

Plant closure and hospitalization

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Abstract

Focussing on full-time, high-tenure workers, we investigate whether job loss due to plant closure causes increased risk of hospitalization for many different diagnoses. We use unique administrative data: A sample of *all* persons in Denmark who lost their job due to closure of plants in the private sector in the period 1981-2000, and a random 10% sample of the Danish population (used to form control groups). The data contain full records on demographics, health and work status, and a link from workers to plants. We use the method of ‘matching on observables’ combined with ‘difference-in-differences’ and duration analysis.

Keywords: Unemployment, Job Displacement, Plant Closure, Health, Hospitalization, Matching on observables, Difference-in-differences, Duration analysis

JEL-Code: C23, I18, J21

1. Introduction

It is well documented that unemployment is associated with poor health; see e.g. the survey in Kasl and Jones (2000). However, the determinants of this correlation are far from fully understood. Many studies have tried to investigate if there is a causal effect of unemployment on health by using firm or plant closure as a quasi-experiment; see e.g. Morris and Cook (1991) and Eliason and Storrie (2003). This is also the approach of the present paper. We focus on the effect of displacement due to plant closure on the risk of hospitalization, and we investigate effects on a wide range of different categories of diagnoses.

The population studied is restricted to full-time, high-tenure workers with a strong labour market attachment since this group may be assumed to experience significant negative health effects if displaced. We use unique administrative data: A sample of *all* persons in Denmark who lost their job due to closure of plants in the private sector in the period 1981-2001, and a random 10% sample of the Danish population (used to form control groups). The data contain very full records on demographics, health and work status for each person, and a link from every working person to a plant. Health outcomes are based on diagnoses from somatic hospital departments. We use the method of ‘matching on observables’ combined with ‘difference-in-differences’ and duration analysis to estimate effects of plant closure on hospitalization.

In an earlier paper (Browning et al., 2006) we used the same basic strategy to investigate if there is a causal effect of displacement on hospitalization. However, in the earlier paper we focused only on stress-related diagnoses of the circulatory and digestive systems. In the present paper we analyse, as explained above, many different categories of diagnoses. Other important differences compared to Browning et al. (2006) is that we in this paper focus exclusively on high-tenure workers and displacements due to plant closure (and not just downsizing), and that we use a much larger dataset.

In section 2 we discuss the econometric methods used. Section 3 describes the data and the identification of treatment and control groups. Sections 4 and 5 present estimation results for the propensity score and health outcomes, respectively. Section 6 contains conclusions.

2. Empirical methods

The aim of this paper is to investigate if there is a causal effect of being displaced due to plant closure on hospitalization for different categories of diagnoses. We use propensity score matching; see e.g. Rubin (1977, 1980), Rosenbaum and Rubin(1983, 1985), and Heckman, LaLonde and Smith (1999). Let displacement status be denoted by the dummy variable D where $D=1$ if displaced (treated) and 0 otherwise, and let Y_0 and Y_1 denote the potential health outcomes where 0 denotes non-treatment and 1 treatment. The observed outcome for an individual is $Y=DY_1 + (1-D)Y_0$. We want to estimate the average treatment effect on the treated (ATET):

$$E(Y_1 - Y_0 | D = 1) = E(Y_1 | D = 1) - E(Y_0 | D = 1) \quad (1)$$

The problem is that $E(Y_0 | D = 1)$ is unobserved. Since in our data treatment is not randomly assigned we can not assume that $E(Y_0 | D = 1) = E(Y_0 | D = 0)$. The probability of being displaced may be influenced by characteristics (e.g. age and education) which also influence health outcomes. Conditioning on a vector of covariates X , ATET is given by

$$E(Y_1 - Y_0 | D = 1, X) = E(Y_1 | D = 1, X) - E(Y_0 | D = 1, X) \quad (2)$$

where X is a vector of characteristics not affected by the treatment. We use the method ‘matching on observables’ to estimate the last term on the RHS, which is an unobserved counterfactual. Thus, we assume ‘conditional mean independence’:

$$E(Y_0 | D = 1, X) = E(Y_0 | D = 0, X) \quad (3)$$

In our case this assumption implies that conditioning on the observables X , the expected potential health outcome in case of non-displacement is the same for the two groups of displaced and not-displaced workers, respectively. So if assumption (3) holds we can use observed health outcomes of non-displaced workers to measure potential health outcomes for displaced workers had they not been displaced, conditional on the characteristics X .

As a practical matter it is difficult to match on a high-dimensional X vector, and some of the variables may be continuous. Therefore, we follow the conventional procedure of matching on the (estimated) propensity score, which is the conditional probability of treatment, $P(X) \equiv \Pr(D=1 | X)$. We estimate probit propensity score functions and check balancing properties carefully.

It is important to note that even though matching is done using estimated parametric propensity scores, the method of matching still has the virtue of not relying on distributional assumptions or functional form restrictions in the outcome equation, and the method does not put any restrictions on heterogeneity of individual treatment effects.

We use one-to-one matching, where each treated person is matched to that non-treated person who has the closest propensity score. Actually, we match on the linear index of the propensity score since this generates better matches in regions where probabilities are very close to zero or one, see Lechner (2000). Since our control groups are large compared to the treatment groups, matching without replacement is used.

We consider a wide range of different categories of hospital diagnoses, and for each of these we consider different specifications of outcomes: being hospitalized in the four years after displacement, being hospitalized in the data period, and the duration to the first entry into hospital (see sections 3 and 5 for details). In estimating the causal effect of being displaced due to plant closure we also use conditional difference-in-differences matching

where the ‘lagged outcome variable’ is used to construct the differences; see Heckman, Ichimura and Todd (1997).

3. Data

3.1 Register data

We use Danish administrative register data. In Denmark all residents have a personal number which is used for administrative purposes to record activities such as education, hospitalization, employment status, interactions with the welfare system, income, and residence. This information is collected centrally by Statistics Denmark which makes these data available for statistical and research purposes. We use a sample of all persons in Denmark who lost their job due to closure of plants in the private sector in the period 1981-2001, and a random 10% sample of the Danish population for the same period (used to form control groups). We have data on diagnoses from somatic hospital departments for these persons for the period 1981-2003.

The dataset contains variables connecting individuals to plants (if they are at work), and data for plants such as the number of employees (recorded in November each year), the status of the plant one year ahead (e.g. continuing or closed), and the percentage of employees who are the next year employed at a newly established plant.

3.2 Definition of plant closure

We can identify plant closures in our data for the period 1981-2000. We only consider plants in the private sector. How to define whether a plant is closed or continuing from one year to the next is not trivial. As has become standard in analyses on Danish register data, we consider a plant as continuing if at least one of the following criteria is satisfied: (1) The same owner and the same industry; (2) the same owner and the same employees; (3) the same employees and the same address; (4) the same employees and the same industry. The “same industry” means the same ISIC code at the 5 digit level. In case (2) “same employees” means that those who remain employed at the plant at the end of the current year constitute either at

least 30% of the employees at the end of the preceding year *or* they make up at least 30% of the employees at the end of the current year. In cases (3) and (4) the definition of “same employees” is more restrictive since here it means that those who remain employed at the plant at the end of the current year constitute at least 30% of the employees at the end of the preceding year *and* they make up at least 30% of the employees at the end of the current year. If none of the four criteria are satisfied the plant is defined as closed. However, even if condition (1) above is fulfilled, the plant is considered closed if the number of employees at the end of the year is zero.

There are basically two problems with this – and any other – definition of continuing or closing plants in relation to identification of displacements. First, a plant may be closed via absorption into (or merging with) another plant. In the registers we can identify “closure via absorption” (defined as at least 30% of the employees of the closing plant obtaining employment at the absorbing plant). We therefore modify the definition of plant closure to be more restrictive: closure via absorption is not considered as closure.

Second, even if a plant closes, a large fraction of the employees may at the end of the year be employed at other newly established plants. If this is the case for at least 40% of the employees we do not consider the plant closed.

3.3 Definition of year of plant closure

The year a plant closes according to the above definition of closure is not necessarily the most relevant year to consider for our purposes. For instance, a plant may reduce the number of employees from 1000 to 10 in year t , from 10 to 5 in year $t+1$, and from 5 to 0 in year $t+2$ (where it closes). In this case, it is obvious that year t (and not $t+2$) should be defined as the year of plant closure.

Having identified plants which close according to the definition in the previous section, we define the year t of plant closure as *the year with the largest absolute reduction in the number of employees* given that the following conditions are satisfied for this year:

1. There are at least 5 employees at the end of year $t-1$

2. The number of employees is reduced by at least 50% for plants with less than 100 employees at the end of year $t-1$, and by at least 10% for plants with at least 100 employees at the end of year $t-1$
3. The plant is not in year t or in following years characterized by ‘non-identical continuation’ in the sense that the number of employees falls because part of the plant and its employees are separated out to another plant.

If a plant is closed according to the definition of the previous section, but the three conditions above are not satisfied in any year in the sample period, this plant closure is ignored in the analysis. Also, we ignore closure of plants which have existed for less than three years prior to closure (in accordance with our tenure restriction, see below).

The year of plant closure as defined above is for 62% of the closures identical to the year of final closure; for 19% the year of final closure is 1 year later, for 5% it is 2 years later; for 90% it is at most 3 years later.

The data on plants – including the number of employees, the link between plants and employees and status variables concerning closure/continuation – are recorded at the end of November each year. We define the base year as the year prior to the year of plant closure as defined above. For instance, those who are employed in November 1989 at plants which close in 1990 (strictly speaking between end of November 1989 and end of November 1990) are in the treatment group for base year 1989. We focus in our analysis on plants which close in the years 1985-2001 and employees at these plants in base years 1984-2000. We do not consider plant closures in the first three years of our data period since we want to focus on employees with at least three years of tenure; also this enables us to condition on initial health status.

For each base year, Table 1 shows the number of closures (in the following year), and the average (and minimum and maximum) number of employees in the base year. It can be seen that there are relatively many plant closures from the mid 1980’ies to 1992-93 which reflects the Danish business cycle.

3.4 Identification of treatment and control groups

The treatment group in our analysis covers employees in base years 1984-2000 at plants which close in the following year (according to the definition above). We identify treatment and control groups for each base year 1984-2000. Both groups of workers are defined by the following characteristics in the base year: They are 20-60 years of age, they have at least three years of tenure, they are employed in a private sector plant with at least five employees, they are full-time employed, and they had no unemployment in the year three years prior to the base year. Thus, we focus on high-tenure workers with a strong labour market attachment. We allow workers to be unemployed part of the base year and part of the two years prior to the base year. This is because plants which are eventually going to close down may be more inclined to lay off workers temporarily in the years prior to closure, so that part of the possible health effect of plant closure on employees may work through some degree of unemployment in the period prior to the year of closure.

A person can only be in the treatment group in one base year. Persons meeting the requirements for being in the treatment group in more than one base year are defined to be in the treatment group in the first year only. For employees to be in the control group of base year t , we furthermore require: that the firm is not downsizing (specifically, the number of employees in year $t+1$ is required to be more than 90% of the number of employees in year t); that if they are in year t employed at a plant which will eventually close down, this will happen more than three years later; and that they are not in the treatment group in any year. Table 2 shows how the different restrictions reduce the size of treatment and control groups. We end up with 71,157 persons in the treatment group (50,526 men and 20,631 women) and 298,727 controls (214,986 men and 83,741 women). In this paper we focus on men. Table 3 shows the number of men in the treatment and control groups for each base year. There are relatively large numbers in the treatment group from the mid-1980'ies to 1993 which is not surprising given the figures for plant closures in Table 1; this reflects the general recession in the Danish economy in this period. The treatment group of base year 1998 is also large, but

this is due to the fact that the average number of employees at the plants which closes from 1998 to 1999 is large, not that many plants are closing (see also Table 1).

3.5 Hospitalization

We investigate a wide range of hospitalization outcomes: Hospitalization for any diagnosis (except birth and a few other diagnoses not related to illness), broad categories of diagnoses based on the 'S-list', and more specific groups of diagnoses which might be especially relevant.¹ The S-list is a standard categorization of all hospital diagnoses. The more specific groups of diagnoses which we analyse are: (1) gastric catarrh, gastric ulcer, etc. (including oesophagus catarrh or perforation, and illnesses of stomach and duodenum); (2) high blood pressure; (3) heart attack (myocardial infarction), etc. (including heart failure and cardiac arrest); (4) neurotic diseases, etc. (including anxiety neurosis, depression neurosis, palpitation, and fainting); (5) Selected trauma and violent bodily harm (including fracture due to external causes, concussion of the brain, and fracture of the skull); (6) diseases related to alcoholic abuse (including cirrhosis of the liver, poisonings with alcohol and antabuse, delirium, alcoholism, and alcoholic psychosis); (7) suicide attempt.

The specific groups of diagnoses (1)-(3) represent serious stress-related diseases which are of particular interest because displacement and possible unemployment due to plant closure may be expected to cause serious stress. These three groups of diagnoses taken together was the focus of the analysis in Browning et al. (2006). They may also be caused by depression. Depression and nervousness may also cause neurotic diseases, etc., represented by category (4) above. Note, though, that these outcomes are 'underrepresented' in our analysis because we do not have data from psychiatric hospital departments. Increased risk of hospitalization for the diagnoses of category (5), selected trauma and violent bodily harm, may be caused by weakened self control and reduced reaction; for instance, this may be a short-run effect of alcoholic abuse. The diagnoses (6) represent long-run consequences of alcoholic abuse. Most of these diagnoses are related to very serious abuse or abuse over several years. Suicide

attempts (category (7) above) may be a consequence of displacement and unemployment through, e.g., depression.

Table 4 shows, for the different health outcomes considered, mean hospitalization rates for the treatment and control groups, respectively. Outpatients are included in the hospitalization measures used. If a person is hospitalized more than once for a given category of diagnoses, he only counts as one admission. That is, the hospitalization rates measure the probability of being hospitalized for the different categories of diagnoses. For each group of diagnoses the first two columns of the table show the average hospitalization rate for the whole sample period. Differences between treatment and control groups in these health outcomes are of course affected by the distribution of treatment and control persons over the base years since individuals of early base years have higher hospitalization rates because we can follow them for a longer period of time. The next two columns in Table 4 are not subject to this problem: they show the hospitalization rate 1-4 years after the base year.ⁱⁱ The last two columns show the hospitalization rate 3 years prior to the base year. This is an indicator of initial health status. For persons of base year t , we measure hospitalization outcomes from year $t+1$ onwards, and initial health indicators are measured from year $t-1$ and backwards.

The treatment group has higher hospitalization rates than the control group when we consider outcomes during the whole sample period (see the first two columns of Table 4). However, this may at least in part be explained by the fact that a relatively large proportion of the treatment group belongs to base years in the beginning of the sample period (see Table 3) so that we can on average follow health outcomes of treated persons for more years than is the case for controls. Thus, it is very important in the econometric analysis to control properly for the distribution of treatment and control groups on base years. We do that by matching on each base year separately, see section 4.1.

For most categories of diagnoses the control group has higher hospitalization rates than the control group 1-4 years after base year, but this is also true for hospitalization rates before the base year. Thus, the descriptive Table 4 does not give any clear indication of possible health effects of displacement due to plant closure.

4. Estimation results: Matching

In this section we discuss the matching procedure, the estimation of the propensity score and balancing properties.

4.1 Matching procedure and empirical strategy

As discussed in section 2 we use matching techniques. We estimate a probit propensity score function for each base year 1984-2000 and match controls to persons in the treatment group for each base year separately. We use one-to-one matching without replacement since the control group is relatively large. We match on the linear index of the probit function (rather than on the propensity score itself) since this generates better matches in regions where probabilities are very close to zero or one, see Lechner (2000). The displacement groups of the different base years are pooled into one, and similarly the matched control groups are pooled.

For the pooled sample we estimate the average treatment effect on the treated, i.e. the average causal effect of being displaced due to plant closure on the probability of hospitalization. We use basically four types of outcome measures: dummy variables for being hospitalized (for different categories of diagnoses) 1-4 years after the base year, similar dummy variables for being hospitalized until the last year in the sample period (2003), the duration to hospitalization (based on the non-parametric Kaplan-Meier estimator of survival until hospitalization), and dif-in-dif estimates on the matched samples of the probability of being hospitalized over different spans of years around the base year.

4.2 The propensity score functions

As explained, we estimate 17 propensity score probit functions, one for each base year. The explanatory variables are age and education dummies, a dummy for being part of a couple (as opposed to being single), a dummy for living in the province (as opposed to the metropolitan area of Copenhagen) and industry dummies. Given that both treatment and control groups are

high-tenure workers with a strong labour market attachment, these variables seem to be sufficient in the propensity score function. We have tried to also include different variables for hospitalization prior to the base year, but this actually results in poorer balancing properties with respect to initial health status. One reason for this may be that only few persons have been hospitalized in the three years prior to the base year.

The propensity score estimates are rather different for the different base years, especially the estimated coefficients of the industry dummies vary considerably. This is of course due to the fact that business cycles vary over industries and that closure of a few large plants within a specific industry will affect the sample of a particular base year significantly. We do not show the estimates of the 17 propensity scores here, but to give an impression of the average effects of the conditioning variables, we show the propensity score function estimated on the pooled sample of all base years (although the results from this estimation is of course not actually used in the matching procedure). The specification of this probit model for the pooled sample is identical to that of the propensity score functions estimated for each base year, except that we include base year dummies. The result is shown in Table 5 together with the means of the explanatory variables for the treatment and control groups (the last two columns). Most base year dummies are highly significant which is not surprising given Table 3 (and the means in the two last columns of Table 5). All industry dummies are highly significant compared to the reference category which is services: The probability of working at a closing plant is higher in the construction industry, and smaller in manufacturing, infrastructure, financial services and other industries. Otherwise, the most marked differences between the two groups (which are also reflected in the coefficient estimates) are that relatively few of those who were employed at closing plants in the base year are younger than 30 years of age (the percentages aged 20-24 is 3.4 and 5.1, respectively, and the percentages aged 25-29 are 8.6 and 9.0), or have a higher education (2.6% compared to 3.6%), or live in the province (66.3% compared to 70.1%).

4.3 Balancing properties of the matching procedure

When matching for each base year separately using the estimated propensity score functions for each year, we check for common support problems and balancing properties. It is important for the validity of matching estimators that there are no common support problems: For each person in the treatment group there should be at least one person in the control group with almost the same propensity score. In the present analysis there are no common support problems: We do not lose any treated persons and only 125 controls due to lack of common support.

To check balancing properties, we have calculated two-sample t test statistics for the explanatory and pre-base-year hospitalization variables for each base year separately. The balancing properties seem to be good although a few differences are significant for some base years. We do not show the statistics for all base years separately here, but only for the pooled sample of treated and matched controls. Table 6 shows the balancing properties of the matching procedure with respect to the explanatory variables, i.e. the differences in means between treatment and matched control groups. It will be seen that the only significant differences between the two groups are with respect to short and long further education. However, the differences are very small: 0.2 and 0.4 percentage points, respectively.

Table 7 shows the balancing properties with respect to pre-base-year hospitalization for all the categories of diagnoses included in Table 4. As explained above, these variables are not included in the propensity score function. Comparing the first two columns of Table 7 with the last two columns of Table 4 it will be seen that the matched control group resembles the treatment group much more regarding initial health measures than the unmatched control group. For all diagnoses together and for most broad and specific categories the treatment group has higher pre-base-year hospitalization rates than the matched control group, but the differences are very small. The only difference which is significant at the 5% level is for neurotic diseases, etc. (t value of 2.8) where the hospitalization rates are very small (0.25 and 0.17%, respectively). The small differences in pre-base-year health status indicated in Table 7

should not be expected to bias the analysis of health outcomes after displacement significantly, but as explained above we also present matched dif-in-dif estimates.

5. Estimation results: Hospitalization outcomes

In this section we present estimation results for health outcomes: effects on hospitalization rates, effects on duration to hospitalization, and difference-in-differences estimates of effects on hospitalization rates.

5.1 The treatment effect on hospitalization rates

Table 8 shows the proportions hospitalized 1-4 years after base year for the treatment and control groups, respectively, and the average treatment effect on the treated (ATET) estimated as the difference in these hospitalization rates. There is no significant effect for the overall hospitalization rate including all diagnoses. For most of the broad categories of diagnoses based on the S-list, the estimated effects are not significant. However, displacement due to plant closure seems to increase the risk of hospitalization for diseases of blood and blood-forming organs, and to reduce the risk of hospitalization for 'symptoms and other ill-defined conditions' (t values are 3.9 and -3.3, respectively). There is also a weak indication of an increased risk of hospitalization for nutritional and metabolic diseases. Turning to the more specific categories of diagnoses, the results indicate an increased risk of hospitalization for 'Selected trauma and violent bodily harm', diseases related to alcoholic abuse, and suicide attempt, but a reduced risk of hospitalization due to high blood pressure. It is surprising that the results indicate no effect or even reduced risk of hospitalization for diseases of the circulatory system, since especially stress-related circulatory diseases such as high blood pressure and heart attack are often expected to be likely consequences of displacement and unemployment; see the discussion and references in Browning et al. (2006). The same applies for the specific digestive diagnoses gastric catarrh and gastric ulcer, etc. which may also be associated with stress.

Table 9 corresponds to Table 8, except that hospitalization rates after base year are measured to the end of the sample period; for instance, we measure hospitalization rates in 19 years for observations in base year 1984 (from 1985-2003), and in 3 years for observation in base year 2000 (from 2001-2003). Since we match exactly on base year this should not cause any systematic bias in the results. Thus, the results in Table 9 reflect more long-run health outcomes, and the hospitalization rates are of course higher. Again we find indication that displacement in connection with plant closure causes an increased risk of hospitalization for diseases of blood and blood-forming organs, for trauma, poisonings and other violent bodily harm (both for the broad and more specific categories of such diseases), and for diseases related to alcoholic abuse. In addition the results indicate increased risk of neurotic disease, infective and parasitic diseases, and diseases of respiratory organs. The effect on suicide attempt is now clearly insignificant.

As in Table 8 we find indications of displacement due to plant closure causing reduced risk of hospitalization for ‘symptoms and other ill-defined conditions’, and now we also find indication of a reduced risk of diseases of the musculoskeletal system. The reduced risk of high blood pressure of Table 8 is no longer significant, but the results indicate that the risk of hospitalization for the three stress-related categories of diseases (gastric catarrh, gastric ulcer, etc., high blood pressure and heart attack) taken together is reduced (see the last row of the table).

5.2 The treatment effect on duration until hospitalization

We consider in this section the ATET with regard to the duration to the first entry into hospital for each of the general and specific categories of diagnoses discussed above. For each base year and each category of diagnoses, the duration until hospitalization is computed for each person. Based on these duration data, we compute the non-parametric survival functions (for ‘survival’ until hospitalization for each category of diagnoses) of Kaplan and Meier (1958) for the treatment and matched control groups, respectively, taking account of right censoring due to death, emigration and the fact that hospitalization is only observed until

2003 irrespective of base year. We are able to estimate the survival curve up to a duration of 19 years from the base year since the first base year is 1984 and the last year with hospitalization data is 2003. The Kaplan-Meier product limit estimator of the survival function at duration t , $S(t)$, and the Greenwood (1926) estimator of its variance are given by

$$\hat{S}(t) = \prod_{i \leq t} \left(1 - \frac{d(i)}{n(i)} \right), \quad \hat{V}(\hat{S}(t)) = \hat{S}(t)^2 \sum_{i \leq t} \frac{d(i)}{n(i)[n(i) - d(i)]} \quad (4)$$

where $d(i)$ and $n(i)$ are the number of ‘deaths’ (hospitalizations) and the number ‘at risk’, respectively, in year i after the base year ($i = 1, 2, \dots, t$); $d(i)/n(i)$ is the estimate of the hazard rate at duration i .

Figures 1-12 show the estimated Kaplan-Meier survival curves for the categories of diagnoses for which there are significant differences between treatment and matched control groups, at least for a few of the durations. However, in order to reduce the number of figures, we do not show survival curves for the specific categories of diagnoses ‘gastric catarrh, gastric ulcer, etc.’ and ‘heart attack (myocardial infarction), etc.’ where there are some significant differences in survival rates, but only at very long durations. Table 10 summarizes the results for *all* categories of diagnoses by showing the t test statistics for differences in survival rates between treatment and matched control groups at durations 1-19 years from base year. It is the t test for ‘survival rate of matched controls *minus* survival rate of treated’. Thus, a positive value at a given duration indicates that the survival curve of the matched control group is above the survival curve of the treatment group at this duration, i.e. that the probability of having been hospitalized within this duration from the base year is higher for the treatment group than for the matched control group.

The figures 1-12 show the survival curve for the matched control group with 95% confidence bounds and the survival curve for the treatment group. Figure 1 shows the results for *infective and parasitic diseases*. The survival curve of the treatment group is below that of the matched control group for all durations, and it is below the lower 95% confidence bound for durations longer than 5 years; the survival rates are significantly different at the 5% level

for durations longer than 6 years. Thus, the results indicate that displacement may increase the risk of hospitalization for infective and parasitic diseases, especially after five or six years from the base year. We may interpret one minus the survival rate at duration t as the probability of being hospitalized up to year t after the base year. Ten years after the base year the probability of having been hospitalized is 2.6% for the controls and 2.9% for the treated; after 19 years the percentages are 5.1 and 6.1, respectively.

It can be seen that the confidence interval around the survival curve of the matched control group is widening for longer durations which is also the case in figures 2-11. This is due to the right censoring of observations of late base years at longer durations, i.e. the smaller numbers at risk at longer durations; observations for all base years are used to calculate the hazard and survival rates one year after the base year, whereas only observations for base year 1984 are used to calculate the hazard rate at duration 19 and the corresponding last term in the sum of the formula for the variance of the survival curve in (4).

Figure 2 shows results for *diseases of blood and blood-forming organs*. Here the survival curve of the treatment group is below the lower 95% confidence bound of that of the matched controls at all durations, and the survival rates are significantly different at the 5% level for durations of 2-16 years (at the 10% level the differences are also significant for durations of 17-19 years). However, hospitalization for these diagnoses is a rare event. The probabilities of having been hospitalized for these diseases within ten years from the base year are 1.0 and 0.8% for the treatment and control groups, respectively; after 19 years the probabilities are 2.7 and 2.4%.

Figure 3 shows the survival curves until hospitalization for *diseases of respiratory organs*. The survival rates are not significantly different for the first nine years. For durations 10 and above the difference is significant at the 5% level (except for duration 11 where it is significant at the 10% level), and the survival curve of the treatment group is below that of the control group indicating a higher risk of hospitalization for these diseases in 'the long run' for the displaced. The probability of hospitalization within 10 years is 6.8% for the treatment

group and 6.5% for the control group; after 19 years the percentages are 14.0 and 13.0, respectively.

Figure 4 shows the results for *diseases of the musculoskeletal system*. Here the results indicate *reduced* risk of hospitalization for the treatment group compared to the matched control group, and the difference in survival rates are significant at the 5% level at durations 8 and above (except at duration 10 where it is significant at the 10% level). The probability of hospitalization within 8 years is 13.1% for the treatment group and 13.7% for the control group; after 19 years the percentages are 29.2 and 30.4, respectively.

Also the results for *symptoms and other ill-defined conditions* may indicate reduced risk of hospitalization for the treatment group, see figure 5. The survival curve of the treatment group is significantly above that of the control group at durations 2-7, 9 and 11 years (at the 5% level). However, at these durations the difference in survival probabilities is only 0.3-0.8 percentage points in spite of the fact that hospitalization with these diagnoses is very common (26% have been hospitalized within 10 years and 53% within 19 years).

Figure 6 shows survival curves for *trauma, poisonings and other violent bodily harm*. Hospitalization with these diagnoses is also a rather common event; about 40% have been hospitalized within 10 years and 60% within 19 years from base year. The results indicate that displacement increases the risk of hospitalization for these diagnoses: The survival curve for the treatment group is consistently below that of the matched control group, and the differences are significant at the 5% level for durations of three years or longer (except for durations 4, 6, 7 and 19 where the differences are significant at the 10% level). The survival rate for the treatment group is 0.4 percentage points smaller at a duration of three years, and 0.7 and 1.4 percentage points smaller at durations of 8 and 16 years, respectively.

Displacement seems to *reduce* the risk of hospitalization due to *high blood pressure*: The survival curve of the treatment group is above that of the control group at all durations, and the differences are significant at the 5% level for the first five years after the base year; see figure 7.

There is some indication that displacement increases the risk of hospitalization for *neurotic diseases, etc.*, see figure 8. The survival curve of the treatment group is lower than the survival curve of the control group at all durations, but the differences are only significant at the 5% level for durations 7, 9 and 13-19. Note also, that since we only have hospitalization data for somatic hospital departments, we only have rather few observations on neurotic diseases.

Figure 9 shows the results for a *selective group of diagnoses for trauma and violent bodily harm*. The results corresponds more or less to those of figure 6 which covered a broader group of such diagnoses, but the differences between the survival curves of the treatment and control groups are more significant for the more selective set of diagnoses represented in figure 9. The results indicate that displacement may increase the risk of hospitalization. The survival rates are significantly different at the 5% level for durations of 3 years and above.

Figure 10 indicates that displacement may increase the risk of hospitalization for *diseases related to alcoholic abuse*. The survival curve of the treatment group is consistently below that of the control group, and the difference is significant at the 5% level for durations 1-11 and 14 years. It may seem surprising that there are short-run effects since most of these diseases are only observable after several years of alcoholic abuse. One explanation may be that displacement worsens the alcoholic abuse of those who are already abusers, and thus causes a higher risk of (earlier) hospitalization.

Hospitalization for *suicide attempt* is a very rare phenomenon. Figure 11 shows that this has occurred only for about 0.3% after 19 years. However, the survival curve of the treatment group is below that of the control group indicating that the displacement may increase the risk of suicide attempt. The differences are significant at the 5% level for durations of 4 and 7 years only, but at the 10% level for durations of 3-10 years.

Figure 12 shows results for the first three specific categories of diagnoses taken together, i.e. the *stress-related diagnoses of the digestive and circulatory systems*. The survival curve of the treatment group is consistently above that of the control group, and the differences are significant at the 5% level for durations 2, 3, and 14-19. This confirms the surprising result of

tables 8 and 9: Displacement seems to *reduce* the risk of hospitalization for stress-related diseases. However, the difference in survival rates is only 0.1 percentage point three years from the base year and 0.5 percentage point 19 years from the base year.

5.3 Dif-in-Dif matching estimates of treatment effect on hospitalization rates

We have calculated difference-in-differences estimates based on the treatment and matched control groups using the same number of years to measure hospitalization rates before and after the base year. Thus, we have calculated one set of estimates using the difference in hospitalization rates between 1 year after base year and 1 year before base year, another set of estimates using the difference in hospitalization rates between 1-2 years after and 1-2 years before the base year, etc. We are able to calculate such dif-in-dif estimates using hospitalization up to 11 years after and before base year (for this calculation, only observations of base year 1992 can be used). The general result of these calculations is that only very few dif-in-dif estimates are significant for ‘short-run effects’, i.e. effects based on hospitalization rates a few years around the base year, whereas ‘long-run effects’ (using a longer span of years around the base year) are more significant.

As an illustration, we show in Table 11 dif-in-dif estimates based on hospitalization rates 1-8 years after and 1-8 years before the base year. As in Tables 8 and 9 we find again an indication that displacement due to plant closure increases the risk of hospitalization for diseases of blood and blood-forming organs, and for trauma, poisonings and other violent bodily harm (both for the broad and more specific category), for diseases of respiratory organs, and also for infective and parasitic diseases (although this effect is less significant). None of the dif-in-dif estimates of Table 11 are significantly negative, i.e. there is no indication that displacement due to plant closure will reduce the risk of hospitalization for any of the categories of diagnoses analysed. Note also that the effects on the three stress related outcomes (gastric catarrh and gastric ulcer, etc., high blood pressure, and heart attack) are clearly insignificant (and even with positive signs).

6. Conclusion

The analysis of this paper has focused on the causal effect of displacement due to plant closure on hospitalization for a wide range of categories of diagnoses. The analysis has focused on high-tenure workers with a strong initial labour market attachment. The results indicate that displacement due to plant closure may increase the risk of hospitalization for diseases of blood and blood-forming organs, for trauma, poisonings and other violent bodily harm, for diseases of respiratory organs, and perhaps also for infective and parasitic diseases. The duration analysis also indicates that displacement may increase the risk of hospitalization for neurotic diseases, etc., diseases related to alcoholic abuse, and suicide attempt, whereas there may be a reduced risk of hospitalization due to diseases of the musculoskeletal system, and ‘symptoms and other ill-defined conditions’.

Surprisingly the results indicate no effect on (or even reduced risk of) hospitalization for diseases of the circulatory system. Especially stress-related circulatory diseases such as high blood pressure and heart attack are often expected to be likely consequences of displacement and unemployment; see the discussion and references in Browning et al. (2006). The same applies for diagnoses of the digestive system such as gastric catarrh and gastric ulcer, etc. which may also be associated with stress.

More in line with our expectations, we do not find any indication of an effect of displacement on the risk of hospitalization for tumours, nutritional and metabolic diseases, diseases of the nervous system and sensory organs, diseases of the genitor-urinary system, or skin diseases.

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Table 1. Number of plant closures and number of employees in the base year

Base year	No. of plant closures	Percent of total	No. of employees*		
			Mean	Minimum	Maximum
1984	1825	5.73	14.63	5	985
1985	2031	6.38	15.26	5	682
1986	2196	6.90	14.68	5	782
1987	2626	8.25	13.69	5	620
1988	2509	7.88	13.62	5	618
1989	2389	7.50	12.52	5	517
1990	2292	7.20	15.06	5	702
1991	2209	6.94	14.59	5	910
1992	2160	6.78	14.58	5	739
1993	1665	5.23	12.88	5	361
1994	1615	5.07	14.14	5	754
1995	1443	4.53	12.82	5	279
1996	1389	4.36	13.83	5	549
1997	1432	4.50	12.51	5	322
1998	1499	4.71	17.11	5	853
1999	1451	4.56	14.96	5	638
2000	1112	3.49	14.94	5	543
All years	31843	100	14.2	5	985

Note. The number of employees includes sideline and part-time workers.

Table 2. Sample restrictions and size of treatment and control groups for base years 1984-2000

Restrictions	Size of treatment group	Size of control group
Basic restrictions *	307,989	1,349,788
Tenure of employee at least 3 years	114,147	608,426
Full time employed 1-3 years before base year	93,598	533,786
Age 20-60	91,181	515,902
If in treatment group in more than one year, only first year counts	89,548	
If in treatment group, then not in control group in any year		344,351
No unemployment 3 years prior to base year	71,157	298,727
Men	50,526	214,986
Women	20,631	83,741

* Treatment group: Employees in base year at closing private sector plants with at least five employees; plants have existed for at least three years prior to closure.

Control group: Observations of employees at private sector plants with at least five employees; the plants are either not downsizing, or downsizing by less than 10%; if the plants are eventually closing, the base year must be more than three years before the year of closure.

Table 3. Numbers in treatment and control groups by base year; males.

Base year	# treated	%	# controls	%	treated as a percentage of treated and controls
1984	2249	4.45	9391	4.37	19.32
1985	2474	4.9	11585	5.39	17.60
1986	2948	5.83	11357	5.28	20.61
1987	3748	7.42	11237	5.23	25.01
1988	2831	5.6	12063	5.61	19.01
1989	3377	6.68	12546	5.84	21.21
1990	4452	8.81	11378	5.29	28.12
1991	4066	8.05	12437	5.79	24.64
1992	3960	7.84	12409	5.77	24.19
1993	2990	5.92	14035	6.53	17.56
1994	2606	5.16	13514	6.29	16.17
1995	2217	4.39	13401	6.23	14.20
1996	2152	4.26	14007	6.52	13.32
1997	2016	3.99	14333	6.67	12.33
1998	3646	7.22	13884	6.46	20.80
1999	2721	5.39	13982	6.5	16.29
2000	2073	4.1	13427	6.25	13.37
All years	50526	100	214986	100	19.03

Table 4. Hospitalization rates (%) for treatment and control groups; different categories of diagnoses.

Variable	Hospitalization after base year (whole period)		Hospitalization 1-4 years after base year		Hospitalization 1-3 years before base year	
	Treated	Controls	Treated	Controls	Treated	Controls
All diagnoses	74.94	73.10	36.84	39.47	21.17	23.29
<i>Broad categories of diagnoses based on S-list:</i>						
Infective and parasitic diseases	3.63	2.97	1.03	0.97	0.50	0.58
Tumours (malignant neoplasm)	8.94	8.43	2.54	2.58	0.96	1.02
Nutritional and metabolic diseases	6.61	6.26	1.89	1.91	0.82	0.86
Diseases of blood and blood-forming organs	1.37	1.23	0.33	0.29	0.10	0.10
Mental disorders	2.54	2.35	0.76	0.71	0.34	0.35
Diseases of the nervous system and sensory organs	14.87	14.09	3.89	4.16	1.60	1.69
Diseases of circulatory organs	18.08	17.22	5.55	5.78	2.46	2.53
Diseases of respiratory organs	8.40	7.76	2.55	2.61	1.35	1.49
Diseases of digestive system	16.75	16.06	5.55	5.86	3.19	3.37
Diseases of the genito-urinary system	8.72	8.33	2.50	2.61	1.36	1.49
Skin diseases	4.68	4.39	1.43	1.51	0.78	0.87
Diseases of musculoskeletal system	19.57	19.09	6.46	7.15	2.81	3.19
Symptoms and other ill-defined conditions	33.76	32.79	8.68	10.13	3.13	3.51
Trauma, poisonings and other violent bodily harm	45.75	43.82	17.72	19.65	9.39	10.94
<i>Specific categories of diagnoses:</i>						
Digestive: gastric catarrh, gastric ulcer, etc.	4.67	4.56	1.45	1.46	0.68	0.78
Circulatory: high blood pressure	4.92	4.90	1.05	1.33	0.43	0.51
Circulatory: heart attack (myocardial infarction), etc.	8.84	8.42	2.49	2.55	1.04	0.96
Neurotic diseases, etc.	2.17	1.80	0.49	0.49	0.25	0.22
Selected trauma and violent bodily harm	11.79	10.74	3.98	4.08	2.36	2.54
Diseases related to alcoholic abuse	1.84	1.60	0.66	0.56	0.33	0.29
Suicide attempt	0.23	0.22	0.12	0.10	0.05	0.04
First three specific categories taken together	14.98	14.57	4.45	4.75	1.98	2.08

Table 5. Propensity score estimation result for the pooled sample of all base years 1984-2000 (probit model for being employed at a closing plant in the base year), and means for treatment and control groups

Variable	Coef.	Std. Error	z	P> z	Means	
					Treated	Controls
Base year 1985	-0.0473	0.0183	-2.5900	0.0100	0.0490	0.0539
Base year 1986	0.0639	0.0179	3.5700	0.0000	0.0583	0.0528
Base year 1987	0.1967	0.0174	11.2700	0.0000	0.0742	0.0523
Base year 1988	-0.0094	0.0179	-0.5200	0.6010	0.0560	0.0561
Base year 1989	0.0730	0.0175	4.1800	0.0000	0.0668	0.0584
Base year 1990	0.2827	0.0171	16.4900	0.0000	0.0881	0.0529
Base year 1991	0.1802	0.0172	10.5100	0.0000	0.0805	0.0579
Base year 1992	0.1687	0.0172	9.8100	0.0000	0.0784	0.0577
Base year 1993	-0.0604	0.0176	-3.4400	0.0010	0.0592	0.0653
Base year 1994	-0.1139	0.0179	-6.3600	0.0000	0.0516	0.0629
Base year 1995	-0.1991	0.0183	-10.8700	0.0000	0.0439	0.0623
Base year 1996	-0.2393	0.0183	-13.0600	0.0000	0.0426	0.0652
Base year 1997	-0.2839	0.0184	-15.3900	0.0000	0.0399	0.0667
Base year 1998	0.0650	0.0172	3.7900	0.0000	0.0722	0.0646
Base year 1999	-0.1110	0.0178	-6.2500	0.0000	0.0539	0.0650
Base year 2000	-0.2386	0.0185	-12.8900	0.0000	0.0410	0.0625
Age 20-24	-0.3053	0.0164	-18.6700	0.0000	0.0341	0.0510
Age 25-29	-0.0767	0.0119	-6.4700	0.0000	0.0857	0.0900
Age 30-34	-0.0132	0.0103	-1.2800	0.2000	0.1325	0.1309
Age 35-39	-0.0040	0.0100	-0.4000	0.6910	0.1490	0.1446
Age 45-49	-0.0049	0.0098	-0.5000	0.6140	0.1606	0.1549
Age 50-54	-0.0003	0.0101	-0.0300	0.9790	0.1433	0.1413
Age 55-60	-0.0298	0.0108	-2.7600	0.0060	0.1123	0.1146
Vocational education	-0.0104	0.0064	-1.6200	0.1050	0.5425	0.5306
Short further education	-0.0537	0.0167	-3.2100	0.0010	0.0313	0.0335
Long further education	-0.0407	0.0121	-3.3600	0.0010	0.0686	0.0713
Higher education	-0.2167	0.0180	-12.0600	0.0000	0.0255	0.0363
Couple	-0.0229	0.0074	-3.0900	0.0020	0.7903	0.7847
Manufacturing	-0.0710	0.0075	-9.5200	0.0000	0.3598	0.3684
Construction	0.0871	0.0105	8.2600	0.0000	0.1161	0.0900
Infrastructure	-0.1232	0.0103	-11.9800	0.0000	0.1123	0.1192
Financial services	-0.0883	0.0103	-8.5500	0.0000	0.1181	0.1269
Other industries	-0.3845	0.0145	-26.5500	0.0000	0.0359	0.0647
Province	-0.0931	0.0062	-14.9900	0.0000	0.6627	0.7012
Constant term	-0.6848	0.0176	-38.8800	0.0000		
Log likelihood	-126,535					
Observations	265,512				50,526	214,986
LR test of model, $\chi^2(34)$	5,355					

Note. The reference categories are: Base year 1984, age 40-44, no education beyond compulsory, single, service industry, and living in the metropolitan area of Copenhagen.

Table 6. Balancing properties with respect to explanatory variables of the propensity score. Treatment and matched control groups.

Variable	Mean Treated	Mean Controls	Difference in means	Std. dev.	Two-sample t test
Age 20-24	0.0341	0.0351	-0.0010	0.0011	-0.84
Age 25-29	0.0857	0.0860	-0.0003	0.0018	-0.16
Age 30-34	0.1325	0.1332	-0.0007	0.0021	-0.33
Age 35-39	0.1490	0.1492	-0.0002	0.0022	-0.08
Age 45-49	0.1606	0.1601	0.0005	0.0023	0.21
Age 50-54	0.1433	0.1434	-0.0001	0.0022	-0.04
Age 55-60	0.1123	0.1115	0.0008	0.0020	0.41
Vocational education	0.5425	0.5446	-0.0021	0.0031	-0.68
Short further education	0.0313	0.0291	0.0022	0.0011	2.08
Long further education	0.0686	0.0648	0.0037	0.0016	2.38
Higher education	0.0255	0.0241	0.0014	0.0010	1.40
Couple	0.7903	0.7905	-0.0002	0.0026	-0.09
Manufacturing	0.3598	0.3604	-0.0006	0.0030	-0.20
Construction	0.1161	0.1133	0.0028	0.0020	1.38
Infrastructure	0.1123	0.1114	0.0009	0.0020	0.46
Financial services	0.1181	0.1210	-0.0028	0.0020	-1.39
Other industries	0.0359	0.0351	0.0008	0.0012	0.71
Province	0.6627	0.6640	-0.0013	0.0030	-0.45

Table 7. Balancing properties with respect to initial health status: Probability of hospitalization 3 years before base year. Mean hospitalization rates (%) for treatment and matched control groups.

Variable	Rate Treated	Rate Controls	Difference in rates	Std. dev.	Two-sample t test
All diagnoses	21.17	20.79	0.38	0.26	1.48
<i>Broad categories of diagnoses based on S-list:</i>					
Infective and parasitic diseases	0.50	0.50	0.00	0.04	0.00
Tumours (malignant neoplasm)	0.96	0.92	0.04	0.06	0.72
Nutritional and metabolic diseases	0.82	0.81	0.01	0.06	0.18
Diseases of blood and blood-forming organs	0.10	0.10	0.00	0.02	0.20
Mental disorders	0.34	0.32	0.02	0.04	0.60
Diseases of the nervous system and sensory organs	1.60	1.48	0.12	0.08	1.51
Diseases of circulatory organs	2.46	2.48	-0.01	0.10	-0.14
Diseases of respiratory organs	1.35	1.47	-0.12	0.07	-1.63
Diseases of digestive system	3.19	3.22	-0.03	0.11	-0.27
Diseases of the genito-urinary system	1.36	1.43	-0.07	0.07	-0.99
Skin diseases	0.78	0.72	0.06	0.05	1.13
Diseases of musculoskeletal system	2.81	2.81	0.00	0.10	-0.02
Symptoms and other ill-defined conditions	3.13	3.07	0.05	0.11	0.49
Trauma, poisonings and other violent bodily harm	9.39	9.09	0.30	0.18	1.63
<i>Specific categories of diagnoses:</i>					
Digestive: gastric catarrh, gastric ulcer, etc.	0.68	0.76	-0.08	0.05	-1.48
Circulatory: high blood pressure	0.43	0.50	-0.07	0.04	-1.66
Circulatory: heart attack (myocardial infarction), etc.	1.04	1.00	0.03	0.06	0.53
Neurotic diseases, etc.	0.25	0.17	0.08	0.03	2.78
Selected trauma and violent bodily harm	2.36	2.30	0.06	0.09	0.58
Diseases related to alcoholic abuse	0.33	0.26	0.07	0.03	1.92
Suicide attempt	0.05	0.03	0.02	0.01	1.41
First three specific categories taken together	1.98	2.10	-0.12	0.09	-1.38

Table 8. Proportions hospitalized (%) 1-4 years after base year for treatment and matched control groups, and average treatment effects on the treated (ATET).

Variable	Rate Treated	Rate Controls	ATET	Std. error	Two-sample t test
All diagnoses	36.84	36.77	0.07	0.30	0.24
<i>Broad categories of diagnoses based on S-list:</i>					
Infective and parasitic diseases	1.03	0.94	0.09	0.06	1.43
Tumours (malignant neoplasm)	2.54	2.52	0.03	0.10	0.28
Nutritional and metabolic diseases	1.89	1.74	0.15	0.08	1.77
Diseases of blood and blood-forming organs	0.33	0.20	0.12	0.03	3.86
Mental disorders	0.76	0.70	0.07	0.05	1.22
Diseases of the nervous system and sensory organs	3.89	3.88	0.01	0.12	0.07
Diseases of circulatory organs	5.55	5.78	-0.23	0.15	-1.61
Diseases of respiratory organs	2.55	2.62	-0.07	0.10	-0.69
Diseases of digestive system	5.55	5.63	-0.08	0.14	-0.58
Diseases of the genito-urinary system	2.50	2.48	0.03	0.10	0.26
Skin diseases	1.43	1.39	0.05	0.07	0.64
Diseases of musculoskeletal system	6.46	6.69	-0.24	0.16	-1.51
Symptoms and other ill-defined conditions	8.68	9.27	-0.59	0.18	-3.29
Trauma, poisonings and other violent bodily harm	17.72	17.36	0.36	0.24	1.51
<i>Specific categories of diagnoses:</i>					
Digestive: gastric catarrh, gastric ulcer, etc.	1.45	1.44	0.01	0.08	0.11
Circulatory: high blood pressure	1.05	1.27	-0.22	0.07	-3.20
Circulatory: heart attack (myocardial infarction), etc.	2.49	2.60	-0.11	0.10	-1.12
Neurotic diseases, etc.	0.49	0.47	0.02	0.04	0.41
Selected trauma and violent bodily harm	3.98	3.71	0.27	0.12	2.21
Diseases related to alcoholic abuse	0.66	0.54	0.12	0.05	2.49
Suicide attempt	0.12	0.08	0.04	0.02	2.13
First three specific categories taken together	4.45	4.71	-0.27	0.13	-2.02

Table 9. Proportions hospitalized (%) from one year after base year to the end of the sample period (2003) for treatment and matched control groups, and average treatment effects on the treated (ATET).

Variable	Rate Treated	Rate Controls	ATET	Std. error	Two-sample t test
All diagnoses	74.94	75.23	-0.29	0.27	-1.08
<i>Broad categories of diagnoses based on S-list:</i>					
Infective and parasitic diseases	3.63	3.19	0.44	0.11	3.86
Tumours (malignant neoplasm)	8.94	9.07	-0.13	0.18	-0.71
Nutritional and metabolic diseases	6.61	6.60	0.01	0.16	0.06
Diseases of blood and blood-forming organs	1.37	1.16	0.21	0.07	3.04
Mental disorders	2.54	2.44	0.10	0.10	1.03
Diseases of the nervous system and sensory organs	14.87	15.19	-0.31	0.22	-1.39
Diseases of circulatory organs	18.08	18.33	-0.25	0.24	-1.03
Diseases of respiratory organs	8.40	7.99	0.41	0.17	2.36
Diseases of digestive system	16.75	16.78	-0.03	0.24	-0.11
Diseases of the genito-urinary system	8.72	8.62	0.10	0.18	0.57
Skin diseases	4.68	4.75	-0.07	0.13	-0.50
Diseases of musculoskeletal system	19.57	20.49	-0.92	0.25	-3.67
Symptoms and other ill-defined conditions	33.76	34.46	-0.69	0.30	-2.32
Trauma, poisonings and other violent bodily harm	45.75	44.89	0.86	0.31	2.75
<i>Specific categories of diagnoses:</i>					
Digestive: gastric catarrh, gastric ulcer, etc.	4.67	4.92	-0.25	0.13	-1.87
Circulatory: high blood pressure	4.92	5.14	-0.22	0.14	-1.60
Circulatory: heart attack (myocardial infarction), etc.	8.84	9.12	-0.28	0.18	-1.57
Neurotic diseases, etc.	2.17	1.91	0.26	0.09	2.87
Selected trauma and violent bodily harm	11.79	11.20	0.59	0.20	2.94
Diseases related to alcoholic abuse	1.84	1.67	0.17	0.08	2.11
Suicide attempt	0.23	0.19	0.04	0.03	1.30
First three specific categories taken together	14.98	15.66	-0.67	0.23	-2.97

Table 10. t test statistics of difference in survival rates between matched control and treatment groups: t(survival rate of matched control group minus survival rate of treatment group).

Variable	Duration from base year (years)																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
All diagnoses	-0.78	-0.54	-0.03	0.41	0.65	-0.02	-0.66	-0.19	0.15	0.48	0.98	1.33	1.19	1.02	0.59	0.35	-0.39	-0.92	-0.67
<i>Broad categories of diagnoses based on S-list:</i>																			
Infective and parasitic diseases	0.25	1.32	1.14	1.47	1.53	1.81	2.70	2.94	3.13	3.14	3.39	3.47	3.47	3.37	3.10	3.26	3.52	3.96	4.21
Tumours (malignant neoplasm)	0.21	-0.83	-0.37	0.34	0.50	0.70	0.93	1.14	0.27	0.16	-0.40	-0.19	-0.45	-0.49	-0.73	-0.84	-0.79	-0.40	-0.78
Nutritional and metabolic diseases	-0.74	1.30	0.74	1.80	2.25	1.53	0.96	0.61	0.24	-0.22	-0.49	-0.19	-0.09	-0.17	0.11	-0.03	0.32	-0.20	0.40
Diseases of blood and blood-forming organs	1.31	2.44	3.39	3.88	4.09	3.86	3.37	3.30	2.98	3.16	3.39	2.99	2.52	2.05	2.41	2.59	1.89	1.76	1.90
Mental disorders	1.72	1.11	1.20	1.25	0.89	1.14	1.12	0.94	0.69	0.00	0.30	0.23	0.60	1.07	1.19	1.26	1.73	1.55	0.86
Diseases of the nervous system and sensory organs	0.50	0.33	0.10	0.14	0.28	-0.21	-0.17	-0.54	-0.77	-1.17	-0.86	-0.67	-0.37	-0.82	-0.79	-0.78	-0.71	-1.15	-1.36
Diseases of circulatory organs	0.18	-0.98	-1.63	-1.54	-1.36	-0.89	-1.15	-1.49	-1.51	-1.21	-0.81	-0.44	-0.60	-0.58	-0.56	-0.10	-0.65	-0.39	0.10
Diseases of respiratory organs	-1.13	-0.91	-0.70	-0.62	-0.23	0.22	0.42	1.41	1.69	2.02	1.91	2.12	2.69	2.83	2.89	2.87	2.30	2.75	2.82
Diseases of digestive system	-0.93	-1.23	-0.63	-0.51	-0.42	-0.03	-0.14	0.55	0.34	-0.37	0.21	0.22	0.09	0.47	0.51	-0.18	-0.36	-0.07	0.64
Diseases of the genito-urinary system	-0.36	-0.90	-0.23	0.36	-0.09	0.43	0.93	1.06	0.74	1.07	0.90	0.91	0.45	1.02	0.64	0.20	0.55	0.60	0.63
Skin diseases	1.81	0.28	0.12	0.69	0.31	0.47	-0.43	-0.99	-0.77	-0.60	-0.60	-0.20	-0.72	-0.65	-0.26	0.12	-0.41	-0.47	0.32
Diseases of musculoskeletal system	-1.41	-1.09	-1.61	-1.40	-1.03	-1.45	-1.73	-2.55	-2.32	-1.84	-2.27	-2.57	-2.60	-2.58	-2.90	-3.42	-3.50	-3.51	-2.70
Symptoms and other ill-defined conditions	-1.61	-2.63	-2.79	-3.17	-3.18	-2.59	-2.07	-1.51	-2.09	-1.80	-2.45	-1.88	-1.79	-1.51	-1.21	0.03	-0.49	-0.03	-0.46
Trauma, poisonings and other violent bodily harm	0.10	1.38	1.98	1.68	2.09	1.62	1.72	2.24	2.33	2.22	3.20	3.49	3.61	3.72	3.35	3.46	3.55	2.54	1.94
<i>Specific categories of diagnoses:</i>																			
Digestive: gastric catarrh, gastric ulcer, etc.	-1.14	-1.23	-0.41	0.14	-0.59	0.02	-0.70	-0.62	-1.06	-1.66	-1.40	-1.42	-1.95	-2.01	-2.10	-1.92	-2.14	-1.08	-1.00
Circulatory: high blood pressure	-2.44	-2.22	-3.03	-3.15	-2.94	-1.44	-1.36	-1.43	-1.62	-1.24	-0.39	-0.42	0.09	-0.05	-0.71	-0.70	-1.50	-1.79	-1.82
Circulatory: heart attack (myocardial infarction), etc.	-0.19	-0.53	-0.83	-1.04	-0.28	-0.72	-0.92	-0.63	-0.35	0.00	0.00	-0.03	-0.67	-1.12	-1.04	-0.72	-1.47	-2.31	-2.51
Neurotic diseases, etc.	0.99	0.48	0.77	0.44	1.06	1.66	2.03	1.78	1.98	1.89	1.84	1.86	2.10	2.61	3.00	2.74	2.63	3.41	3.21
Selected trauma and violent bodily harm	0.13	1.83	2.21	2.31	2.46	2.49	2.80	2.94	2.94	2.74	2.71	2.68	2.62	2.67	2.91	3.14	3.21	2.93	2.68
Diseases related to alcoholic abuse	2.69	2.63	2.43	2.51	2.13	2.43	2.23	2.18	2.53	2.39	2.26	1.73	1.91	2.15	1.64	1.10	1.47	1.56	1.59
Suicide attempt	0.87	0.90	1.80	2.15	1.82	1.81	2.01	1.80	1.84	1.95	1.42	1.49	1.49	1.54	0.99	0.54	0.28	0.28	0.28
First three specific categories taken together	-1.62	-2.00	-1.99	-1.94	-1.85	-1.17	-1.46	-1.49	-1.71	-1.74	-1.14	-1.14	-1.49	-2.05	-2.55	-2.05	-2.99	-3.28	-3.31

Table 11. Hospitalization rates (%) 8 years after base year and 8 years prior to base year for treatment and matched control groups; differences in these rates for treated and controls, respectively, and Difference-in-Differences estimates of ATET.

Variable	Treated		Controls		Treated		Controls		Dif-in-Dif		SE	t-test
	After	Prior	After	Prior	Diff.	Prior	Diff.	ATET				
All diagnoses	65.61	28.66	65.14	29.02	36.95	36.12	0.83	0.57	1.45			
<i>Broad categories of diagnoses based on S-list:</i>												
Infective and parasitic diseases	2.28	1.12	1.95	1.10	1.16	0.85	0.31	0.17	1.86			
Tumours (malignant neoplasm)	4.68	1.51	4.59	1.57	3.18	3.02	0.16	0.22	0.73			
Nutritional and metabolic diseases	3.90	1.08	3.96	1.14	2.82	2.82	0.00	0.18	0.00			
Diseases of blood and blood-forming organs	0.61	0.20	0.42	0.20	0.41	0.22	0.19	0.08	2.47			
Mental disorders	1.47	0.71	1.51	0.51	0.77	0.99	-0.23	0.13	-1.76			
Diseases of the nervous system and sensory organs	10.31	1.97	10.37	1.88	8.34	8.49	-0.14	0.30	-0.48			
Diseases of circulatory organs	11.05	3.82	11.35	4.25	7.22	7.10	0.12	0.32	0.38			
Diseases of respiratory organs	5.26	2.74	5.01	3.14	2.52	1.87	0.66	0.25	2.61			
Diseases of digestive system	11.70	6.18	11.37	6.37	5.52	5.00	0.52	0.35	1.46			
Diseases of the genito-urinary system	5.68	2.70	5.56	2.69	2.97	2.87	0.10	0.25	0.39			
Skin diseases	3.42	1.31	3.44	1.29	2.11	2.15	-0.04	0.20	-0.22			
Diseases of musculoskeletal system	14.95	3.60	15.16	3.97	11.35	11.19	0.15	0.36	0.42			
Symptoms and other ill-defined conditions	21.31	3.45	21.64	3.15	17.86	18.50	-0.64	0.41	-1.55			
Trauma, poisonings and other violent bodily harm	39.88	9.31	39.05	9.62	30.58	29.43	1.14	0.51	2.24			
<i>Specific categories of diagnoses:</i>												
Digestive: gastric catarrh, gastric ulcer, etc.	3.20	1.31	3.25	1.40	1.88	1.85	0.03	0.19	0.17			
Circulatory: high blood pressure	2.69	0.55	2.87	0.78	2.13	2.08	0.05	0.16	0.31			
Circulatory: heart attack (myocardial infarction), etc.	5.21	1.39	5.19	1.51	3.81	3.68	0.14	0.22	0.63			
Neurotic diseases, etc.	1.25	0.33	1.16	0.21	0.92	0.95	-0.03	0.11	-0.25			
Selected trauma and violent bodily harm	9.32	3.92	8.70	4.03	5.41	4.67	0.73	0.32	2.31			
Diseases related to alcoholic abuse	1.03	0.64	1.00	0.50	0.39	0.50	-0.12	0.11	-1.05			
Suicide attempt	0.15	0.15	0.14	0.09	0.00	0.05	-0.05	0.05	-1.12			
First three specific categories taken together	9.53	3.08	9.74	3.38	6.45	6.36	0.09	0.30	0.31			

Note. Estimates are based on persons in treatment and control groups of base years 1989-1994.

Figure 1. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *infective and parasitic diseases*.

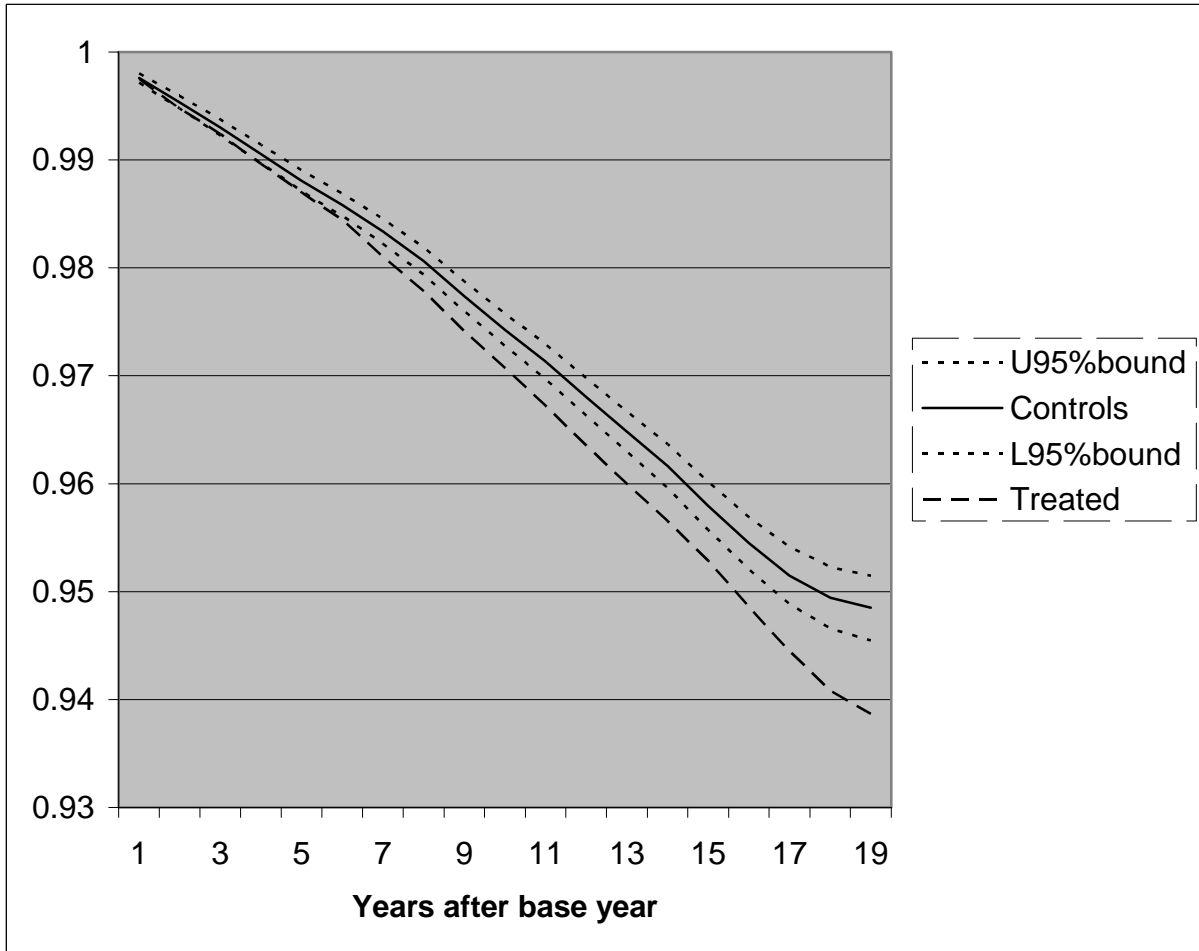


Figure 2. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *diseases of blood and blood-forming organs*.

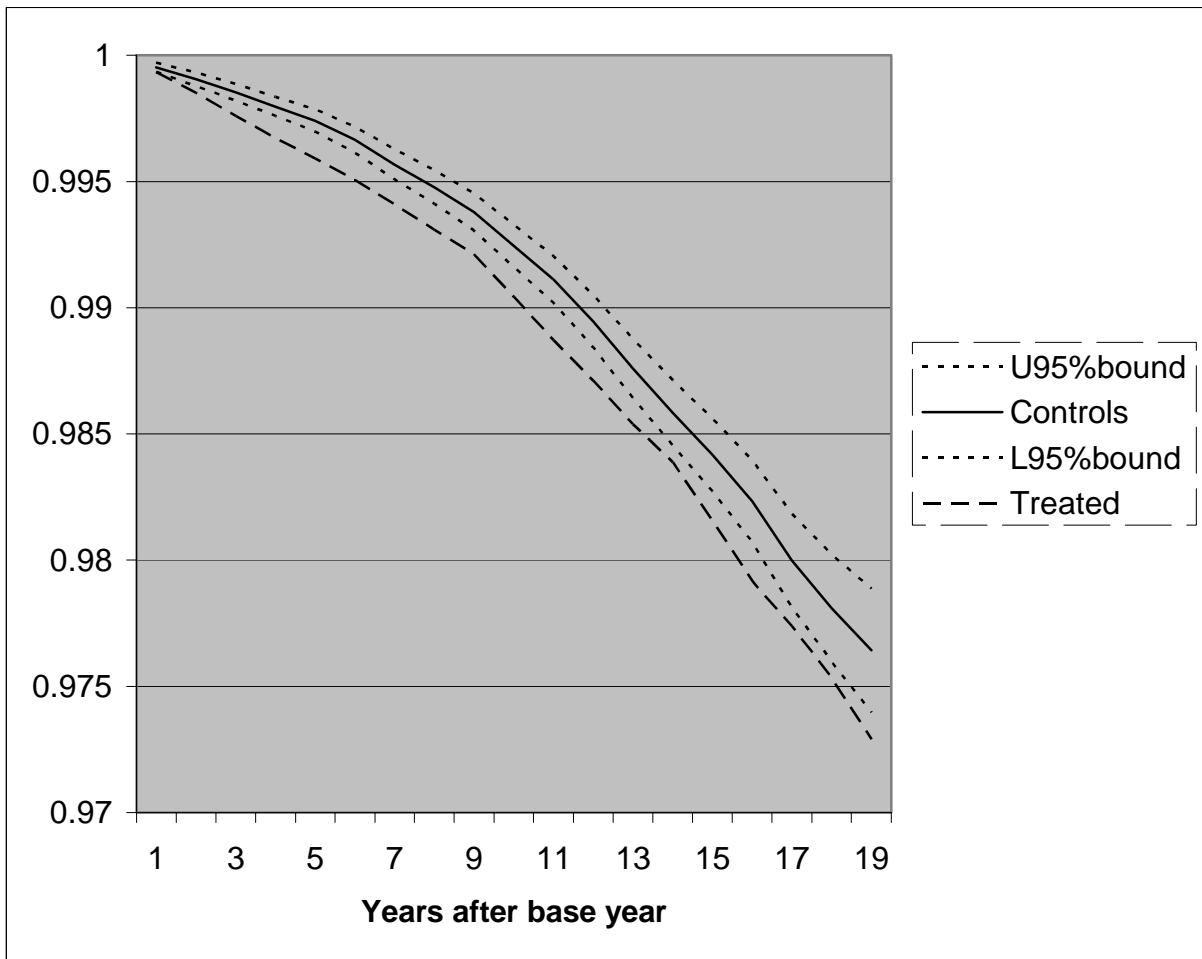


Figure 3. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *diseases of respiratory organs*.

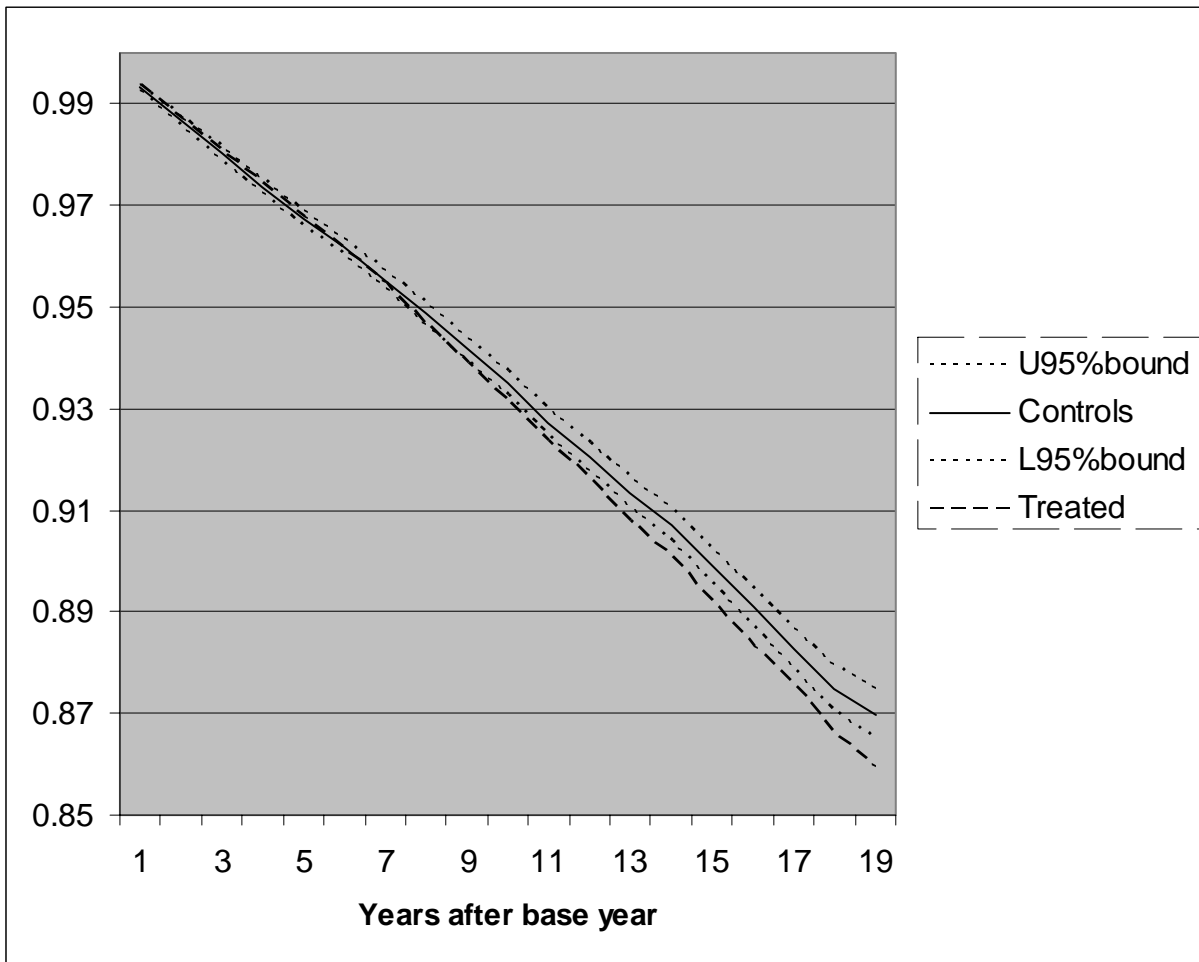


Figure 4. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *diseases of musculoskeletal system*.

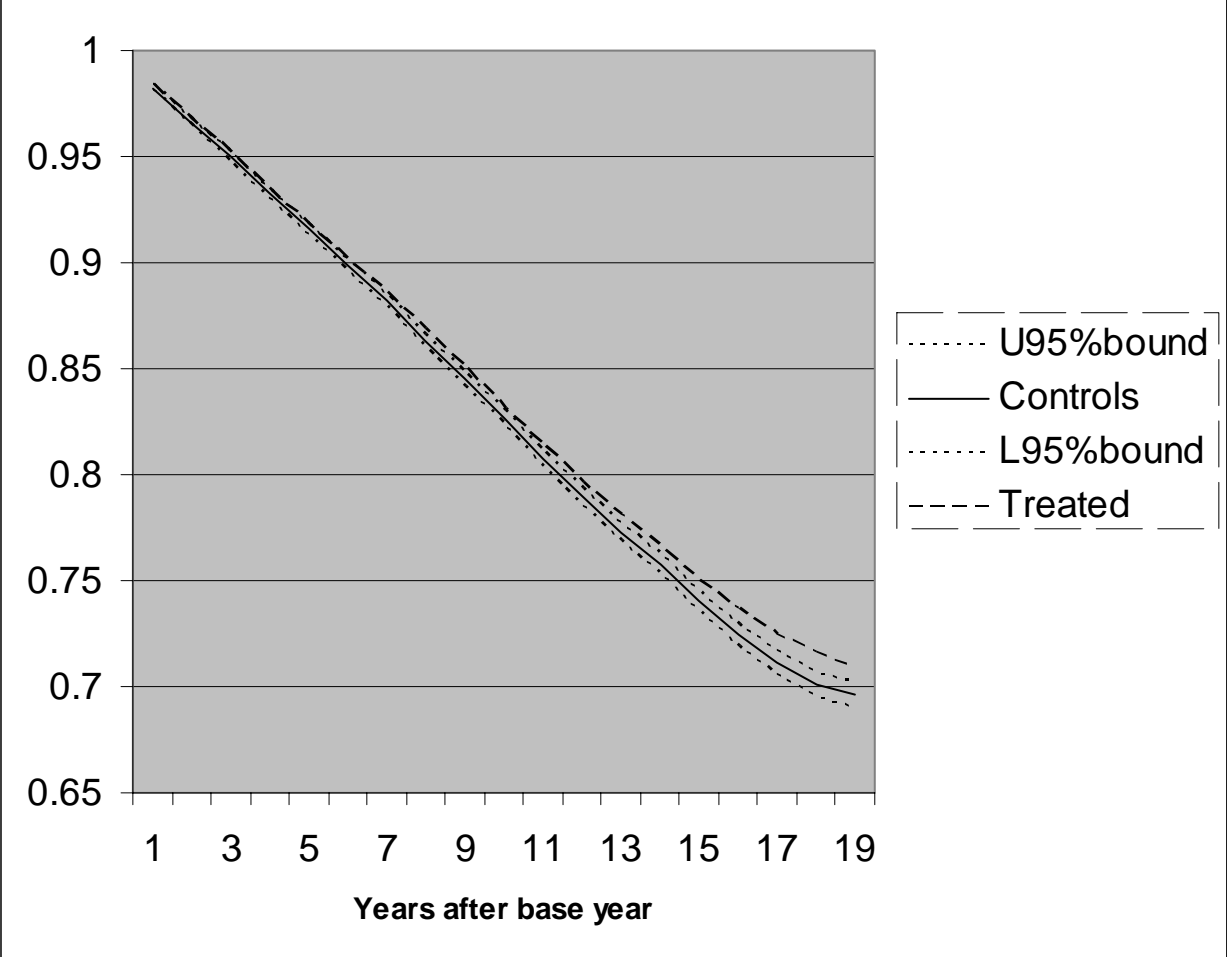


Figure 5. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *symptoms and other ill-defined conditions*.

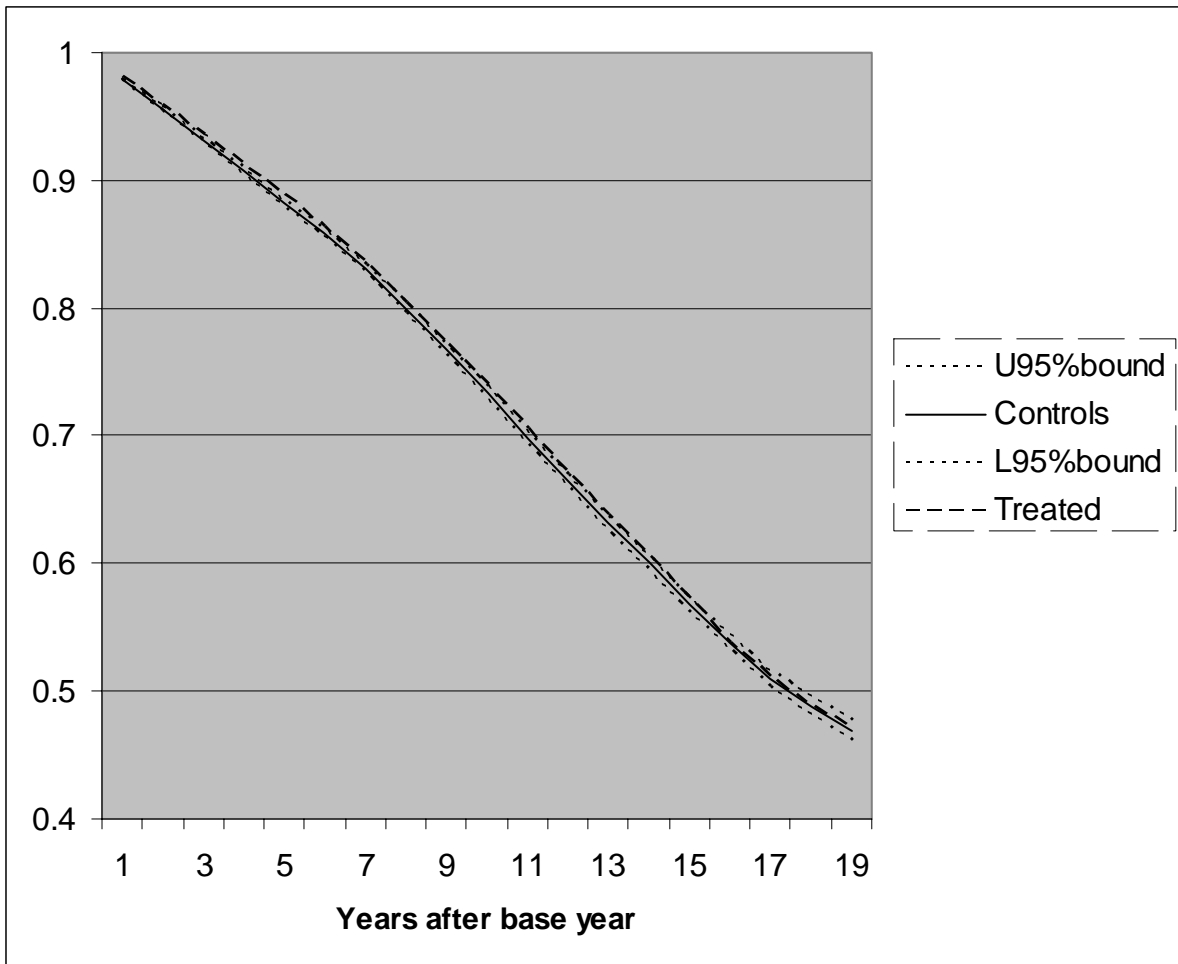


Figure 6. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *trauma, poisonings and other violent bodily harm*.

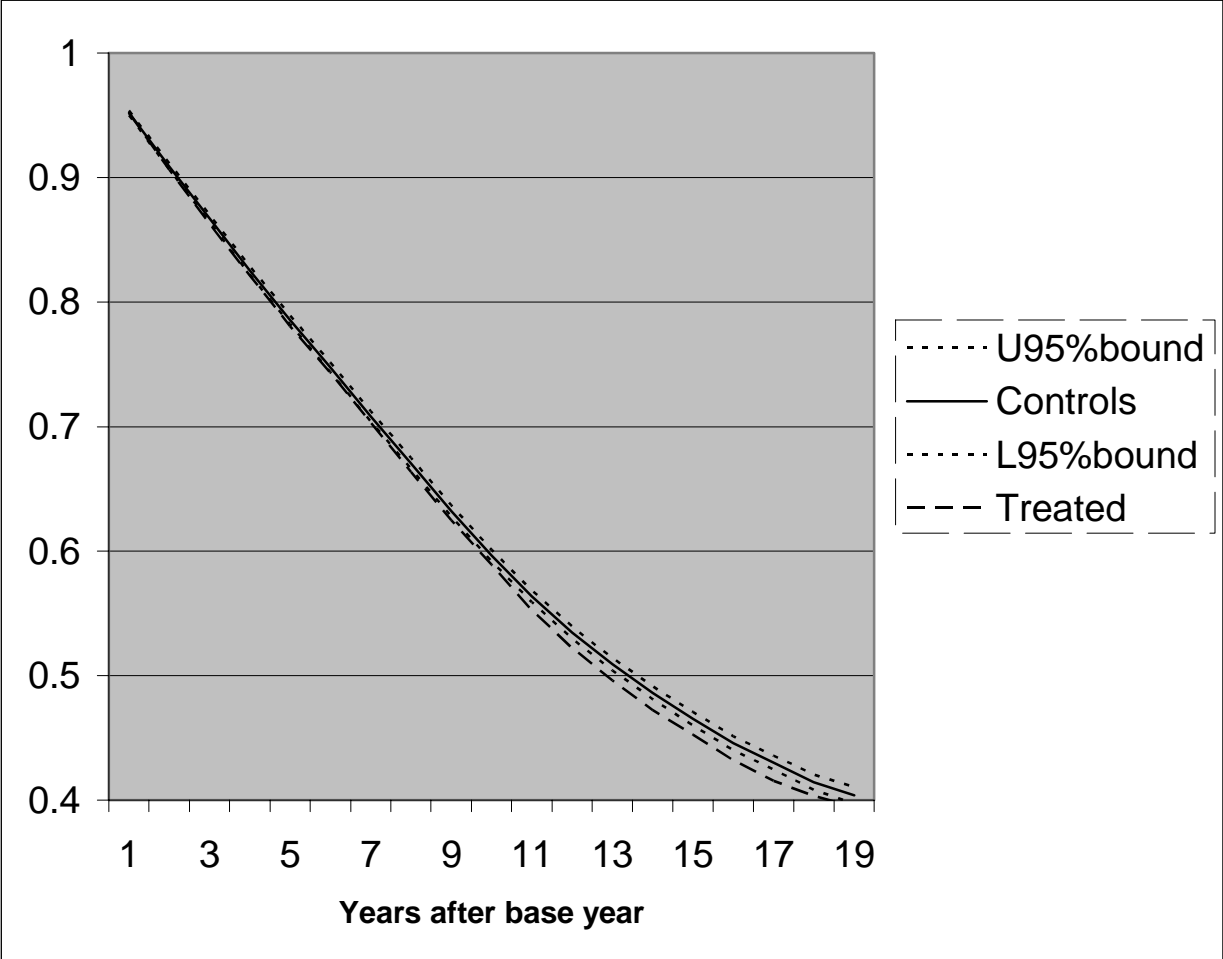


Figure 7. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *high blood pressure*.

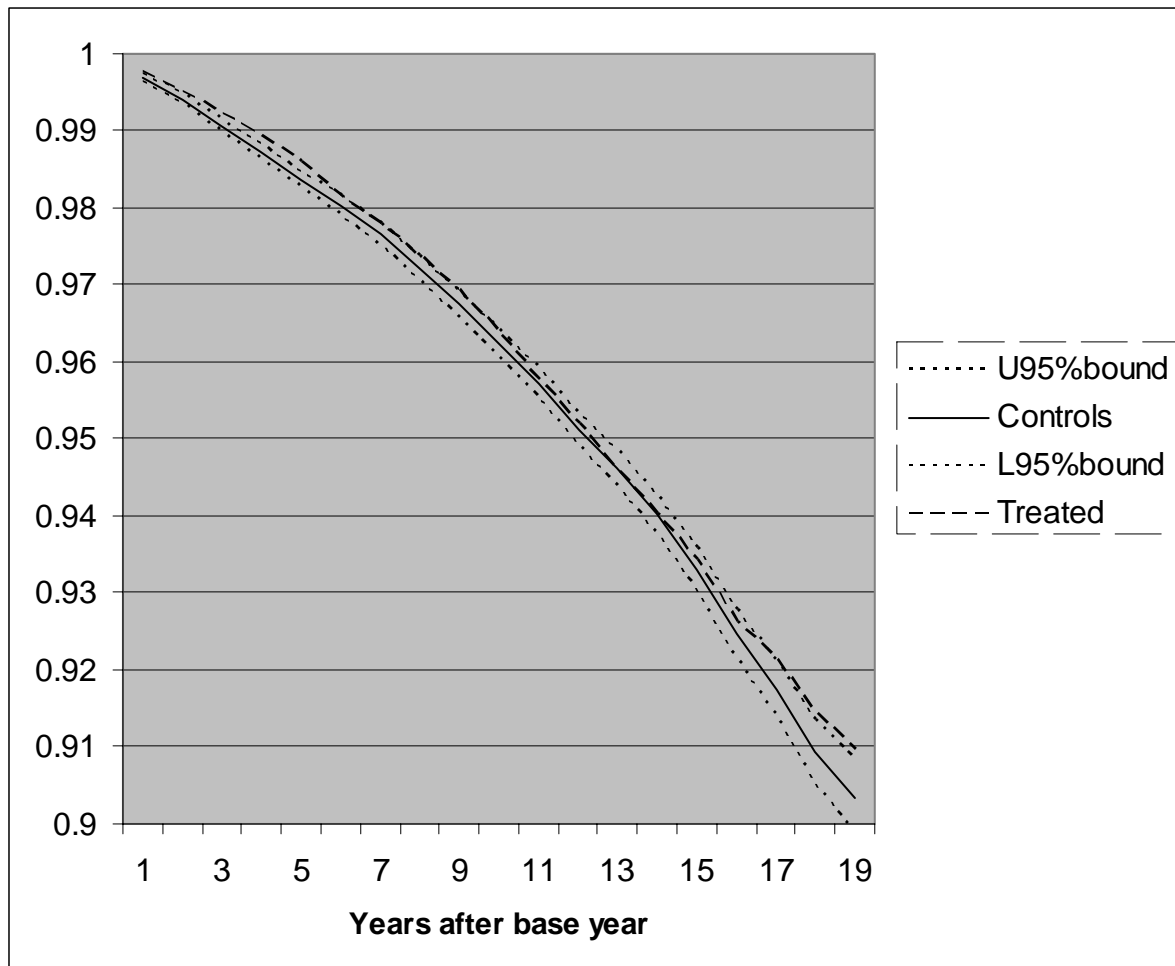


Figure 8. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *neurotic diseases, etc.*

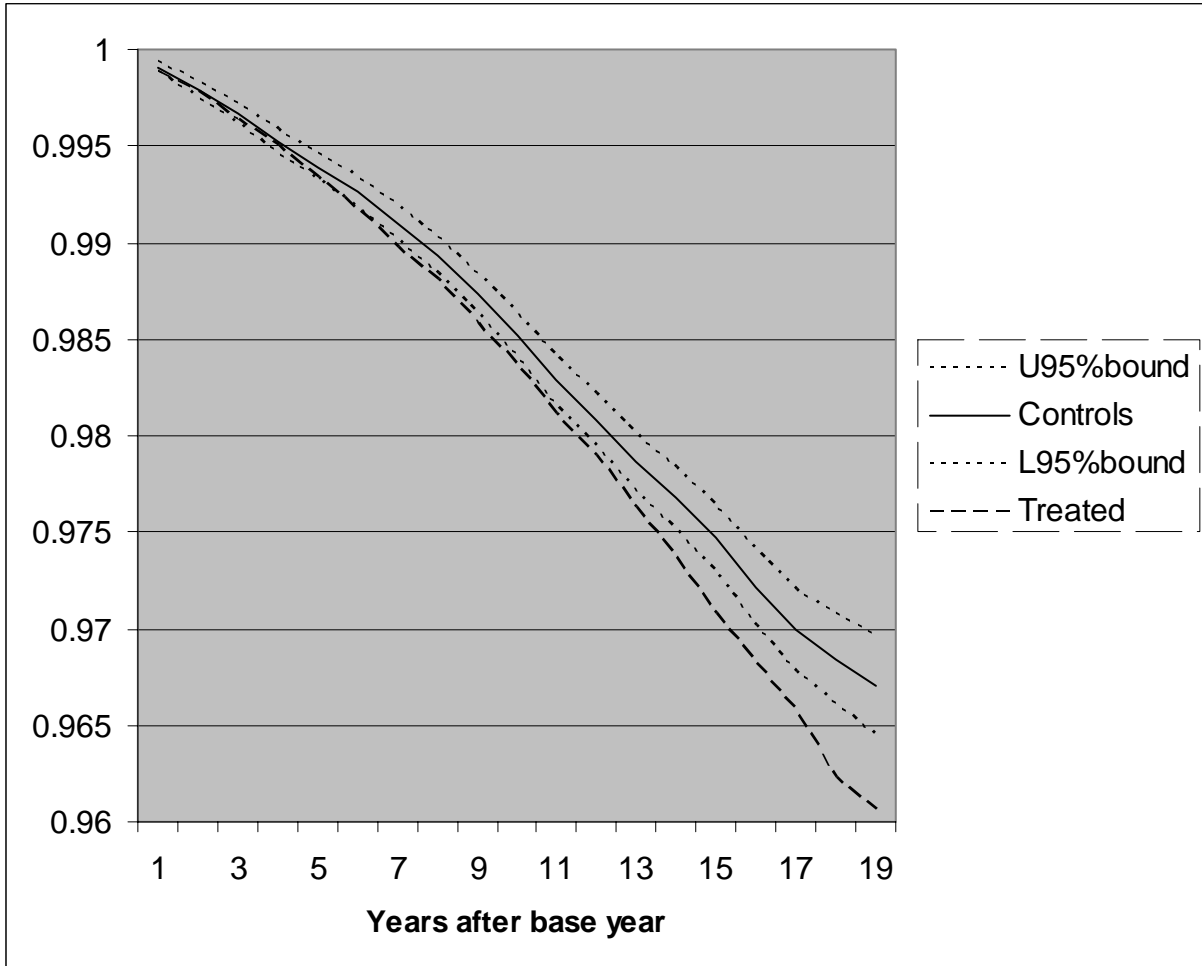


Figure 9. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *Selected trauma and violent bodily harm*.

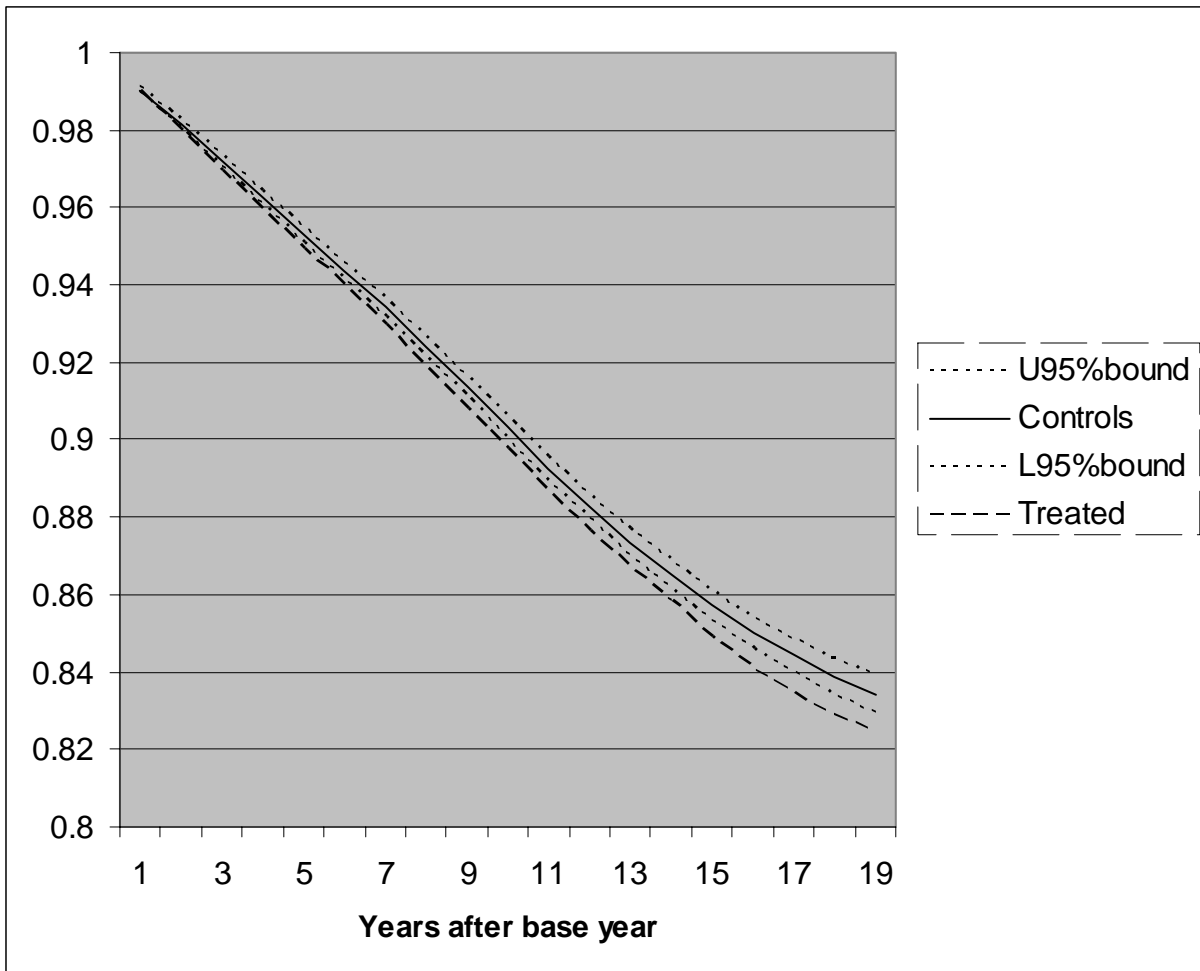


Figure 10. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *diseases related to alcoholic abuse*.

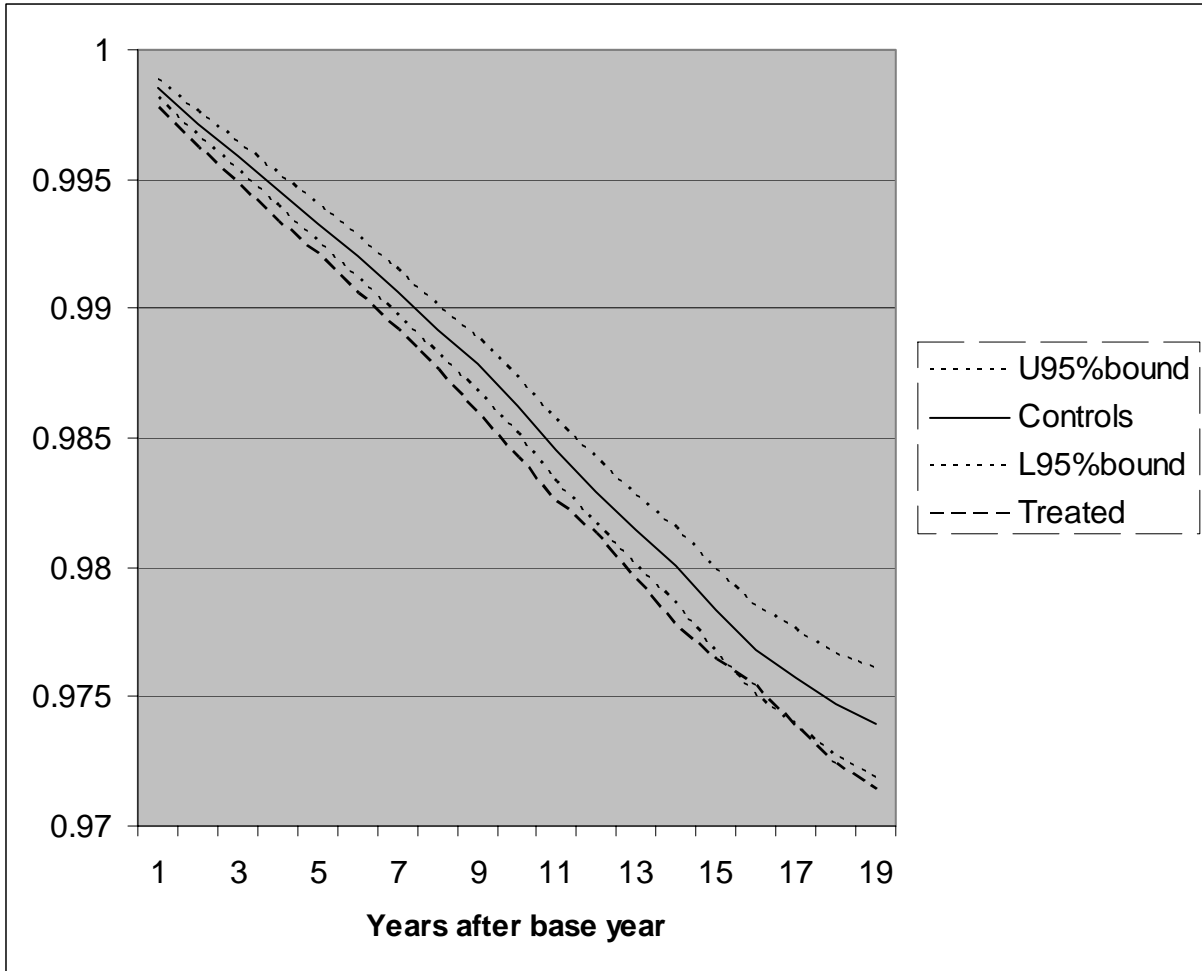


Figure 11. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *suicide attempt*.

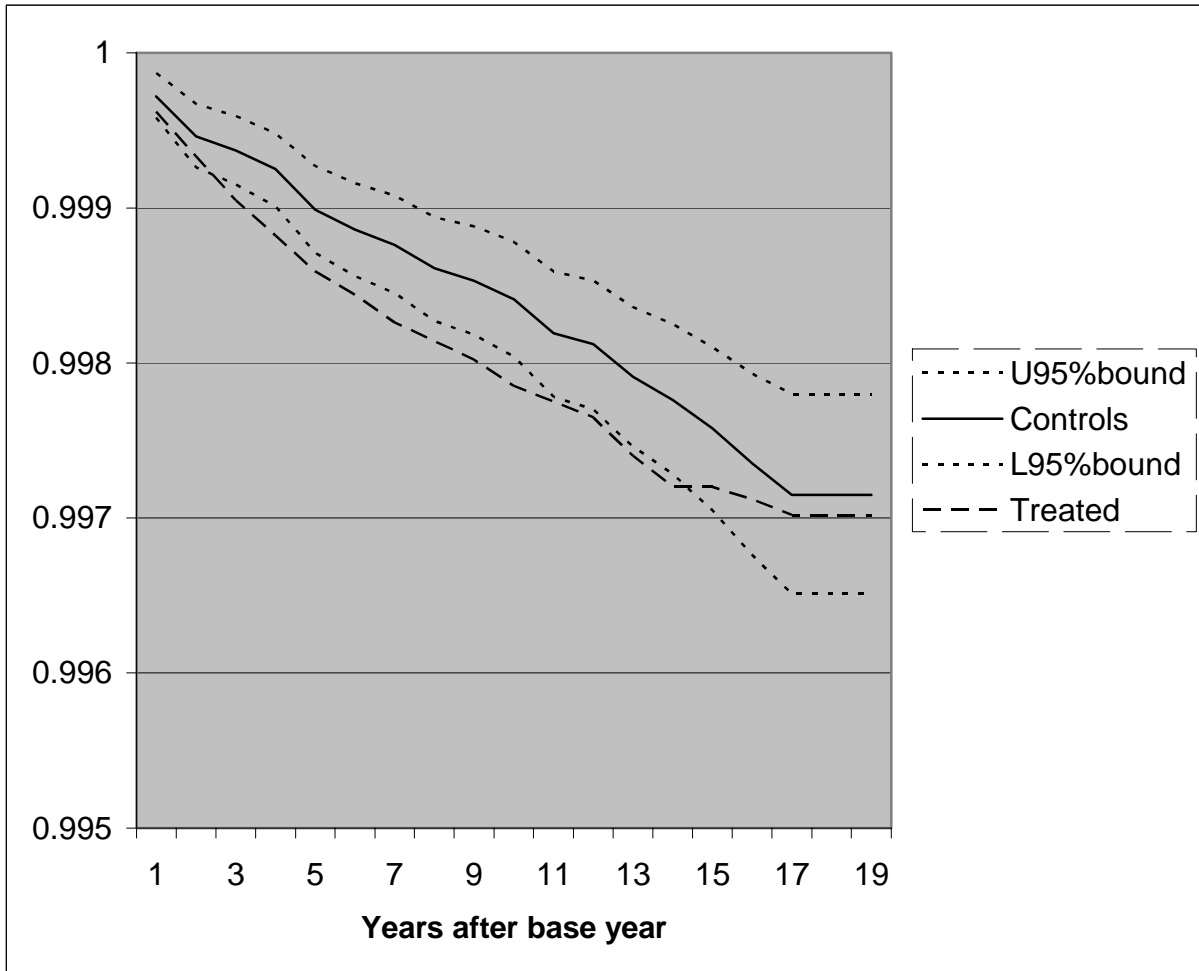
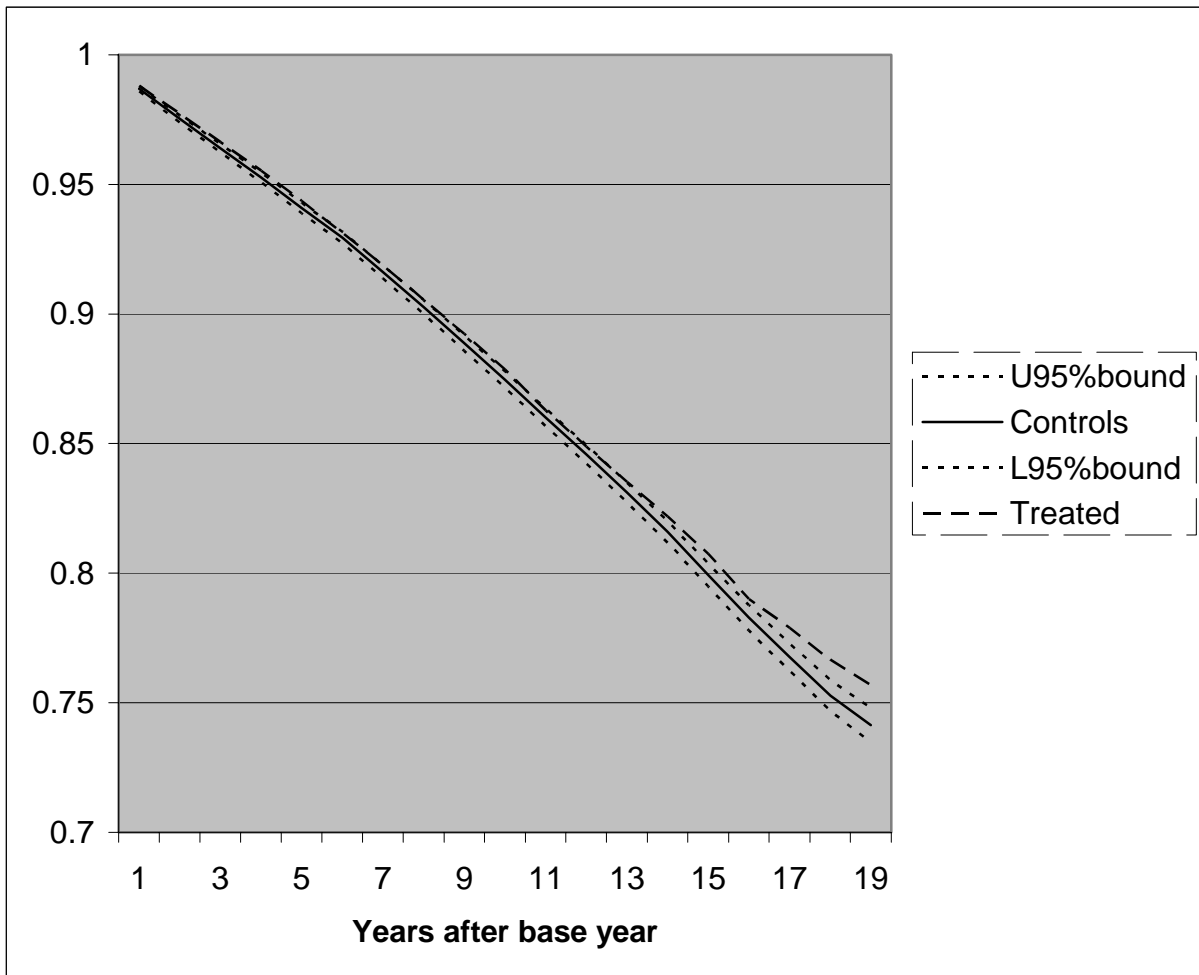


Figure 12. Kaplan-Meier estimates of survival functions for treatment and matched control groups, and 95% confidence bounds for control group: The probability of no hospitalization for *stress related diseases of the digestive and circulatory systems* (the first three specific categories of diagnoses taken together).



Endnotes

ⁱ The categories of diagnoses from the S-list which are ignored because they are clearly irrelevant are: Diseases in connection with pregnancy and birth, congenital anomalies, certain causes of diseases in the perinatal period, liveborn children, relatives accompanying the patient.

ⁱⁱ Except for the fact that we can only follow base year 2000 observations in three years after the base year.