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Is your commute killing you? On the mortality risks of long-distance commuting

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Abstract. There is a general belief that expanding labour-market regions, triggered by increased commuting, have positive economic effects on individuals, firms, and society. Recently, however, scholars have reported possible negative outcomes related to health and well-being. Based on these findings, this study addresses the association between long-distance commuting, and mortality. Using longitudinal individual data from between 1985 and 2008, focusing on 55-year-olds in 1994, we model mortality through propensity score matching and Kaplan–Meyer estimates of survival among long-distance commuters and matched controls from the population travelling short distances to work. The results indicate that women who have experienced long-distance commuting face a significantly higher mortality risk compared with women with short commutes to work. This seems to be driven by variations in income and education: for example, for women with long-distance commuting experience, substantially lower survival rates are found among those with low education and low income. A very different picture emerges for men, for whom mortality risks do not seem to be associated with long-distance commuting. Our findings suggest that men and women are subject to different mechanisms regarding the nexus between commuting and mortality.

Keywords: long-distance commuting, health, mortality, propensity score matching, survival rates

1 Introduction

Commuting to work over longer distances is an increasingly common phenomenon in most European countries (Hofmeister and Schneider, 2010). While commuting may play an important part in terms of efficient job matching [see Johansson et al, 2002), its potential downsides have received relatively little attention in the scientific literature. In particular, there are few quantitative studies based on larger samples examining the health effects of commuting. This study represents a first attempt to exploit rich longitudinal population data to examine the association between long-distance commuting and mortality.

Many factors drive the increase in long-distance commuting (LDC)—some related to market forces, some to social changes, and some to public policy. Studies using contemporary data show that the importance of localized physical advantages (eg, place-specific raw materials, and proximity to energy such as water power, harbours) for economic activities has decreased substantially (eg, Ellison and Glaeser, 1999). Today, the colocation of firms is propelled by agglomeration externalities that are nourished by different types of social and economic interactions rather than by physical advantages (eg, Storper and Venables, 2004). However, change in settlement patterns has turned out to be a slow process (eg, Håkansson, 2000)—regarding labour mobility, this is especially the case in Europe compared with the US (Crescenzi et al, 2007)—whereas the geography of jobs has been subject to more rapid transformation. In particular, the employment shift of trade and industry in recent decades from traditional manufacturing to a wide variety of knowledge-intensive production has created new conditions for economic activities. Expanding firms, not only in new sectors but also in innovation systems where firms interact across various sectors (business transactions, labour flows, etc), tend to be located in metropolitan areas and regional centres (eg, Power and Lundmark, 2004). In these regions, agglomeration economies are triggered by the benefits of colocation that enable firms to reduce transaction costs and expenses associated with accessing and transferring knowledge (eg, Maskell and Malmberg, 2007).

However, these centripetal forces operating on economic activities also imply a gradually increasing deviation between the geography of people and the geography of jobs. This development causes imbalances on regional labour markets as reflected in, for example, high unemployment rates and competence-specific labour shortage. Another possible consequence of the spatial mismatch between jobs and people is increased interregional migration. Nonetheless, empirical studies indicate that interregional migration among the gainfully employed is low and that families seem to be unwilling to relocate (Lundholm, 2009). Immobility may be related to location specificity in human capital (eg, Fischer and Malmberg, 2001; Sjaastad, 1962) and place attachment accumulated through long-term continuity (Hay, 1998), which is built up through a slow-paced population redistribution.

The increased divergence between jobs and people has caused politicians and decision makers to create 'expanding regional labour markets' by investing in various types of infrastructure (eg, highways, railways, and airports). Improved infrastructure and new technology will make it possible for people to accept job offers further from their place of residence, which is believed to facilitate the skill-matching needed for sustained economic development (eg, Östh and Lindgren, 2012). Naturally, visions of extended labour-market regions would remain merely visions if not for people changing their mobility behaviour. Statistics for the Swedish case show convincingly that commuting across municipality borders has gradually increased during the past decades (Sandow, 2011). There is also some evidence that the average distance between place of residence and workplace is growing (Amcoff, 2007). Thus, there are more commuters than ever, and they travel longer distances. In spite of the likely aggregate positive economic effects of enhanced skill-matching efforts as a consequence of extended regional labour markets, scholars have started to question whether it is really beneficial to the individuals involved. Admittedly, people who start commuting commonly increase their wages (eg, Manning, 2003), but Friberg (2006) argues that more time spent on commuting reinforces traditional gender relations because it is usually men who engage in long-distance journeys to work. Absent men cannot participate in everyday family activities, which affects the life situation of all members of the family. Other studies have found that commuting might be associated with reduced well-being, manifested in stress symptoms (eg, Costa et al, 1988; Gottholmsmeder et al, 2009; Kluger, 1998; Koslowsky et al, 1996; Novaco et al, 1991; Stutzer and Frey, 2008) and illnesses (eg, Hansson et al, 2011; Karlström and Isacsson, 2009).

Based on findings in numerous studies, there seem to be rather clear indications of health-related consequences of commuting. Despite the good merits of these studies, however, they are generally based on data stemming from various types of surveys and interviews that may be regarded as small datasets. Relatively few studies have utilized register data covering entire populations. Moreover, there is a great variety of effect dimensions (eg, strain, stress, cardiovascular diseases, perceived health situation, subjective well-being, illnesses, or sick leave) in these studies. On the basis of these results, it might be difficult to make an unambiguous overall interpretation of the consequences of commuting on health. As an alternative approach, we propose the use of an indicator that reflects the ultimate consequence of ill health: death. To the best of our knowledge, there is no study focusing on the potential effects of LDC on mortality. Moreover, the use of long-term longitudinal register data covering the entire nation over more than twenty years allows access to a relatively long period with retrospective information as well as a long follow-up period. Register data are particularly suitable for this purpose because they combine a longitudinal trait with the potential to observe rare events. The mortality rate among people not having reached old age is low, especially when the group of interest is narrowed down to individuals with a history of being long-distance commuters.

The aim of this study is to assess the association between LDC and mortality. We stratify the analyses by looking more closely at differences between men and women, and different socioeconomic positions. By focusing on long-distance commuters aged 55 years in 1994, and matched controls drawn from the group of short-distance commuters, we follow the individuals until 2008 and observe their survival during this period. The structure of the paper is as follows. In the next section we provide a theoretical discussion and review some literature focusing on commuting and its consequences for people. In section 3 data and methods are presented. The results of the empirical analyses are laid out in section 4, which is followed by a summary and discussion in section 5.

2 Commuting and health—a background

Theoretically, commuting distance may be perceived as the outcome of sequential or simultaneous choices regarding place of residence and outcomes of job matching. In economic theory, individual choice maximizes subjective utility, given individual preferences and a limited choice set. Differences in preferences and choice sets will produce differences in disutility from commuting and required compensations for commuting time. Possible negative effects on health do not necessarily imply policies counteracting LDC, since benefits of commuting have to be taken into account. Also, LDC may be optimal and health risks correctly discounted by the individuals, although this would require very strong assumptions.

The possible effect of LDC on mortality is an empirical question. There is no lack of arguments regarding why commuting could have negative effects on health. But the alternative to accepting LDC could be associated with higher health risks: for example, insecure employment or jobs with inferior work environments. Also, as has been found in previous research, some commutes are associated with increased utility from the commute itself. Therefore, the potential effect of LDC on mortality is indeterminate on theoretical grounds. However, as indicated by the review of previous research in the next section, there is a clear preponderance of studies pointing at negative effects on health and subjective indicators of well-being.

2.1 Commuting—a stress factor

Commuting has been found to be a major cause of stress impacting on the individual's physical and psychological health and well-being (Evans et al, 2002; Gottholmseder et al, 2009; Hansson et al, 2011; Kluger, 1998). Commuters report experiencing more negative stress than noncommuters and stress levels also increase with age (Gottholmseder et al, 2009; Rüger and Ruppenthal, 2010). Longer commutes are also associated with other negative health outcomes, such as higher blood pressure, obesity, poor sleep quality, fatigue and low self-rated health (Hansson et al, 2011; Hoehner et al, 2012). These indirect health effects of commuting to work are all prognostic for heart disease, diabetes, and some forms of cancer (Hoehner et al, 2012), and thus also for the mortality risk.

2.2 Commuting costs and life satisfaction

From an urban economic perspective, these perceived commuting burdens and extra monetary costs (eg, travel expenses) are compensated for by a career or financially rewarding job, lower rents, and/or affordable housing prices (eg, Renkow and Hower, 2000; van Ommeren and Rietveld, 2005), or desired housing or neighbourhood characteristics (Plaut, 2006), thus equalizing the commuter's well-being or utility. But, according to some studies, long-distance commuters are not compensated for the stress they experience, and therefore on average have lower life satisfaction than noncommuters (Fults, 2010; Stutzer and Frey, 2008). For example, Stutzer and Frey found that German long-distance (one hour or more) commuters would have to make 40% more in salary to be as satisfied as those with shorter commutes.

While on average stress decreases one's satisfaction with a commute (Abou-Zeid and Ben-Akiva, 2011), commuting in the morning is found to be experienced as especially unpleasant and affects subjective well-being negatively (Kahneman and Kruger, 2006). Having experience of commuting makes it more predictable, and has been found to make the commute less stressful (Kluger, 1998) and to lower the experienced negative subjective life satisfaction due to time pressure (Rüger and Ruppenthal, 2010). This may imply a customization process whereby years of LDC have made it easier to cope with consequences for the daily organization of life and one's health (Rüger and Ruppenthal, 2010).

2.3 The importance of contextual factors

Perceived commuting stress has been found to vary depending on contextual factors, such as the traffic situation and the public transportation system available. The lack of control over and the unpredictability of the commute to work, such as traffic congestion, the behaviour of other drivers, or unreliability of public transport services, increase the perceived stress of commuting (Evans et al, 2002; Gottholmseder et al, 2009; Koslowsky et al, 1996, Kluger, 1998). Active commuting by walking or cycling is related to less negative health outcomes (Hansson et al, 2011) and more satisfaction with the commute (Olsson et al, 2013) than commuting by car, train, or bus. Commuting by car is by far the most common way of commuting in Sweden (62%), while the use of public transportation accounts for only 14% (SIKA, 2007). In a Swedish study (Hansson et al, 2011) the negative health effect of public transport users was found to increase with journey time. However, those commuting by car for 30–60 minutes experienced poorer health than those commuting more than one hour. One possible explanation for this discrepancy between car commuters and public transport users could be that LDC by car in Sweden for the most part does not imply more than one hour in rush-hour traffic. It is more likely that these commutes involve driving in the countryside, which can even offer a positive utility of commuting (see subsection 2.7).

2.4 Various health consequences across genders

Some studies have found significant effects of gender on commuting stress, and report women to be more negatively affected by commuting stress than men (Koslowsky et al, 1996; Novaco et al, 1991). In a study by Roberts et al (2011) in the UK it was found that women were more sensitive to commuting stress than men, even when working hours and occupations were controlled for, and that the stress came from a gendered division of everyday household-related activities, including childcare. Other studies have also found evidence that this stress is a result of too many duties, of which caring for children is the most stressful (Collet and Dauber, 2010). On the other hand, analyses by Gottholmseder et al (2009) on long-distance commuters' stress perception in Austria did not find any significant gender differences, but did find that commuters living in a partnership could handle commuter stress better than single commuters could. Fults (2010) found that both male and female commuters in Sweden experienced disutility of longer commuting times, affecting their subjective well-being, but if there were young children in the household the disutility was higher for female commuters than their male counterparts.

2.5 Balancing home, family, and long-distance commuting

It is not always unproblematic for commuters to balance work and everyday life when commuting long distances every day. Having a lengthy commute decreases the time available for other daily activities, and can mean insufficient energy and/or time to combine work and family life adequately. Long commuting times to work (over 60 minutes one way) have also been found to be significantly correlated with elevated levels of work–family-life conflict, which itself has important health implications in terms of various physical and mental health problems (Hämming et al, 2009; Jansen et al, 2003). In cross-sectional study in Switzerland, Hämming et al (2009) found a significant correlation between LDC and work–family-life conflict, with associated negative health outcomes for both women and men. However, a Dutch cohort study (Jansen et al, 2003) found this correlation to be only significant in women.

2.6 Indirect health consequences

Other studies also report health outcomes not related to the commuting situation itself but, rather, associated with behaviour patterns that over time may contribute to obesity and other poor health outcomes. As the day is constrained to 24 hours, holding working time constant, increases in commuting time must necessarily mean that one has to trade off this time against other activities. According to a recent American study (Christian, 2012), these trades-offs often result in less engagement in health-related activities. While the greatest share of commuting times comes from sleep reduction, time is also taken from physical activity and food preparation. Consequently, indirect health effects of spending long periods on the road to work are related to higher weight, lower fitness levels, and higher blood pressure, all of which are prognostic for heart disease, diabetes, and some cancers (Hoehner et al, 2012).

That increased absenteeism from work due to sickness is also related to LDC, has been found in Sweden (Hansson et al, 2011) and elsewhere in Europe (Costa et al, 1988; Kluger, 1998). The relationship is not clear or unambiguous, however. The increased sickness absence from work among Swedish long-distance (one hour or more) commuters involves few or short periods of sick leave (Hansson et al, 2011), and being on sick leave for a longer period of time (>15 days) is associated with lower income groups, particularly women (Karlström and Isacsson, 2009).

2.7 Positive aspects of the commute

One line of research focuses on the positive utility of commuting for the individual's personal well-being and on how long commutes can constitute a source of emotional benefit for the commuter him or herself. In contrast to the conventional view that commuting time is a source of disutility that must be minimized, in these studies (eg, Lyons and Urry, 2005; Mokhtarian and Salomon, 2001) it is argued that activities that can be conducted while travelling can add a positive utility to the commute. Examples include reading, listening to music or relaxing, mentally shifting between one's work and home, or using the time to work with modern information technology. Commuters who actively make use of their commuting time also report feeling healthier and less stressed, and experience less disutility from the commute compared with those reporting not making active use of the commuting time (Gottholmseder et al, 2009; Lyons and Urry; 2005; Ory and Mokhtarian, 2005). However, not all long-distance commuters have the opportunity to actively make use of their commuting time. For instance, driving a car does not provide choices to read, work on your laptop, or sleep while commuting, unlike to commuting by public transport.

It has also been argued that the commute itself can be an activity desired for its own sake (Mokhtarian and Salomon, 2001; Mokhtarian et al, 2001), due to factors such as enjoyment of the environment or the speed, or the commute providing an opportunity for driving a car, which projects high social status. Despite various ways of adding potential positive utility to a long commute, the willingness to commute still decreases when commuting times become too long. The majority of commuters would also prefer to decrease their commuting, regardless of the mode used (Páez and Whalen, 2010; Redmond and Mokhtarian, 2001; Sandow and Westin, 2010).

Accordingly, various factors have an influence on long-distance commuters' physical and psychological health, and thus also their mortality risk. Regardless of the motives behind LDC, the present situation on the labour market is that more people than ever are commuting long distances to work and the long-term health consequences, in terms of mortality, are still unknown.

3 Empirical analysis

3.1 Data and design of the study

The analyses are based on longitudinal register data on the entire Swedish population from the ASTRID database, compiled by Statistics Sweden and hosted by the Department of Geography and Economic History at Umeå University. The data contain yearly detailed individual information on socioeconomic and demographic variables, such as family situation, income, education level, and employment status, and are georeferenced with coordinates for place of residence and work at a resolution of 100 m. This information is available for the period 1985 to 2008.

The sample is conditioned to include individuals who in 1994 were aged 55 years and active on the labour market (were employed and had income from work). By choosing this cohort we obtain both relatively long historical and follow-up periods. The age restriction was due to the extremely low mortality in younger cohorts.

Individuals are defined as 'treated' if they were long-distance commuters in 1993 and/or 1994. The 'untreated' individuals in the control group consist of those who did not long-distance commute during 1985–2008. Here, LDC is defined as traveling at least 50 km to work 'one way'. This commuting distance is measured as the Euclidean distance between the coordinates of home and work. Thus it does not measure the actual distance, which is about 30% longer, but is likely to be equivalent to 55–70 km on the ground and correspond to an average of 60 minutes by car in Sweden. While there is no consensus in research on what constitutes a long commuting distance (see overview in Sandow, 2011), a time threshold of around 45 minutes one way has been found to constitute an acceptable daily travel time both nationally and internationally (Sandow and Westin, 2010; van Ham, 2001; van Ommeren, 1996; Wachs et al, 1993). Consequently, the commuters in this study all have in common that they have accepted daily commuting times well above the average and at a level implying considerable disutility as reflected by actual commuting patterns. Unfortunately, the data do not include direct information on travel mode or costs. It is unlikely that people choose an active commuting mode for daily commuting distances exceeding 50 km, which is the focus of this study. However, the dataset at hand provides a comparatively useful proxy for nonobservable characteristics related to lifestyle and attitudes towards taking daily exercise keeping the individual in good physical shape. For the year 1990, prior to the time period over which we observe LDC (1993–94), there is information about mode of travel to work. This variable distinguishes between individuals biking or walking to work compared with those commuting by car or public transports. The variable 'active commuting 1990' is included in the analysis to control for potential health differences between the group of long-distance commuters and the group of people without experience of LDC.

The distribution of job openings varies significantly across different regions. To control for regional diversity regarding the labour market situation, we included a measure of interregional accessibility to employment opportunities 'access job openings' in line with the indicator proposed by Eliasson et al (2003).

The total sample size is fairly large, encompassing more than 2700 long-distance commuters (1961 men and 775 women) and 56 800 potential controls (27 462 men and 29 373 women).

3.2 Method

The potential effect of commuting on mortality is estimated using propensity score matching (Rosenbaum and Rubin, 1983), and Kaplan–Meyer estimates of survival for long-distance commuters and matched controls from the population of employed individuals with short commutes to work. For a similar approach see, for example, Stenberg et al (2012). Technically, we estimate the so-called 'average treatment effect on treated'. However, for reasons discussed below, the results should not be given strong causal interpretations. The sample of long-distance commuters may be nonrandomly selected from the total population of employees. To find a relevant group of controls, the propensity score is estimated as the probability of being a long-distance commuter as a function of individual and regional characteristics. Using nearest-neighbour matching on the propensity score, the group of matched controls is obtained by selecting four individuals from the group of short-distance commuters with the propensity scores closest to those of each long-distance commuter. The outcome of interest is the difference in mortality between long-distance commuters and the matched control group, as indicated by nonparametric estimates of survival functions. Although our data cover a relatively long follow-up period, the analysis includes censored observations: survivors at the last time point of observation. Because of potential differences between the sexes in the underlying process of becoming a long-distance commuter and possible differences in outcomes thereof, the empirical models are estimated separately for men and women.

As is the case with all nonexperimental designs, an unbiased estimate of a causal effect can only be obtained under certain identifying assumptions. In the present context: (i) an individual's decision to become a long-distance commuter does not affect the mortality of other individuals; (ii) conditional on the covariates used to estimate the propensity score, the probability of being a long-distance commuter is independent of the potential outcome (survival); (iii) conditional on the covariates, the probability of treatment is strictly positive and strictly smaller than 1; and (iv) conditional on the covariates, the censoring mechanism is independent of the outcome.

The variables used for estimating the propensity scores are measures of the following attributes: the individual's income; recent income changes and unemployment; educational level; whether previously having chosen an active commuting mode; and variables for family situation (partner, children 0–10 years of age in the household, and whether there were children living in another household but within 10 km of the individual's own place of residence); access to job openings in neighbouring labour markets; and a set of dummy variables for region of residence, using the metropolitan area of Stockholm as the reference region. The regional division is the NUTS 2 classification (EC, 2003). Some employment sectors employing large numbers of long-distance commuting men or women (construction, manufacturing, real estate, and education) were included as dummy variables, as was the health sector, which employs relatively few long-distance commuters.

The explanatory variables in the logit models for estimation of the propensity score are subsets of these variables. This is because overparameterization increases the mean squared error and may cause problems with common support (Caliendo and Kopeinig, 2008; Waernbaum, 2008). For this reason, covariates associated with p-values of 0.2 or above have been excluded—except for cases where the inclusion of a covariate was necessary to balance the LDC and matched comparison groups.

The empirical analysis is based on rich information, and the chosen method provides several advantages compared with parametric regression models. First, the identification of effects relies on less restrictive parametric assumptions. Second, it provides better control for common support in data: that is, the treated are compared with comparable individuals in all measured attributes. Contrary to parametric regression models, identification relying on extrapolation outside support in data is avoided. Third, in combination with highly informative data, it allows examination of differences in effects between subsamples while upholding control over common support in data. As is the case with all nonexperimental designs, the question of possible remaining selection bias in estimated effects cannot be dismissed (eg, Smith and Todd, 2005). To identify the effects of LDC it is crucial that assumption (ii) above is not violated by unobserved factors that affect both the probability of being a long-distance commuter and mortality. If, for some reason, long-distance commuters have shorter longevity than other employees because of unobserved factors, the estimated effect of LDC on mortality will be biased unless the covariates in the propensity score reflect these factors sufficiently. Except for the indicator 'active commuting 1990' we have no direct observations of individuals' habits/lifestyles affecting health, and we have no direct information on poor work environments or illness/morbidity. Theoretically, there may be systematic differences between long-distance commuters and the control group in these respects. However, they are presumably correlated with the aforementioned travel-mode variable and other observed characteristics such as education, income, branch of employment, individual experience of unemployment, or other confounders included in the estimation of the propensity score. It is only the extent to which the covariates do not capture factors (which cannot be directly observed), and the extent to which the distribution of remaining heterogeneity in these attributes differs systematically between long-distance commuters and the matched comparison group, that would lead to biased estimates. Whether this hypothetical case would introduce a positive or negative bias in our results is an open and untestable question. Some health conditions associated with higher mortality may be an obstacle to LDC, and therefore a potential source of negative bias—that is, an underestimation of the effects on mortality.

Even under the assumption of a close correlation between observed indicators of socioeconomic status and unobserved factors, there is particular concern regarding whether *changes* in unobserved conditions may affect the probability of LDC and also mortality [see Heckman and Smith (1999) for a discussion on changes in pretreatment status]. For example, negative labour-market events may cause both increased stress and an increased probability of searching for new jobs involving long-distance commutes. For this reason, the robustness of our results is also checked by controlling for changes in employment status as well as levels of and the dynamics in earnings prior to commuting.

4 Results

In this section we first present the logit estimates for the propensity score using the full sample of women and men. This is followed by a comparison of sample means for unmatched and matched samples, including balancing tests for the matched samples (ie, tests of equality in sample means of the variables used in the logit model). In a third step the estimated survival rates for long-distance commuters and matched comparisons are presented. This is accompanied by log–rank tests for differences in survival. Finally, we examine potential differences in mortality for matched subsamples by socioeconomic status.

Table 1 displays the logit model estimates of the probability of being a long-distance commuter. In line with expectations, the results indicate a higher probability of LDC for singles persons, the previously unemployed, and individuals with higher education. Overall, most estimates are strongly significant and the signs of coefficients offer no surprises.

It is essential that the samples of matched controls are comparable with the long-distance commuters in all attributes affecting the probability of LDC. Table 2 gives descriptive

Table 1. Logit estimates for the propensity score.

	Men			Women		
	coefficient	standard error	p-value	coefficient	standard error	p-value
Household characteristics						
Partner	−0.201	0.055	0.000	−0.292	0.079	0.000
Child(ren) aged 0–10 years at home [a]	0.418	0.114	0.000			
Income, SEK [b]	0.739	0.054	0.000	0.028	0.066	0.675
Previous employment situation						
Employed 1990 and 1991, unemployed 1992	0.785	0.148	0.000	0.551	0.237	0.020
Unemployed 1990 and 1991, employed 1992	0.487	0.751	0.517	0.995	0.372	0.007
Income changes (1990–92)[c]	−0.120	0.031	0.000	−0.107	0.059	0.069
Access job openings	0.002	0.000	0.000	0.004	0.001	0.000
Active commuting 1990	−0.850	0.080	0.000	−0.727	0.097	0.000
Education level						
High school education	0.164	0.056	0.003	0.346	0.095	0.000
University education	0.280	0.082	0.001	1.004	0.117	0.000
Employment sector						
Real estate, renting, and business activities	−0.188	0.086	0.030	0.691	0.127	0.000
Public administration and defence; compulsory social security	0.162	0.088	0.065	0.075	0.143	0.598
Construction	0.376	0.078	0.000	0.736	0.283	0.009
Manufacturing	−0.508	0.065	0.000	0.063	0.133	0.637
Health and social work	−0.416	0.134	0.002	−0.571	0.102	0.000
Residential region						
East middle Sweden	0.630	0.116	0.000	0.411	0.188	0.029
Småland and the islands	0.787	0.110	0.000	0.364	0.191	0.057
Southern Sweden	0.660	0.097	0.000	0.663	0.153	0.000
West Sweden	0.626	0.094	0.000	0.643	0.149	0.000
North middle Sweden	0.972	0.102	0.000	0.608	0.174	0.000
Middle Norrland	1.342	0.122	0.000	1.501	0.188	0.000
Upper Norrland	1.385	0.121	0.000	1.693	0.181	0.000
Constant	−12.535	0.667	0.000	−5.122	0.797	0.000
Pseudo R^2	0.0521			0.0524		

Note. Variables measured in 1994 unless stated otherwise. Dependent variable: LDC in 1993 and/or 1994.

[a] There are no small children living at home for women in this sample (age 55 years)

[b] In 1994, €100 was approximately 920 SEK.

[c] Income changes 1990−92 defined as 'income 1992 −income 1990'.

Table 2. Descriptive statistics of long-distance commuters and comparisons as measured in 1994, unless stated otherwise.

Variable	Men					Women				
	LDC [a]	no LDC	*p*-value [b]	matched comparisons	*p*-value [b]	LDC	no LDC	*p*-value [b]	matched comparisons	*p*-value [b]
N	1961	27462				775	29373			
Household characteristics										
Partner	0.732	0.736	0.683	0.733	0.911	0.647	0.698	0.003	0.656	0.662
Child(ren) aged 0–10 years at home [c]	0.049	0.033	0.000	0.044	0.920					–
Income, SEK [d]	12.332	12.156	0.000	12.296	0.617	11.856	11.801	0.015	11.848	0.914
Previous employment situation										
Employed 1990 and 1991, unemployed 1992	0.031	0.017	0.025	0.727		0.027	0.015	0.011	0.024	0.590
Unemployed 1990 and 1991, employed 1992	0.001	0.001	0.689	0.001	0.651	0.011	0.004	0.011	0.009	0.887
Income changes (1990–92) [d]	−0.010	0.023	0.054	0.001	0.653	0.044	0.087	0.034	0.058	0.761
Access job openings	169.290	164.090	0.009	169.160	0.414	172.780	162.590	0.001	167.820	0.595
Active commuting 1990	0.099	0.199	0.000	0.104	0.707	0.186	0.318	0.000	0.196	0.815
Education level										
High school education	0.486	0.459	0.022	0.49232	0.830	0.492	0.531	0.035	0.507	0.873
University education	0.178	0.128	0.000	0.16301	0.832	0.247	0.129	0.000	0.219	0.885
Employment sector										
Real estate, renting, and business activities	0.096	0.097	0.933	0.099	0.912	0.117	0.059	0.000	0.107	0.522
Public administration and defence; compulsory social security	0.097	0.066	0.000	0.094	0.699	0.084	0.073	0.261	0.081	0.883
Construction	0.131	0.085	0.000	0.122	0.725	0.019	0.010	0.014	0.019	0.681
Manufacturing	0.206	0.310	0.000	0.214	0.555	0.105	0.108	0.754	0.109	0.983
Health and social work	0.036	0.041	0.318	0.036	0.791	0.213	0.345	0.000	0.223	0.848

Table 2 (continued)

Variable	Men					Women				
	LDC [a]	no LDC	p-value [b]	matched comparisons	p-value [b]	LDC	no LDC	p-value [b]	matched comparisons	p-value [b]
N	1961	27462				775	29373			
Residential region										
East middle Sweden	0.204	0.174	0.001	0.198	0.405	0.200	0.168	0.024	0.184	0.784
Småland and the islands	0.087	0.093	0.362	0.088	0.758	0.063	0.092	0.006	0.064	0.708
Southern Sweden	0.139	0.144	0.493	0.143	0.766	0.149	0.141	0.491	0.154	0.766
West Sweden	0.198	0.197	0.908	0.203	0.590	0.227	0.197	0.046	0.224	0.898
North middle Sweden	0.107	0.096	0.112	0.109	0.536	0.079	0.097	0.096	0.083	0.942
Middle Norrland	0.066	0.042	0.000	0.056	0.381	0.069	0.046	0.003	0.070	0.917
Upper Norrland	0.076	0.052	0.000	0.025	0.727	0.092	0.057	0.000	0.093	0.908

[a] LDC—long-distance commuting.
[b] t-test of equality in means between long-distance commuters and comparison groups.
[c] There are no small children living at home for women in this sample (age 55 years).
[d] For 1994 €100 was approximately 920 SEK.

averages for long-distance commuters, the full sample of non-long-distance commuters, and the matched sample of controls. The *p*-values indicate significance levels of differences in sample means. There are clear indications of systematic selection into LDC of, for example, the previously unemployed and individuals with higher education. However, matching on the propensity scores yields matched samples that are comparable in all dimensions measured by the covariates in the matching process. All estimates of differences in survival presented in this section are based on matched samples and the covariate selection follows the criteria stated above. All covariates in the logit model pass the balancing test based on *t*-tests of differences in means.

The estimated survival rates of matched samples are displayed in figures 1 and 2. For males, the survival rates do not differ between long-distance commuters and matched comparisons in the short term. After six years of follow-up and beyond, the estimated survival rates are lower for the sample of long-distance commuters. However, the log–rank test for difference in survival over the entire follow-up period indicates no significant difference in survival.

Turning to the sample of women, the estimated survival rates are consistently lower for long-distance commuters and the log–rank test indicates that the null hypothesis of no difference in survival between groups can be rejected. Table 3 gives hazard ratios based on Nelson–Aalen estimates of cumulative hazards (not reported in the table). At the end of the fourteen-year follow-up, the estimated cumulative hazard (cumulative risk of death) was 0.0967 (SE = 0.019) among long-distance commuters and 0.0665 (SE = 0.0051) among matched comparisons, which means a hazard ratio of 1.43. The estimated risk of dying within 14 years of follow-up is 43% higher for long-distance commuters. Although the hazard ratio is relatively high, mortality is low as indicated by the survival functions and the cumulative hazards at the end of follow-up.

The use of alternative specifications of the propensity score does not change the main picture: we find no strong evidence of a significant association between LDC and mortality for the full samples of men, but consistent indications of lower survival rates among women who commute long distances.

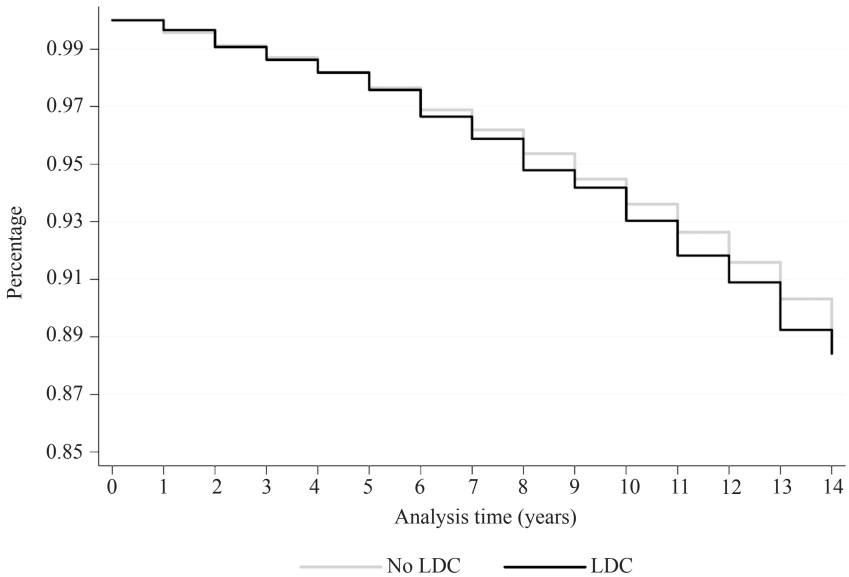

Figure 1. Survival rates, men 1995–2008. Matched samples of long-distance commuting (LDC) men and controls (log–rank test for equality of survivor functions: *p*-value = 0.3933, $\chi^2 = 0.73$).

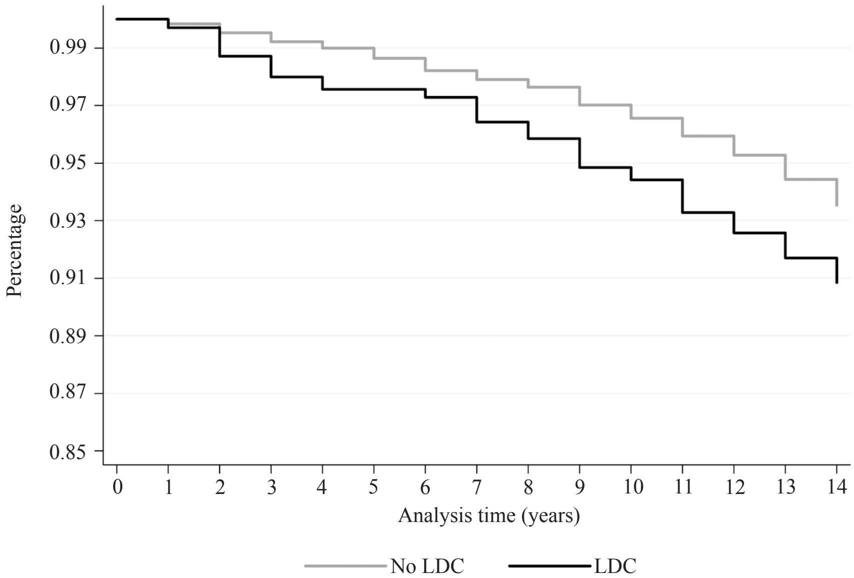

Figure 2. Survival rates, women 1995–2008. Matched samples of long-distance commuting (LDC) women and controls (log–rank test for equality of survivor functions: p-value = 0.0118, $\chi^2 = 6.34$).

Table 3. Hazard ratios of mortality risk between long-distance commuting (LDC) and non-LDC women.

Time (years)	All	Low incomes	Low education
1	1.933	1.222	1.946
2	2.804	4.296	1.419
3	2.577	3.064	1.230
4	2.426	2.942	1.361
5 [a]	na	na	na
6	1.531	1.908	1.210
7	1.716	2.034	1.344
8	1.773	2.071	1.672
9	1.742	1.982	1.742
10	1.636	1.676	1.711
11	1.676	1.801	1.783
12	1.595	1.677	1.728
13	1.508	1.578	1.696
14 [b]	1.436	1.539	1.663

[a] na—not applicable; there were no deaths among long-distance commuters in year 5 of follow-up.

[b] The underlying Nelson–Aalen point estimates of cumulative hazards for treated and untreated at the last year of follow-up are significantly different at the 10% level. The overall test of difference in survival rates are provided by the log–rank test reported in the corresponding figures 2–4.

4.1 Survival by socioeconomic status

As shown in previous studies on commuting and health, there is strong reason to expect differences in potential effects on mortality with respect to social/socioeconomic context. Estimation results based on subsamples defined by education and income levels indicate statistically significant associations between LDC and survival rates for the samples of women with low income (below median) and of women with low education (less than high school). The point estimates for women with low income (figure 3) indicate differences

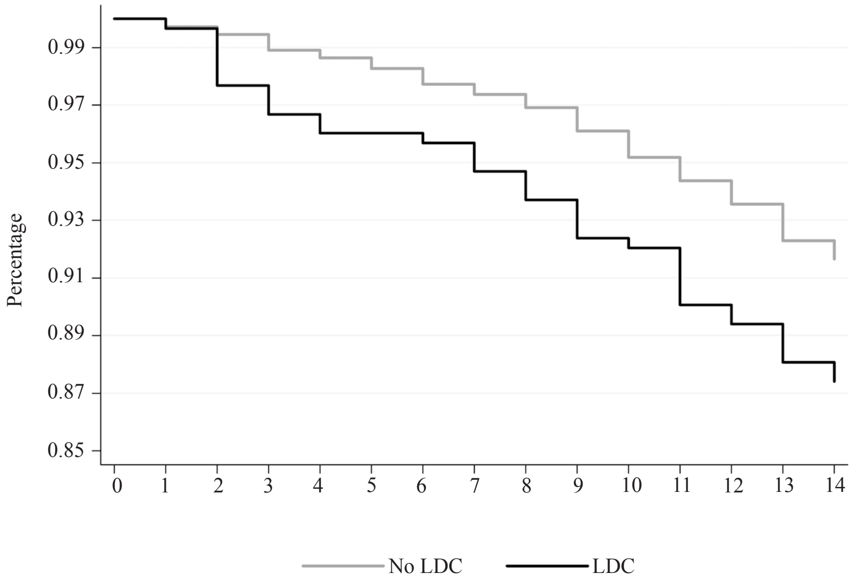

Figure 3. Survival rates for women with low incomes, 1995–2008. Matched samples of treated and controls (LDC = long-distance commuting; log–rank test for equality of survivor functions: p-value = 0.0203, $\chi^2 = 5.39$; 'low income' = annual income below median).

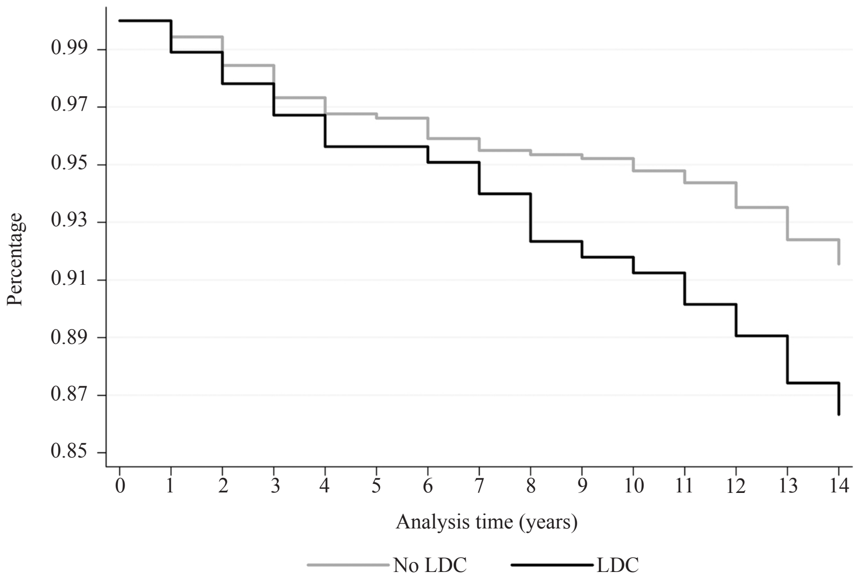

Figure 4. Survival rates for women with low education , 1995–2008. Matched samples of treated and controls (LDC = long-distance commuting; log–rank test for equality of survivor functions: p-value = 0.0310, $\chi^2 = 4.65$; 'low education level' = completed less than high school).

in survival rates amounting to about 1 to 2 percentage points up to around eight years of follow-up, increasing in the following years to approximately 3 to 5 percentage points. At the end of follow-up, the estimated cumulative hazard is 0.1336 (SE = 0.0217) for long-distance commuters and 0.0868 (SE = 0.009) for the matched control group. The hazard ratio indicates a 54% higher risk for long-distance commuter of dying within 14 years compared with matched controls (table 3). Higher mortality is also indicated for long-distance commuters in the sample of women with low education (figure 4). The ratio of cumulative hazards at the end of follow-up is 1.66 (table 3). At that point, the estimated cumulative hazard is 0.146 (SE = 0.0292) for long-distance commuters and 0.0878 for matched controls. Again, the

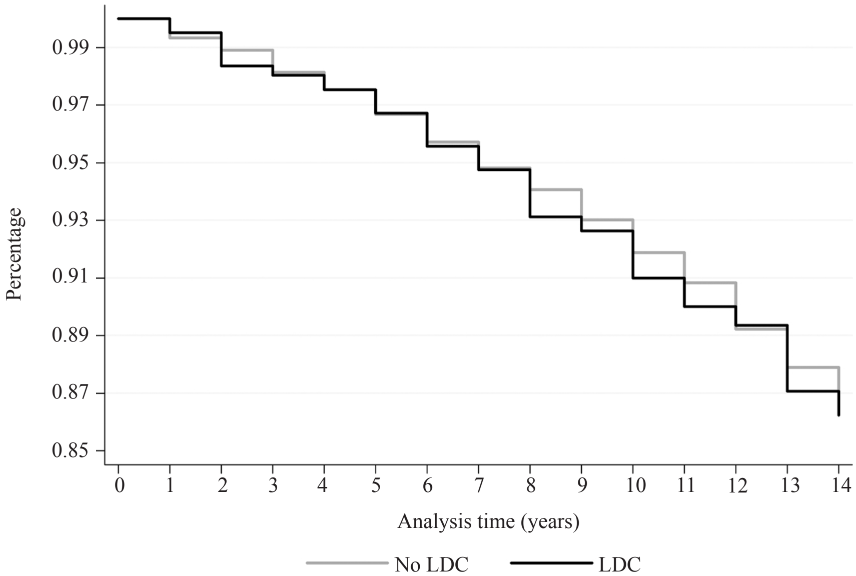

Figure 5. Survival rates for men with low income, 1995–2008. Matched samples of treated and controls (LDC = long-distance commuting; log–rank test for equality of survivor functions: p-value = 0.9823, χ^2 = 0.00; 'low income' = annual income below median).

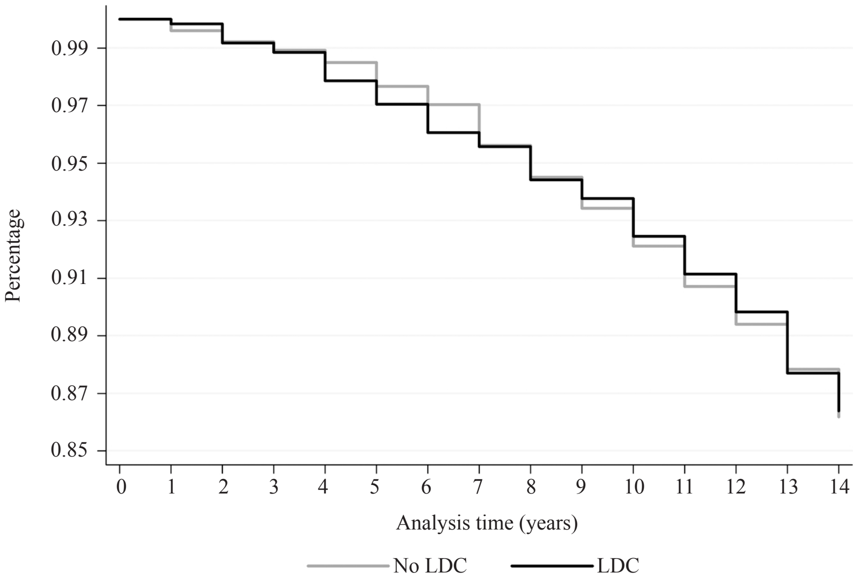

Figure 6. Survival rates for men with low education, 1995–2008. Matched samples of treated and controls (LDC = long-distance commuting; log–rank test for equality of survivor functions: p-value = 0.9069, χ^2 = 0.01; 'low education level' = completed less than high school).

hazard ratio should be viewed against the backdrop of the overall low mortality as displayed by the survival functions and cumulative hazard rates.

The results for men are very different from those for the corresponding subsamples of women (figures 5 and 6): there are no significant differences in estimated survival rates between the long-distance commuters and the comparison groups. This applies for the full sample of men as well as for subsamples of men with low income and men with low education. Figures 7–10 show survival rates by level of education.

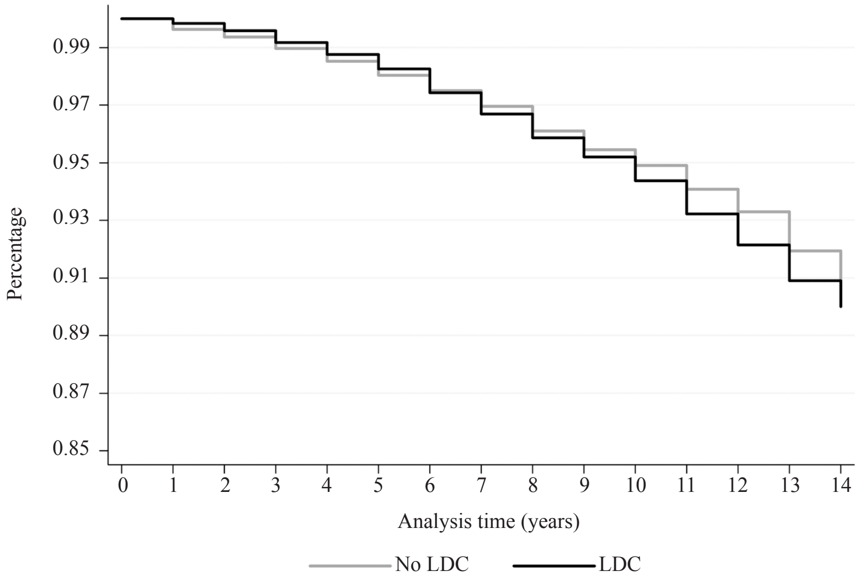

Figure 7. Survival rates for men with high income, 1995–2008. Matched samples of treated and controls (LDC = long-distance commuting; log–rank test for equality of survivor functions: p-value = 0.4494, $\chi^2 = 0.57$; 'high income = annual income above median).

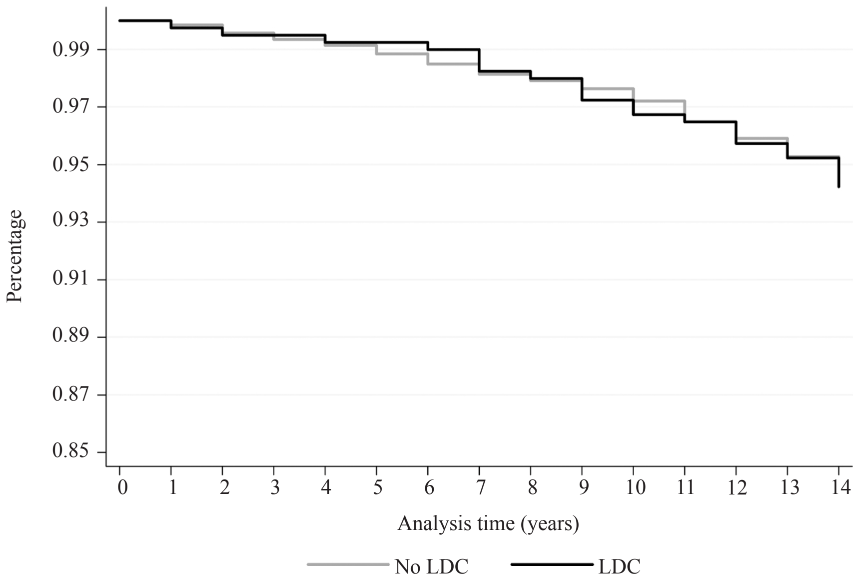

Figure 8. Survival rates for women with high income , 1995–2008. Matched samples of treated and controls (LDC = long-distance commuting; log–rank test for equality of survivor functions: p-value = 0.9366, $\chi^2 = 0.01$; 'high income = annual income above median).

4.2 Robustness checks

The general message of the results presented thus far is that the estimates indicate increased mortality among females who commute long distances, but not for men. For women the results seem to be driven by lower survival rates among long-distance commuters with lower socioeconomic status as measured by income and education. These results are stable with respect to alternative specifications of the logit model for the propensity score, and increasing the trimming of the tails of the distribution of the propensity score from 5% to 7%. Outliers in terms of differences in mortality do not drive our results at 'young age'. Removing people passing away in the first or second year of follow-up (aged 56 or 57) does not affect

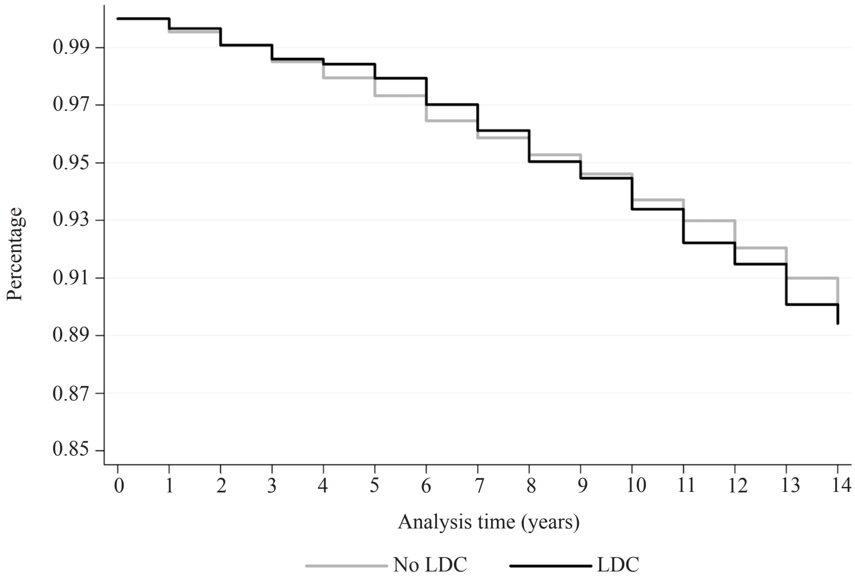

Figure 9. Survival rates for men with high education , 1995–2008. Matched samples of treated and controls (LDC = long-distance commuting; log–rank test for equality of survivor functions: p-value = 0.7724, $\chi^2 = 0.08$; 'high education level = completed at least high school).

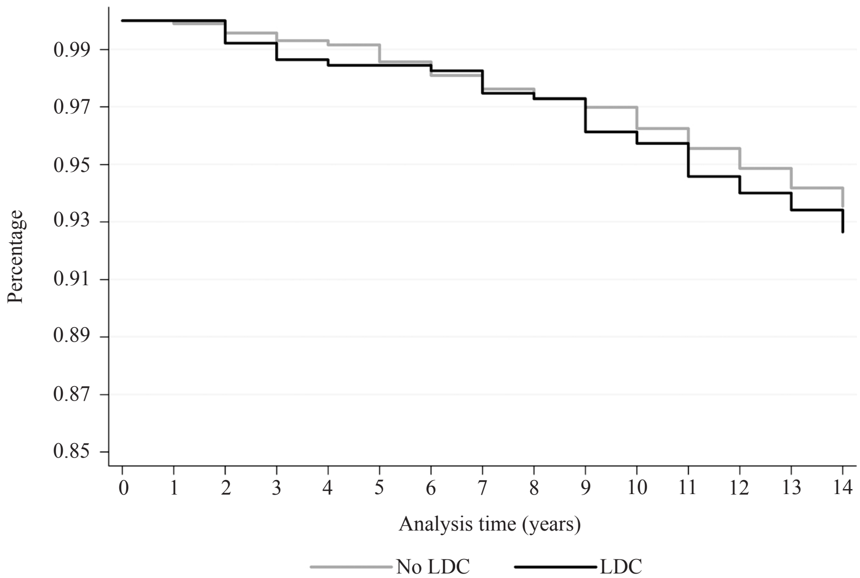

Figure 10. Survival rates for women with high education , 1995–2008. Matched samples of treated and controls (LDC = long-distance commuting; log–rank test for equality of survivor functions: p-value = 0.4627, $\chi^2 = 0.54$; 'high education level = completed at least high school).

our main conclusions. This also applies for using the Wilcoxon test of statistical significance as an alternative to the log–rank test.

5 Summary and discussion

Long commutes have been found to have negative health consequences for many commuters, but the long-term health effects of commuting are still unknown. To measure the long-term health implications of LDC, we have analysed the association between LDC and mortality. Using annual register data, a large sample of workers aged 55 years in 1994 have been followed over a period of 14 years (1985–2008). The difference in mortality between LDC and matched controls has been estimated using propensity score matching and nonparametric estimates of survival.

Conditional on a large set of confounders, the results indicate a statistically significant higher mortality among women with long-distance commutes. Specifically, the estimated association between LDC and mortality for the full sample of women seems to be confined to individuals with lower educational attainment and low incomes. There is no evidence of differences in survival rates between long-distance commuters and matched controls in the corresponding subsamples of men.

The gender differences in mortality risk support results from previous studies suggesting that negative health effects due to commuting are more evident for women than men (eg, Karlström and Isacsson, 2009). Possible explanations for this difference by gender may be related to still existing gender roles in the household. As gender expectations and structural constraints about breadwinning, parenthood, care taking of elderly parents, and other family matters still prevail, women face a double burden: retaining the main responsibility for household-related activities while also being expected to be employed (Coltrane, 2000; William, 2000). This double burden may cause the negative effects of LDC to be worse for women than men. We know from previous studies that female long-distance commuters experience more time pressure and stress induced by commuting than male long-distance commuters, and that this stress is a result of a gendered division of household-related activities (Collet and Dauber, 2010; Roberts et al, 2011). That LDC is particularly related to lower survival rates among women with a lower income or education level may then reflect a high gender inequality in housework. Findings from Sweden, the Netherlands, and the US (Evertsson et al, 2009) show that less educated women spend more time on household work than do more highly educated women, and that this inequality decreases with the level of education—which may reflect more equalitarian work–family arrangements among the well educated. In addition, low education and low income are presumably associated with relatively less flexibility regarding work arrangements (eg, presence at the workplace), which may exacerbate stress from commuting. This, combined with a relatively larger share of household responsibilities, could be an underlying mechanism for negative long-term health consequences, and a higher risk of mortality for women with a lower education or income levels.

Nonexperimental approaches always entail some uncertainty concerning the extent to which the results are influenced by selection bias. In the absence of data from randomized experiments, using rich longitudinal population data still offers excellent possibilities to study the potential health effects of LDC. Although our findings may be interpreted as *indications* of negative effects for women with low socioeconomic status and an absence of effects in corresponding samples of men, they should not be given strong interpretations in terms of causal effects. These results should, rather, inspire further research on this highly relevant and heavily underresearched issue. Adding direct observation of health status and information on causes of death in a large population data setting would allow a substantial step towards causal interpretations of (potentially) statistically significant results. Furthermore, the lack of transit mode data is unfortunate and future research on this subject could focus on possible differences in mortality risk depending on mode of transport. Additional research is also required for statements on possible policy implications. It can provide an understanding of how various socioeconomic factors interact with the long-term effects of commuting, which can be used to identify and mitigate potential negative health outcomes.

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References

Abou-Zeid M, Ben-Akiva M, 2011, "The effects of social comparison on commute well-being" *Transportation Research Part A* **45** 345–361

Amcoff J, 2007 *Regionförstoring—idé, mätproblem och framtidsutsikter* Institutet för Framtidsstudier, Arbetsrapport 2007:7

Caliendo M, Kopeinig S, 2008, "Some practical guidance for the implementation of propensity score matching" *Journal of Economic Surveys* **22** 31–72

Christian T J, 2012, "Trade-offs between commuting time and health-related activities" *Journal of Urban Health* 89 746757

Collet B, Dauber A, 2010, "Gender and job mobility", in *Mobile Living Across Europe II. Causes and Consequences of Job-related Spatial Mobility in Cross-national Perspective* Eds N Schneider, B Collet (Barbara Budrich, Oplanden) pp 173–194

Coltrane S, 2000, "Research on household labor: modeling and measuring the social embeddedness of routine family work" *Journal of Marriage and Family* **62** 1208–1233

Costa G, Pickup L, Di Martino V, 1988, "Commuting a further stress factor for the working people, evidence from the European Country II. An empirical study" *International Archive of Occupational and Environmental Health* **60** 377–385

Crescenzi R, Rodríguez-Pose A, Storper M, 2007, "The territorial dynamics of innovation: a Europe–United States comparative analysis" *Journal of Economic Geography* **7** 673–709

EC, 2003, "Regulation (EC) No 1059/2003 Common classification of territorial units for statistical purposes" *Official Journal of the European Communities* **L 154** 21 May (European Commission, Brussels)

Eliasson K, Lindgren U, Westerlund O, 2003, "Geographical mobility: migration or commuting?" *Regional Studies* **37** 827–837

Ellison G, Glaeser E, 1999, "The geographic concentration of an industry: does natural advantage explain agglomeration?" *American Economic Association Papers and Proceedings* **89** 311–316

Evans G W, Wener R E, Phillips D, 2002, "The morning rush hour: predictability and commuter stress" *Environment and Behaviour* **34** 521–530

Evertsson M, England P, Mooi-Reci I, Hermsen J, De Bruijn J, Cotter D, 2009, "Is gender inequality greater at lower or higher educational levels? Common patterns in the Netherlands, Sweden and the United States" *Social Politics* **16** 210–241

Fischer P A, Malmberg G, 2001, "Settled people don't move: on life course and (im-)mobility in Sweden" *International Journal of Population Geography* **7** 357–371

Friberg T, 2006, "Kommunala utmaningar och genus. Om regionförstoring, pendling, produktion och reproduktion" in *Kommunledning och samhällsförändring* Ed. L Jonsson (Studentlitteratur, Lund) pp 169–194

Fults K K, 2010 *A Time Perspective on Gendered Travel Differences in Sweden* Licentiate thesis, Department of Transport and Economics, Royal Institute of Technology, Stockholm

Gottholmseder G, Nowotny K, Pruckner G J Theurl E, 2009, "Stress perception and commuting" *Health Economics* **18** 559–576

Håkansson J, 2000 *Changing Population Distribution in Sweden—Long Term Trends and Contemporary Tendencies* PhD thesis, GERUM Kulturgeografi, Umeå University

Hämming O, Gutzwiller F, Baurer G, 2009, "Work–life conflict and associations with work- and nonwork-related factors and with physical and mental health outcomes: a nationally representative cross-sectional study in Switzerland" *BMC Public Health* **9** 435

Hansson E, Mattisson K, Björk K, Östergren P O Jakobsson K, 2011, "Relationship between commuting and health outcomes in a cross-sectional population survey in southern Sweden" *BMC Public Health* **11** 834

Hay R, 1998, "Sense of place in developmental context" *Journal of Environmental Psychology* **18** 5–29

Heckman J, Smith J, 1999, "The pre-programme earnings dip and the determinants of participation in a social programme. Implications for simple programme evaluation strategies" *Economic Journal* **109** 313–348

Hoehner C M, Carolyn E B, Barlow M S, Allen P, Schootman M, 2012, "Commuting distance, cardiorespiratory fitness, and metabolic risk" *American Journal of Preventive Medicine* **42** 571–578

Hofmeister H, Schneider N F, 2010, "Job mobilities in Europe: core findings, policy implications future outlook", in *Mobile Living Across Europe II. Causes and Consequences of Job-related Spatial Mobility in Cross-national Perspective* Eds N Schneider, B Collet (Barbara Budrich, Oplanden) pp 337–356

Jansen N W H, Kant I J, Kristensen T J, Nijhuis F J N, 2003, "Antecedents and consequences of work–family conflict: a prospective cohort study" *Journal of Environmental Medicine* **45** 479–491

Johansson B, Klaesson J, Olsson M, 2002, "Time distances and labour market integration" *Papers in Regional Science* **81** 305–327

Kahneman D, Krueger A B, 2006, "Developments in the measurements of subjective well-being" *The Journal of Economic Perspectives* **20** 3–24

Karlström A, Isacsson G, 2009, "Is sick absence related to commuting travel time? Swedish evidence based on the generalized propensity score estimator", WP 2010:3, Swedish National Road and Transport Research Institute (VTI), Stockholm

Kluger A N, 1998, "Commute variability and strain" *Journal of Organizational Behaviour* **19** 147–165

Koslowsky M, Aizer A, Krausz M, 1996, "Stressor and personal variables in the commuting experience" *International Journal of Manpower* **17**(3) 4–14

Lundholm E, 2009, "Interregional migration propensity and labour market size in Sweden, 1970–2001" *Regional Studies* **44** 455–464

Lyons G, Urry J, 2005, "Travel time use in the information age" *Transportation Research Part A* **39** 257–276

Manning A, 2003, "The real thin theory: monopsony in modern labour markets" *Labour Economics* **10** 105–131

Maskell P, Malmberg A, 2007, "Myopia, knowledge development and cluster evolution" *Journal of Economic Geography* **7** 603–618

Mokhtarian P, Salomon I, 2001, "How derived is the demand of travel? Some conceptual and measurement considerations" *Transportation Research Part A* **35** 695–719

Mokhtarian P, Salomon I, Redmond L, 2001, "Understanding the demand for travel: it's not purely 'derived'" *Innovation* **14** 355–380

Novaco R W, Kliewer W, Broquet A, 1991, "Home environmental consequences of commute travel impedance" *American Journal of Community Psychology* **19** 881–909

Olsson L E, Gärling T, Ettema D, Friman M, Fujii S, 2013, "Happiness and satisfaction with work commute" *Social Indicators Research* **111** 255–263

Ory D T, Mokhtarian P L, 2005, "When is getting there half the fun? Modeling the liking of travel" *Transportation Research Part A* **2–3** 97–123

Östh J, Lindgren U, 2012, "Do changes in GDP influence commuting distances? A study of Swedish commuting patterns between 1990 and 2006" *Tijdschrift voor Economicsche en Sociale Geografie* **103** 443–456

Páez A, Whalen K, 2010,"Enjoyment of commute: a comparison of different transportation modes" *Transportation Research Part A: Policy and Practice* **44** 537–554

Plaut P, 2006, "The intra-household choices regarding commuting and housing" *Transportation Research Part A* **40** 561–571

Power D, Lundmark M, 2004, "Working through knowledge pools: labour market dynamics, the transference of knowledge and ideas, and industrial clusters" *Urban Studies* **41** 1025–1044

Redmond L, Mokhtarian P, 2001, "The positive utility of the commute: modeling ideal commuting time and relative desired commute amount" *Transportation* **28** 179–205

Renkow M, Hower D, 2000, "Commuting, migration and rural–urban population dynamics" *Journal of Regional Science* **40** 261–287

Roberts J, Hodgson R, Dolan P, 2011, "It's driving her mad: gender differences in the effects of commuting on psychological well-being" *Journal of Health Economics* **30** 1064–1076

Rosenbaum P R, Rubin D B, 1983, "The central role of the propensity score in observational studies for causal effects" *Biometrika* **70** 41–55

Rüger H, Ruppenthal S, 2010, "Advantages and disadvantages of job-related spatial mobility", in *Mobile Living Across Europe II. Causes and Consequences of Job-related Spatial Mobility in Cross-national Perspective* Eds N Schneider, B Collet (Barbara Budrich, Oplanden) pp 69–93

Sandow E, 2011 *On the Road—Social Aspects of Commuting Long Distances to Work* PhD thesis, GERUM Kulturgeografi 2011:2, Umeå University

Sandow E, Westin K, 2010, "The persevering commuter—duration of long-distance commuting" *Transport Research Part A* **44** 433–445

SIKA, 2007, "The national travel survey RES 2005/2006", no. 2007:19, Swedish Institute for Transport and Communication Analysis (SIKA), Stockholm

Sjaastad, L A, 1962, "The costs and returns of human migration" *The Journal of Political Economy* **70** 80–93

Smith J, Todd P, 2005, "Does matching overcome LaLonde's critique of non-experimental estimators?" *Journal of Econometrics* **125** 305–353

Stenberg A, Luna X, Westerlund O, 2012, "Can adult education delay retirement from the labour market?" *Journal of Population Economics* **25** 677–696

Storper M, Venables A J, 2004, "Buzz: face-to-face contact and the urban economy" *Journal of Economic Geography* **4** 351–370

Stutzer A, Frey B S, 2008, "Commuting and life satisfaction in Germany" *Scandinavian Journal of Economics* **110** 339–366

van Ham M, 2001, "Workplace mobility and occupational achievement" *International Journal of Population Geography* **7** 295–306

van Ommeren J, 1996 *Commuting and Relocation of Jobs and Residences: A Search Perspective* PhD thesis, Vrije Universiteit Amsterdam

van Ommeren J, Rietveld P, 2005, "Compensation for commuting in imperfect urban markets" *Regional Science* **86** 241–259

Wachs M, Taylor B D, Levine N, Ong P, 1993, "The changing commute: a case study of the jobs–housing relationship over time" *Urban Studies* **30** 1711–1730

Waernbaum I, 2008 *Covariate Selection and Propensity Score Specification in Causal Inference* PhD thesis, Statistics, Umeå University

William J, 2000 *Unbending Gender: Why Family and Work Conflict and What to Do About It* (Oxford University Press, New York)