Socioeconomic status and out-of-hospital cardiac arrest

A quantitative analysis of the relationship between socioeconomic status, incidence, and survival from out of hospital cardiac arrest.

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Abstract

BACKGROUND This thesis studies the relationship between area-level socioeconomic status and the incidence and 30-day survival of out of hospital cardiac arrest. The effect of socioeconomic status on health has been studied for over 150 years. Although cardiac arrest is a major public health problem there has been very little focus on socioeconomic status and out of hospital cardiac arrest. DATA AND METHODS The cardiac arrest data are obtained from the Swedish cardiac arrest registry. Data on age structure and percentage of immigrants is from SCBs total population registry and socioeconomic data come from SCBs LISA database. The incidence analysis is made in two steps. The first step calculates the age standardized incidence and the second step is an OLS analysis. For the survival analysis a logistic regression analysis is made to measure the probability of survival in different income areas. RESULTS For the socioeconomic status – incidence analysis the results from the OLS analysis suggest that the incidence is almost twice as high in the lowest income area. Intercept (Highest group) = 26.8 and <140 000 (lowest group) = 24.5. In the survival analysis (using a binary logistic regression analysis) there was a significantly lower OR for the lowest income group for all patients (OR= 0.521, p= 0.049) and for the sub group (patients 18-75 years old) there was a significant negative relationship for the two lowest groups. <140 000 (OR= 0.444, p= 0.032) and 140 000-159 000 (OR= 0.620, p= 0.046). CONCLUSION There is a significant relationship between living in a poor neighborhood and out of hospital cardiac arrest. Those living in poorer areas have both an increased incidence and lower chance of survival of out of hospital cardiac arrest.

Keywords
Socioeconomic status, out-of-hospital cardiac arrest, health differences, age standardization,
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Introduction

A cardiac arrest is “…the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation” (Jacobs et al, 2004).

According to the European resuscitation council approximately 275 000 persons suffer a cardiac arrest each year in Europe. In Sweden alone there are 10000 out of hospital cardiac arrests (OHCA) each year and in about 5000 of these the EMS\(^1\)-personnel starts resuscitation attempts (Herlitz, 2013). Although out of hospital cardiac arrest is a major public health problem, the links between socioeconomic status (SES) and cardiac arrest are considerably less investigated than the links between SES and cardiovascular diseases over all.

The literature on socioeconomic status and cardiovascular disease is wide. The evidence for this relationship is strong and it has been an area of research for over 50 years. In 2013, the Swedish heart and lung foundation published a report which emphasized the growing inequalities in cardiovascular health between different socioeconomic groups (Hjärtrapporten, 2013).

The links between socioeconomic status and incidence/survival from out of hospital cardiac arrest has not been extensively studied around the world, and in Sweden it has not been studied at all. In the last 10 to 15 years the survival from out of hospital cardiac arrest has increased rapidly in Stockholm, from 2.5% in 2000 (Hollenberg et al, 2005) to 10.2% in 2012 (Herlitz, 2013). This increase raises the question whether SES differences in OHCA incidence and survival prevail.

This thesis will focus on socioeconomic status on an area level, which in this case means parish (församling). This means that SES is measured in the parish where the cardiac arrest victims live which is not necessarily where they suffer their cardiac arrest. SES-data are on an area level due to data limitations. The results will therefor only tell us differences based on

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\(^1\) EMS is short fo Emergency Medical Service. In Stockholm the EMS is same as ambulances.
where people live but it provides a first step to understanding SES gradients in OHCA more broadly. Therefore it contributes to the wider SES – Health literature.

Objectives and research questions

The objective of this thesis is to study if socioeconomic characteristics at an area level predict incidence of and survival from out of hospital cardiac arrest. The subject of SES and OHCA has not been properly studied so the purpose of this paper is to contribute to an understudied field. The results will hopefully also contribute to the wider SES and health literature. There are two research questions which follow;

1. Do people who live in low income areas have a higher incidence of out of hospital cardiac arrest?
2. Do people from low income areas have a decreased chance of survival after having an out of hospital cardiac arrest?

Strengths and limitations

Due to data limitations SES is measured at an aggregated “area level”. Areas in this thesis are parishes (församlingar). This will make it possible to draw inferences about difference in incidence and survival of out of hospital cardiac arrest on an area level but not on an individual level. This is due to the risk of ecological fallacy. A relationship at an area level does not have to be a relationship on an individual level. Therefore no such inferences will be made.

This thesis is limited to out of hospital cardiac arrests (OHCA) in Stockholm County. The reason for that is again the accessibility of data. Socioeconomic status can be measured in many different ways. In this thesis annual disposable income at an area level will be used. The use of parish-level data is because it’s the smallest administrative unit in Sweden.
Theories and previous research

The effect of socioeconomic status as a predictor of health has been up for discussion in the social sciences since Friedrich Engels wrote the book “The condition of the working class” (1845). Although the discussion has lasted for over 150 years there is no easy answer to the question how and why SES and health are connected.

This part will begin with some theories that try to explain why people from lower socioeconomic groups have worse health status compared to people from higher status groups. After that I focus on previous research, first on SES and cardiovascular disease, followed by incidence of and survival from out of hospital cardiac arrest. Finally some studies on SES and cardiopulmonary resuscitation (CPR) and on minorities/ethnicity and CVD/OHCA will be presented.

Socioeconomic differences in health

In this thesis aggregated data will be used. Although the majority of the theoretical explanations focus on links between SES and health at an individual level, the same general theories will be used to guide the theoretical discussion.

In the 1980s, the Black report was published in the UK, which focused on mortality rates and health in different classes. The report had a significant impact on politics in the UK. The overall finding is that there were large class differences in both mortality and health between different socioeconomic groups. The Black report suggests four possible explanations for these differences. The first is the artefact explanation which suggests that there is no real relationship between SES and health. The relationship is purely due to measurement error of SES, health, or both (Macintyre, 1997). The second explanation is the social selection explanation which suggests that health determines a person’s class position (Ibid.).

The third explanation from the Black report is materialistic, which suggest that the differences in health are due to the material and physical condition of life in different social classes. The

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2 Engels measured SES in different streets, which is similar to an area level analysis. He ranked the streets in three different classes, first, second and third class and then measured the mortality in the different groups.
fourth and last explanation is behavioral. According to this explanation persons from lower social classes are more likely to engage in health damaging behaviors (Macintyre, 1997).

Later research has often built on these explanatory approaches. Raphael (2009) has focused on materialistic resources as a determinant of health. Raphael suggests that a person’s living conditions are more important to a person’s health than lifestyle choices. House and Williams (2003) have shown that people from lower socioeconomic classes have a higher prevalence of almost all psychosocial risk factors, such as smoking, lack of exercise and unhealthy eating/drinking habits, than people from higher socioeconomic groups. People from lower SES-groups are also more likely to experience stress. A possible explanation for this, according to House and Williams, is economic strain and higher rates of ill health among friends and relatives.

The theory of social conditions as a fundamental cause of disease (Link & Phelan, 1995) focuses on a person’s or a group’s resources, such as income, education, knowledge, power and networks. A person will use the resources he has to avoid disease or ill health. People from higher socioeconomic groups will always have more of these resources and will therefore be more successful in avoiding disease. An example of this is the prevalence of heart disease. Before many of the risk factors were known, heart diseases were more common in higher socioeconomic groups. As the risk factors became common knowledge the prevalence decreased in these higher SES-groups. Another example is that lung cancer was more common in wealthier parts of the USA before the 1950s. When the connection to cigarette smoking was found the incidence of lung cancer dropped and are now more common in poorer states (Carpiano et al, 2008). What Link and Phelan stress in the theory is that no matter of the disease, the lower socioeconomic groups will be at a disadvantage because of their lack of resources.

Wilkinson and Pickett (2009) argue for the relative deprivation argument. The link between SES and health is not due to an absolute level of resources which is promoted in the previous explanations. The point is that a person’s relative position in a society leads to ill health. Persons from the lower SES-groups have worse health status because they are poorer than the rest of society. An example is that a black male in USA had a life expectancy of 66.1 years with an annual income of 26,522$ while a male in Costa Rica had a life expectancy of 75 years with an income of only 6,410$ (Wilkinson & Pickett, 2007). The explanation for this is according to this view that people tend to compare themselves to others. The feeling of
inferiority leads to more stress which have a negative effect on health. Studies on primates have shown that a lower social position leads to both stress and ill health (e.g Atherosclerosis) (Shively, 1994; 1997). Wilkinson and Pickett (2009) suggest that evidence for this is that more equal societies have a lower mortality and prevalence of disease than unequal societies. From this point of view they conclude that the vast majority will benefit from a more equal society.

Marmot and colleagues (1991) have also found evidence that support the relative deprivation argument. They studied civil servants in Britain and found that although they all had good material standard, civil servants who worked in lower status jobs reported worse health than persons who worked in higher status jobs. One possible explanation for this is that lower status employees felt that they had less control over work which can result in more psychosocial stress (Marmot et al, 1991).

The fourth factor in the Black report was behavioral explanations. In neighborhoods with high prevalence of smoking it is more likely for people living there to start smoke and a decreased chance for those who smoke to quit (Adler 2002). People from lower socioeconomic groups also drink more alcohol, this relationship between SES and drinking only shows for heavy drinking (Ibid.) and this have a negative effect on a person’s health.

People from lower socioeconomic neighborhoods are also more exposed to negative stress in their lives. Brunner (1997) identified some factors which lead to stress, including economic strain, insecure employment and low control over their work. It is showed that by helping people manage their stress they also reduced hypertension (Adler 2002).

Another possible explanation is what is called health or, as in the Black report, social selection. The idea is that there is not a relationship between SES and health. The differences in health between higher and lower socioeconomic groups are due to sick people tend moving down the social ladder. There are some results showing that ill health lead to a lower social position. Schuring et al (2007) found that in the European countries, ill health was an important factor for entering and maintaining employment, which is important for the SES position. Haas have found similar results when he studied the relationship between childhood health and SES-position later in life. The results show relatively strong evidence that childhood health is important for the SES-position in adult life (Haas, 2006).
Adler (2002) addresses that environment might have an effect on health. Besides other environmental factors, she argues that the social environment may be crucial to the inhabitants’ health. She refers to Berkman who found that relative mortality is between 1.9 to 5 times higher for persons who live in social isolation. Communities differ in the amount of institutions which promote positive social ties according to Adler. Other possible factors that Adler (Ibid.) lists are the amount of healthcare people consume and the accessibility to it, exposures to damaging agents such as air pollutions, overcrowding, and noise. MacIntyre et al (2002) have also discussed the possible effects neighborhood conditions can have. The factors are about the same as those Adler mentions in her paper.

Pickett and Pearl (2001) reviewed 25 studies on the subject of neighborhood effects on health. The articles they reviewed focused on different form of ill health. Among other the focus was mortality, chronic disease and mental illness. They found, although the studies used different methods, that there was at least one significant effect of neighborhood socioeconomic status and health in 23 of the 25 studies when they controlled for individual socioeconomic status.

Leventhal and Brooks-Gunn (2003) evaluated a project called “Moving to opportunity (MTO)”. They found that there was a positive effect on person’s mental health if they moved from a lower socioeconomic community (e.g public housing) to a better community (e.g private housing). Other health problems have been studied in the MTO project. Ludwig et al (2011) found a decrease in both extreme obesity and diabetes after moving to a community with higher socioeconomic status.

The different explanations for the relationship between socioeconomic status and health overlap in many cases. Different kinds of stress are seen as an explanation in many of the explanations above. In the materialistic view the stress come from economic hardship, in the relative hierarchy explanation from feelings of inferiority and from social factors, among others from low control over their work.

**Previous research**

Inequalities in cardiovascular disease (CVD) are a well-known public health problem and have been for a long time. Two decades ago, Kaplan and Keil reviewed the literature on
socioeconomic status and cardiovascular disease between 1956 and 1992 and concluded that there was consistent evidence for a negative relationship (Kaplan & Keil, 1993). Later studies have found that mortality from CVD is higher in lower socioeconomic groups (Mackenbach 2000, Wennerholm 2011, Villanueva 2013). Similar results have been found for heart failure (Hawkins, 2012) and for acute myocardial infarction (Salomaa 2000, Donyavi 2011, Gerber 2010).

These results show an increase in mortality, but there is also a relationship in incidence. Sundqvist et al (2004) found that the overall incidence of cardiovascular disease was higher in lower socioeconomic areas. Similar results are seen for acute myocardial infarction (Hallqvist 1998, Koopman 2012; 2013, Gonzalez-Zobl 2010) and hypertension (Colhoun 1998, Grotto 2007; 2008). Kaplan and Kiel’s (1993) write in their review about possible risk factors which are higher in lower socioeconomic groups. The prevalence of smoking, hypertension, overweight/obesity and high cholesterol was higher in groups with lower socioeconomic status. These risk factors are all directly or indirectly due to social causes.

The relationship between socioeconomic status and out of hospital cardiac (OHCA) arrest is considerably less investigated than other forms of heart disease. The research on SES and OHCA has three different focuses, survival, incidence and the amount of bystander CPR. When the focus in this paper is the relationship between SES and incidence/survival of OHCA, the previous research will primarily be on these subjects. The relationship between SES and bystander CPR and the relationship between ethnicity and OHCA is not the focus of this paper. However, these variables are used as control variables in the different analyses so some studies will be mentioned in the previous research.

**SES and incidence of OHCA**

As noted, there are not that many studies on the relationship between socioeconomic status and incidence of out of hospital cardiac arrest. Reiner and associated have in two studies investigated the relationship between SES and incidence of OHCA in North America. The first study was made in Oregon, USA and showed that the incidence was higher in the lower income group (Reiner et al, 2006). The other study is made at seven different locations in USA and Canada and the results suggested that there was a relationship in both the US and Canadian sites, the relationship was however stronger in US sites (Reiner, 2011). In both of these studies the relationship seemed stronger for people under 65 years of age.
Other studies have showed similar results. Soo et al (2001) found that the incidence was higher in more deprived areas in Nottinghamshire, UK. Other studies that have not primarily studied SES and incidence of OHCA have found interesting results. Folke et al (2010) found that in Copenhagen, Denmark there was a higher incidence of OHCA in areas with a high proportion of people with low education and low household income. As with Folke, Semple et al (2013) did not focus on SES and incidence of OHCA but instead on finding high and low incidence areas. The high incidence areas had a notable lower income and a larger proportion people that lived under the poverty line.

**SES and survival of OHCA**

As with SES and incidence of OHCA, there are quite a few studies which investigate the relationship between socioeconomic status and survival after out of hospital cardiac arrest. The first study published on the subject is from Seattle (including King county) in the 1990s. Hallstrom et al (1993) discovered that lower socioeconomic status associated with lower survival rates. After this, different studies have shown different results. There is some evidence that persons from lower socioeconomic groups have a decreased chance of survival. Chu et al (1998) found that income had a significant effect on predicting survival from OHCA in Michigan, USA. Vaillancourt et al (2008) found that areas with lower property value (used as a proxy for SES) had lower chance of survival in Ontario, Canada. In South Korea Ahn et al (2011) studied community deprivation and incidence of OHCA and showed a strong relationship. The most deprived quintile had an Odds ratio of 0.58 compared with the least deprived.

All studies do not show as compelling results. Clarke et al (2005) found a relationship when SES was measured on an individual level but not for an area level in King County, USA (the city of Seattle was excluded). Others have not been able to find any relationship between SES and survival from OHCA. (Sayegh et al (1999) in Michigan USA, Soo et al (2001) in Nottinghamshire, UK and Fake et al (2013) in Wellington, New Zealand).

To summarize the previous research in SES and OHCA you can say that there seem to be a relationship between SES and incidence of OHCA. All studies that have investigated the relationship have found that the incidence is significantly higher in lower socioeconomic
groups. The results are not as clear for survival after an out of hospital cardiac arrest. Some studies have found a significant lower survival for lower socioeconomic groups while others did not. What causes the differences in incidence and survival from cardiac arrest is not properly addressed. Reiner (2006) address social factors such as smoking and eating habits for incidence. Clarke (2005) speculates in differences in in-hospital care. Hallstrom (1993) is on the same track as Reiner with social factors as a plausible explanation.

**SES and bystander CPR**

Bystander cardiopulmonary resuscitation (CPR) is a universal predictor of both return of circulation and survival after a cardiac arrest and can explain survival differences by SES. Some studies have investigated the relationship between socioeconomic status and bystander CPR. Root et al (2013) compared two cities in USA and found that there was a lower rate of bystander CPR in lower socioeconomic areas.

Sasson et al (2012) have also made a multicenter analysis of socioeconomic status and bystander CPR. The result showed that the proportion of bystander CPR is significantly lower in neighborhoods with lower socioeconomic status. As noted earlier, Vaillancourt et al (2008) found that there was an increasing proportion of bystander CPR in areas with a higher socioeconomic status. Semple et al (2013) found in their hot spot analysis that the proportion of bystander CPR differed between the hot and cold spots.

**Minority groups/ethnicity and out of hospital cardiac arrest**

There is evidence that minorities have a higher risk of cardiovascular disease. Mody and colleagues have reviewed the literature on this subject (2012). Black men and women have both a higher incidence rate of myocardial infarction and death rates in coronary heart disease compared with whites. Minorities in the USA such as African Americans and Hispanics also have an earlier onset of heart failure and a higher mortality rate in cardiovascular disease compared with whites (Mody et al, 2012). McDowell et al (2006) have also found that the risk of adverse reactions to cardiovascular medicine is higher in minority groups compared with whites.

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3 The term “race” is used in most of the US studies.
In the case of out-of-hospital cardiac arrest a few studies have investigated the links to minority groups. Semple et al (2013) found in their hot spot analysis that there was a notably higher proportion of African Americans in the hot spots versus the cold spot (42% vs 1.6%). Chu et al (1998) didn’t find any relationship between minority status and survival of OHCA. Similar results were seen in Sayegh’s et al (1999) study with no relationship.

From the previous research on the subject the following hypotheses are formed:
1. Residents from lower income parishes have a higher incidence of out of hospital cardiac arrest.
2. Individuals who live in lower income areas have a lower chance of survival than persons in areas with higher socioeconomic status.

Data and method

For the first analysis, which focuses on parish-level incidence rates of out of hospital cardiac arrest, a multiple ordinary least square (OLS) analysis will be used, because the dependent variable is continuous. The independent variables are the average annual disposable income, percentage of people with higher education, and the percentage of immigrants in each parish.

For the second analysis, which focuses on the chance of survival 30 days after out of hospital cardiac arrest of residents in different socioeconomic areas, a binary logistic regression will be used. The reason for this is simply because the dependent variable is dichotomous (dead or alive). Logistic regression is preferable to an OLS when the outcome variable is binary (Edling & Hedström 2003:173).

Data

The data in this thesis come from two different data sources. The data on OHCA are from the Swedish Cardiac Arrest Registry (SCAR) which is a national quality register with support from Sveriges kommuner och landsting (SKL). The register collects data on circumstances around and treatment of out of hospital cardiac arrest. All cardiac arrests in Sweden are reported to this registry. Information on in which parish (församling) the cardiac arrest
patients live in are conducted from the Swedish Church’s website using the postal code/ home address of the patients.

The second source is from Swedish statistics (SCB). Data on age structure (number of people in each age group) and percentage of immigrants in each parish are from SCBs total population registry (RTB). In this paper there are no individual SES-data due to lack in the cardiac arrest data (SCAR) which makes it impossible to link to individual incidence/survival so data on annual disposable income and percentage of persons with higher education are on an aggregated level. The source of the socioeconomic data (education and average annual disposable income in each parish) is SCBs longitudinal integration database (LISA).

The cardiac arrest data, both incidence and survival is merged with the socioeconomic data on a parish level from the LISA database. The different data sources are in the next section described more in detail.

**Cardiac arrest data (individual level)**

The definition of cardiac arrest (ICD-10 I46.0-I46.9) is according to the widely used Utstein criteria “Cardiac arrest is the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation” (Jacobs et al, 2004). A loss of heart activity means that the body’s organs can’t get oxygen which is crucial to survival, especially oxygen to the brain. If the cardiac arrest is not treated immediately it leads to death. Cardiac arrest is the cause of more than 60% of all death from cardiovascular disease in the adult population (Zheng 2001). The term out of hospital cardiac arrest (OHCA) simply means that the cardiac arrest occurred outside a hospital.

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4 Short for “register över totalbefolkningen”

5 LISA is short for Longitudinell integrationdatabas för sjukförsäkrings- och arbetsmarknadsstudier. English translation is the following; Longitudinal integration database for health insurance and labour market studies.

6 ICD is short for International Classification of Diseases which is created by the world health organization.

7 Utstein is a abbey outside Stavanger, Norway where cardiac arrest researchers have agreed on guidelines on which parameters should be reported in a cardiac arrest. These guidelines are used in many different centers around the world.
The collection of data to SCAR is made by the EMS-personnel. Each time the Emergency Medical Service-personnel starts treatment after a cardiac arrest they write a cardiac arrest report. This is later sent to the Swedish cardiac arrest registry. The registry documents close to 100% of the cardiac arrests in Sweden (Herlitz, 2013). When the EMS services fail to report to the registry there is a manual reading through pre-hospital patient charts which includes words related to out of hospital cardiac arrest. The registry includes variables such as sex, age, response time, witness status, bystander CPR, place of event and other treatment related variables. For the Stockholm County, the home address of each patient is also available. That is the reason for limit the data to the Stockholm County.

Between 2006 and 2012 there were 6336 EMS-treated, non-traumatic cardiac arrests in Stockholm. Of these, 103 are excluded due to, occurrence to persons less than 18 years old and an additional 213 are excluded because they don’t live in the Stockholm County. 717 cases were excluded because of inability to locate which parish they lived in, mostly because of missing data on the personal identification number.

Geocoding of the home address of each cardiac arrest patient is collected from the Swedish church’s website (www.svenskakyrkan.se) which has a function making it possible to see in which parish each address belongs to. In this paper it is only important where the persons lived. It does not matter where in Stockholm the persons suffered their cardiac arrest. If a person lives in the rural areas and has the cardiac arrest in the city central, the cardiac arrest will be coded as residents of a rural parish.

**Control variables for analysis of survival from OHCA**

For the individual level data there are some aspects that are important for survival. These aspects will be used in the survival analysis as control variables. There are 9 factors that often are used as control variables in OHCA studies. These factors will be used as control variables in this thesis and it is assumed that these will correlate with SES.

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8 A traumatic cardiac arrest is when the primary cause is trauma such as car accidents, hit by a train or knife stabbings.

9 This is due to that cardiac arrest in children differs from cardiac arrests in the adult population in both treatment and etiology.
*Cardiac etiology* measures if the cause of the cardiac arrest is assumed to be from previous heart disease. The Utstein criteria suggest that an arrest is assumed to be of cardiac origin if there is no other obvious cause.

*Crew witnessed* if the EMS services witness the cardiac arrest. It’s a strong predictor of survival because of the short time to advance treatment.

*Sex* in cardiac arrest studies they usually control for gender differences.

*Witnessed* If the cardiac arrest was witnessed (seen or heard) by bystanders. A witnessed cardiac arrest has most likely a shorter time between the cardiac arrest and treatment.

*Bystander CPR* means that the person who witnessed the cardiac arrest or/and other person starts cardiopulmonary resuscitation. The main focus on bystander CPR is chest compressions.

*VF/VT* is the rhythms that you are able to treat with a defibrillator. It is the strongest predictor of survival. Most of the patients have ventricular fibrillation in the minutes after the cardiac arrest but after a couple of minutes the rhythms transform into a non-shockable rhythm. On a ECG this looks like a straight line.

*Age* is a strong predicting factor of survival. The younger you are the higher chance of survival.

*Response time* is important because of the chances for VF is higher in the first minutes after a cardiac arrest. To complete the response time variable I have used the mobitex time\(^\text{10}\) and added 2 minutes. The compute variable equation is (call_time – mobitex_time) + 2. The adding of 2 minutes is due to that both the mean and median time between the call and mobitex in all other cardiac arrest alarms.

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\(^{10}\) Mobitex time is the time that the dispatch center sends the alarm to an ambulance.
Place of cardiac arrest. The chances of survival are higher if you have your cardiac arrest outside your home. More of these cases are witnessed and the proportion of bystander CPR is higher. Usually the response time is also lower.

Socioeconomic data

Data on the age structure of each parish come from SCBs total population registry (RTB). The data collected are number of people living in each age group. The age groups in this paper <50, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85-89 and >90 years. These data are used to calculate the age standardized incidence rates of OHCA in each parish.

Socioeconomic data are provided from Swedish statistics (SCB) longitudinal database (LISA). For each parish area aggregated data for annual income are used (median disposable income). The annual disposable income variable is calculated with the amount of money left after taxes and also it takes in to consideration the number of children in the household in different age groups. Different weights are given to different family compositions. A household with one adult and another adult in cohabitation is given the weight of 1.00. The first child between 0-19 years old is given the weight of 0.52 and the second child is given the weight of 0.42 (Statistics Sweden). The income is presented in 100 SEK (e.g 1800 in annual disposable income is 180 000).

Data on percentage of immigrants in each parish are also used as a control variable and is retrieved from SCBs total population registry. The definition of immigrant is in this case persons born outside Sweden. The percentage of immigrants is used as a control variable due to the previous research on differences between minorities and majorities and the high neighborhood segregation in Sweden with immigrants concentrated on low income neighborhoods. The previous research have shown a relationship between minorities and CVD overall but not of OHCA.

In the first analysis, both annual disposable income and percentage of people with high education is tested in the same analysis. The correlation between income and education are on a parish level very high (0.88). The $R^2_k$ value is also very high 0.846 when both income and percentage of immigrants are used as independent variables. A value this high is problematic when the variables are used in a regression analysis. Income and education will take out each other’s effect and then it’s hard to measure the effect for both income and education. With
high correlation values, the standard error will raise quite rapidly. With an $R^2_k$ value at 7.5 the standard error will be two times as high and with a $R^2_k$ value at 9 more than three times as high (Edling & Hedström, 2003:147). Due to this the education variable is dropped from the main analyses.

The first idea was to analyze the relationship between SES and incidence of OHCA both for men and women. That analysis wasn’t possible to perform because of the overall low incidence for women. About two thirds of all cardiac arrests happen to males (Herlitz, 2013).

**Method**

The use of statistical methods in this thesis depends on the research question. To see if there are differences in incidence in poor and rich areas an ordinary least square regression analysis on aggregated data at the parish level is used. As an age standardized incidence is the dependent variable, this need to be calculated first. This will be explained in detail in the next section. The second analysis is to see if there are any differences in chance of survival in rich and poor areas. For this a binary logistic regression will be used. This is due to the dichotomous dependent variable (dead/alive). All the statistical analyses are done in IBM SPSS 22.

**SES and incidence of OHCA**

**Age standardization**

The first hypothesis focuses on the prevalence of out of hospital cardiac arrest in different socioeconomic groups. To measure the incidence of OHCA an age standardization of the incidence is used. It takes the age structure in each parish in account to calculate what the incidence would be like if all parishes had the same structure as Stockholm County. The reason for this is that age is one of the strongest predictors of a cardiac arrest and to standardize for it is a basic demographic method (Preston, 2001:21). Older people have a higher incidence of cardiac arrests than young people and therefore it is important to control for different age structures (Preston, 2001). The age structure may also correlate with area level SES, which can confound the SES – incidence of OHCA relationship.
To calculate an age specific incidence you count the numbers of events in each age group. This is used as the dependent variable in the incidence analysis. The following equation is from Preston et al (2001) but is rewritten to be easier to understand. In table 1 under results I show what the age standardization does to the incidence.

\[
ASIR = \frac{E_1 \cdot b_1 \cdot 7 \cdot n_1 + E_2 \cdot b_2 \cdot 7 \cdot n_2 + \cdots + E_{10} \cdot b_{10} \cdot 7 \cdot n_{10}}{\text{Population in Stockholm County}}
\]

ASIR= Age standardized incidence rate \( E_i \)= cardiac arrest in age group, \( b_i \)= persons in age group in parish, \( n_i \)= persons in age group Stockholm county, this is due to that I use the population in Stockholm county as the standard population. The number 7 is due to that we study cardiac arrests over 7 years.

The reason for age standardization is that a relationship between socioeconomic status and cardiac arrest can be lost in the age structure. Areas with a large portion of old people will most likely have a higher incidence of cardiac arrest. Age standardization takes this into account and will give a larger weight to each event (cardiac arrest) in an area with larger portion young inhabitants than an area with a large portion of older persons. This way we get an incidence rate which is cleared from age structure.

**OLS analysis**

To evaluate the effect of socioeconomic status in each income group, an ordinary least square regression (OLS) analysis is used. This method is suitable when the dependent variable is continuous. The general idea is to find the line which best describe the relationship. The OLS analysis minimizes the gap between the predicted, and the actual value in the data (Edling & Hedström, 2003). The income groups are made into four different dummy variables (<140 000, 140 000-159 000, 160 000-179 000 and >180 000) and are used as independent variables. The reasons to use dummy variables are to see if there are any curvilinear relationships.

The income distribution with this categorization is show that the areas that are commonly referred to as rich areas. The map below shows the income distribution where the darker areas have the highest disposable income and the lighter ones the lowest.
Survival analysis

For the survival analysis a binary logistic regression analysis is being used. The reason for this is that the outcome variable is binary. The difference from a linear regression is that it predicts a probability instead of a value. When the dependent variable is binary the logistic regression is preferable to the linear (Edling & Hedström, 2003:173). A probability is always between 0 and 1 (Ibid.:175). A linear regression would be able to predict values outside that range.

Ecological fallacy

As noted under ‘strengths and limitations’ there is always a risk of ecological fallacy when using aggregated data. An ecological fallacy occurs when one use aggregated data as a substitute measure for individual level data. To assume that a relationship found at an area level also exists at an individual can be problematic. A famous example is that of being foreign-born and literacy. Robinson (1950) found that states with a high percentage of
immigrants had a higher literacy rate. The explanation for this relationship was that immigrants tended to move to states with a high rate of literacy. Robinsons (Ibid.) conclusion was that researchers can’t use aggregated data as a substitute for individual level data.

The discussion of use of aggregated data on an ecological level is still ongoing. Pearce (2000) argues that there have been some important findings in epidemiology that came from comparative ecological studies (e.g the relationship between hepatitis B and liver cancer). Another example Pearce demonstrates is social in its nature. A person’s relative income can have an effect on his health. To ignore the ecological context can lead to what Pearce call “the individualistic fallacy”. Freedman (1999) points out that aggregated data are easier to collect and therefore these kind of studies will continued to be done.

In this thesis aggregated data for the SES-variables are used due to lack of individual SES-data. As there are risks of ecological fallacy no conclusions will be drawn at an individual level. The conclusions from this thesis will be strictly on an area level. The bright side of this problem is that the most studies made on the subject of SES and OHCA have used aggregated data and therefore it is possible to compare the results with the previous studies.

**Results**

The first hypothesis focuses on the relationship between SES and incidence of OHCA. The first step in this analysis is to calculate the age standardized incidence in each parish. The second step is an OLS regression with the age standardized incidence as the dependent variable and SES-variables as independent variables. This analysis is made in the next section.

As seen in Table 1 below, the prevalence of out of hospital cardiac arrest changes if the incidence variable is standardized. Some parishes have a lower prevalence after the standardization. The reason for this is presumably their large proportion of elderly people. In the same way the prevalence changes in areas with a younger population but in the opposite direction.
Table 1 below shows the changes in selected parishes before and after the age standardization. As seen in the parishes with a low proportion of old people the rate increases after the age standardization. The same applies for the parishes with a high proportion of old people. But they have a lower rate after the age standardization.

<table>
<thead>
<tr>
<th>Parish</th>
<th>Unstandardized rate</th>
<th>Age standardized rate</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bro</td>
<td>6</td>
<td>52</td>
<td>46</td>
</tr>
<tr>
<td>Vämdö</td>
<td>37</td>
<td>57</td>
<td>20</td>
</tr>
<tr>
<td>Flemingsbergs</td>
<td>40</td>
<td>55</td>
<td>14</td>
</tr>
<tr>
<td>Hölö-Mörkö</td>
<td>21</td>
<td>34</td>
<td>12</td>
</tr>
<tr>
<td>Spånga-Kista</td>
<td>38</td>
<td>51</td>
<td>12</td>
</tr>
<tr>
<td>Björkö-Arholma</td>
<td>131</td>
<td>60</td>
<td>-71</td>
</tr>
<tr>
<td>Blidö</td>
<td>72</td>
<td>35</td>
<td>-36</td>
</tr>
<tr>
<td>Häverö-Edeo-Singö</td>
<td>75</td>
<td>53</td>
<td>-21</td>
</tr>
<tr>
<td>RoslAEsbro-Vätö</td>
<td>61</td>
<td>43</td>
<td>-18</td>
</tr>
<tr>
<td>Väddö</td>
<td>50</td>
<td>32</td>
<td>-17</td>
</tr>
</tbody>
</table>

**Figure 2** The incidence and age standardized incidence per 100 000 inhabitants in Stockholm County.

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That the incidence in the parishes changed after the age standardization shows that it is important to standardize the variable before looking for a relationship between socioeconomic status and incidence of OHCA.

There are as seen on the maps in figure 2 some differences in incidence of OHCA. In table 2 there are some examples from different income group areas. There is a pattern that the richer income areas have a lower incidence of out of hospital cardiac arrest than the poorer areas. Some areas which are well known to have a rich population such Danderyd and Lidingö have a notably lower age standardized incidence than the areas with a poor population such as Skärholmen and Spånga-Kista.

### Table 2 Examples of parishes in each income group with age standardizes incidence per 100 000 inhabitants

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Parishes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;140 000</td>
<td>Södertälje (47) Skarpnäcks (39) S:t Mikael (32) Danderyds (28)</td>
</tr>
<tr>
<td>140 000-159 000</td>
<td>Skärholmens (49) Brännkyrka (44) Hägerstens (37) Lidingö (28)</td>
</tr>
<tr>
<td>160 000-179 000</td>
<td>Spånga-Kista (51) Hässelby (44) Bromma (38) Kungsholms (38)</td>
</tr>
<tr>
<td>&gt;180 000</td>
<td>Botkyrka (54) Vällingby (46) Katarina (42) S:t Görans (26)</td>
</tr>
<tr>
<td></td>
<td>Flemingsbergs (55) Tyresö (50) Solna (45) Stockholms domk. (23)</td>
</tr>
</tbody>
</table>

(\() = \text{age standardized incidence per 100 000 inhabitants.}

**SES and incidence of OHCA**

In this part an ordinary least square regression analysis is used to see if the age standardized incidence is different in each income group. To make the interpretation easier and to see any non-linear relationships dummy variables are being used for each income category.

As mentioned under the data section, the education variable is very highly correlated with the income variable and is therefore dropped from the further analysis. The removal of the education variable is due to that it is easier to interpret the results compared to creating an index variable for socioeconomic status. The relationship between the percentage of immigrants and disposable income didn’t have any disturbing multicollinearity. So it’s possible to use both of them in the same analysis.

In Table 3, model 1 shows the results from the first OLS analysis. In that analysis there was some unexpected results. There seemed to be a non-linear relationship between the income groups and
the incidence of cardiac arrest. The lower middle income group (140 000-159 000) had the highest prevalence of cardiac arrest according to the output. The relationship was, however, significant in all income groups.

The next step was to do some regression diagnostics. To see whether any heteroscedasticity or outliers in the model, a residual plot is made for the linear income variable and the incidence variable. As seen below in figure 3, there are six observations (highlighted dots)\(^{11}\) that deviate from the line. All of these six have a relatively low population and 5 of them have a population of less than 2000 inhabitants. All of these parishes are in the rural areas of the Stockholm County.

**Figure 3** Residual plot with outliers

When these outliers are excluded from the analysis the b-values changed. It can be seen in table 3, model 2 that the incidence is more gradient like over the income groups with the lowest incidence in the high income reference group (<1800). The incidence then increases in each of the lower income groups. The p-value for all income groups is <0.000 and its notable that the incidence is almost twice as high in the lowest income group compared with the highest. The percentage of immigrants is still non-significant and the p-value has increased to a very high level. There is a

\(^{11}\) Highlighted parishes are the following; Gottröra, Edsbro-Ununge, Riala, Husby, Skederid och Rö, Vårpinge and Fasterna.
noticeable increase in the $R^2$-value in this model compared with the previous. From 0.136 it increases to 0.391.

**Table 3** OLS regression analysis of the relationship between income group and age standardized incidence of OHCA.

<table>
<thead>
<tr>
<th>OLS regression</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$B$</td>
<td>$\text{Sig}$</td>
</tr>
<tr>
<td>&gt;180 000 (Intercept)</td>
<td>23.045</td>
<td>.000</td>
</tr>
<tr>
<td>&lt;140 000</td>
<td>13.715</td>
<td>.047</td>
</tr>
<tr>
<td>140 000-159 000</td>
<td>15.863</td>
<td>.001</td>
</tr>
<tr>
<td>160 000-179 000</td>
<td>11.485</td>
<td>.033</td>
</tr>
<tr>
<td>Immigrants %</td>
<td>0.230</td>
<td>.236</td>
</tr>
<tr>
<td>$R^2$-value</td>
<td>0.136</td>
<td></td>
</tr>
</tbody>
</table>

The figure below plots the predicted incidence rate from the regression analysis. It shows a quite rapid decrease in the age standardized incidence of OHCA when moving from lower to higher income parishes. The lowest income group has a median incidence rate of 51 cardiac arrest per 100 000 inhabitants compared with only 26 in the richest income group (>180 000). The prevalence of OHCA is in other words almost twice as high in the lowest income groups compared with the highest. **Figure 4** Median incidence per 100 000 inhabitants in different income groups.
**SES and survival of OHCA**

In this analysis a binary logistic regression is used to analyze whether the chance of survival is lower among residents in lower SES parishes. The reason to use a logistic regression for this analysis is due to the binary outcome variable (alive or dead after 30 days).

The background characteristics for the different income groups are fairly similar as in Table 4. The biggest differences are according to sex, cardiac etiology and age. The lowest income group has a smaller proportion of cardiac arrest with cardiac etiology, and a larger proportion of men and a lower median age. The highest income group has a notably higher age than the other groups. This is probably because people in this group have their cardiac arrests later in life. This is also suggested by the above analysis showing lower incidence in higher-income areas, which suggest that if their residents have a OHCA they have it in an older age. The response time is also higher in the two lower income groups. The proportion of bystander CPR is about the same in all groups.

<table>
<thead>
<tr>
<th>Table 4 Cardiac arrest background variables in each income group</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;140 000</td>
</tr>
<tr>
<td>n</td>
</tr>
<tr>
<td>Sex % (men)</td>
</tr>
<tr>
<td>Cardiac cause %</td>
</tr>
<tr>
<td>Witnessed %</td>
</tr>
<tr>
<td>Bystander CPR %</td>
</tr>
<tr>
<td>VF/VT %</td>
</tr>
<tr>
<td>At Home %</td>
</tr>
<tr>
<td>EMS witnessed %</td>
</tr>
<tr>
<td>Age (median)</td>
</tr>
<tr>
<td>Survival 30 d %</td>
</tr>
<tr>
<td>Response time median</td>
</tr>
</tbody>
</table>

There seems to be a curvilinear relationship for survival in the different groups. The two middle (140 000-159 000 and 160 000-179 000) groups have a higher rate of survival than the lowest (<140 000) and highest (>180 000) group. After excluding all patients with an age over 76 years the gradient changes. The increase in survival is most notable in the highest income group. This
suggests that the fairly low survival in the highest income group is due to the high age in that group as discussed above. The proportion of VF also rises in all groups when the oldest patients are excluded.

Table 5 Proportion survivors and VF/VT for patients 18-75 years old.

<table>
<thead>
<tr>
<th></th>
<th>&lt;140 000</th>
<th>140 000-159 000</th>
<th>160 000-179 000</th>
<th>&gt;180 000</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>661</td>
<td>1244</td>
<td>768</td>
<td>404</td>
<td></td>
</tr>
<tr>
<td>Survival 30 d %</td>
<td>10.6</td>
<td>11.3</td>
<td>12.4</td>
<td>14.4</td>
<td>0.255</td>
</tr>
<tr>
<td>VF/VT</td>
<td>25.1</td>
<td>24.7</td>
<td>24.5</td>
<td>24.9</td>
<td>0.994</td>
</tr>
</tbody>
</table>

The exclusion of patients over 75 years is due to the low probability of survival. Regardless of other positive factors around the cardiac arrest, the chance of survival is low, as seen in figure 5 below.

Figure 5 The relationship between age and survival

To investigate if the chance of survival is lower in lower socioeconomic parishes, as previous noted, binary logistic regression is being used. There are many known factors which increase the chance of survival. As can be seen in Table 6, model 1 below where only income and the chance of survival are tested, there is no relationship at all. The Nagelkerke R2 value is only 0.001 which
suggests that our model is not good at all to predict survival of cardiac arrest. When adjusted for immigrants nothing happens. Everything is still non-significant and there is no increase in Nagelkerke R2.

In model 3 however, when adjusting for factors that are known to increase the chance of survival (age, response time, bystander CPR etc.), the odds ratio for the income variable changes. There are some interesting results when adjustments are made for individual level data. The lowest income group (<140 000) has a significant (p-value of 0.049) negative effect as seen in model 3 in table 6 below. The odds ratio is 0.521 which show that the chance of survival is considerably lower in the lowest income area compared with the highest income area. Hosmer & Lemeshow goodness of fit test shows a p-value of 0.381 which is non-significant. This is a good thing which says that the model fits the data (Field, 2005:233:254).

We saw in table 5 above that patients who were older than 75 years were excluded, we saw that the percentage of survivors was higher in the higher income areas. In model 4 the same selection is used (18-75 years). In this model, the confidence intervals change for the different income areas. The odds ratio for the lowest income areas decreases further and has now a lower p-value (0.032). For the second lowest income group (140 000-159 000) the odds ratio falls quite considerably, from 0.790 in model 3 to 0.620 in model 4. The negative effect for this group is in this model significant with a p-value of 0.046. Also in this model Hosmer & Lemeshow test show a non-significant value of 0.379 which suggests that the model fits the data. The same logistic regression is calculated for the patient over 76 years. There are no significant p-values for either income group. Other variables as response time, cardiac etiology and age lose their significance in that analysis. The patients over 76 years is such a big group (n=1881) that it effects the overall results in model 3.
Table 6 Binary logistic regression analysis of SES and the chance of survival after OHCA

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4 (patients 18-75 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;140 000</td>
<td>0.855 (0.418)</td>
<td>0.789 (0.399)</td>
<td>0.521 (0.049)*</td>
<td>0.444 (0.032)*</td>
</tr>
<tr>
<td>140 000-159 000</td>
<td>1.015 (0.93)</td>
<td>0.999 (0.994)</td>
<td>0.790 (0.232)</td>
<td>0.620 (0.046)*</td>
</tr>
<tr>
<td>160 000-179 000</td>
<td>1.066 (0.709)</td>
<td>1.057 (0.746)</td>
<td>0.871 (0.495)</td>
<td>0.747 (0.237)</td>
</tr>
<tr>
<td>&gt;180 000</td>
<td>REF</td>
<td>REF</td>
<td>REF</td>
<td>REF</td>
</tr>
<tr>
<td>Immigrants %</td>
<td>1.003 (0.691)</td>
<td>1.007 (0.401)</td>
<td>1.008 (0.363)</td>
<td></td>
</tr>
<tr>
<td>Cardiac etiology</td>
<td>1.645 (0.009)*</td>
<td>1.838 (0.008)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crew witnessed</td>
<td>3.622 (0.000)*</td>
<td>3.661 (0.000)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>1.219 (0.181)</td>
<td>1.321 (0.121)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Witnessed</td>
<td>2.957 (0.000)*</td>
<td>3.321 (0.000)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bystander CPR</td>
<td>1.359 (0.072)</td>
<td>1.210 (0.347)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VF/VT</td>
<td>12.506 (0.000)*</td>
<td>13.912 (0.000)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.964 (0.000)*</td>
<td>0.959 (0.000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response time</td>
<td>0.973 (0.012)*</td>
<td>0.956 (0.002)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>0.559 (0.000*)</td>
<td>0.677 (0.014)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-2.247</td>
<td>-2.469</td>
<td>-2.417</td>
<td>-1.934</td>
</tr>
<tr>
<td>N</td>
<td>4428</td>
<td>4428</td>
<td>4428</td>
<td>2547</td>
</tr>
<tr>
<td>Nagelkerke R2</td>
<td>0.001</td>
<td>0.001</td>
<td>0.376</td>
<td>0.403</td>
</tr>
</tbody>
</table>

* = Significant on a 0.05 percent level

Discussion

The objective of this paper was to analyze whether the incidence and survival from out of hospital cardiac arrest varies between different areas characterized by different income levels. The study had two parts. One focused on incidence of out of hospital cardiac arrest and the other focused on survival from out of hospital cardiac arrest. I will discuss the results from these two parts separately. The last part of the discussion focuses on the possible explanations in the SES – health field and how theses explanations can be used to describe differences in incidence and outcome in OHCA.
Socioeconomic status and incidence of out of hospital cardiac arrest

The first hypothesis stated that residents from poorer parishes have a higher incidence of out of hospital cardiac arrest. First, the age standardization shows that it’s important to control for the age structure. As seen in Table 1 there was quite a big difference before and after age standardization in some parishes. Age standardization removes the risk the result would have been due to the age structure in each parish and not from its income profile.

There is a strong relationship between the median income level of a parish and the incidence of out of hospital cardiac arrest. The incidence increases significantly in each income group and the follows a positive gradient. This result suggests that people who live in economically weaker areas have a higher prevalence of out of hospital cardiac arrest.

These results follow the same pattern as the previous studies on socioeconomic status and incidence of out of hospital cardiac arrest. In all studies which have focused on SES and incidence of OHCA there has been a significant relationship. All of these studies have used aggregated data on an area level. Reiner’s studies (2006; 2011) and Soo (2001), which are the three studies that primarily focused on SES and incidence of OHCA, used a fairly similar method as I did in this thesis. This makes it possible to compare the results with the previous research.

The percentage of immigrants is included as a control variable because it is possible that there would be differences as seen in the previous research section. The results show that there is no relationship in any of the models. This result is the same as in other OHCA studies. But as with income and education one cannot draw any conclusions from this result to an individual level. It only suggests that areas with a high proportion of immigrants do not seem to have a higher incidence when controlled for income.
Socioeconomic status and survival of out of hospital cardiac arrest

The second hypothesis in this paper was: Individuals who live in lower socioeconomic areas have a lower chance of survival than persons in areas with higher socioeconomic status. The background variables are as seen in table 5 fairly similar.

The high median age in the highest income group could be hiding a possible effect of socioeconomic status so I did the same analysis for 30 days survival and proportion of VF with all patients over 75 are excluded. As seen in table 5, after the exclusion the rate of survival is highest in the richest income group. This exclusion is due to the poor chance of survival after OHCA for the older patients (See figure 5).

In the logistic regression analysis we can see that neither income nor percentage of immigrants do not alone predict survival (model 1 and 2 in table 6). When controlled for individual level data on medical conditions and especially age we see a relationship between income and the chance of survival. For the lowest income group there is a significant relationship between SES and the chance of survival. When I use the same selection as above (18-75 years old), there is a significant negative relationship for the two lowest income groups.

The odds ratio for, especially the lowest income group is quite low. Persons from the highest income groups have a more than twice as high chance of survival than persons from the lowest in the 18-75 age group. The relationship seems to be stronger for the, in this case, younger population. In the separate logistic regression analysis for the older population (>76 years) there was no relationship at all between SES and the chance of survival. This follows the low overall survival in that group.

These results are similar to some of the previous studies on of SES and survival of OHCA. It is also the first study made in Europe which has found a relationship between a SES measure and survival from out of hospital cardiac arrest. To date the relationship between SES and survival from OHCA has only been investigated in one European study (Soo et al, 2001) and they might not have considered the issue of age structure well enough. The results in this
study show the same pattern as Reiner and colleagues (2006; 2011) has shown for incidence. The relationship between SES and OHCA is stronger for younger persons than older.

Another interesting result from this analysis is the proportion of bystander CPR. Previous studies (Sasson, 2012; Root, 2013; Vaillancourt, 2008) found a lower proportion of bystander CPR in lower socioeconomic groups. In this case there does not seem to be a relationship. There difference between the lowest and the highest income group is only two percentages. This doesn’t seem to be an explaining factor for the differences in survival in this case.

**SES - health theories and OHCA**

It is hard to say why there is a relationship between area level SES and both incidence and the chance of survival in OHCA. In the case of incidence it can of course be that persons living in the richer areas have, as Link and Phelan (1995) suggested more resources to prevent and avoid risk factors of disease. The higher age of the cardiac arrest patients in the richest income group can suggest evidence that they can avoid cardiac arrest longer than persons from lower SES groups.

The relative deprivation argument can also be an explanation. Wilkinson and Pickett (2007) suggests that people compare themselves with other and the feeling of inferiority leads to stress which is bad for a person’s health. This is of course hard to answer, to do that you need to know which group/groups the poorer groups compare themselves to as the explanation is for relative and not absolute materialistic standard.

Another possible explanation is what is called health- or social selection. This suggests that people that are already sick tend to move down (or at least don’t move up) the social ladder, in this case to poorer neighborhoods. The explanation is in this case not a relationship between SES and health but a relationship between health and SES. As Shuring (2007) and Haas (2006) have shown there is some evidence for that relationship.

The behavioral explanation is possibly one of the most appealing ones in the case of OHCA. It is well known that some behavioral factors are bad for cardiovascular health. As Adler (2002) has shown people from lower socioeconomic groups tend to smoke, drink and eat more unhealthy food than people from higher socioeconomic groups. These behavioral
explanations are well known to lead to different health problems which increase the risk of cardiovascular disease such as coronary heart disease, hypertension and diabetes.

**Conclusions and future research**

The objectives for this thesis were to study if there were any differences in both incidence and survival of out of hospital cardiac arrest. In this study there seems to be a strong relationship between socioeconomic status and OHCA. The results are statistically significant in both the incidence and survival analysis, which are similar to many of the previous studies on the subject. It is also the first study in Europe that shows a significant relationship between SES and survival of out of hospital cardiac arrest.

The results in this paper suggest that there are differences between socioeconomic groups regarding incidence of OHCA and survival after OHCA on an area level. It is however hard to draw conclusions from these results at the individual level. Future research should focus on individual level socioeconomic status as a predictor of incidence and survival of OHCA. When using aggregated data on an area level there is always a risk of ecological fallacy. If individual level data were used the possibilities to use other SES variables would be possible, assuming that the correlation between income and education is not as high on an individual level that it is on an area level. However, a plausible hypothesis is that the relationship also exists at an individual level.

Other future research should focus on why there is a relationship between SES and survival of OHCA. The possible SES - health explanations which are presented in the theoretical explanations section and the discussion can’t be answered in this paper. Future studies should investigate what causes the differences in incidence and survival of OHCA in different SES groups.
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**Electronic sources**
