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Differences in declining mortality rates due to coronary heart disease by neighborhood deprivation

Daniel Oudin Åström¹, Jan Sundquist¹, Kristina Sundquist¹

¹Center for Primary Health Care Research, Department of Clinical Sciences, Malmö, Lund University

Abstract

Background: Cardiovascular disease (CVD) is the main cause of death in most industrialized countries, including those in Europe. The mortality rates due to coronary heart disease (CHD), one of the most serious CVD conditions, have been decreasing in most European countries during the last decades. However, whether the trends over time in CHD mortality rates differ depending on neighborhood deprivation has rarely been investigated.

Methods: For each year of the study period, 1988–2012, in Sweden, age-standardized mortality rates were calculated for three different types of neighborhoods, characterized by a neighborhood deprivation index. Joinpoint regression was used to investigate potential changes in age-standardized mortality rates by neighborhood deprivation and over time.

Results: Over the study period, age-standardized mortality rates due to CHD were consistently the highest in the deprived neighborhoods and the lowest in the affluent neighborhoods. We observed a statistically significant overall decline, ranging from 67% to 59%, in the age-standardized CHD mortality rates for each level of neighborhood deprivation. Furthermore, the decline for the affluent neighborhoods was significantly higher compared to the decline in the deprived neighborhoods.

Conclusion: Age-standardized CHD mortality rates decreased significantly in Sweden between 1988 and 2012. This decline was more pronounced in the affluent neighborhoods, which indicates that the improvements in prevention and treatment of CHD have not benefitted individuals residing in deprived neighborhoods to an equal extent. Knowledge of time trends in CHD mortality by level of neighborhood deprivation may help guide decision-makers in the development of appropriate health care policies for deprived neighborhoods.

Keywords

Neighborhood deprivation; coronary heart disease; trends over time

Corresponding author: Daniel Oudin Åström, Center for Primary Health Care Research, Department of Clinical Sciences, Malmö, Lund University, daniel.oudin_astrom@med.lu.se.

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INTRODUCTION

Cardiovascular disease (CVD) is the main cause of mortality in most industrialized countries, including those in Europe, and accounts for approximately half of all deaths across the European continent. [1,2] Despite having an aging population, [2–4] the mortality rates in Europe due to coronary heart disease (CHD), one of the most serious CVD conditions, [1] have been decreasing in most European countries during recent decades. On a population level, underlying causes that may partially explain this decrease have been a declining prevalence of factors associated with CHD mortality, e.g. smoking, as well as preventive strategies for other risk factors. In addition, increasingly efficacious medical and surgical treatments have contributed to this decline.[1,2,5]

Recent research suggests a continuation of the decline in CHD mortality rates in Europe. [4] In Sweden, a continuous decline in CHD mortality rates since the 1970s has been reported by Peltonen & Asplund (1997) and, since the 1980s, by Björk et al. (2009).[6,7] More recently, Nichols et al. (2013) in the European Union and Berg et al (2014) in Sweden reported continuously declining CHD mortality rates.[4,8] However, some studies have suggested a flattening of the decline among certain groups in society .[9–11] It may therefore not be appropriate to assume that declining trends over time may continue or that declining trends are found in all groups in the society.

Even within a homogeneous country, such as Sweden, differences in CHD mortality rates have been observed, where rural northern regions have higher CHD mortality rates than southern or metropolitan regions. [12] Differences in CHD mortality rates have also been attributed to individual-level socioeconomic indicators such as education and employment. [13–15]

Furthermore, individuals residing in deprived neighborhoods have both higher age-standardized CHD incidence rates as well as higher case fatalities as compared to those residing in affluent neighborhoods.[16] These findings remain after adjustment for individual-level confounders such as age, personal income and level of education, which indicates underlying health differences between the populations that cannot be explained by individual characteristics alone.[17–19] Trends in CHD mortality rates in socioeconomically diverse neighborhoods between 1984–1993 in Sweden were examined by Malmström et al. (1999); the authors reported an overall decline in CHD mortality rates, which was significantly higher in the most affluent neighborhoods as compared to the most deprived ones. [20]

For the development of suitable neighborhood policies, it may not be appropriate to assume that the trends occurring over time may be similar in an affluent neighborhood as compared to a relatively more deprived neighborhood. Our hypothesis was that the neighborhood differences in the declining trends in CHD mortality rates, observed in the previous study by Malmström et al.,[20] would remain in more recent Swedish CHD mortality data. With this in mind, the aim of the present study was to examine if CHD mortality rates differs over time (i.e., between 1988 and 2012) and whether the trends over time in CHD mortality rates differs depending on neighborhood deprivation.

METHODS

Data sources

This is a population-based study where we for each year of the study period, 1988 to 2012, collected the number of deaths due CHD (ICD-9 codes 410-414 and ICD-10 codes I20-I25) occurring in each municipality in Sweden for the entire population above 30 years of age. The CHD mortality counts were obtained from the Cause of Death Register and provided to us by the National Board of Health and Welfare and the yearly population count was obtained from the Total Population Register, provided to us by Statistics Sweden. Supplementary Table 1 shows the number of deaths and the size of the population by the three neighborhood categories of deprivation (see below).

The home addresses of all Swedish adults have been geocoded to represent small geographic units. These areas, known as small area market statistics (SAMS), have an average population of 1,000 to 2,000 inhabitants. SAMS were used as proxies for neighborhoods, as described elsewhere. [16] We calculated a neighborhood deprivation index (NDI) for each SAMS in Sweden for each year of the study. In short, NDI is a summary measure based on the following four variables indicating deprivation: low educational status, low income, unemployment and being on social welfare.[16] NDI was categorized into three groups: below one standard deviation (SD) from the mean (affluent), above one SD from the mean (deprived), and within one SD of the mean (middle). In the present study, lower scores indicated more affluent neighborhoods, whereas higher scores indicated more deprived neighborhoods.

Statistical analyses

We calculated age-standardized mortality rates based on a direct method of standardization using the Swedish population in the year 2014 as the standard population.[21] For the three different levels of neighborhood deprivation, we calculated these age-standardized mortality rates for the population aged above 30 years. We used the Joinpoint Regression Program, version 4.5.0.1, to investigate any changes occurring over time in the age-standardized mortality rates.[22] This also allowed us to identify any point in time during the study period where the rate of change over time was significantly changed. A standard log-linear model was used with a maximum of four possible join points. The annual percentage change was estimated along with its corresponding 95% Confidence Interval (CI). Using the test for parallelism provided in the Joinpoint Regression Program, we investigated if the slope showing the change over time differed between the three different levels of neighborhood deprivation.

RESULTS

During the course of the study period, i.e., 1988-2012, the age-standardized mortality rates due to CHD were consistently the highest in the deprived neighborhoods and the lowest in the affluent neighborhoods (Table 1, Figure 1).

Over the entire study period, we observed a statistically significant overall decline in the age-standardized CHD mortality rates for each investigated level of neighborhood

deprivation. For the affluent neighborhoods, the overall decrease between 1988-2012 was 67.2%, whereas for the deprived neighborhoods the overall decrease was 59.2%. The decrease for the neighborhoods defined as “middle” was 60.8%. The average annual percentage change over the entire study period was for the affluent neighborhoods -4.4% (95% CI: -4.8% to -3.9%), the middle neighborhoods -3.8% (95% CI: -4.0% to -3.6%) and the deprived neighborhoods -3.6% (95% CI: -4.1% to -3.1%).

We used the Joinpoint Regression Program to identify any point in time during the study period where the rate of average annual decline was significantly changed. The cut point in time was 2002 for both the affluent and the deprived neighborhoods, which yielded two time periods, i.e. 1988-2002 and 2002-2012. Please note that the program includes the cut point 2002 in both time periods. For the affluent neighborhoods, the annual percentage change for the period 1988-2002 was -3.5% (95% CI: -4.1% to -3.0%) and for the period 2002-2012 -5.5% (95% CI: -6.4% to -4.7%). For the deprived neighborhoods, the annual percentage decline during the first period was -2.9% (95% CI: -3.5% to -2.3%) and -4.6% (95% CI: -5.6% to -3.6%) during the second period. For neighborhoods categorized as “middle”, one single trend over the entire study period was identified in the program with an annual percentage decline of -3.8% (95% CI: -4.0% to -3.6%). However, for consistency, the annual percentage change for both periods are presented for all three neighborhood categories (Figure 1, Table 1).

The potential differences in annual percentage change between the three neighborhood categories were tested for the entire study period by using the test for parallelism provided in the Joinpoint Regression Program. Our data in Figure 1 suggested that the slopes over time differed significantly between the affluent neighborhoods as compared to the two other types of neighborhoods (test of parallelism rejected). We observed no significant differences in the slopes between the deprived neighborhoods and the neighborhoods classified as “middle” in the test for parallelism.

DISCUSSION

During the course of the last 30 years, age-adjusted CHD mortality rates have been decreasing in Sweden. In our study, we found an overall decrease in the different types of neighborhoods varying between 67.2% and 59.2%. In all three categories of neighborhood deprivation, a continuous and statistically significant decreasing trend was found during our study period. The decline was higher in the affluent neighborhoods in Sweden as compared to the deprived neighborhoods.

Our findings corroborate those of Björck et al (2009) and Berg et al (2014), who in two recently published studies reported declining CHD mortality rates in Sweden over roughly the same study period. [7,8] Björck et al (2009) reported an approximate 50% decline of the mortality rates due to CHD between 1986 and 2002.[7] In addition, Berg et al (2014) reported a similar magnitude in the decrease in the CHD mortality rates in all age-groups 35-84, between 1987 to 2009. [8] The present study contributed with new knowledge to previous studies as it focused on CHD mortality rates in different types of neighborhoods and over time, which has not been done recently on a nationwide basis.

Our findings that are based on recent data are in line with the previous study by Malmström et al. that examined data between 1984 and 1993 and found an overall decline in CHD mortality, which was significantly higher in the most affluent neighborhoods as compared to the most deprived ones.[20]

The declining trend in CHD mortality rates may reflect a decline in the prevalence of risk factors associated with CHD,[1,2,5,7], improvements in the treatment of CHD,[1,5,7] enhanced prevention measures of CHD-related outcomes,[5,7] or a combination of these. For instance, Björck et al (2009) attributed the majority of the decrease in CHD mortality rates to reduced CHD risk factors at the population level in combination with improved treatments at the individual-level. [7] Interestingly, smoking and obesity are both important individual risk factors for CHD. [1,2] In contrast to the decreasing trends in CHD mortality in Sweden reported by us and others, [7,8,20] obesity rates have been increasing over the course of the study period in Sweden. [23] The prevalence of smoking, on the other hand, has been decreasing during the same time period. [24] These contrasting findings makes it difficult to disentangle the separate contributions of changes in risk factors that has occurred during the time period when decreasing trends in CHD mortality in Sweden have been observed.

Some of the differences between the different rates of decline between neighborhoods may be related to socioeconomic status.[12,16,25] In northern Sweden, Peltonen et al (1998), used education as a marker of social status and reported that those with a university degree had, generally, lower levels of a number of cardiovascular risk factors. [25] Veronesi et al (2016) reported similar findings in a recent large European study, where educational differences accounted for more than half of the average CHD event rates. [26]

In addition to low socioeconomic status, there is today substantial evidence of an additional effect of residing in neighborhoods with low socioeconomic status. In Sweden, those residing in deprived neighborhoods have been found to have both higher age-standardized CHD incidence rates as well as higher case fatalities as compared to those residing in affluent neighborhoods. [16] Survivors of myocardial infarction, who resided in relatively more deprived neighborhoods in Sweden, were also reported to have higher mortality. [27] Recently, Carlsson et al (2016) reported an increased risk of myocardial infarction and CHD in adults between 40 and 50 years residing in deprived neighborhoods as compared to those counterparts residing in wealthier areas. [28]

Our results indicate that it may not be appropriate to assume that the trends occurring over time may be the same in an affluent as compared to a deprived neighborhood. These differences by level of deprivation may be observed between smaller geographical units, [29] as well as between larger regions and cities.[30–31] For instance, Wennerholm et al (2011) reported differences in cardiovascular mortality between two closely located but socioeconomically different cities in Sweden, where the population in the “blue-collar” city had statistically significantly higher incidence of a number of cardiovascular events than the neighboring “white-collar” city.[30] In addition, Engström et al (2000) reported that for the city of Malmö, the third largest city in Sweden, socioeconomic differences contributed to a significant intra-city variation in cardiovascular disease rates.[31]

Strengths and limitations

The main strengths of the current study are that we, over a long time period, calculated mortality rates due to CHD by neighborhood deprivation. The small SAMS in Sweden allowed us to accurately identify neighborhoods characterized by a well-established deprivation index as affluent, middle or deprived. A potential limitation is that we estimated, for the three levels of neighborhood deprivation, the mortality rates due to CHD for all counties in Sweden to obtain the observed trends over time. We did thus not separate the trends occurring in metropolitan areas with trends occurring in more rural areas of Sweden. Another potential limitation is the ecological design. However, the aim of this study was to examine time trends in mortality rates due to CHD in the Swedish population and whether the observed decline in mortality rates due to coronary heart disease differed depending on neighborhood deprivation. For this purpose, an ecological design is ideal and, since we are not drawing any conclusions about individuals from results obtained for groups, there is no ecological fallacy.

CONCLUSION

The decline of CHD mortality rates in Sweden between 1988 and 2012 was more pronounced in the most affluent neighborhoods, which indicates that the improvements in prevention and treatment of CHD have not benefitted individuals residing in deprived neighborhoods to an equal extent. For the development of suitable neighborhood policies, it is of importance to continuously evaluate the trends in CHD mortality by neighborhood deprivation as it may not be appropriate to assume that the declining trends in CHD mortality rates will be equal in all types of neighborhoods. Knowledge of such time trends in CHD mortality by level of neighborhood deprivation may help to guide decision-makers in the development of tailored health care policies for deprived neighborhoods.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What is already known about this subject?

The association between neighborhood deprivation and mortality due to coronary heart disease (CHD) is well established.

In many European countries mortality rates due to CHD have been decreasing in recent decades.

However, little is known whether these trends over time differ between deprived and affluent neighborhoods.

What does this study add?

The most deprived neighborhoods had consistently higher mortality rates due to CHD than relatively more affluent neighborhoods.

The rate of decline over time was higher in the most affluent neighborhoods as compared to the most deprived neighborhoods.

The improvements in prevention and treatment of CHD may have not benefitted individuals residing in deprived neighborhoods to an equal extent.

It is important to continuously evaluate the trends in CHD mortality by neighborhood deprivation in order to guide health policies.

Figure 1.
Development over time in mortality rates due to coronary heart disease by neighbourhood deprivation for the periods 1988–2002 and 2002–2012.

Table 1.

Age-standardized trends in mortality due to coronary heart disease for the three categories of neighborhoods: affluent, middle and deprived

Neighborhood category	Number of deaths Median (Min –max)	Mortality Rates / 100,000 Min Max	Annual percentage change (95% CI)
<i>Affluent</i>			
1988-2002	3546 (2794 – 3967)	184.9 ; 314.8	–3.5 (–4.1 to –3.0)
2002-2012	2309 (2051 - 2794)	103.1 ; 184.9	–5.5 (–6.4 to –4.7)
<i>Middle</i>			
1988-2002	14918 (12565 – 17437)	217.4 ; 357.3	–3.8 (–4.0 to –3.6)
2002-2012	11753 (8513 - 13487)	218.2 ; 139.8	–3.8 (–4.0 to –3.6)
<i>Deprived</i>			
1988-2002	4312(3901 - 4896)	270.8 ; 412.5	–2.9 (–3.5 to –2.3)
2002-2012	3481 (3189 - 3967)	168.0 ; 270.8	–4.6 (–5.6 to –3.6)