# Hospital Readmission and Mortality Among Frail Elderly – The Importance of Spouse and Adult Children

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Working paper

7 - 2015

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ISSN 1503-0946

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Uni Research AS, Bergen

December 2015

**WP 7 – 2015**

# Contents

# 1. Introduction

In many Western societies, the aging of the population puts a strain on health care service delivery and financing. In particular, demand for specialist services attracts attention, as these services are the most costly. Developing adequate treatment at lower levels of care is a challenge, as well as stimulating prevention at different stages of illness; from prevention of incidence to preventing recurring need of hospitalization for those already suffering from an illness. Therefore, in several countries with different health care systems, for instance the USA, UK, Australia, Denmark, Sweden, and Norway, initiatives are taken to improve coordination of services and introduce specific readmission policy (Burgess and Hockenberry, 2014; see references in Grimsmo et al., 2015).

As of January 1 2012, Norway introduced a large health service reform (hereafter «Care Coordination Reform»). The aim of this reform is to promote better integration of care services and primary and specialist health care services, as well as prevention of illness and strengthening of public health efforts. While the reform is clearly motivated by non-pecuniary aspects such as patient involvement and quality of services (less fragmented clinical pathways), one driving force is future health care costs. Two important strategies are to treat more patients in primary health care instead of at hospitals and to have hospitalized patients discharged earlier (Romøren et al., 2011). The Care Coordination Reform does not include elements specifically directed towards informal care provision.[1]

In this analysis, we study how individual patients' outcomes – mortality and readmission – are related to the availability and characteristics of spouse[2] and off-spring (hereafter «family resources»). The analysis focuses on cases where good coordination is of particular importance, namely when a patient is discharged from hospital. Furthermore, it focuses on fragile patients; elderly who have been discharged with specific primary diagnoses (heart attack, heart failure, pneumonia, hip fracture), which are often used in the literature (see for instance Laudicella et al., 2013). Patient health (all-cause mortality) and probability of readmission is investigated within a time frame of 30 days after hospital discharge.

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[1] However, policies have been implemented to support informal care provision, for instance through tax credits in the USA (van Houtven and Norton, 2004). For the Norwegian case, see section 3 below.

[2] The term «spouse» includes cohabitants.

Readmission clearly incurs large costs both to the patient and the society. However, from the perspective of the individual patient's welfare, it is not obvious how readmission should be viewed. It can be an indication of poor hospital treatment, for example, too early discharge, or of poor post-hospitalization treatment, whether care is formal or informal. On the other hand, for fragile patients, there is inherently a high risk of complications, and readmissions may also be viewed as an indication that the health care system is responsive to changes in the medical needs of the individual patient. [3]

In brief, the analysis addresses the following research questions:

i) Do family resources affect mortality and readmission?

ii) Are potential effects of family resources related to the characteristics of spouse and children?

iii) Does the potential effect of relatives vary by patient diagnosis?

iv) Does the potential effect vary by municipality characteristics?

v) Has the association between family resources and patient outcomes changed over time, in particular, from the period before to the period after the Care Coordination Reform?

Our analysis benefits from detailed individual-level registry data over a 5 year period (2009-2013). In light of the selection bias problem in this type of analysis (see sections 2 and 5), it is particularly important to have an extensive set of control variables. We have data on the availability of both spouse and off-spring, as well as their demographic and socioeconomic characteristics. Regarding the patient, we also benefit from medical information that indicates health status, both prior to hospitalization and at the time of discharge.

The paper proceeds as follows. Section 2 gives a brief overview of some related literature, followed by a description of the institutional framework in section 3. Our data is presented in section 4, while the empirical specification is outlined in section 5. Results are reported in section 6 and further discussed in section 7, which concludes the paper.

[3] Rate of readmission is often used as an indicator of hospital quality (Laudicella et al., 2013). With the caveat that some readmissions are unavoidable, The Norwegian directorate of health defines low rates of readmission as an indicator of good cooperation for specific primary diagnoses, including heart failure, fractures, and pneumonia (www.helsedirektoratet.no).

## 2. Related literature

The lower mortality of married adults is a well-established empirical finding (see the references in Manzoli et al., 2007; Rendall et al.; 2011). However, it is not clear that an estimated association between family resources and the elder's health or health care use can be given a causal interpretation. The concern is to what extent this stylized fact is because of health-related selection in the marriage market and in fertility, as opposed to a causal, protective effect of spouse and off-spring. Such an effect could arise through the provision of social/economic support, better health behavior, or the absence from the stress of bereavement or marital dissolution (see Manzoli et al., 2007). Similarly, family resources can impact on the use of health care. The input of time and effort of spouse and off-spring may complement or substitute for formal care (van Houtven and Norton, 2004; Bonsang 2009). Spouse and adult children may be a source of knowledge about the disease and treatment and may be good advocates for the elder, securing him/her more or better quality formal care than would be offered otherwise (ibid).

The health economics literature on the impact of informal care on formal health care use is limited. It emerged as survey data became available on time input from informal care, focuses on informal care provided by adult children, and is in most cases restricted to single elderly. Regarding services that require relatively low levels of formal qualifications (labelled «formal home care», «paid domestic help», «home health care» by the authors cited), informal care are found to be substitutes for formal care (Bolin et al. (2008a); Bonsang(2009); van Houtven and Norton(2004)). Van Houtven and Norton (2004) found the same result for use of nursing home and doctor visits, while informal care was found to be complementary to outpatient clinic visits. Regarding the probability of hospitalization, results are more mixed: Bolin et al. (2008a, on SHARE data) found that informal care is a complement to hospital visits, while van Houtven and Norton (2004, on US data) and Weaver and Weaver (2014, on Swiss data) did not detect any statistically significant association between informal care and hospitalization.[4] Regarding length of stay (conditional

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[4] Weaver and Weaver defined the key explanatory variable as availability of informal care, not time input reported. They included the spouse, or any other adult co-residing with the elderly, as potential care-givers.

[4] Iwashyna et al.(2003), using Medicare claims data, compared readmission within 14 days among married and widowed hospitalized elderly, and found no difference between the two groups. The medical literature on the relationship between readmission and marital status or social support is substantial and outside the scope of this report.

on hospitalization), van Houtven and Norton (2004) and Weaver and Weaver (2014) found informal care to be a substitute to hospital nights, whereas the relationship between informal care and length of stay was insignificant in Bolin et al. (2008a).

Our analysis diverts from the studies mentioned above in several ways. It addresses both health outcomes and use of health care services. While the surveys in question intend to be representative of the general population of elderly, this analysis focuses on frail elderly and their outcomes shortly after hospitalization. Thus, the health care use of interest it is not hospitalization per se but readmission. Having access to individual-level registry data of the whole population, we avoid the potential problems of health-related non-response inherent in survey data. Moreover, a beneficial aspect of our data set is that it covers five years. Several analyses have concluded that excess mortality of non-married or never-married individuals has increased over time (Berntsen, 2011; Kravdal and Syse, 2011). One suggested mechanism behind this trend is the introduction of more complex treatments which makes having a spouse more important (Kravdal and Syse, 2011). Furthermore, the Care Coordination Reform which was launched within the period studied, may have affected the role and importance of spouse and children.

We study how the availability of family resources relates to mortality and readmission, not the actual time input. As is known from the literature, the spouse is an important care provider for elderly couples (for example, Lakdawalla and Philipson. 2002, find that spouses are willing and able to take care of each other, except in the most severely disabled cases), and adult children play an important role in informal care as well (Bonsang, 2009; Charles and Sevak, 2005). Indeed, for frail elderly who are married, the primary caregiver is usually the spouse (OECD, 2005; Kalwij et al., 2014). In an international, even European perspective, Nordic countries are characterized by a large formal health care sector. Scandinavian countries have been referred to as 'weak-family-ties countries' compared to Southern European countries (see references in Bolin et al., 2008a). Still, analyses indicate that adult children are indeed engaged in caring for their parents. The costs of such care in terms of foregone labour-market opportunities vary between European countries (Bolin et al., 2008b). Analyses based on Norwegian administrative registry data show that care for elderly parents affect the labour supply of adult children in general (Løken et al., 2014) and particularly when the parents are in the terminal phase (Fevang et al., 2012). Caregiving for elderly was found to be related to poorer self-reported health and higher sickness absence among full-time working adult children (Ugreninov, 2013).

## 3. Institutional framework

Within Norwegian health policy, the declared aim is equal access to services independent of factors like the patient's income and place of residence (the Patients' Rights Act, www.lovdata.no). Primary and secondary care face different systems of laws and regulation and financing, which clarifies the division of labour within the health care sector. This division also implies that they sometimes face opposite incentives, which complicates coordination and integration of care (Grimsmo et al., 2015).

The Norwegian health care system is characterized by a large element of public ownership and provision of services. All emergency hospital treatment is carried out at public hospitals and free-of-charge at the point of usage. The Norwegian hospital sector is organized in four state-owned health regions which are divided in 17 health trusts which own and administer hospitals. Thus, while the majority of specialist services are provided by the state, primary care is the responsibility of Norway's 428 municipalities, which differ profoundly, for instance in terms of number of inhabitants and population density. Primary care for elderly includes family doctors/GPs, emergency care, habilitation and rehabilitation services, home care and home nursing, and nursing homes.

Norwegian public hospitals are financed by a combination of activity-based funding and block grants. Activity-based financing is a system where hospitals are remunerated based on how many patients they treat, within categories called Diagnosis Related Groups (DRG), where each DRG is given a certain number of DRG points. As part of the state budget, a price set for each DRG point. Norwegian municipalities, on the other hand, get their main income from taxes (income and property) and state transfers. These revenues are spent on a wide range of services, for example, mandatory education, local roads, home care, nursing homes, and primary health care. For a description of the Norwegian health care system, see Romøren et al. (2011).

The Care Coordination Reform was launched January 2012 with the aim to strengthen prevention of disease and early intervention, better clinical pathways and more treatment at municipal level instead of at hospital/specialist level. Although the reform had several elements, its main tools for achieving better coordination and integration are economic incentives. Municipal co-payment was introduced to facilitate cost-effective services of good quality. Co-payment amounted to 20 per cent of the DRG price and concerned all medical DRGs, whether inpatient, outpatient or day treatment. Surgical DRGs were exempted as well as births, some rare and expensive treatments, and treatment at private outpatient clinics (for further details, see Askildsen et al., 2015). Municipalities were compensated for the stipulated co-payment cost, as funds were transferred from hospital to municipal budgets. Co-payment was abolished in 2015, but was in effect the two last year of our study period, 2012 and 2013. Another economic incentive – relevant for all diagnoses - was a fee that municipalities had to pay for patients who stayed in hospital even though the hospital assessed they were ready to discharge. This penalty fee was NOK 4000 per diem, irrespective of DRG. It lead to a substantial decrease in the number of days patients ready to be discharged stayed at hospital, both for the population of hospitalized patients at large and for specific groups (Melberg, 2014; Grimsmo 2013; Hagen et al., 2013).

In addition to economic incentives, the Care Coordination Reform includes legal means, in that agreements between health trusts and municipalities were made mandatory. However, these agreements were to a large extent standardized across municipalities (Kirchhoff et al., 2015) and therefore cannot explain geographical variation in outcomes. As part of the reform, municipalities were mandated to establish pre-hospital low threshold wards in primary health care by 2016, and were given allowances from central government to finance this. By 2013, few beds/spots were in place and they had a poor rate of utilization.

For the provision of informal care, labour market arrangements are potentially important. The labour force participation is high in Norway, both among men and women. By 2011, seventy-two percent of men and sixty-seven percent of all women aged 15-74 years were employed (http://www.ssb.no/befolkning/statistikker/fobsysut). Working-part-time is common among women, although more women work full-time after the pension reform in 2011. For both genders, labour force participation has increased in the age group 60+, especially for individuals aged 62-65 (Claus et al., 2015).

If a spouse or parent is ill, Norwegian social security and working life legislation gives adult children certain rights. If approved by the municipality, spouse or adult children may be remunerated for taking care of elderly who would otherwise receive municipal health care («omsorgsløn», lov om sosiale tjenester).In the elderly's terminal phase, spouse or adult children may get «pleiepengar» (Care allowance) from The Norwegian Labour and Welfare Administration to compensate for loss of labour income (www.nav.no). The maximum period of compensation is 60 days, it can be split into several intervals and divided between several care-givers. In Norway, sickness absence allowance is generous, with 100 % compensation from the first day of absence. The cause of absence should be medical reasons. Uncertified absence because of care for sick children is permitted up to a limit, but not care for elderly parents/spouse. Still, it probably takes place, to some extent. Employed individuals are entitled to ten days leave every calendar year to give care to close adult family members, for instance spouse or parent («omsorgspermisjon», Arbeidsmiljølova § 12-10 2.ledd). The loss of labour income will not be compensated for by social insurance, but may be covered by the employer, often through collective agreements.

The development within care services gives reason to believe that spouse and adult children have become more important as care-givers. In an article discussing the development of municipal home care and nursing care 1994-2013, the author notes three main trends: *i)* There are fewer living in institutions, more in private homes, *ii)* The growth in home care and nursing care has been stronger than in spots in institutions, services have become more health-related rather than related to practical tasks, *iii)* Services to younger individuals have grown more than services to the elderly (Otnes, 2015).

# 4. Data and descriptive statistics

Several datasets are used in this analysis. First, the Norwegian Patient Register (NPR) gives information on each visit at a hospital or an outpatient clinic. The data provide the patient's date of admission and discharge from the hospital or the outpatient clinic, gender, municipality of residence, main and secondary diagnoses, the place where the patient was admitted from and discharged to (for example private home, institution, etc.), type of admission (emergency or planned), health trust, etc. Through the patients' unique identification number the patients can be linked to other Norwegian registry data from Statistics Norway, which provide more patient characteristics, such as date of birth and possibly date of death, education, and income, as well characteristics of the patient's spouse and children, including their age, gender, education, municipality of residence and income. Finally, we use the Norwegian municipality-state reporting from Statistics Norway (KOSTRA), which provides information on a wide range of municipality characteristics, such as health care expenditure and personnel resources.[5]

**Sample selection criteria**

Our sample covers the period 2009-2013, that is, three years before and two years after the Care Coordination Reform. We perform the analysis based on patients aged 70 and above, and focus on four main diagnoses: heart attack, heart failure, pneumonia, and hip fracture.[6] These diagnoses are very common reasons for hospital admission among elderly patients; together they represent about 29% of all emergency hospital admissions of patients aged 70 and above. Our descriptive data show that they are also among the most severe in terms of high in-hospital as well as post- hospitalization mortality (not reported here). These diagnoses are also commonly used in various quality indicators in the literature (see www.helsenorge.no.)

In order to study post-hospitalization outcomes, we need to define the index hospitalization. It is defined as the first acute hospital admission for a given diagnosis in a given year, lasting

[5] The analysis applies 2014 municipality structure, i.e., two municipalities which were merged with other municipalities in the period 2009-2013 are registered by their new number during the whole period.

[6] The ICD-10 codes for the diagnoses used in the analysis are as follows: Heart attack I21, heart failure I099, I119, I130, I132, I255, I420, I971, I425, I426, I427, I428, I429, I43, I50, J81, pneumonia J12-15, hip fracture S720-722. The codes for the diagnoses agree with the codes used by Norwegian Directorate of Health (www.helsenorge.no).

more than one day, under the restriction that the patient could not be hospitalized for the same diagnosis in the previous twelve-month period. Samples are first generated for each year and each diagnosis separately and then pooled across years and diagnoses (thus, the same patient can emerge in the dataset multiple times. We will treat such observations as independent). The sample is restricted to patients coming from private homes or from emergency primary health care, since spouse/adult children are hypothesized to have a lower impact on patients who stay at institutions. Since we study post-hospitalization outcomes, patients who are not alive at the time of discharge are excluded. Observations with missing data on some of the characteristics used in the analysis and patients discharged after December 1st 2013 (for whom the outcome within 30 days after hospital discharge is not observable) are excluded. With these restrictions, our sample for analysis includes 97,920 observations of inpatients.

*Dependent variables*. Our two dependent variables are mortality and of readmission within 30 days after hospital discharge. Readmission is defined as acute, all-cause hospitalization that takes place between 1 and 30 days after hospital discharge. Following The Norwegian Directorate of Health, we exclude hospitalization due to some specific diagnoses, such as accidents, cancer, and poisoning (ibid)[7]. When estimating readmission, we restrict the sample to patients who were at risk of readmission the whole post-hospitalization period; therefore, patients who died within 30 days after discharge are excluded. Thus, the sample used for estimating readmission includes 91,446 observations.

*Explanatory variables*. Our two variables of prime interest are: (1) *has spouse*, an indicator variable for whether a patient has a spouse (who is alive at the time the outcome is measured); and (2) *has child*, an indicator variable for whether a patient has at least one child. Unfortunately, because of data limitations we cannot be certain that the spouse lives in the same household as the patient. This limitation may result in underestimated coefficients on *has spouse* since a spouse who does not live in the same household as the patient (but, for example, lives at an institution) is believed to have a lower impact. Due to

[7] The complete list of ICD-10 diagnoses excluded from the definition of readmission is as follows: C, D00-09, D37-48, V01-Y98, T (except for T40-50, 80-89), Z (except for Z03, 42, 47-48, 54, 74-75).

data limitations we are not able to distinguish between widow(er)s, divorced, and never-married.[8]

Other explanatory variables include patient characteristics, such as age (level and squared), gender, education (in three levels: compulsory, intermediate and tertiary)[9], income (sum of employment income, capital income, taxable and tax-free transfers received during the calendar year), and the main diagnosis. Family resources might be positively correlated with patient's unobserved health. This correlation would overstate our effect of interest if patients with spouse/adult children have indeed lower probability of death and readmission in general, irrespective of receiving home care and assistance from their relatives. Hence, it is important to control for patient's general health status, both before and during index hospitalization. We, therefore, generate a set of control variables in order to capture patient's health status one year before the index hospitalization, such as number of elective/emergency visits at outpatient clinic, and length of elective/emergency stay at hospitals. Characteristics of the index hospitalization itself include the length of stay, whether the patient was discharged to home or to an institution, dummies for number of co-morbidities, and health trust. We also include controls for the year, month, and day of week the patient was admitted to hospital. The day of week serves as a proxy for *days at hospital before treated*, since weekends might be less convenient days for admissions. In addition, we include the following municipality characteristics among our control variables: municipality size, net expenditure on care services, percentage of man-labour-years with professional health care education above upper secondary level, coverage of institution and rehabilitation slots, number of physician and physiotherapist hours in nursing homes, and the rate of sick leave. **Table 1** provides an overview and definitions of the patient and municipality characteristics used in the analysis.

To be able to analyse whether patient's health outcome varies by spouse characteristics, we include the following information: the spouse's age (level and squared), education (three

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[8] The dummy for whether the elder person is married or not is based on yearly data from 2007 onwards. «Non-married» is a residual category.
[9] For a detailed definition of the three educational levels, see http://www.ssb.no/a/english/publikasjoner/pdf/nos_c751_en/nos_c751_en.pdf.

categories), income, and whether the spouse has education related to the health care sector. This latter variable possibly increases the impact of the spouse's role as a caregiver.

For analogous reasons we include children characteristics. Since one patient can have more than one child, we have to decide which child's characteristics to include, as including all children's characteristics would be overwhelming, and including averages might not be representative. We believe the most representative would be to include the characteristics of the child who has the greatest probability of being the main care provider. To maximize this probability, our first criterion is geographical proximity (on municipality level). If several adult children live equally close, we choose the oldest daughter. In case of no daughter, we choose the oldest son, and if more than one child fits the criteria, for example, in case of twins, we choose the first one in the data. The reason for this selection criterion follows the findings in empirical studies; for example, Horowitz (1985) find that sons provide less care to their parents than daughters do, and that sons tend to become a caregiver only in the absence of an available female sibling. A more recent study confirms that women are more likely to be main caregivers than men (Carmichael and Charles, 2003). Children characteristics are number of siblings, whether any of the children have education from the health care sector, the reference child's gender, age, education, income, and whether the reference child resides in the same municipality (about 78 % do). The latter variables are proxies for the opportunity cost of providing care. **Table 2** gives an overview and definitions of the spouse and children characteristics used in the analysis.

**Descriptive statistics**

[**Table 1**]

As shown in **Table 1**, there are fewer men than women in the sample (43 percent), probably due to lower life expectancy. The average patient age is 83 years. Most patients have compulsory education only (43%), only 11% have tertiary education. The average length of stay of the index hospitalization was seven days. About half of the patients were discharged to home, and they had on average three co-morbidities.

[**Table 2**]

From **Table 2** we learn that spouses are on average younger and somewhat more educated than the patient sample (which includes patients without spouse or children). Ten percent of spouses have education in the health care sector. Provided that patients have at least one child, they have on average 2.6 children, and the reference child is mostly female (59%), and aged about 53. The reference children have on average higher education and income than the average patient, and 78 % of them live in the same municipality as their parents. Within the group of siblings, there is a 25% chance of at least one child having an education in the health care sector.

[**Table 3**]

**Table 3** describes our key explanatory variables; family resources. About 38% of the patients have a spouse and most patients (84%) have at least one child. Out of the four possible categories, the largest category is patients without a spouse but with children (49 %). About 13% have neither spouse nor children. The shares differ by gender; women are less likely to have a spouse (22% have a spouse as opposed to 60% for men), which is in line with the fact that women live longer. However, both genders are similarly likely to have children.

[**Table 4**]

**Table 4** describes the outcome variables and patient characteristics by the availability of family resources. In the raw data, the general picture for mortality is that patients with more family resources have on average lower mortality. For readmission, on the other hand, patients with more family resources have higher average readmission rate. When we look at the composition of the subsamples, men are more likely to have a spouse (we already saw this pattern in Table 3). By construction, patients whose spouse and child are alive are themselves on average younger, and they are somewhat more educated and with higher income. The same holds for patients with spouse only. However, these younger subsamples («only spouse» and «both») score unfavourably on use of specialist health services the year before the current hospitalization. This may reflect that patients who have survived till high ages are positively selected. Younger subsamples have on average a shorter index hospitalization stay, and they are more likely to be discharged to their home, which is either an indication of a better post-hospitalization health status or the fact that the hospital takes into account the patient's access to family resources when deciding length of stay and discharge destination. These composition differences will be taken into account in the regression analysis.

[Table 5]

Table 5 presents how outcome variables differ by gender and diagnosis. The overall mortality is 6.6%. As expected, the mortality for men is higher than for women. Heart attack has the lowest mortality rate and pneumonia the highest. The readmission rates are in general much higher; 21.3% for the whole sample. The probability of readmission is higher for men. There is also a large variation in the readmission rate for different diagnoses: while the readmission rate for hip fracture patients is 14 %, it is 39 % for heart attack patients.

Since we are interested in trends in our outcome variables, and municipalities are the main provider of primary care, we also inspect how the municipal care sector has developed. Appendix Table A1 provides a comparison of the municipality characteristics over time. *Care services* and *slots in institutions* are quite stable in time, while other variables increase steadily increase in time, except for *sick leave*, which is decreasing in time. The two variables that display a major change in the time trend after 2012, are *slots in rehabilitation* (a large increase in 2013) and *physician hours* (a large growth in 2012, which continues in 2013).

[Figure 1]

Figure 1 plots the development in the average length of hospital stay, which has been seasonally adjusted for monthly variation. The left panel contains all acutely hospitalized patients in Norway aged 70 and above, excluding patients who were not alive at the time of discharge. First, we see a downward trend. This has also been documented in the literature; for example, Ramm (2013) finds that the length of a hospital stay for patients over 70 has been steadily decreasing in the period 1999–2011 from about 8 days to about 6 days on average. In addition to this general downward trend, we see a rather distinct fall in the length of stay from December 2011 to January 2012 that persists over time. This suggests that the reform might have shortened the average length of hospitalization, which might have affected the importance of family resources after the reform – if elderly patients tend to be hospitalized for shorter periods after the reform, they might be in poorer health at the time of discharge, and the relatives may become more important. The right panel of **Figure 1** shows the average length of stay for the sample used in our analysis of mortality. We note that length of stay is on average higher for our sample than for the whole patient population, which indicates that the patient groups studied are fragile. After the introduction of the reform, the drop in length-of-stay is still distinct, though of a smaller magnitude than for the whole population of acutely hospitalized patients aged 70 and above.

To sum up, the descriptive statistics suggest that family resources are negatively related to mortality, and positively related to readmission. However, these relationships are possibly driven by differences in the sample composition, since the descriptive statistics also indicate that the characteristics of patients with and without relatives differ. In our regression analysis, we will study how the main picture for mortality and readmission changes after controlling for patients' age, socioeconomic and health status and other control variables. The descriptive statistics further suggest a large variation in the outcome variables with respect to gender and diagnosis. We will analyse whether the differences with respect to gender and diagnosis apply as well to the importance of family resources, after controlling for background variables. Finally, the descriptive statistics show a drop in the average length of hospital stay that coincides with the implementation of the reform. We will study whether the reform coincide with changes in the relationship of our interest, between patient's health outcome and family resources.

## 5. Empirical specification

Our interest is in *(i)* the effects of family resources on the probability of death or hospital readmission for elderly patients, after controlling for patient and municipality characteristics; *(ii)* the heterogeneity in these effects with respect to relatives' characteristics; *(iii)* the heterogeneity in these effects with respect to diagnosis; *(iv)* the heterogeneity in these effects with respect to municipality characteristics; and *(v)* whether the Care Coordination Reform impacted these effects. However, identifying effects is difficult primarily since there might be some unobservable characteristics associated with both the patient's health outcome and the family resources. Marital status and parenthood, as well as the survival of spouse and children until old ages, are likely to correlate positively with the overall health status of the patient. Therefore, we face an endogeneity (omitted variable) problem. Finding a valid identification strategy appears to be extremely difficult in this setting, because any seemingly exogenous variation in the endogenous variables *Has spouse* or *Has child* (for instance a war) is likely to have a direct impact on the elderly's health, through his/her own exposure or through bereavement. Since we do not have any instrumental variable or other identification strategy that could solve this endogeneity problem, the estimated parameters below should be considered associations rather than causal effects.

To investigate *(i)* the relationship between family resources and mortality or readmission, we estimate a linear probability model of the following form, using the OLS estimator:

$$Y_i = \alpha_1 + \alpha_2 Has\ spouse_i + \alpha_3 Has\ child_i + \alpha_4 X1_i + \alpha_5 Time_i + \varepsilon_i, \qquad (1)$$

where *i* indexes the elderly patient, *Y* is an indicator variable for whether the patient died or was readmitted to hospital within 30 days from hospital discharge, *Has spouse* and *Has child* are indicator variables for whether the patient has a spouse, and at least one child, respectively. The variable vector *X1* contains an extensive set of control variables for patient and municipality characteristics listed in **Table 1** (in addition to the variables listed there, the vector *X1* includes age squared). The variable vector *Time* captures year, month, and day-of-week fixed effects. Since the dependent variable is a probability, the estimated parameters are measured in percentage points.

The parameters $\alpha_2$ and $\alpha_3$ represent the difference in probability of death/readmission for patients with a spouse or with children, respectively, compared to the baseline category of patients without a spouse or children. If these estimates were to be given a causal interpretation, the identifying assumption would be that patients with and without relatives are otherwise similar on unobservable characteristics, and thus the patients without relatives constitute a valid comparison group to the patients with relatives. Under this assumption, for the mortality outcome, the estimates of $\alpha_2$ and $\alpha_3$ should be negative if we believe that close relatives provide home care that decreases the probability of the elderly patient's death. For the readmission outcome, the prediction is less straightforward. The home care provided by the relatives can decrease the probability of readmission, which would be reflected in negative estimates of $\alpha_2$ and $\alpha_3$, while the role of the relatives as advocates for patient's needs can, in fact, increase the probability of hospital readmission, which would imply positive estimates of $\alpha_2$ and $\alpha_3$. We suspect that the endogeneity of the *Has spouse* and *Has child* variables leads to downwards biased estimates of $\alpha_2$ and $\alpha_3$ since readmission and mortality should be negatively correlated with true (unobserved) health which is, in turn, assumed to be positively correlated with family resources. Controlling for variables such as patient's background characteristics, patient's health status, and characteristics of the index hospitalization reduces the endogeneity problem of the *Has spouse* and *Has child* variables. Although the bias is probably not eliminated, the estimates provide valuable insights into health and health care outcomes of frail elderly.

Similarly, our controls for municipality characteristics might not capture all relevant differences across municipalities. If some unobserved municipality characteristics have independent influence on patients' health outcomes and are as well correlated with our variables of interest, our estimates of parameters of interest will be biased. Therefore, we also employ an alternative specification to (1), where we include municipality fixed-effects. In this way, all time-invariant municipality characteristics will be controlled for. We find that results are very robust to this specification and that such municipality characteristics impose only a minor bias to our estimates (results not reported).

To study (ii) how the spouse's characteristics influence the relationship between the patient's health outcomes and family resources, we estimate separately for elders who have a spouse and augment model (1) with spouse characteristics, denoted *Spouse char*, see model (2a) below. The influence of children's characteristics, *Child char*, is analysed in a similar way, on the subsample of elders who have children, see model (2b):

$$Y_i = \beta_1 + \beta_2 Spouse\ char_i + \beta_3 Has\ child_i + \beta_4 X1_i + \beta_5 Time_i + \mu_i, \qquad (2a)$$

$$Y_i = \lambda_1 + \lambda_2 Child\ char_i + \lambda_3 Has\ spouse + \lambda_4 X1_i + \lambda_5 Time_i + v_i, \qquad (2b)$$

Spouse's and children's characteristics contain variables listed in **Table 2** (plus age squared). As before, *X1* contains patient and municipality characteristics (those listed in **Table 1**, plus age squared), and vector *Time* contains year, month, and day-of-week dummies.

To study *(iii)* how the relationship between the patient's health outcomes and family resources varies by diagnosis, we estimate model (1) on subsamples split by diagnosis and study how the sign and significance of the estimated coefficients vary among those subsamples.

To evaluate *(iv)* the changes in the relationship of interest according to municipality characteristics, we define municipality characteristics as explained below and interact each relevant municipality characteristic *m* with our key explanatory variables, as follows:

$$Y_i = \gamma_1 + \gamma_2 Has\ spouse_i + \gamma_3 Has\ child_i + \gamma_4 Mun\ char_{im} + \gamma_5 (Has\ spouse_i \times Mun\ char_{im}) + \\ + \gamma_6 (Has\ child_i \times Mun\ char_{im}) + \gamma_7 X1_i + \gamma_8 Time_i + \varsigma_i. \qquad (3)$$

Thus, we estimate separate equations for each municipality characteristic *m*. $Mun\ char_m$ is an indicator variable that represents the high or low level of the relevant municipality characteristic *m*. For example, if we want to evaluate whether having a spouse in large municipalities differs from having a spouse in small municipalities then *Mun char* will be one for large municipalities and zero otherwise. We choose to analyse the following municipality characteristics: care services expenditures, share of personnel with above upper secondary professional education, share of slots in institutions, and municipality size. For each of these characteristics we create an indicator variable $Mun\ char_m$, which is equal to one for municipalities above the median and zero for municipalities below the median in the given characteristic. For municipality size, we define 5,000 and 20,000 inhabitants as cut-off values. If the relevant municipality characteristic is important, the estimated coefficient $\gamma_5$ should be significantly different from zero.

To evaluate *(v)* whether the Care Coordination Reform influenced the relationship between family resources and patient outcomes, we augment model (1) with interaction terms between the indicator variables for having a spouse/children and the set of year dummies *Year*:

$$Y_i = \delta_1 + \delta_2 Has\ spouse_i + \delta_3 Has\ child_i + \delta_4 (Has\ spouse_i \times Year_i) + \\ + \delta_5 (Has\ child_i \times Year_i) + \delta_6 X2_i + \delta_7 Time_i + \xi_i. \quad (4)$$

In the analysis, we want to exclude explanatory variables that might be affected by the incentives in the Care Coordination Reform. Therefore, the variable vector *X2* contains only pre-determined characteristics, namely the patient's gender, age, age squared, education, log of income, co-morbidity dummies, the main diagnosis, health trust, and municipality size. As before, the variable vector *Time* includes year dummies in level form, in addition to month and day-of-week fixed effects.

In this way, we can evaluate how the importance of family resources changed year by year and whether the results indicate a change after the reform in 2012. An indication of a clear change after the reform, however, does not necessarily have to be a result of the reform, but might be due to other changes in the society that coincide with the reform and that affect the relationship between family resources and patient outcomes. Similarly, no indication of a clear change after the reform does not necessarily imply that the reform did not have an effect, but that the effect could have been offset by other changes in society that took place in the same period. Although it is a strong assumption that the reform is the only change that affects the relationship of interest, we are not aware of any other relevant changes in the Norwegian society that took place in 2012.

In all specifications, the error terms are clustered at the municipality level.

# 6. Results

*Main results*

[**Table 6** Main regression results]

*Family resources.* **Table 6** shows that having a spouse is associated with a significant reduction of 0.4 percentage points (pp) in mortality. Having adult children is strongly negatively associated with mortality as well, with the coefficient of 0.53 pp. Since the overall mean mortality is 6.6 percent in the sample (**Table 5**), the estimated associations are of considerable relative magnitude.

Whereas mortality is negatively associated with having a spouse or a child, the probability of (all-cause) readmission given survival is positively associated. For elderly who have a spouse the probability of readmission is 1.48 pp higher compared to individuals without a spouse, cet. par., and for elderly who have children the probability of readmission is 0.7 pp higher compared to individuals without children, cet. par. The mean frequency of readmission is 21.3 percent, see **Table 5**. Thus, in relative terms, the estimated association with family resources is larger in the mortality regression than in the readmission regression. More important, while family resources are negatively associated with mortality, having spouse or children is positively associated with readmission.

We have also investigated (not reported here) whether having children bears a stronger association with our outcomes for elderly who do not have a spouse, compared to those who have. This could be the case if spouse and children are substitutes in the provision of care. We include an interaction term between *Has Spouse* and *Has Child* in equation (1), and expect it to have a negative sign. The coefficient of the interaction term is negative, as expected, although the estimate is not statistically significant.

*Patient characteristics.* Many of the patient characteristics are highly statistically significant for both mortality and readmission. They all have the expected sign: mortality and readmission are higher among men, and naturally increase in age. We find a negative association between educational level and both mortality and readmission, whereas the estimates for income are statistically insignificant. This might be because pensions do not reflect the economic status of the elderly individuals so well since there is much lower variation in pension income than in labour income. Indicators of patient severity such as use of health care the previous 12 month period and number of co-morbidities show positive associations (if significant).

There is no significant association between the length of stay of index hospitalization and mortality, while for readmission we find a negative, although small association, suggesting that a too short hospital stay can increase the probability of readmission. These findings do not support the endogeneity hypothesis that the patients with long hospital stays are negatively selected with respect to health and thus have a higher risk of dying or readmission. Being discharged to private home has a very large negative coefficient, which supports the argument that hospitals assess the patient's health status before deciding discharge destination[10]. The estimation results for our variables of interest vary with diagnoses. Hip fracture, the base category, has the lowest risk of both mortality and readmission. Hearth attack has rather low risk of mortality, but the highest risk of readmission. The rankings follow the pattern we saw in the descriptive **Table 5**, with the exception that with controls for other patient characteristics, heart attack patients face a higher risk of dying than hip fracture patients. This is most likely because hip fracture patients score relatively unfavourably on some patient characteristics that are associated with mortality, such as high age, low education and income. The health trust appears not to play any significant role (output omitted).

*Municipality characteristics.* For mortality, only care services expenditures are significant at 5% level. The estimated coefficient is positive, reflecting the potential endogeneity of the variable – the municipalities with the highest mortality rates spend the most resources on care services – rather than higher expenditures having a negative effect on mortality. For readmission, larger municipalities appear to have lower readmission rates. The number of slots in institutions is negatively associated with readmission and sick leave positively.

*Time controls.* Mortality appears to be decreasing over time, though not in a steady manner. There are no significant changes in readmission over time. Month of hospitalization does not

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[10] We suspect that the *To home* variable is endogenous; correlated to patient health in a way that is observable to the hospital but not fully captured by the included variables.

appear to be related to the outcome variables, and Sunday appears to be the day with the higher risk of mortality and readmission, at least compared to the days at the beginning of the week.

*Heterogeneity*

*By gender.* Since our explanatory variables of prime interest are related to life expectancy and gender roles within the family, we estimate our main specification separately by gender, as reported in **Table 7**.

[**Table 7**]

From **Table 7** it seems that the negative association between having a spouse and mortality is mostly driven by male patients – having a wife is associated with 0.62 pp lower probability of death, while having a husband does not seem to be significantly associated with lower mortality risk. On the other hand, having children appears to be more important for female patients – 0.9 pp decrease in mortality for females versus statistically insignificant decrease for males.

For readmission, the estimated coefficients on having a spouse are positive and significant for both genders, with a similar size (1.42 pp for women and 1.72 pp for men). Similarly to mortality, having children is more important for women – mothers have 0.93 pp higher chance of readmission (although the estimate is significant at 10% level only), while fathers' chances of readmission are not significantly related to having children. The other explanatory variables display no qualitative differences by gender.

*By diagnosis, age, and number of comorbidities.* Separate estimations by diagnosis reveal large variation, as reported in **Table 8**. To be able to evaluate the relative importance of the estimated coefficients, we include the average mortality and readmission values for each subsample.

[**Table 8**]

Overall, in all cases where the estimates for subsamples are statistically significant, they have the same sign as estimated for the full sample (reported in**Table 6**), although in most cases the estimates are no longer statistically significant. The negative relationship between having a spouse and mortality appears to be driven by the hip fracture patients, who are the only group with a significant estimate. Having a child is significantly negatively associated with mortality only for heart attack patients. Heart attack patients are also the only group for which readmission is positively related to having a spouse, and heart failure patients are the only group for which readmission is positively related to having a child. Family resources appear to be of least importance for pneumonia patients (no statistically significant estimates). We also estimate for subsamples characterized by high patient severity, namely patients aged 80 and above and patients with 3 comorbidites or more. Results are reported in columns 5 and 6, and are qualitatively similar to results for the main sample, with the exception that patients with children do not have a statistically significantly lower probability of readmission.

*By municipality characteristics.*

The relationship of main interest can be influenced by the municipalities' availability of resources. If a municipality has abundant resources (for example, financial resources, highly educated personnel, many available slots in institutions), and formal and informal care are substitutes, then relatives will be less important. Appendix table 2 shows the results from estimating equation (3). We find that the relationship of family resources with mortality or readmission does not differ across the different types of municipalities considered. In other words, the relatives of the patients from municipalities with more resources (or inhabitants) do not seem to be more important for the patients than the relatives of the patients from municipalities with less resources (or inhabitants).

*Spouse and children's characteristics*

Our analysis benefits from a rich set of spouse and children characteristics. Descriptive statistics are found in **Table 2**. **Table 9** reports results from estimating equations (2). The bottom panel of the table reports p-values of the joint significance of all spouse/children characteristics. It shows that taken together, spouse and children characteristics are significant for both mortality and readmission, though spouse characteristics are jointly significant for readmission only at 10% level.

Considering each variable separately, we see that having a spouse with education in the health care sector is the only spouse characteristic that is significant for mortality. The positive sign of the coefficient, however, is surprising. We would expect a negative association with mortality since having relevant knowledge from the health care sector might be useful in providing quality health care to the spouse. For readmission, the only relevant variable is age. The turning point is about 69 years; before this point the relationship is increasing in age, and after 69 years it is decreasing. Therefore, for the large majority of married patients (87 per cent have a spouse aged more than 69); it holds that the older the spouse is, the lower is the probability of readmission. This is consistent with the spouse's advocacy role – aging spouses might be less efficient in advocating the patient's rights, thus readmission is lower.

Looking at children's characteristics, we see that mortality decreases the younger and richer the reference child is, and is lower if at least one of the siblings has an education targeted towards the health care sector. From the readmission regression, we learn that if the child lives close to the elderly, the probability of readmission is lower. These associations are compatible with the child taking a role as caregiver. Note that the gender coefficient is not significant. This is in line with Van Houtven and Norton (2008), who found that sons and daughters are equally effective at providing informal care.

*Change over time*

**Table 10** reports results from estimating equation (3), where columns 1 and 3 estimate equation (3) without the interaction terms. The year coefficients reported in columns 1 and 3 do not indicate any clear trend, in particular, the changes in average mortality from one year to another is jumpy. Regarding the rate of readmission, there were no significant changes in the years 2009–2012, however, 2013 stands out as a year with a higher readmission rate. Overall, there is no indication that the Care Coordination Reform implied a shift in any underlying trend in patient outcomes.[11]

Our prime interest is in whether the relationship between family resources and the outcomes studied has changed over time, see columns 2 and 4. When including the interaction terms between family resources and year dummies, there is no indication that the importance of family resources for mortality changed significantly over time (2010 is the only year when the associations estimated differ from 2009). Regarding readmission, it seems that having a child increases the probability of readmission in the years 2011–2013

[11]For better transparency, we estimate year-by-year changes instead of using a before-after specification which compares the average level three years before to the average level two years after.

compared to the years before. However, this time interval does not coincide with the implementation of the Care Coordination Reform; the largest increase in the association was in 2011, one year prior to the reform.

## 7. Discussion

Our main results are that having a spouse and/or adult child is negatively associated with 30 days' mortality and positively associated with readmission. We have tested these results on a number of subsamples defined by gender, diagnosis, and patient severity. Although much heterogeneity is revealed, there is no statistically significant estimates that conflicts with our main finding. When interpreting these results, the main challenge is to isolate the potential effect of health-related selection into marriage and parenthood from the effect of the relatives' activity or functions. Therefore, we are cautious to note that our results can be biased. Indeed, the regression on in-hospital mortality, reported in appendix **Table A3**, indicate better overall health among patients with spouse/children, independent of post-hospitalization care or advocacy.

Still, we want to point to some indications that selection as mentioned above cannot be the only reason for our results. The sheer fact that the association is of opposite sign (negative for mortality, positive for readmission) indicates that spouse/child must have some role to play. Better unobserved health should imply lower risk of readmission. If spouse/child was totally passive and did not engage in the elder's post-hospitalization health, we would not expect to observe more readmission among patients with a spouse/child. The possibility that care from spouse/child is inherently harmful, seems far-fetched. As has been pointed out in the literature, formal care and informal care may be substitutes. We do not have individual-level data on formal post-hospitalization care received. In principle, it could be that the municipal health care sector overcompensates for the disadvantage of not having spouse/child, making readmission less frequent. This argument does not seem very plausible, since mortality is also higher in the group without relatives. A potential – and more reasonable – mechanism is that a spouse/child monitors the elder's health status or acts as an advocate for the elderly, making a readmission more likely, while also reducing the mortality risk.

This analysis is explorative in nature. A surprising result is the variation according to diagnosis. With the same extensive set of control variables, having spouse and/or children is so much more associated with reduced mortality and increased readmission for heart attack patients than for patients hospitalized with pneumonia. More research is needed to understand this variation.

The role of the health care system in compensating for patients' resources has been questioned in the literature. In contrast to Kravdal and Syse (2011), we do not find that mortality is more closely linked to the availability of relatives in recent years than before. Within the five-year period studied, a large reform was launched in the Norwegian health care and care sectors, which could be expected to impact the importance of relatives for mortality or readmission. In particular, there has been a sharp drop in average length of hospital stay. Although the design of the Care Coordination Reform does not allow an evaluation of its (causal) effect, we find it noteworthy that mortality and readmission seem to be related to family resources in the same way the first two years after as the three years before the reform.

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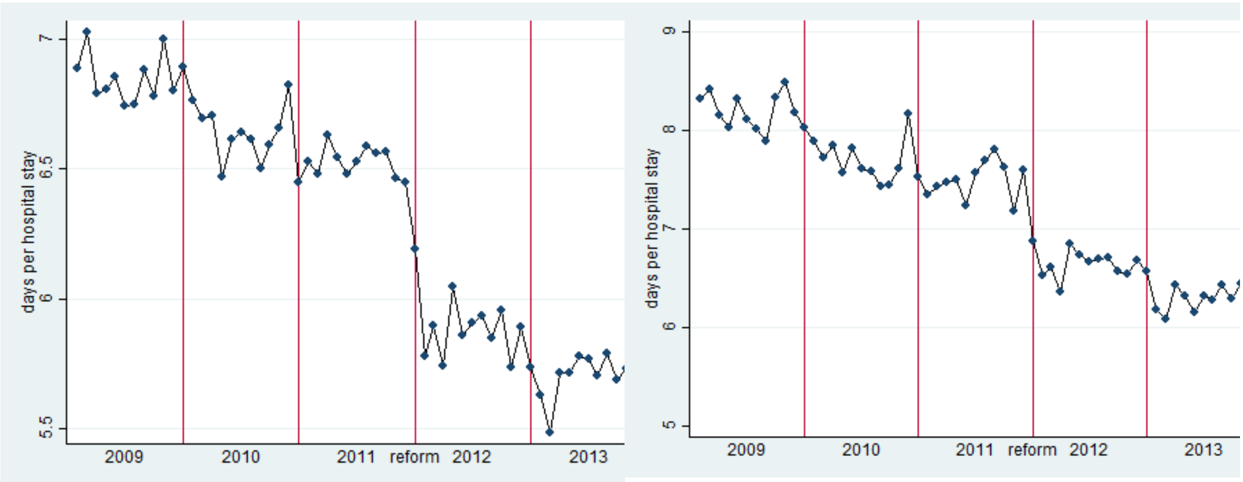
# 9. Figures and tables

**Figure 1** The average length of a hospital stay per month, 2009-2013

All diagnoses　　　　　　　　　　　　Our sample




*Note: The sample used on the left figure contains all acutely hospitalized patients over 70 for any diagnosis, excluding patients who were not alive at the time of discharge. The sample used on the right figure is the sample used in our analysis for mortality. Seasonally adjusted for monthly variations.*

**Table 1** Definitions and descriptive statistics of control variables: patient and municipality characteristics

| Variables | Definition | Mean (s.d.) |
|---|---|---|
| **A. Patient characteristics** | | |
| Male | Gender indicator var., male = 1 | 0.43 (0.5) |
| Age | Age of patient, in years | 83 (6.9) |
| Educ. compulsory | Education indicator var., compulsory = 1 | 0.48 (0.5) |
| Educ. intermediate | Education indicator var., intermediate = 1 | 0.41 (0.5) |
| Educ. tertiary | Education indicator var., tertiary = 1 | 0.11 (0.31) |
| Log income | Log of income | 12.33 (0.63) |
| LOS emergency | Length of emergency stays at hospital the year before | 4.66 (10) |
| LOS elective | Length of elective stays at hospital the year before | 0.95 (4.43) |
| POLY emergency | No. of emergency visits at outpatient clinic the year before | 0.33 (1.25) |
| POLY elective | No. of elective visits at outpatient clinic the year before | 2.03 (3.36) |
| LOS index | Length of stays at hospital for index hospitalization | 6.93 (6.02) |
| To home | Destination indicator var., patient discharged to home = 1 | 0.53 (0.5) |
| Co-morb.=0 | Co-morb. indicator var., no. of co-morb. = 0 | 0.07 (0.25) |
| Co-morb.=1 | Co-morb. indicator var., no. of co-morb. = 1 | 0.16 (0.37) |
| Co-morb.=2 | Co-morb. indicator var., no. of co-morb. = 2 | 0.22 (0.41) |
| Co-morb.=3 | Co-morb. indicator var., no. of co-morb. = 3 | 0.19 (0.40) |
| Co-morb.=4 | Co-morb. indicator var., no. of co-morb. = 4 | 0.14 (0.35) |
| Co-morb.=5 | Co-morb. indicator var., no. of co-morb. = 5 | 0.09 (0.29) |
| Co-morb.=6+ | Co-morb. indicator var., no. of co-morb. = 6 or more | 0.13 (0.33) |
| Hip fracture | Diagnosis indicator var., hip fracture = 1 | 0.30 (0.46) |
| Heart attack | Diagnosis indicator var., heart attack = 1 | 0.21 (0.40) |
| Heart failure | Diagnosis indicator var., heart failure = 1 | 0.19 (0.40) |
| Pneumonia | Diagnosis indicator var., pneumonia = 1 | 0.31 (0.46) |
| Health trust | Set of indicator variables for each health trust (17 categories) | - |
| *Observations* | | *97,920* |
| **B. Municipality characteristics** | | |
| Municip. size | Number of inhabitants, log | 8.6 (1.12) |
| Care services | Net expenditure care services per inhabitant aged 80+, deflated to year 2009 with CPI, log | 12.7 (0.23) |
| Man-labor-years, above upper sec. | Percentage of man-labour-years with professional education above upper sec. level | 29.7 (6.17) |
| Slots in institutions | Slots in institutions per inhabitant 80+, percent | 21.13 (8.72) |
| Slots in rehab. | Slots for (re)habilitation out of all slots in institutions, percent | 7.67 (7.8) |
| Physician hours | Physician hours per week per patient in nursing home | 0.38 (0.19) |
| Physiother. hours | Physiotherapist hours per week per patient in nursing home | 0.34 (0.26) |
| Sick leave | Certified sick leave, percentage of man-labour years | 8.72 (2.14) |
| *Observations* | | *1,780* |

*Notes: The descriptive statistics are calculated for the sample used in the analysis for mortality. The number of municipalities in panel B slightly differs from year to year (from 338 to 389).*

**Table 2** Definitions and descriptive statistics of control variables: spouse and children characteristics

| Variables | Definition | Mean (s.d.) |
|---|---|---|
| **C. Spouse characteristics** | | |
| Age | Age of spouse | 78.0 (7.52) |
| Educ. compulsory | Education indicator var., compulsory = 1 | 0.41 (0.5) |
| Educ. intermediate | Education indicator var., intermediate = 1 | 0.46 (0.5) |
| Educ. tertiary | Education indicator var., tertiary = 1 | 0.13 (0.34) |
| Log income | Log of income | 12.19 (0.81) |
| Health care educ. | Indicator var., spouse's educ. in health care sector = 1 | 0.10 (0.3) |
| *Observations* | | *37,614* |
| **D. Children characteristics** | | |
| No. of children | Patient's number of children | 2.6 (1.27) |
| Male | Gender indicator var., the reference child is male = 1 | 0.41 (0.49) |
| Age | Age of the reference child | 53.2 (7.68) |
| Educ. compulsory | Educ. indicator var., the reference child' educ. is compulsory = 1 | 0.20 (0.4) |
| Educ. intermediate | Educ. indicator var., the reference child' educ. is intermediate = 1 | 0.48 (0.5) |
| Educ. tertiary | Educ. indicator var., the reference child' educ. is tertiary = 1 | 0.32 (0.46) |
| Log income | Log of income of the reference child | 12.75 (1.24) |
| Same municip. | Municip. of residence indicator var., the reference child lives in the same municipality as the patient = 1 | 0.78 (0.42) |
| Health care educ. | Indicator var., at least one child's education in health care sector = 1 | 0.25 (0.43) |
| *Observations* | | *82,471* |

*Notes: The descriptive statistics are calculated for the sample used in the analysis for mortality on patients with a spouse (panel C) or children (panel D).*

**Table 3** Descriptive statistics of family resources: proportion of patients with and without family resources

| | (%) | No children | Has child | *Total* |
|---|---|---|---|---|
| Whole sample | No spouse | 12.8 | 48.8 | *61.6* |
| | Has spouse | 3.0 | 35.5 | *38.4* |
| | *Total* | *15.8* | *84.2* | *100* |
| Women | No spouse | 14.3 | 63.4 | *77.7* |
| | Has spouse | 1.8 | 20.6 | *22.3* |
| | *Total* | *16.1* | *83.9* | *100* |
| Men | No spouse | 10.9 | 29.4 | *40.3* |
| | Has spouse | 4.5 | 55.2 | *59.7* |
| | *Total* | *15.4* | *84.6* | *100* |

*Notes: The descriptive statistics are calculated for the sample used in the analysis for mortality.*

**Table 4** Descriptive statistics of outcome variables and patient characteristics by family resources

| | Mean (s.d.) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | No relatives | | Only child | | Only spouse | | Both | |
| Mortality | 0.084 | (0.28) | 0.071 | (0.26) | 0.065 | (0.25) | 0.052 | (0.22) |
| Readmission | 0.188 | (0.39) | 0.196 | (0.4) | 0.234 | (0.42) | 0.243 | (0.43) |
| | | | | | | | | |
| Male | 0.37 | (0.48) | 0.26 | (0.44) | 0.66 | (0.48) | 0.67 | (0.47) |
| Age | 85.3 | (7.18) | 84.64 | (6.6) | 81.5 | (6.64) | 80.13 | (6.18) |
| Educ. compulsory | 0.53 | (0.5) | 0.52 | (0.5) | 0.43 | (0.5) | 0.41 | (0.5) |
| Educ. intermediate | 0.37 | (0.48) | 0.39 | (0.5) | 0.43 | (0.5) | 0.46 | (0.5) |
| Educ. tertiary | 0.1 | (0.23) | 0.08 | (0.28) | 0.14 | (0.34) | 0.14 | (0.35) |
| Log income | 12.25 | (1.02) | 12.33 | (0.49) | 12.28 | (0.85) | 12.35 | (0.58) |
| LOS emergency | 4.55 | (9.49) | 4.64 | (9.68) | 4.82 | (10.5) | 4.72 | (10.54) |
| LOS elective | 0.75 | (4.14) | 0.83 | (4.01) | 0.96 | (4.69) | 1.18 | (5.) |
| POLY emergency | 0.32 | (1.09) | 0.31 | (1.05) | 0.33 | (1.28) | 0.38 | (1.52) |
| POLY elective | 1.52 | (2.9) | 1.74 | (3.01) | 2.43 | (3.89) | 2.6 | (3.83) |
| LOS index | 7.35 | (6.33) | 7.08 | (6.1) | 6.84 | (6.04) | 6.58 | (5.79) |
| To home | 0.45 | (0.5) | 0.48 | (0.5) | 0.61 | (0.49) | 0.63 | (0.48) |
| No. of co-morb. | 2.92 | (1.76) | 2.97 | (1.76) | 2.96 | (1.76) | 2.92 | (1.77) |
| *Observations* | *12,557* | | *47,749* | | *2,892* | | *34,722* | |

*Notes: The descriptive statistics are calculated for the sample used in the analysis for mortality (only readmission rates are calculated for the sample used in the analysis for readmission).*

**Table 5** Descriptive statistics of the outcome variables, by gender and diagnosis

| (%) | Whole sample | By gender | | By diagnosis | | | |
|---|---|---|---|---|---|---|---|
| | | Women | Men | Hip fracture | Heart attack | Heart failure | Pneu-monia |
| Mortality | 6.6 | 6.1 | 7.3 | 6.3 | 4.9 | 7.2 | 7.7 |
| *Observations* | *97,920* | *55,798* | *42,122* | *29,058* | *20,048* | *18,748* | *30,066* |
| Readmission | 21.3 | 18.9 | 24.5 | 14.1 | 38.6 | 20.4 | 16.9 |
| *Observations* | *91,446* | *52,390* | *39,056* | *27,227* | *19,075* | *17,399* | *27,745* |

**Table 6** Main regression results

| | Mortality | Readmission |
|---|---|---|
| Has spouse | $-0.0040^{**}$ | $0.0148^{***}$ |
| Has child | $-0.0053^{**}$ | $0.0070^{**}$ |
| **Patient characteristics** | | |
| Male | $0.0227^{***}$ | $0.0214^{***}$ |
| Age | $-0.0225^{***}$ | 0.0066 |
| Age squared | $0.0002^{***}$ | $-0.0001^{**}$ |
| Educ. intermediate | -0.0026 | $-0.0073^{**}$ |
| Educ. tertiary | $-0.0063^{**}$ | -0.0083 |
| Log income | 0.0002 | 0.0000 |
| LOS emergency | $0.0010^{***}$ | $0.0022^{***}$ |
| LOS elective | 0.0002 | 0.0001 |
| POLY emergency | $0.0033^{***}$ | $0.0032^{***}$ |
| POLY elective | 0.0000 | $0.0029^{***}$ |
| LOS index | 0.0002 | $-0.0014^{***}$ |
| To home | $-0.0695^{***}$ | $-0.1282^{***}$ |
| Co-morb.=1 | 0.0036 | -0.0025 |
| Co-morb.=2 | $0.0122^{***}$ | 0.0026 |
| Co-morb.=3 | $0.0230^{***}$ | 0.0029 |
| Co-morb.=4 | $0.0274^{***}$ | 0.0063 |
| Co-morb.=5 | $0.0375^{***}$ | $0.0153^{**}$ |
| Co-morb.=6+ | $0.0509^{***}$ | $0.0254^{***}$ |
| Heart attack | $0.0181^{***}$ | $0.2645^{***}$ |
| Heart failure | $0.0374^{***}$ | $0.1079^{***}$ |
| Pneumonia | $0.0436^{***}$ | $0.0627^{***}$ |
| **Municipality characteristics** | | |
| Municip. size | -0.0006 | $-0.0059^{***}$ |
| Care services expenditures | $0.0145^{**}$ | -0.0053 |
| Man-labor-years, above upper sec. | $-0.0003^{*}$ | 0.0001 |
| Slots in institutions | -0.0001 | $-0.0022^{***}$ |
| Slots in rehab. | 0.0003 | -0.0003 |
| Physician hours | -0.0032 | -0.0149 |
| Physiother. hours | 0.0003 | -0.0147 |
| Sick leave | -0.0008 | $0.0030^{**}$ |
| **Time controls** | | |
| Year=2010 | $-0.0051^{**}$ | -0.0030 |
| Year=2011 | -0.0037 | 0.0026 |
| Year=2012 | 0.0003 | 0.0018 |
| Year=2013 | $-0.0088^{***}$ | 0.0055 |
| Month=February | 0.0029 | 0.0037 |
| Month=March | -0.0000 | -0.0080 |
| Month=April | 0.0005 | 0.0044 |
| Month=May | $-0.0060^{*}$ | -0.0060 |
| Month=June | -0.0029 | 0.0088 |
| Month=July | 0.0056 | -0.0035 |

| | | |
|---|---|---|
| Month=August | 0.0066 | -0.0037 |
| Month=September | 0.0025 | 0.0037 |
| Month=October | 0.0028 | 0.0000 |
| Month=November | -0.0039 | -0.0021 |
| Month=December | 0.0071* | -0.0055 |
| Day=Monday | -0.0065** | -0.0083* |
| Day=Tuesday | -0.0056** | -0.0110** |
| Day=Wednesday | -0.0103*** | -0.0060 |
| Day=Thursday | -0.0054* | -0.0076 |
| Day=Friday | -0.0033 | -0.0075 |
| Day=Saturday | -0.0021 | -0.0047 |
| *Constant* | *0.6610**** | *0.1579* |
| *Observations* | *97,920* | *91,446* |
| *Adjusted $R^2$* | *0.044* | *0.084* |

*Notes: Results from estimating equation (1). Indicators for health trust omitted from the table. Results from municipality fixed-effects estimator are not reported, available from the authors upon request.* $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table 7** Heterogeneity analysis, by gender

| | Mortality | | Readmission | |
|---|---|---|---|---|
| | Women | Men | Women | Men |
| Has spouse | -0.0023 | -0.0062** | 0.0142*** | 0.0172*** |
| Has child | -0.0090*** | -0.0011 | 0.0093* | 0.0051 |
| **Patient characteristics** | | | | |
| Age | -0.0274*** | -0.0222*** | 0.0008 | 0.0157** |
| Age squared | 0.0002*** | 0.0002*** | -0.0000 | -0.0001*** |
| Educ. intermediate | -0.0058*** | 0.0019 | -0.0045 | -0.0120** |
| Educ. tertiary | -0.0079** | -0.0051 | 0.0018 | -0.0199*** |
| Log income | 0.0002 | 0.0009 | 0.0043 | -0.0024 |
| LOS emergency | 0.0009*** | 0.0011*** | 0.0024*** | 0.0019*** |
| LOS elective | 0.0004 | -0.0000 | 0.0004 | -0.0002 |
| POLY emergency | 0.0035*** | 0.0031*** | 0.0045*** | 0.0024* |
| POLY elective | -0.0003 | 0.0003 | 0.0028*** | 0.0033*** |
| LOS index | -0.0001 | 0.0003 | -0.0014*** | -0.0014*** |
| To home | -0.0619*** | -0.0798*** | -0.0856*** | -0.1847*** |
| Co-morb.=1 | -0.0003 | 0.0097** | -0.0035 | 0.0008 |
| Co-morb.=2 | 0.0075** | 0.0198*** | 0.0083 | -0.0025 |
| Co-morb.=3 | 0.0183*** | 0.0305*** | 0.0080 | -0.0009 |
| Co-morb.=4 | 0.0222*** | 0.0355*** | 0.0116 | 0.0022 |
| Co-morb.=5 | 0.0317*** | 0.0462*** | 0.0157** | 0.0169 |
| Co-morb.=6+ | 0.0491*** | 0.0556*** | 0.0258*** | 0.0279*** |
| Heart attack | 0.0313*** | -0.0045 | 0.2387*** | 0.2938*** |
| Heart failure | 0.0492*** | 0.0157** | 0.0877*** | 0.1371*** |
| Pneumonia | 0.0459*** | 0.0307*** | 0.0486*** | 0.0842*** |
| **Municipality characteristics** | | | | |
| Municip. size | -0.0005 | -0.0008 | -0.0041** | -0.0071** |
| Care services expenditures | 0.0089 | 0.0208* | 0.0093 | -0.0208 |
| Man-labor-years, above upper sec. | -0.0002 | -0.0004 | 0.0000 | 0.0003 |
| Slots in institutions | -0.0006** | 0.0003 | -0.0019*** | -0.0025*** |
| Slots in rehab. | 0.0003 | 0.0003 | -0.0003 | -0.0001 |
| Physician hours | -0.0068 | 0.0003 | -0.0203 | -0.0075 |
| Physiother. hours | -0.0060 | 0.0084 | -0.0108 | -0.0169 |
| Sick leave | -0.0004 | -0.0013 | 0.0025* | 0.0036* |
| **Time controls** | | | | |
| Year=2010 | -0.0077*** | -0.0022 | -0.0082 | 0.0021 |
| Year=2011 | -0.0051 | -0.0021 | -0.0013 | 0.0059 |
| Year=2012 | -0.0002 | 0.0008 | -0.0013 | 0.0028 |
| Year=2013 | -0.0109*** | -0.0062 | 0.0064 | 0.0021 |
| Month=February | -0.0001 | 0.0066 | 0.0077 | -0.0008 |
| Month=March | -0.0007 | 0.0003 | -0.0037 | -0.0133 |
| Month=April | -0.0018 | 0.0035 | -0.0071 | 0.0195** |
| Month=May | -0.0110** | 0.0005 | -0.0000 | -0.0148* |
| Month=June | -0.0036 | -0.0014 | 0.0139* | 0.0036 |
| Month=July | 0.0049 | 0.0059 | -0.0030 | -0.0038 |

| | | | | |
|---|---|---|---|---|
| Month=August | 0.0012 | 0.0138** | 0.0015 | -0.0111 |
| Month=September | 0.0009 | 0.0044 | -0.0043 | 0.0140 |
| Month=October | -0.0039 | 0.0118** | -0.0085 | 0.0124 |
| Month=November | -0.0039 | -0.0034 | -0.0036 | 0.0003 |
| Month=December | 0.0035 | 0.0116** | -0.0106 | 0.0020 |
| Day=Monday | -0.0032 | -0.0104** | -0.0096* | -0.0080 |
| Day=Tuesday | -0.0024 | -0.0093** | -0.0144*** | -0.0066 |
| Day=Wednesday | -0.0070** | -0.0143*** | -0.0074 | -0.0041 |
| Day=Thursday | -0.0023 | -0.0093** | -0.0143** | 0.0003 |
| Day=Friday | 0.0044 | -0.0127*** | -0.0094 | -0.0049 |
| Day=Saturday | 0.0077** | -0.0150*** | -0.0035 | -0.0061 |
| *Constant* | *0.9669**** | *0.5613*** | *0.1295* | *0.0522* |
| *Observations* | *55,798* | *42,122* | *52,390* | *39,056* |
| *Adjusted $R^2$* | *0.040* | *0.051* | *0.063* | *0.106* |

*Notes: Results from estimating equation (1) on the samples split by gender. Indicators for health trust omitted from the table. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$*

**Table 8** Heterogeneity analysis, by diagnosis, age and number of co-morbidities

| | Hip fracture (1) | Heart attack (2) | Heart failure (3) | Pneu-monia (4) | 80+ (5) | 3+ co-morb. (6) |
|---|---|---|---|---|---|---|
| **Mortality** | | | | | | |
| Has spouse | -0.0058* | -0.0047 | 0.0021 | -0.0019 | -0.0055* | -0.0021 |
| Has child | 0.0009 | -0.0130** | -0.0014 | -0.0078 | -0.0046* | -0.0085** |
| *Mean mort. (%)* | *6.3* | *4.9* | *7.2* | *7.7* | *8.0* | *8.1* |
| *Observations* | *29,058* | *20,048* | *18,748* | *30,066* | *66,775* | *53,979* |
| *Adjusted $R^2$* | *0.037* | *0.043* | *0.057* | *0.058* | *0.039* | *0.041* |
| **Readmission** | | | | | | |
| Has spouse | 0.0000 | 0.0329*** | 0.0108 | -0.0011 | 0.0117*** | 0.0152*** |
| Has child | 0.0094 | 0.0088 | 0.0176** | -0.0106 | 0.0047 | 0.0070 |
| *Mean readm. (%)* | *14.1* | *38.6* | *20.4* | *16.9* | *19.3* | *22.1* |
| *Observations* | *27,227* | *19,075* | *17,399* | *27,745* | *61,413* | *49,581* |
| *Adjusted $R^2$* | *0.011* | *0.229* | *0.024* | *0.019* | *0.040* | *0.057* |

*Notes: Results from estimating the equation (1) on different subsamples. Control variables omitted from the table (the set of control variables is the same as in **Table 6** – patient, municipality and time controls). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$*

**Table 9** The importance of spouse and children characteristics

| | Spouse characteristics | | Children characteristics | |
|---|---|---|---|---|
| | Mortality | Readmission | Mortality | Readmission |
| | (1) | (2) | (3) | (4) |
| Educ. secondary | 0.0004 | -0.0069 | -0.0014 | 0.0021 |
| Educ. tertiary | -0.0062* | -0.0033 | -0.0043* | -0.0048 |
| Age | 0.0032 | 0.0090** | 0.0036*** | 0.0021 |
| Age squared | -0.0000 | -0.0001** | -0.0000*** | -0.0000 |
| Log income | 0.0007 | -0.0036 | -0.0021*** | 0.0014 |
| Health care educ. | 0.0090** | 0.0062 | -0.0048** | 0.0056* |
| No. of children | - | - | -0.0012* | -0.0006 |
| Male | - | - | -0.0004 | -0.0017 |
| Same municipality | - | - | 0.0009 | -0.0087** |
| *Joint significance* | *0.0006* | *0.0705* | *0.0028* | *0.0232* |
| Has child | -0.0056 | -0.0021 | - | - |
| Has spouse | - | - | -0.0044** | 0.0143*** |
| *Constant* | *0.8648**** | *-0.3282* | *0.8605**** | *0.3896* |
| *Observations* | *37614* | *35608* | *82471* | *77245* |
| *Adjusted $R^2$* | *0.049* | *0.133* | *0.045* | *0.089* |

*Notes: Results from estimating equation (2a) – columns 1 and 2 – and equation (2b) – columns 3 and 4. The first two columns are estimated on the subsample of patients with a spouse, and the last two columns, of patients with children. Control variables omitted from the table (the set of control variables is the same as in **Table 6** – patient, municipality and time controls).* * *p < 0.1,* ** *p < 0.05,* *** *p < 0.01*

**Table 10** Changes over time

| | Mortality | | Readmission | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Has spouse | -0.0089*** | -0.0151*** | 0.0070** | -0.0017 |
| Has child | -0.0063*** | -0.0049 | 0.0066** | -0.0089 |
| Year=2010 | -0.0056** | -0.0141** | -0.0053 | -0.0235** |
| Year=2011 | -0.0018 | 0.0005 | 0.0005 | -0.0245** |
| Year=2012 | 0.0053** | 0.0037 | 0.0062 | -0.0132 |
| Year=2013 | -0.0031 | -0.0008 | 0.0083** | -0.0110 |
| Has spouse × Year=2010 | | 0.0119** | | 0.0217*** |
| Has spouse × Year=2011 | | 0.0071 | | 0.0077 |
| Has spouse × Year=2012 | | 0.0083 | | 0.0111 |
| Has spouse × Year=2013 | | 0.0035 | | 0.0034 |
| Has child × Year=2010 | | 0.0048 | | 0.0121 |
| Has child × Year=2011 | | -0.0059 | | 0.0264** |
| Has child × Year=2012 | | -0.0018 | | 0.0182* |
| Has child × Year=2013 | | -0.0041 | | 0.0218* |
| *Observations* | *97,920* | *97,920* | *91,446* | *91,446* |
| *Adjusted $R^2$* | *0.026* | *0.026* | *0.061* | *0.061* |

*Notes: Results from estimating equation (4). All regressions include the following list of non-reported control variables (defined in* ***Table 1****): male, age, age squared, educ. intermediate, educ. tertiary, log income, co-morbidities, diagnosis, health trust, month and day-of-week dummies, and municipality size. All variables that might be endogenous to the reform are excluded (LOS emergency, LOS elective, POLY emergency, POLY elective, LOS index, to home, and all municipality characteristics except for municipality size).* * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

# 10. Appendix

**Table A1** Descriptive statistics of the municipality characteristics, year by year

| | Mean (s.d.) | | | | |
|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2012 | 2013 |
| Municip. size | 8.5 (1.2) | 8.5 (1.2) | 8.5 (1.2) | 8.5 (1.2) | 8.5 (1.2) |
| Care services | 12.6 (0.2) | 12.6 (0.2) | 12.6 (0.2) | 12.7 (0.2) | 12.7 (0.2) |
| Man-labor-years, above upper sec. | 28 (6.2) | 28.7 (6.1) | 29.3 (6.1) | 30.5 (6.1) | 31.3 (6.1) |
| Slots in institutions | 21.2 (8.8) | 21.3 (8.7) | 21.4 (8.8) | 21.6 (8.7) | 21.6 (8.9) |
| Slots in rehab. | 6.6 (6.3) | 7 (8.2) | 7.2 (6.8) | 7.5 (7) | 9.5 (9.8) |
| Physician hours | 0.33 (0.2) | 0.35 (0.2) | 0.37 (0.2) | 0.41 (0.3) | 0.45 (0.2) |
| Physiother. hours | 0.31 (0.3) | 0.31 (0.26) | 0.34 (0.26) | 0.35 (0.26) | 0.37 (0.26) |
| Sick leave | 9.4 (2.2) | 8.9 (2.4) | 8.3 (2.0) | 8.8 (2.2) | 8.3 (2.1) |
| *No. of municipalities* | *428* | *428* | *428* | *428* | *428* |
| *Observations* | *2140* | *2140* | *2140* | *2140* | *2140* |

*Notes: The descriptive statistics are calculated for all municipalities since our sample is not balanced w.r.t. number or municipalities over time.*

**Table A2** Heterogeneity analysis, by municipality characteristics

| | Mortality | Readmission |
|---|---|---|
| **Care service expenditures** | | |
| Has spouse | -0.0049** | 0.0188*** |
| Has child | -0.0067** | 0.0073 |
| High expenditures | -0.0058 | -0.0146 |
| Has spouse × High expenditures | 0.0032 | -0.0096* |
| Has child × High expenditures | 0.0025 | -0.0003 |
| *Observations* | *97920* | *91446* |
| *Adjusted $R^2$* | *0.044* | *0.084* |
| **Share of highly educated** | | |
| Has spouse | -0.0047 | 0.0122** |
| Has child | -0.0005 | 0.0028 |
| High share of highly educ. | 0.0062 | -0.0033 |
| Has spouse × High share of highly educ. | 0.0017 | 0.0030 |
| Has child × High share of highly educ. | -0.0068 | 0.0058 |
| *Observations* | *97920* | *91446* |
| *Adjusted $R^2$* | *0.044* | *0.084* |
| **No. of slots in inst.** | | |
| Has spouse | -0.0052** | 0.0128*** |
| Has child | -0.0046 | 0.0060 |
| High no. of slots in inst. | 0.0011 | -0.0265*** |
| Has spouse × High no. of slots in inst. | 0.0049 | 0.0036 |
| Has child × High no. of slots in inst. | -0.0021 | 0.0026 |
| *Observations* | *97920* | *91446* |

| | | |
|---|---|---|
| *Adjusted $R^2$* | *0.044* | *0.084* |

| | | |
|---|---|---|
| **Municipality size, cut-off 5,000** | | |
| Has spouse | -0.0049 | 0.0131 |
| Has child | -0.0116* | 0.0003 |
| More than 5,000 inhabitants | -0.0037 | 0.0158 |
| Has spouse × More than 5,000 inhabitants | 0.0019 | 0.0014 |
| Has child × More than 5,000 inhabitants | 0.0069 | 0.0075 |
| *Observations* | *97920* | *91446* |
| *Adjusted $R^2$* | *0.044* | *0.084* |
| **Municipality size, cut-off 20,000** | | |
| Has spouse | -0.0053** | 0.0119** |
| Has child | -0.0038 | 0.0077 |
| More than 20,000 inhabitants | -0.0064 | 0.0184* |
| Has spouse × More than 20,000 inhabitants | 0.0033 | 0.0039 |
| Has child × More than 20,000 inhabitants | -0.0026 | -0.0013 |
| *Observations* | *97920* | *91446* |
| *Adjusted $R^2$* | *0.044* | *0.084* |

*Notes: Results from estimating equation (3). Control variables omitted from the table (the set of control variables is the same as in* ***Table 6*** *– patient, municipality and time controls).* $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

## **Table A3** In-hospital mortality, by gender

| | In-hospital mortality (1) | Women (2) | Men (3) |
|---|---|---|---|
| Has spouse | -0.0043** | -0.0026 | -0.0058* |
| Has child | -0.0083*** | -0.0079*** | -0.0112*** |
| **Patient characteristics** | | | |
| Male | 0.0200*** | | |
| Age | -0.0043** | -0.0045 | -0.0142*** |
| Age squared | 0.0001*** | 0.0000** | 0.0001*** |
| Educ. intermediate | -0.0039** | -0.0043** | -0.0035 |
| Educ. tertiary | -0.0029 | -0.0065** | -0.0015 |
| Log income | -0.0025** | -0.0037* | -0.0007 |
| LOS emergency | 0.0012*** | 0.0011*** | 0.0013*** |
| LOS elective | 0.0002 | -0.0001 | 0.0005* |
| POLY emergency | 0.0027*** | 0.0017* | 0.0034*** |
| POLY elective | -0.0006** | -0.0010*** | -0.0003 |
| LOS index | -0.0005** | -0.0014*** | 0.0006* |
| Co-morb.=1 | 0.0096*** | 0.0073** | 0.0130*** |
| Co-morb.=2 | 0.0171*** | 0.0151*** | 0.0200*** |
| Co-morb.=3 | 0.0249*** | 0.0203*** | 0.0316*** |
| Co-morb.=4 | 0.0347*** | 0.0268*** | 0.0451*** |
| Co-morb.=5 | 0.0429*** | 0.0362*** | 0.0521*** |
| Co-morb.=6+ | 0.0707*** | 0.0665*** | 0.0760*** |
| Heart attack | 0.0578*** | 0.0692*** | 0.0448*** |

| | | | |
|---|---|---|---|
| Heart failure | 0.0207*** | 0.0279*** | 0.0102*** |
| Pneumonia | 0.0547*** | 0.0534*** | 0.0517*** |
| **Municipality characteristics** | | | |
| Municip. size | 0.0012 | -0.0003 | 0.0029** |
| Care services expenditures | 0.0087 | 0.0053 | 0.0126 |
| Man-labor-years, above upper sec. | -0.0002 | 0.0002 | -0.0006* |
| Slots in institutions | -0.0002 | -0.0002 | -0.0002 |
| Slots in rehab. | 0.0000 | 0.0000 | -0.0000 |
| Physician hours | -0.0087 | -0.0114* | -0.0056 |
| Physiother. hours | -0.0008 | -0.0019 | 0.0004 |
| Sick leave | -0.0000 | 0.0007 | -0.0010 |
| **Time controls** | | | |
| Year=2010 | -0.0047 | -0.0052 | -0.0046 |
| Year=2011 | -0.0048* | -0.0045 | -0.0056 |
| Year=2012 | -0.0040 | -0.0040 | -0.0048 |
| Year=2013 | -0.0062* | -0.0046 | -0.0090* |
| Month=February | 0.0053 | 0.0060 | 0.0045 |
| Month=March | -0.0000 | 0.0012 | -0.0018 |
| Month=April | -0.0056* | -0.0075* | -0.0037 |
| Month=May | -0.0085** | -0.0047 | -0.0135** |
| Month=June | -0.0057* | -0.0034 | -0.0087 |
| Month=July | -0.0105*** | -0.0120** | -0.0091 |
| Month=August | 0.0043 | 0.0021 | 0.0073 |
| Month=September | -0.0067* | -0.0032 | -0.0117* |
| Month=October | -0.0016 | -0.0004 | -0.0032 |
| Month=November | -0.0002 | -0.0001 | -0.0001 |
| Month=December | 0.0072* | 0.0062 | 0.0080 |
| Day=Monday | -0.0050 | -0.0018 | -0.0087** |
| Day=Tuesday | -0.0062* | -0.0037 | -0.0089* |
| Day=Wednesday | -0.0060* | -0.0036 | -0.0091* |
| Day=Thursday | -0.0042 | -0.0011 | -0.0078 |
| Day=Friday | -0.0062** | -0.0029 | -0.0105** |
| Day=Saturday | -0.0007 | 0.0006 | -0.0026 |
| *Constant* | *-0.0455* | *0.0528* | *0.2741* |
| *Observations* | *105,471* | *59,567* | *45,904* |
| *Adjusted $R^2$* | *0.031* | *0.030* | *0.033* |

*Notes: Results from estimating the equation (1) on the sample used in the analysis of mortality, augmented with those who died in hospital. Indicators for health trust omitted from the table. The variable to home is not included since it is not defined for in-hospital mortality. Columns 2 and 3 are estimated for the subsamples split by gender.* $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$