of gender difference in sickness absence (for the deceased we impute the sickness absence the year before the death for all years after the death) and mortality five years after a hospital admission, by disease type. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission (see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
A: Linear regressions (difference-in difference design on gender difference in effect of an admission on days of sickness absence)			
All	5.728***	4.963***	5.738***
N =1,867,013[%]	[5.25 – 6.22]	[4.47 – 5.45]	[5.26 – 6.22]
Circulatory (ICD-10 = I00-I99)	7.102***	6.621***	7.436***
N=255,687	[5.55 – 8.65]	[5.09 – 8.15]	[5.91 – 8.96]
Neoplasms (ICD-10 = C00-D48)	-9.36***	-15.082***	-14.471***
N =223,875	[-11.12 – -7.53]	[-16.93 – -13.24]	[-16.30 – -12.64]
Musculoskeletal (ICD-10 = M00-M99)	3.149***	4.165***	5.772***
N =149,846	[0.96 – 5.33]	[2.00 – 6.33]	[3.63 – 7.91]
Mental (ICD-10 = M00-M99)	4.109**	3.584**	5.305***
N =63,065	[0.74 – 7.48]	[0.24 – 6.93]	[1.96 – 8.64]
B: Cox PH regressions on gender difference in post-admission mortality			
All	-0.279***	-0.226***	-0.314***
N = 233,274	[-0.31 – -0.24]	[-0.26 – 0.19]	[-0.35 – -0.28]
Circulatory (ICD-10 = I00-I99)	-0.449***	-0.400***	-0.473***
N =31,838	[-0.55 – -0.34]	[-0.50 – -0.30]	[-0.58 – -0.37]
Neoplasms (ICD-10 = C00-D48)	-0.918***	-0.752***	-0.847***
N =27,781	[-0.98 – -0.86]	[0.82 – -0.69]	[-0.91 – -0.78]
Musculoskeletal (ICD-10 = M00-M99)	-0.197**	-0.253***	-0.312***
N =18,875	[-0.37 – -0.03]	[-0.42 – -0.08]	[-0.484 – -0.140]
Mental ICD-10 = M00-M99)	-0.578***	-0.559***	-0.606***
N =8,236	[-0.764 – -0.39]	[-0.74 – -0.37]	[-0.80 – -0.41]
Covariates[#]		√	√
Factors[¤]			√

*** p<0.001, ** p<0.05

[%] N is the sample size. In the sickness absence analysis this is the number of individuals multiplied by the number of time periods they are included in the analysis while in the mortality analysis it is the number of individuals.

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap.

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

Table 2. Linear regression slope parameter, that is the difference-in difference estimate of gender difference in sickness absence five years after a hospital admission (for the deceased we impute the sickness absence the year before the death for all years after the death) for 18 disease categories. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission (see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
Accident, N=201,273[%]	5.033***	6.541***	7.653***
Blood, N = 9,973	7.613**	3.717	3.768
Congenital, N =5,530	5.365	3.116	3.924
Digestive, N = 219,619	7.861***	7.628***	8.447***
Ear, N = 25,660	4.459**	4.559**	5.952***
Endocrine, N =40,538	-0.871	-0.964	0.157
Eye, N = 22,685	4.086**	4.648**	5.248***
Factors, N =55,136	-0.147	2.113	3.633***
Genitourinary, N =168,659	4.273***	0.667	0.860
Circulatory (ICD-10 = I00-I99), N = 255,687	7.102***	6.621***	7.436***
Infection, N =40,946	3.555**	3.380**	3.660**
Mental ICD-10 = M00-M99) N =63,065	4.109**	3.584**	5.305***
Neoplasms (ICD-10 = C00-D48), N = 223,875	-9.365***	-15.082***	-14.471***
Nerve, N = 44,075	9.461***	10.397***	11.395***
Respiratory, N = 81,981	7.952***	7.819***	8.688***
Skin, N = 14,040	-0.219	0.983	2.355
Symptoms, N = 244,425	10.072***	9.972***	10.752***
Covariates[#]		√	√
Factors[¤]			√

*** p< 0.001, ** p< 0.05, p<0.10

[%] N is the sample size. This is the number of individuals multiplied by the number of time periods included in the analysis.

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap.

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

In order to find out the importance of the mean imputation method an analysis where we imputed zero for those deceased after their death was conducted. Results from this sensitivity analyses is shown in Table 3. The overall results were basically unaffected but in the sensitivity analysesstatistically significant increases were found in sickness absence for women in sixteen disease categories, including neoplasm. For this disease women increased their absence by 1,6 days more than the men after the admission over the five-year follow up period (0.05 to 3.20).

Table 3. Linear regression slope parameter, that is the difference-in difference estimate of gender difference in sickness absence five years after a hospital admission (imputing zero days of absence for all years after a death for those deceased) for 18 disease categories. Column (1) makes no covariate adjustments, Column (2) adjust for covariates observed before the admission (see the note in the table) and column (3) adjust for factors (see note in the table).

	(1)	(2)	(3)
All, N = 1,867,013	5.156***	4.392***	5.126***
Accident, N=201,273[%]	5.175***	6.693***	7.771***
Blood, N = 9,973	16.757***	12.188***	12.320***
Congenital, N =5,530	5.940	3.660	4.458
Digestive, N = 219,619	7.569***	7.349***	8.137***
Ear, N = 25,660	4.068**	4.190**	5.567***
Endocrine, N =40,538	0.240	0.122	1.212
Eye, N = 22,685	5.576***	6.132***	6.717***
Factors, N =55,136	0.641	2.662*	4.150***
Genitourinary, N =168,659	5.230***	1.570**	1.759**
Circulatory (ICD-10 = I00-I99), N = 255,687	7.385***	6.900***	7.779***
Infection, N =40,946	4.349***	4.153***	4.411***
Mental ICD-10 = M00-M99) N =63,065	5.474***	4.947***	6.713***
Musculoskeletal (ICD-10 = M00-M99), N = 149,846	2.981***	4.009***	5.592***
Neoplasms (ICD-10 = C00-D48), N = 223,875	6.097***	1.108	1.626**
Nerve, N = 44,075	9.607***	10.469***	11.461***
Respiratory, N = 81,981	7.317***	7.294***	8.061***
Skin, N = 14,040	0.114	1.342	2.710
Symptoms, N = 244,425	9.487***	9.419***	10.173***
Covariates[#]		√	√
Factors[¤]			√

*** p< 0.001, ** p< 0.05, p<0.10

[%] N is the sample size. This is the number of individuals multiplied by the number of time periods included in the analysis.

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap.

[¤]Indicators for calendar year, occupational sector and disease category (where feasible).

Previous studies have reported of gender differences in the mortality after an inpatient care visit for an acute myocardial infarct (AMI), see e.g. [13], [14] and [15]. For this reason, additional analyses on the AMI inpatient care visits were made. We re-estimated our models using the AMI sample on (1) total five years mortality, (2) in-hospital death (i.e., where the patient dies before discharge), (3)

one year follow-up period (conditional on discharge) and (4) a follow up period of 1-5 years after the inpatient care visit. We estimated the total effects but also separately for the age groups 40-44, 45-49, 50-54 and 55-59.

Table 4 provides the results from the regressions where we adjusted for the same variables as in the previous analyses. From column (1) it can be seen that men in this population had higher risk of dying within five years and that men in the oldest stratum is primarily driving this effect. For the other outcomes, we found no statistically significant gender differences.

Table 4: Cox regression slope parameters (standard errors within parenthesis). The gender difference in mortality after acute myocardial infarct hospitalization by "timing of death" and age categories

	(1) Total	(2) In-hospital	(3) Post-discharge (<1year)	(4) Post-discharge (1 to 5 years)
All	-0.030**	-0.007	-0.009	-0.013
N = 3,545[%]	[-0.057 – -0.003]	[-0.019 – 0.005]	[-0.019 – 0.001]	[-0.035 – 0.009]
Age cohorts				
40-44	-0.054	-0.011	-0.032	-0.010
N = 211	[-0.140 – 0.032]	[-0.046 – 0.024]	[-0.081 – 0.017]	[-0.075 – 0.055]
45-49	-0.016	-0.004	-0.003	-0.009
N = 604	[-0.081 – 0.049]	[-0.031 – 0.023]	[-0.028 – 0.022]	[-0.064 – 0.046]
50-54	-0.005	-0.013	-0.008	0.016
N = 1,175	[-0.052 – 0.042]	[-0.035 – 0.009]	[-0.026 – 0.010]	[-0.023 – 0.055]
55-59	-0.050**	-0.003	-0.009	-0.038**
N = 1,555	[-0.093 – -0.007]	[-0.021 – 0.015]	[-0.027 – 0.009]	[-0.073 – -0.003]
Covariates and factors[#]	√	√	√	√

[%] N is the number of individuals.

[#]Age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and dummies for whether the individual or the spouse have earnings above the sickness insurance cap, indicators for calendar year, occupational sector and disease category (where feasible).

** p<0.05

DISCUSSION

Measures of morbidity are often used as measures of health in the population as well as inputs to adjust for the remuneration when health care is paid by capitation. Ideally, these measures should not be affected by patients' preferences for health care. If these morbidity measures do not reflect realhealth the design of increasing public health can be misleading and inefficient. For instance, a recently published study shows that among fee-for-service Medicare beneficiaries, there is an inverse relationship between the regional frequency of diagnosis and the case-fatality rate for chronic conditions [16]. The present study focuses on the differences between the sexes and to what extent that sex differences in observed morbidity outcomes reflect differences in behavior rather than differences in health. We test this hypothesis using a novel design made possible by the supply of longitudinal data on a morbidity measure (sickness absence) on the population of working men and women. We found that women extracted relatively more sickness absence and simultaneously had a lower mortality risk than men both before, but in particular after, the hospitalization. This provides strong evidence of more proactive and preventive behavior of women compared to men.

Case and Paxson (2005) [17] and Singh-Manoux et al. [18] could not confirm the hypothesis of differences in preferences between the sexes, that is a more proactive behavior of women than of men or a [13, p. 2251] "greater stoicism among men and a greater willingness among women to use health services, report health problems and factor in less-serious ailments when assessing their own health". As a morbidly measure Case and Paxson [17] focused on self- assessed health while Singh-Manoux et al [18] used self-rated health, longstanding illness, respiratory illness, sickness absence, hypertension and CHD prevalence. The lack of systematic statistically significant differences in association between mortality and the morbidity measures were taken as evidence against the theory. One should, however note that there are patterns in both studies that supports the theory. For example, 8 of 11 morbidly measures have a stronger association to mortality for men than for women and for one (sickness absence) is this difference statistically significant. Men with respiratory

cancer, cardiovascular disease, and bronchitis were found to have higher incidence of hospital episodes and mortality than women who suffer from the same self-reported conditions in the study by Case and Paxson [17]. This suggest that this theory may be one explanation for the observed gender pattern but that the sample size needs to be large and that one need methods not sensitive to unmeasured confounders. The strategy used in this paper was originally suggested in [19] who applied the method to a sample of working Swedish men and women aged 40-45. This paper extends on this study by studying a larger population and by a more elaborate analysis over diagnosis codes. However, the results from the two papers are in agreement.

Our results on mortality after a hospital admission are somewhat in contrast to studies on sex differences in AMI mortality after a hospital admission. For example, some previous studies [13-15] have found a higher risk of mortality after an inpatient care visit for an AMI in younger (less than or equal to 65 or less than or equal to 75) women, compared to men. However, these analyses are based on hospital discharge data, implying that mortality is conditional on patient admission and that death occurred before leaving the hospital. Furthermore, other studies show that female AMI patients have on average longer hospital stays than men [20,21]. The implication is that, if women have longer length of hospital stays (e.g. due to differences in preferences) given a certain health condition, then this could explain women's higher mortality. An advantage of our analysis is that it is not restricted to death in the hospital. In order to shed light on this potential issue, we re-estimated our analyses on the subsample of AMI patients. This sub-analysis could not confirm the results of the previous studies [13-15].

LIMITATIONS

Results based on observational data can always suffer from confounding bias. We empirically analyze changes in sickness absence after a hospital admission for men and women in a difference-in-

differences design commonly used in social science and increasingly applied in medical science [12]. The longitudinal characteristic of our data allows us to condition on group differences in health, working conditions, and other time-invariant factors (e.g. differences in household duties) which might confound the relation between absenteeism and gender-specific health behavior. In this respect, we need to stress that all displayed results are not sensitive to whether observed covariates are included or not. This result is to be expected from the design of the study. If anything the adjustment for covariates increased, rather than decreased, the magnitude of the effects (compare column (1) with no adjustment to column (3)) in Tables 1, 2 and 3. Hence, given that the inclusion of these covariates to some extent captures health before the hospital admission, this empirical pattern indicates that women have, on average, better pre-admission health than men do. The implication would then be that the observed sex differences in sickness absence after a hospital admission is a lower bound of the more proactive and preventive behavior of women in contrast to that of the men.

Another limitation is that our results reflect the findings from a representative sample of employed Swedish individuals aged 40-59 with a hospital visit in 1991. It is not clear that these results would apply to other populations.

IMPLICATIONS

Using morbidity measures in the design of increasing public health can be misleading and inefficient. A more efficient strategy may instead be of affecting attitudes and norms on risks for groups with high mortality. One such strategy would be to inform men to use medical services more pro-actively.

a. Daniel Avdic made all analyses and interpreted the data together with the coauthors. He had approved the version of the manuscript to be published.

Pathric Hägglund interpreted the data together with the coauthors and drafted the

manuscript. He had approved the version of the manuscript to be published.

Bertil Lindahl interpreted the data together with the coauthors, drafted parts of the manuscript and revised the manuscript for important intellectual content. He had approved the version of the manuscript to be published.

Per Johansson designed the study and interpreted the data together with the coauthors and drafted the manuscript of data. He had approved the version of the manuscript to be published.

b. Daniel Avdic – None declared
Pathric Hägglund – None declared
Bertil Lindahl – None declared
Per Johansson – None declared

c. The corresponding author acknowledge funding from the Swedish Research Council for Heath, Working life and Welfare (FORTE).

d. The data used in this analysis are drawn from Swedish administrative registers and are confidential. The data can be obtained for replication by contacting IFAU by email ifau@ifau.uu.se. The data is personal data and are therefore governed by the ethical principles set up by the Swedish government. The data may be transferred to a third country in one of the following situations:

- If there is an adequate level of protection (see * below) in the recipient country (for instance according to decisions by the EU Commission).
- When the data subject has given his/her consent to the transfer.
- In certain specific situations enumerated in section 34 of the Personal Data Act.
- If it is permitted in some other way according to regulations or specific decisions by the Government or the Data Inspection Board with reference to that there are adequate safeguards with respect to the protection of the rights of the data subjects. Such safeguards may result from:
  - Standard contractual clauses approved by the EU Commission.
  - Binding Corporate Rules (BCR).

The processing of personal data that takes place in Sweden must still comply with the rules of the Personal Data Act. This means that data may only be transferred if the data controller in Sweden has complied with the other requirements of the Personal Data Act, for instance the fundamental requirements regarding processing of personal data and the rules about when such processing is permitted on the whole.

*In the Personal Data Act (and in the EC Directive on data protection) there are guidelines on what you have to consider when assessing the level of protection for personal data. All circumstances surrounding the transfer shall be considered. Particular consideration shall be given to the nature of data, the purpose of the processing, the duration of the processing, the country of origin, the country of final destination and the rules that exist for the processing in the third country.
The EU Commission has analyzed the data protection rules of a few countries and decided that the level of protection in these countries is adequate. The decisions concern: Argentina, Bailiwick of Guernsey, Faroe Islands, Isle of Man Jersey, Switzerland
Furthermore the EU Commission has assessed that the level of protection is adequate within certain sectors or under certain conditions in the following countries:

- Canada (if their legislation on protection of personal data in the private sector is applicable on the recipient´s processing of personal data)
- U.S.A. (if the recipient has adhered to the so called Safe Harbor principles)

The decisions of the EU Commission are enumerated in an annex to the Personal Data Ordinance. In the ordinance it is explicitly stated that transfers are permitted in these cases.
The self harbor principle is a set of voluntary rules on privacy and data protection elaborated and decided by the US Department of Commerce (DoC). Organizations in the US can notify the DoC that they adhere to these rules. The EU Commission has assessed that the rules (including accompanying questions and answers) constitute an adequate level of protection. Thus it is permitted to transfer personal data from EU/EEA to organizations in the US who have adhered to the rules. On the website of the US DoC there is a list of companies and organizations that have adhered to the Safe Harbor principles. For further information see http://www.datainspektionen.se/in-english/in-focus-transfer-of-personal-data/

REFERENCES

1. Mastekaasa A, Olsen, K. Gender, Absenteeism and Job Characteristics: A Fixed Effects Approach. *Work and Occupations*. 1998; 25: 195-2228.
2. Sindelar, J L. Differential Use of Medical Care by Sex. *Journal of Political Economy*. 1982; 90: 1003-1019.
3. Lee, C. Gender, Health and Health Behaviors. In J. Chrisler and D. R. McCreary (eds.), Handbook of Gender Research in Psychology. Springer Science, 2010; 20: 471-493.
4. Nathanson, C. Illness and the Feminine Role: A Theoretical Review. *Social Science and Medicine*. 1975;9: 57-62.
5. Verbrugge, L M. Sex Differentials in Health. *Public Health Report*. 1982; 97: 417-437.
6. Stronegger, W J, Freidl, W, Rasky, V. Health Behaviour and Risk Behaviour: Socioeconomic Differences in an Austrian Rural County. *Social Science and Medicine*. 1997;44: 423-426.
7. Uitenbroek, D. G., Kerekovska, A, Festchieva, N. Health Lifestyle Behaviour and Socio-Demographic Characteristics. A Study of Varna, Glasgow and Edinburgh. *Social Science and Medicine*. 1996;43:367-377.
8. Graunt, J. Natural and Political Observations Mentioned in a Following Index and Made Upon the Bills of Mortality. London: Tho: Roycroft, for John Martin, James Allestry, and Tho: Dicas, 1662, London: Martin, Allestry and Dicas.
9. Bertrand, M. New Perspectives on Gender. In O. Ashenfelter and D. Card (eds.), Handbook of Labor Economics 4b, Elsevier Ltd. 2010: 1545-1592.
10. CIA factbook, 2011. https://www.cia.gov/library/publications/the-world-factbook/index.html
11. Snow, John (1855). On the Mode of Communication of Cholera (2nd ed.). London: John Churchill.
12. Dimick J B, Ryan A M. Methods for evaluating changes in health care policy: the difference-in-differences approach. *JAMA*. 2014; 312(22):2401-2. doi: 10.1001/jama.2014.16153.
13. Vaccarino V, Parsons L, Every NR, Barron HV, Krumholz HM.; National Registry of Myocardial Infarction 2 Participants. Sex-based differences in early mortality after myocardial infarction. *N Engl J Med*. 1999;341(4):217-225.

14. Vaccarino V, Krumholz HM, Yarzebski J, Gore JM, Goldberg RJ. Sex differences in 2-year mortality after hospital discharge for myocardial infarction. *Ann Intern Med.* 2001;134(3):173-181.
15. Canto JG, Rogers WJ, Goldberg RJ, et al. Association of Age and Sex With Myocardial Infarction Symptom Presentation and In-Hospital Mortality. *JAMA.* 2012;307(8):813-822. doi:10.1001/jama.2012.199.
16. Welch GH, Sharp SM, Gottlieb DJ, Skinner JS, Wennberg JE. Geographic Variation in Diagnosis Frequency and Risk of Death Among Medicare Beneficiaries. JAMA. 2011;305(11):1113-1118. doi:10.1001/jama.2011.307
17. Case A, Paxson C. Demography. 2005 May;42(2):189-214. Sex differences in morbidity and mortality.
18. Singh-Manoux A, Guéguen A, Ferrie J, Shipley M, Martikainen P, Bonenfant, S, Goldberg M, Marmot, M Association Between Morbidity and Mortality Among Middle-Aged Men and Women Am J Public Health. 2008; 98: 2251–2257.
19. Avdic D, Johansson P. Absenteeism, Gender and the Morbidity–Mortality Paradox. *Journal of Applied Econometrics*. 2017; 32: 440-462.
20. Every N R, Spertus J, Fihn SD, Hlatky M, Martin JS, Weaver WD. Length of hospital stay after acute myocardial infarction in the Myocardial Infarction Triage and Intervention (MITI) Project registry. *J Am Coll Cardiol.* 1996;28(2):287-93.
21. Kinjo K1, Sato H, Nakatani D, Mizuno H, Shimizu M, Hishida E, Ezumi A, Hoshida S, Koretsune Y, Hori M; Osaka Acute Coronary Insufficiency Study (OACIS) Group. Predictors of Length of Hospital Stay After Acute Myocardial Infarction in Japan. *Circ J.* 2004; 68: 809– 815.

Legends Figures

Figure 1. Number of days of absence for men and women before and after a (first) hospital admission for the population of employed (prior to the hospital admission) individuals 40-59 years of age in 1993 to 2004. Left panel average. Right panel conditional on a cancer, myocardial infarction, musculoskeletal and mental diseases.

Figure 2. Five-year mortality risk for men and women after a hospital admission by diagnosis category for the population of employed (before the hospital admission) individuals 40-59 years of age in 1993 to 2004.

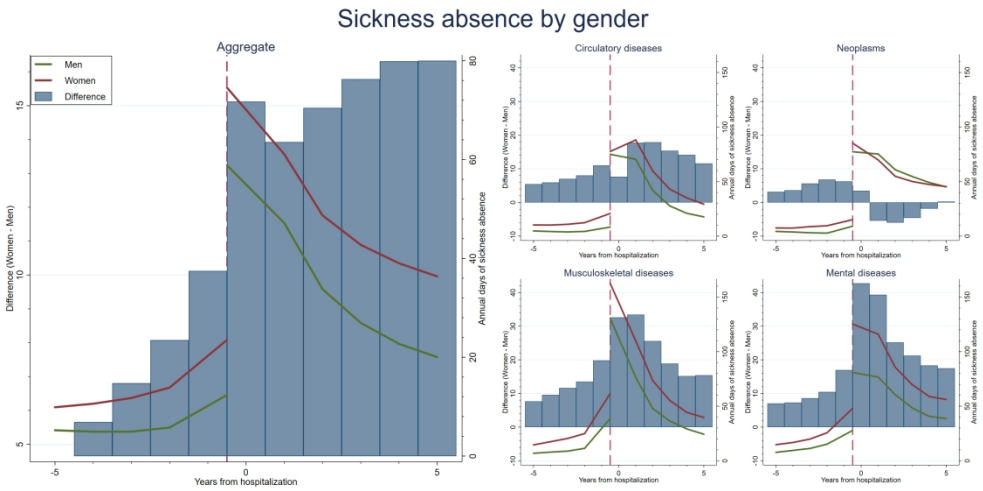

Figure 1. Number of days of absence for men and women before and after a (first) hospital admission for the population of employed (prior to the hospital admission) individuals 40-59 years of age in 1993 to 2004. Left panel average. Right panel conditional on a cancer, myocardial infarction, musculoskeletal and mental diseases.

254x127mm (300 x 300 DPI)

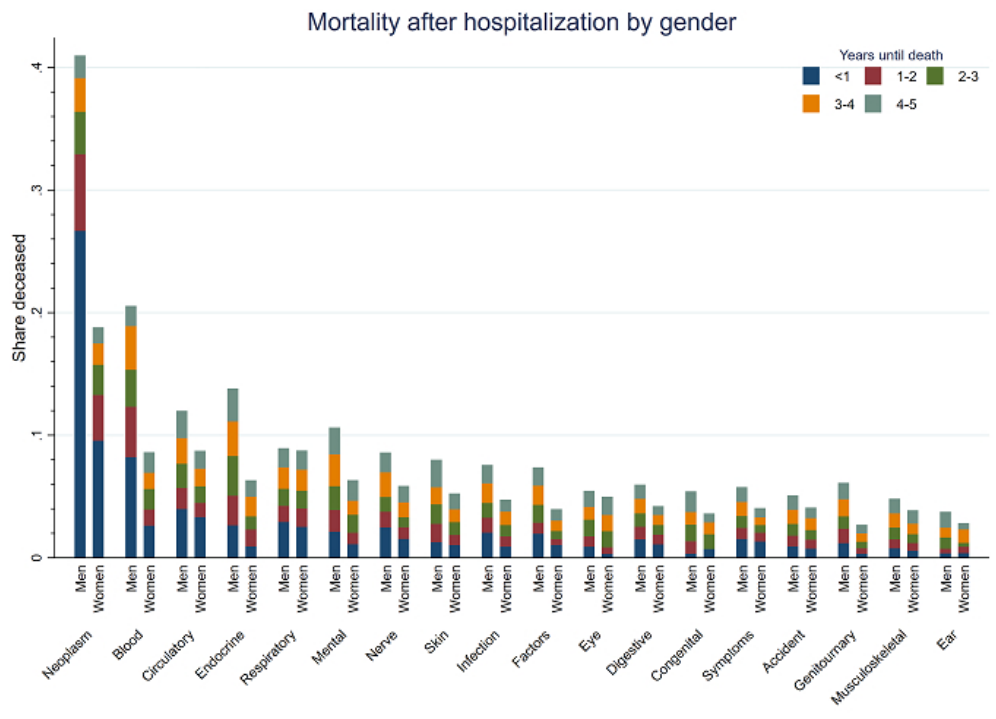

Figure 2. Five-year mortality risk for men and women after a hospital admission by diagnosis category for the population of employed (before the hospital admission) individuals 40-59 years of age in 1993 to 2004.

57x42mm (300 x 300 DPI)

Appendix: Descriptive statistics

Table 1: Sample summary statistics

	(1) Total	(2) Male	(3) Female
Age 40-44	46,581	22,778	23,803
Share of total	0.200	0.098	0.102
Age 45-49	57,069	27,654	29,415
Share of total	0.245	0.119	0.127
Age 50-54	66,545	32,701	33,844
Share of total	0.285	0.140	0.145
Age 55-59	63,079	32,297	30,782
Share of total	0.269	0.138	0.131
Total	233,274	115,430	117,844
Share of total	1.000	0.495	0.505

30 percent random sample of the population of employed individuals 40-59 years of age in 1993 who were hospitalized at some point between years 1994-2004.

Table 2: Sample summary statistics

	Hospitalized Men		Hospitalized Women		Non-hospitalized Men		Non-hospitalized Women	
Variable	(1) mean	(2) sd	(3) mean	(4) sd	(5) mean	(6) sd	(7) mean	(8) Sd
Age	52.477	7.195	51.906	7.078	51.571	7.662	52.161	7.826
Earnings	6.845	5.152	4.694	2.732	7.497	6.166	5.035	3.319
Non-labor income	3.741	29.641	4.535	19.479	4.041	30.506	5.028	25.609
Household earnings	10.586	30.201	9.230	19.799	11.538	31.264	10.062	25.987
Infection	0.024	0.154	0.019	0.138				
Neoplasm	0.062	0.242	0.175	0.380				
Blood	0.003	0.056	0.007	0.084				
Endocrine	0.019	0.138	0.025	0.155				
Mental	0.041	0.199	0.030	0.169				
Nerve	0.026	0.159	0.020	0.139				
Eye	0.013	0.115	0.011	0.104				
Ear	0.014	0.118	0.013	0.114				
Circulatory	0.186	0.389	0.088	0.284				
Respiratory	0.048	0.213	0.041	0.198				
Digestive	0.125	0.331	0.110	0.313				
Skin	0.008	0.090	0.007	0.085				
Musculoskeletal	0.082	0.275	0.080	0.271				
Genitourinary	0.049	0.216	0.131	0.338				
Congenital	0.003	0.050	0.004	0.059				
Symptoms	0.145	0.352	0.116	0.320				
Accident	0.123	0.328	0.092	0.289				

Factors	0.028	0.165	0.032	0.176		
# Individuals	115,430		117,844		205,762	198,992

30 percent random sample of the population of employed individuals 40-59 years of age in 1993 who were hospitalized at some point between years 1994-2004 and not-hospitalized during the same period. Earning and Non-labor income and both measure as price base (PBA) amounts in 1992 (one PBA is 33,700 SEK (= £2,9452 in December 2018)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	Longitudinal data at the individual level and using a difference-in-differences design for the analysis on sickness absence (before and after a hospital admission)..
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1	Women increase their sickness absence by around five more days per year than the males (95% confidence interval 5.25 to 6.22 (mean) and 4.66 to 5.60 (zero)). At the same time men have higher risk of mortality for the eighteen diagnosis categories analyzed.
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2	The global average gender difference in life expectancy was about four years in 2010 and has been persistently so for a long time [3]. This has led some scholars to label the relationship the morbidity-mortality or gender paradox [4].

Objectives	3	State specific objectives, including any prespecified hypotheses	1	To analyze if gender-specific health behavior can be one explanation why women outlive men while at the same time have worse morbidity outcomes, known as the morbidity-mortality or gender paradox.
Methods				
Study design	4	Present key elements of study design early in the paper	4	The difference-in-difference design allows us to adjust for unobserved confounders of importance for sickness absence that may differ between men and women before the admission to the hospital
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2-3	Our empirical analysis exploits micro-data originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. Sweden
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	2-3	The data on socioeconomic variables covering the entire Swedish (16-65) population for years 1993-2004 were

		Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants		obtained from Statistics Sweden
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3	The information about sickness absence covers all individual spells of paid sick leave from the statutory sickness insurance in Sweden. The diagnoses, are made at discharge by the responsible senior consultant and classified according to the World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD-10).
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*3*	Information on sickness absence were obtained using a register at the Swedish Social Insurance Agency. Data on discharge diagnosis was obtained from the National Patient Register covers all inpatient medical contacts in public hospitals at the Swedish National Board of Health and Welfare.
Bias	9	Describe any efforts to address potential sources of bias	3-4	In the analyses we made use of

				regression analysis and adjusted for age in years, level of education (three levels; less than secondary, secondary and post-secondary), own and spousal earnings and a factor for whether the individual or the spouse had earnings above the sickness insurance cap and factors for year of the admission, occupational sector and disease category. The difference-in-difference design allowed us to adjust for unobserved confounders of importance for sickness absence that may differ between men and women before the admission to the hospital.
Study size	10	Explain how the study size was arrived at	12	No formal sample size calculation was performed. That data from the whole country were used.

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	2-3	Our empirical analysis exploited micro-data originating from administrative population registers on sickness absence, hospitalizations, mortality and socioeconomic variables. The data on socioeconomic variables covering the entire Swedish (16-65) population in the age interval 16-65 for years 1993-2004 were obtained from Statistics, Sweden. These data were linked to information on sickness absence and inpatient care over the same time period using registers at the Swedish Social Insurance Agency and the Swedish National Board of Health and Welfare, respectively.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	3-5	
		(*b*) Describe any methods used to examine subgroups and interactions		
		(*c*) Explain how missing data were addressed		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		
		(*e*) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6	We have included a supplementary table with the number of men and women at different age strata. for potential online publication

		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6	We have included a supplementary table with descriptive statistics for potential online publication.
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		Table1-4
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures		
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		Table 1-4
		(*b*) Report category boundaries when continuous variables were categorized		
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		
Discussion				
Key results	18	Summarise key results with reference to study objectives	13	We found that women extracted relatively more sickness absence and simultaneously had a lower mortality risk than men both before, but in particular after, the hospitalization. This provides strong evidence of more proactive and preventive behavior of women than that of the men.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15	
Generalisability	21	Discuss the generalisability (external validity) of the study results	15	
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based		

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.