

From DEPARTMENT OF PUBLIC HEALTH SCIENCES
Karolinska Institutet, Stockholm, Sweden

INCOME DISTRIBUTION AND HEALTH – THE ROLE OF INDIVIDUAL AND MUNICIPALITY LEVELS

Göran Henriksson



**Karolinska
Institutet**

Stockholm 2014

All previously published papers were reproduced with permission from the publisher.

Published by Karolinska Institutet. Printed by Universitetservice AB.

© Göran Henriksson, 2014

ISBN 978-91-7549-416-6

ABSTRACT

The question whether income inequality is detrimental for health is still, after almost a quarter of a century and an impressive amount of literature, debated. The purpose of this thesis is to explore the association between income inequality and different health outcomes in a relatively egalitarian country during the 1990s and early 2000s, thereby contributing to a better understanding of the multitude of interpretations. Specific aims are to analyse whether there is an association between income distribution in Swedish municipalities and risk of death and to test the hypothesis that manual workers are at higher risk of death than are non-manual employees when living in municipalities with higher income unequal. Further, to disentangle the effects of income inequality and residential segregation, measured as parish level homogeneity, on acute myocardial infarction and to test the hypothesis that income inequality at the municipality level, as a marker of social stratification within the municipalities, would be associated with risk of attempted suicide.

The data used for the four studies in the thesis were compiled as two data sets. The mid-aged data set comprised all people 40 - 64 years in 1990 Swedish census and linked with the national cause-of-death register and the National Patient Register, altogether 2.5 million individuals. The second data set consisted of all individuals living in Sweden at age 16 and born 1972 or 1977 (N= 213 395). The unique personal identification number used in Sweden enabled linkage between the national inpatient register at the National Board of Health and Welfare and Statistics Sweden.

The effect from income inequality on mortality was overestimated using an ordinary least square regression as compared to the estimates in a hierarchical analysis. The latter showed an *inverse* association with the relative risk which, once adjustment for individual level variables was made, disappeared. We used data comprising all people 40 - 64 years and being employed in 1990 to analyse the hypothesis that manual workers had a higher “vulnerability” than non-manual employees to income inequality. The results indicated that unskilled manual workers living in municipalities with higher income inequality had a higher mortality risk than their peers living in more income egalitarian municipalities. For high level non-manual employees the risk was inverse. We studied how the association between AMI and income inequality at the municipality level changed when parish level homogeneity regarding affluence and disadvantage respectively, was included in the analysis. There was an overall inverse association between income inequality and AMI which seemed to be explained by the level of homogeneity regarding affluence at the parish level within the municipalities. We noted that the affluent parishes tended to be within the municipalities within the three largest metropolitan areas Stockholm, Gothenburg and Malmö. To better understand the role of economic activity we used the concept of economic regions in analyses of associations between income inequality, economic deprivation at parish and individual level and attempted suicide (AS) among youth. We found no overall association between income inequality and AS but once adjustment for economic region was made, there was a significant *inverse* association between income inequality and AS, strongest in the three metropolitan areas. Although there was a strong association between the degree of economic deprivation at the parish level and AS it did not explain much of the association between income inequality and attempted suicide at the municipality level.

The overall conclusion from the four studies is that there seems to be an inconsistent (weak) association between income inequality and health, dependent on which context analyses are made and the choice of outcome. However, the studies raise a number of issues related to the complexity in which the research question is embedded, for example the lack of data on welfare institutions or other potentially “buffering” mechanisms.

Keywords: income inequality, Sweden, mortality, ischemic heart disease, attempted suicide, multilevel analysis

SVENSK SAMMANFATTNING

Frågan om inkomstspridning är skadlig för hälsan är fortfarande efter ett kvarts sekel en omstridd fråga. Syftet med denna avhandling är att undersöka sambandet mellan inkomstspridning och hälsa i ett relativt jämlikt land under 1990-talet och början av 2000-talet för att därigenom bidra till att bättre förstå de tolkningar som gjorts av de många studierna som genomförts. Avhandlingen syftar specifikt till att analysera om det finns ett samband mellan inkomstspridning i svenska kommuner och dödlighet; att testa hypotesen att arbetare har en högre dödlighet om de bor i kommuner med högre inkomstspridning, jämfört med tjänstemän; att undersöka sambandet mellan inkomstspridning, boendesegregation och hjärtinfarkt; att testa hypotesen att inkomstspridning på kommunnivå är associerad med risken för självmordsförsök bland unga.

De data som använts till de fyra studierna var sammanställda till två databaser. Den ”medelålders” databasen omfattade samtliga 40 – 64 år i 1990 års Folk- och Bostadsräkning, sammankopplade med Dödsorsaksregistret och Patientregistret vid Socialstyrelsen, ca 2,5 miljoner individer. Den andra databasen omfattade samtliga individer boende i Sverige vid 16 års åder och födda 1972 eller 1977 (N=213 395). Personnumret användes för att länka registren vid Socialstyrelsen och SCB. Effekten av inkomstspridning på dödlighet överskattades då en ”ordinary least square”-regression användes, jämfört med skattningarna från en hierarkisk regressionsanalys. Den senare indikerade ett *omvänt* samband med dödlighet, vilket försvann då modellen justerades för individbundna faktorer. Vi använde data på samtliga 40 – 64 år och som hade anställning 1990, för att analysera hypotesen att arbetare hade större ”sårbarhet” än tjänstemän för inkomstojämlikhet. Resultaten indikerade att icke facklärd arbetare hade högre dödlighet om de bodde i kommuner med högre inkomstojämlikhet än icke facklärd arbetare som bodde i kommuner med mindre grad av inkomstojämlikhet. För högre tjänstemän fanns ett omvänt samband. Vi studerade hur sambandet mellan hjärtinfarkt och inkomstspridning på kommunnivå förändrades då graden av homogenitet avseende välstånd respektive deprivation inkluderades i analysen. Det fanns ett generellt *omvänt* samband mellan inkomstspridning på kommunnivå och hjärtinfarkt, vilket till stor del förklarades av segregation av höginkomsttagare på församlingsnivå inom kommunerna. Församlingar med stor andel höginkomsttagare tenderade att finnas i kommunerna inom något av de tre storstadsområdena kring Stockholm, Göteborg och Malmö. För att bättre förstå om graden av ekonomisk aktivitet spelar någon roll användes begreppet ”ekonomisk region” för att analysera sambanden mellan inkomstspridning på kommunnivå, ekonomisk deprivation på församlings- och individnivå, och självmordsförsök bland unga. Det fanns inget generellt samband mellan inkomstspridning och självmordsförsök men då modellen justerades för ekonomisk region fanns det ett påtagligt och omvänt samband, starkast i de tre storstadsområdena. Även om det fanns ett starkt samband mellan graden av ekonomisk deprivation på församlingsnivå och självmordsförsök förklarade inte det sambandet mellan inkomstspridning på kommunnivå och självmordsförsök. Den generella slutsatsen utifrån de fyra studierna är att det finns ett inkonsistent (svagt) samband mellan inkomstspridning och hälsa, betingat av den kontext i vilken analyserna är gjorda och vilket hälsoutfall som valts. Men resultaten väcker en rad frågor som är relaterade till den komplexitet forskningsfrågeställningen är inbäddad i,

till exempel den avsaknad av relevanta data som beskriver välfärdsinstitutioners betydelse och andra potentiellt ”buffrande” mekanismer.

LIST OF PUBLICATIONS

This thesis is based on the following publications which will be referred to by their Roman numbers. They are reprinted with kind permission from Sage Publications, Oxford University Press and Elsevier.

- I. Henriksson, G., P. Allebeck, G. R. Weitoft and D. Thelle (2006). "Income distribution and mortality: implications from a comparison of individual-level analysis and multilevel analysis with Swedish data." Scand J Public Health **34**(3): 287-294.
- II. Henriksson, G., P. Allebeck, G. R. Weitoft and D. Thelle (2007). "Are manual workers at higher risk of death than non-manual employees when living in Swedish municipalities with higher income inequality?" Eur J Public Health **17**(2): 139-144.
- III. Henriksson, G., G. R. Weitoft and P. Allebeck (2010). "Associations between income inequality at municipality level and health depend on context - A multilevel analysis on myocardial infarction in Sweden." Soc Sci Med **71**(6): 1141-1149.
- IV. Henriksson, G., S. Zammit, D. Rai, S. Löfving and P. Allebeck (2012). Pattern of suicide attempts in two birth cohorts of Swedish men and women: Role of income inequality and economic deprivation. (Manuscript).

CONTENTS

1	Introduction	1
1.1	Background.....	1
1.1.1	The international findings	1
1.1.2	The Scandinavian countries	6
1.2	Interpretations of the empirical findings.....	8
1.2.1	There is no “true” association.....	8
1.2.2	There is evidence for a “true” association, but no firm conclusion about the nature of the association	9
1.2.3	Integration of interpretations.....	16
2	Theoretical framework	18
2.1	The problem.....	18
2.1.1	Methodological individualism or methodological collectivism?.....	18
2.1.2	The conceptual model	20
2.2	Multilevel analysis.....	20
2.2.1	What is special with multilevel analysis?.....	21
3	Aims.....	23
4	Data and methods	24
4.1	Data	24
4.1.1	The mid-age data set	24
4.1.2	The adolescent cohorts.....	24
4.2	Measures	24
4.2.1	Individual level.....	24
4.2.2	Parish level	25
4.2.3	Municipality level	26
4.2.4	Outcomes	27
4.3	Statistical methods.....	28
4.3.1	Logistic models	28
4.3.2	Poisson models.....	29
5	Results	30
5.1	Study 1: Income distribution and mortality: Implications from a comparison of individual-level analysis and multilevel analysis with Swedish data.....	30
5.2	Study 2: Are manual workers at higher risk of death than non-manual employees when living in Swedish municipalities with higher income inequality?.....	30
5.3	Study 3: Associations between income inequality at municipality level and health depend on context. A multilevel analysis on myocardial infarction in Sweden	31
5.4	Study 4: Pattern of suicide attempts in two birth cohorts of Swedish men and women: Role of income inequality and economic deprivation.	31
6	Discussion.....	32
6.1	General conclusion	32
6.1.1	Heterogeneity at different levels.....	32

6.1.2	Residential segregation	34
6.2	Weaknesses	37
6.2.1	Lack of data	37
6.2.2	The choice of aggregate level	37
6.2.3	Parish as neighbourhood proxy.....	38
6.2.4	Lag time	38
6.2.5	The role of migration.....	39
6.2.6	The “small N problem”, apparent in Swedish municipalities.	39
6.3	Conclusions.....	39
6.4	The policy implications	41
6.5	Implications for future research	42
7	Acknowledgements	43
8	References.....	45

1 INTRODUCTION

1.1 BACKGROUND

The associations between economic prosperity, growth, wealth and health are a classic theme with many variations within social epidemiology but also within politics. These associations have also profound ethical connections, to fairness and to the distribution and redistribution of resources within a society. With his suggestion that mortality has a stronger association to income distribution than to average income measures such as GDP per capita, in developed countries, Wilkinson (1992) started a debate which has engaged many researchers and grown to a research area of its own which, far from uncontested, has made considerable contributions to health policy making at the international and national scenes. This dissertation takes Wilkinson's suggestion and later debate as the starting point to explore whether the use of Swedish register data could help to clarify some of the controversies.

The first section will account briefly for the literature, outlining the heterogeneity in the findings. Then follows a review of the findings from studies exploring the association between income inequality and health in the Scandinavian countries. The section concludes with a summary of the different interpretations of the diverse results found in the literature.

1.1.1 The international findings

In his widely cited paper from 1992 Wilkinson suggests that mortality is affected by income distribution and that GNP per capita, as the prime measure of economic growth, was a poorer predictor of health in the population. He underpins his suggestion by analysing cross-sectional and aggregated data on income distribution and life expectancy in a selected number of developed countries in which data were available. The paper, together with his book from 1996 (Wilkinson, 1996), started a debate in the scientific community as well as among policy-makers. The argument challenged the prevailing idea that the average income standard in industrialised developed countries was the appropriate measure of prosperity. Instead it suggested that the more egalitarian the society, the better the health of the population.

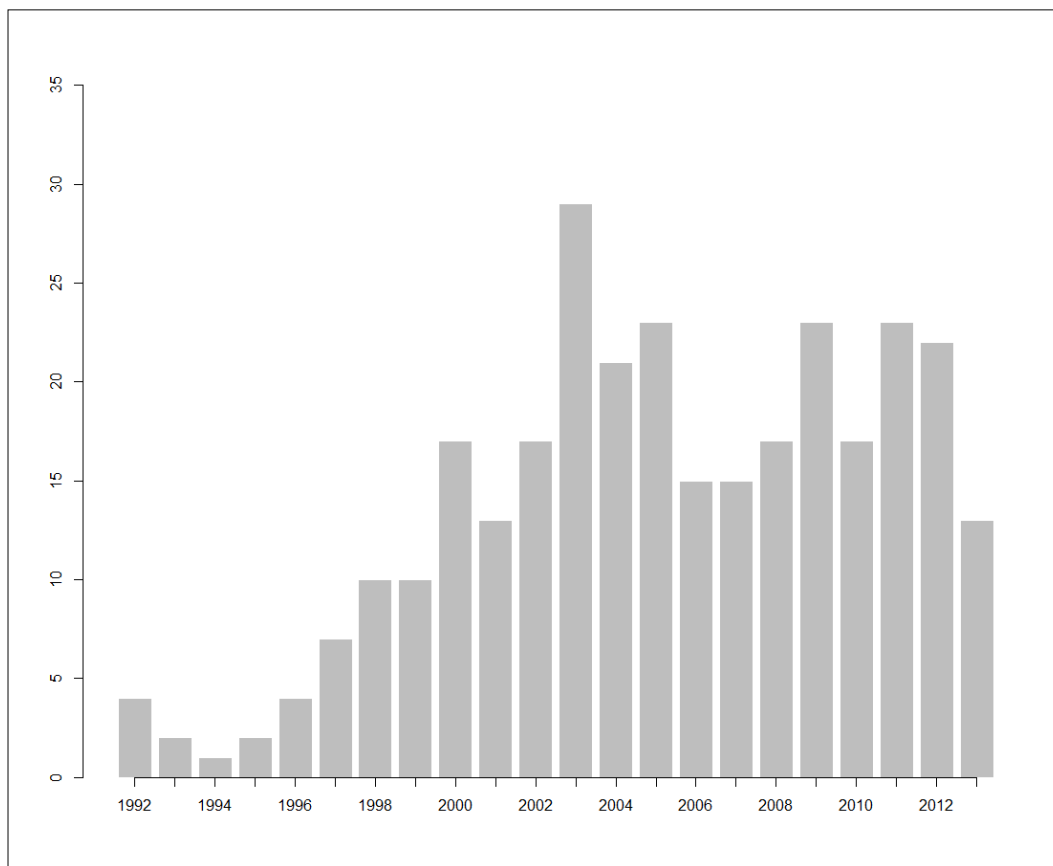


Figure 1 The annual number of published papers on the association between income inequality and health 1992 - Sep 2013, according to a quick search in PubMed and World of Science.

Wilkinson's suggestion was not original. Several researchers had noticed a growing income inequality in many high income countries since 1970's (Atkinson, 2003). Some researchers also discussed a possible association between income, income inequality and health.

In the mid-seventies, Preston (1975) estimated the relative contribution of economic factors to the increases in the life expectancy during the 20th century and found that there was a loglinear association between per capita national income and life expectancy, such that gains in income at the lower end was associated with a steeper gain in the life expectancy and that higher income levels had a diminishing return in terms of increased life expectancy.

In his study of income and income inequality as determinants of mortality Rodgers (2002) compared cross-national data from 56 countries in which data on income distribution were available. He concluded that the income distribution variable was consistently significant regardless of the health outcome measured. He also noted that there might be other factors than the income distribution operating and suggests that income distribution is likely to be associated with a number of welfare institutions.

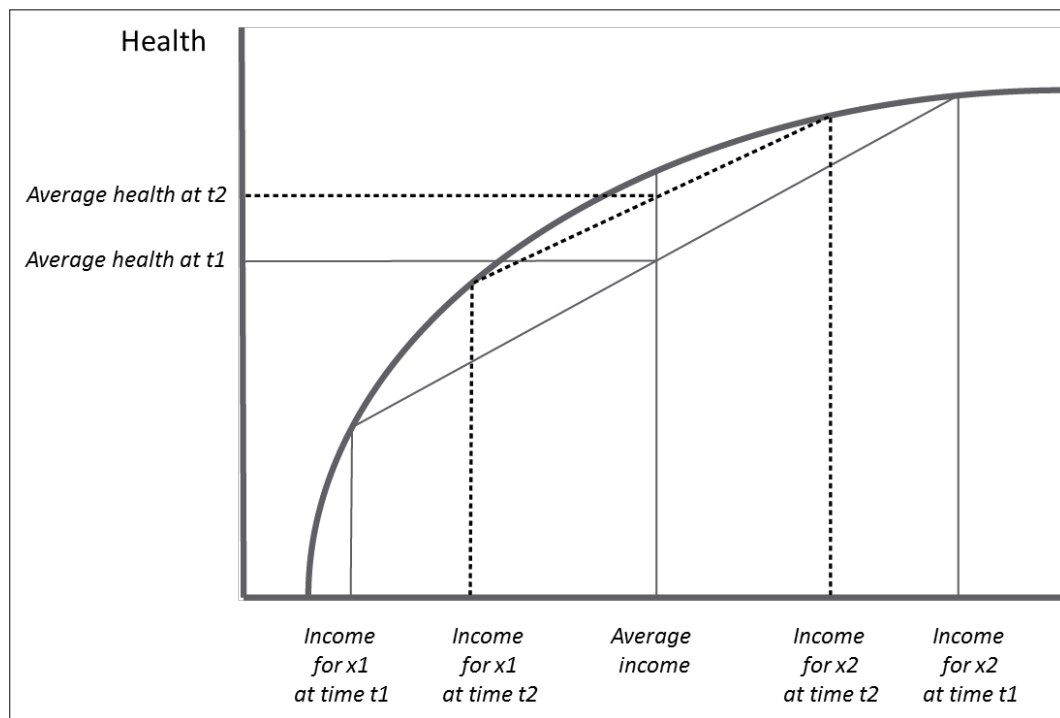


Figure 2 Theoretical connections between individual and group level relationships between income and health (Adapted from (Rodgers, 2002)).

Rodgers discussed this in relation to a theoretical reasoning in which the association between income and health is curvilinear with diminishing health returns for higher income levels. The health of individual x1 is lower than that of individual x2. Provided that the relation between income and health is curvilinear as in the figure, a narrowing of the income distribution would lead to a higher level of health (average health at t2). A question that has occupied much interest from scholars is whether such a curvilinear shape of the relation explains the association between income inequality and health or whether there is an added effect from income inequality per se.

Wilkinson studied trends in mortality differences, income, income distribution and poverty in England and Wales during six decades until 1981 and found a relation between trends in class differences in relative poverty and mortality but no relation between class differences in *average* earnings and mortality (Wilkinson, 1989).

In another paper at about the same time Wilkinson aims to deepen the discussion on income inequality and health by studying repeated cross-sectional relations between income and mortality within Great Britain (Wilkinson, 1990). He found a strong association between relative poverty and mortality which he concluded “was at least partly causal and is responsive to changes in income” and supported the proposition that income inequality is linked to health.

In the wake of Wilkinson’s BMJ paper 1992 the number of studies on income inequality and health increased considerably. By the end of the 1990’s there were at least sixteen published papers which explicitly investigated a possible association between income inequality and health, 11 from US settings mostly states (Kaplan et al., 1996; Kennedy et al., 1996; Fiscella and Franks, 1997; Kawachi and Kennedy, 1997; Kawachi et al., 1997; Daly et al., 1998; Kahn et al., 1998; Kennedy et al., 1998; Lynch et al., 1998; Shi et al., 1999; Soobader and LeClere, 1999), 4 from the OECD-members or “developed countries” (Duleep, 1995; Judge, 1995; McIsaac and

Wilkinson, 1997; Judge et al., 1998) and 1 from the UK (Stanistreet et al., 1999). Of these papers there were 10 supportive, 3 partly supportive and 2 unsupportive. The three papers which gave partial support were based on analyses where individual level variables were used (Daly et al., 1998; Kahn et al., 1998) or when different measures of income inequality were used (Kennedy et al., 1996). The two papers rejecting the hypothesis (Judge, 1995; Judge et al., 1998) were based on recalculations on updated data income inequality and mortality data from OECD-countries.

This lack of agreement and diverse findings is something that still characterises this research area. By the end of the decade the debate had outlined two main streams. One that rejected or at least questioned whether there was a “true” effect from income inequality on health outcomes and one that accepted the possibility or even plausibility that there was a true finding but discussed the mechanisms and explanations behind the findings. The arguments concerned different interpretations, different approaches for the analyses, the generalizability from the predominantly used US data and appropriateness of the data used.

In their review, Wagstaff & Doorslaer (2000) suggested a structure for the many different types of hypotheses that has been suggested in the literature so far. They grouped the hypotheses into four different categories: the Absolute Income Hypothesis (AIH) which suggest that it is the *absolute* income that is important for health; the Relative Income Hypothesis (RIH) which suggest that it is the income *relative* to others that affect the health of individuals; the Deprivation Hypothesis (DH) suggesting that it is not the absolute income that matters but rather the degree of deprivation, often measured as the gap between the income and some average or poverty threshold; the Relative Position Hypothesis (RPH) which suggest that it is the relative position in the entire income distribution that matters; the Income Inequality Hypothesis (IIH) which suggest that the income distribution has an effect over and above the effect from the absolute income.

Another way of structuring the proposed hypotheses which has been influential especially in the social epidemiology stream, was made by Lynch et al (2000). They suggested three broad interpretations of the association between income inequality and health: the individual income interpretation, the psychosocial environment interpretation and the neo-material interpretation. There are overlaps between this and the structure proposed by Wagstaff & Doorslaer. The individual income interpretation is the same as the Absolute Income Hypothesis, the psychosocial environment interpretation and the neo-material interpretation might be the mechanisms underlying the Income Inequality Hypothesis.

By the end of the nineties the development of powerful statistical techniques such as multilevel analysis made it possible to improve the analyses of hierarchical data sets, such where individuals were nested within geographical areas (Duncan et al., 1998; Rice and Leyland, 1996; Leyland and Goldstein, 2001; Leyland and Groenewegen, 2003). This development paved the way for the expansion of the research area and also the debate. At the beginning of the new century the criticism of the hypothesis often concerned the inability of the current studies to conclude whether the observed association at the national level was an effect from individual level income or individual level poverty since an ecologic effect could be a “true” effect at the ecological level or it could reflect an association between people with low incomes residing in unequal nations.

This inability and the fact that among the multitude of studies investigating the associations between income inequality and health, few studies supported positive

findings outside the United States, which led Mackenbach (Mackenbach, 2002) to conclude that

“Overall these papers reinforce the idea that the evidence for a correlation between income inequality and the health of the population is slowly dissipating. There is very little confirmation of such a relation outside the United States.”

In their often cited review, Subramanian & Kawachi summarise the findings in 21 studies using multilevel designs to analyse the associations between income inequality and health, published from 1997 to 2004. They concluded that the evidence suggesting that income inequality is a threat to health is far from complete. They identified a number of issues that have to be studied further such as confounding from individual income or education, confounding by regional (sub-national) effects and lag effects from income inequality on health.

Lynch et al (2004) found 98 studies in their systematic review, published from 1979 to 2003. The authors reviewed the evidence for income inequality as a determinant of population health and concluded that there was meagre evidence to support a direct effect from income inequality on health.

In an attempt to gain an understanding of the evidence for the disparate findings, Wilkinson & Pickett (2006) reviewed all published peer reviewed reports on the relation between income inequality and health. They found 155 papers containing 168 separate analyses. The methods in the papers reflected a vast number of ideas and suggestions about the nature of mechanisms involved. The authors concluded that the two most important kinds of differences between the methods are related to the size of the area at which income inequality is measured and in what researchers regarded as the legitimate control variables.

The authors suggested that “income distribution is related to health where it serves as a measure of the scale of social class differences in a society”, i.e. the scale of the geographical area at which income inequality is measured is important since income inequality is a proxy for the degree of social stratification in that area.

We participated in a comparison between five countries (USA, Canada, Australia, UK and Sweden) where 528 metropolitan areas (MA) in the five countries were compared with respect to income inequality (measured as the median share of income) and all-cause mortality in the working-age population (25-64 years) (Ross et al., 2005). We used pooled census data from 1990-91. There was a significant overall association between income inequality and mortality among the MA:s as showed in figure 3.

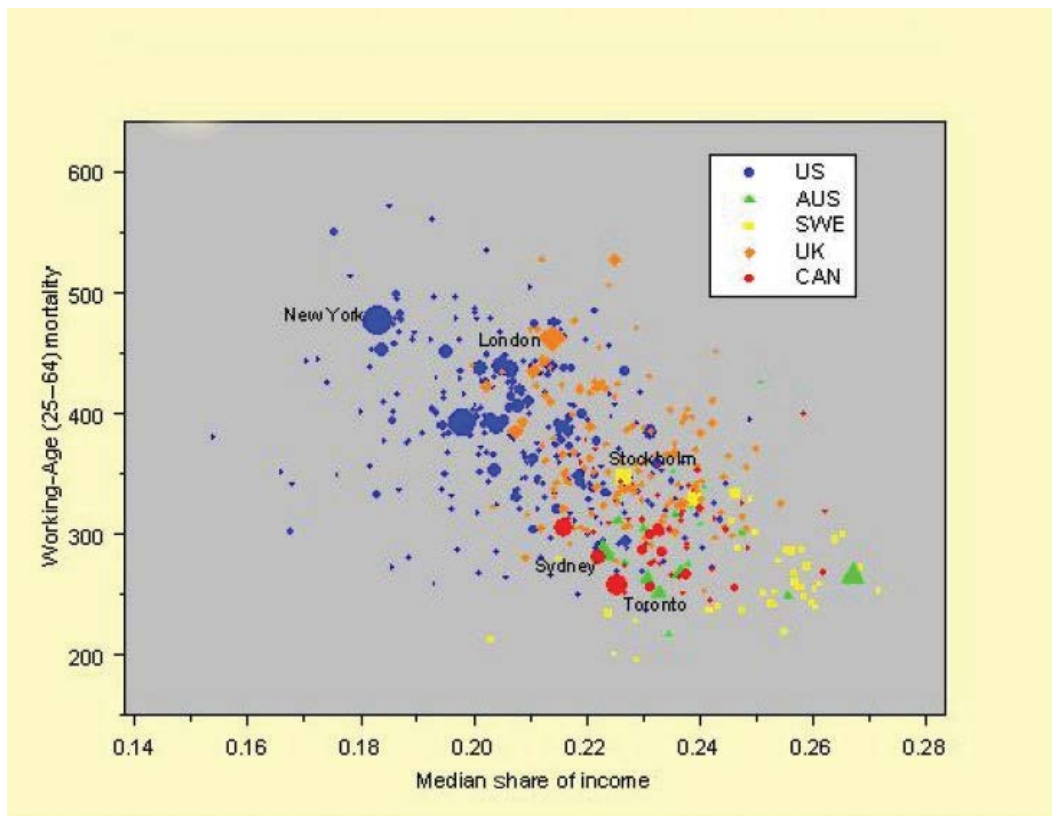


Figure 3 Working-age mortality by the median share of household income in Australian, British, Canadian, Swedish, and the US metropolitan areas (MAs), 1990–1991. Reprinted from *J Urban Health*, 2005, 82(1): p. 101-110; Ross, N. A., D. Dorling, J. R. Dunn, G. Henriksson, J. Glover, J. Lynch and G. R. Weitoft, *Metropolitan income inequality and working-age mortality: a cross-sectional analysis using comparable data from five countries*, with kind permission from Springer Science and Business Media.

Income inequality alone accounted for 34% of the total variation. However, it was only within the US and UK cities that we found a significant association among their MA:s. the absence of an association among MA:s in Australia, Canada or Sweden might be suggestive of policies that buffer the hypothetical health damaging effects from income inequality, e.g. transfers, health care, social welfare.

A comparative cross-sectional study on income inequality and child mortality among USA and 19 western countries found a correlation between health expenditure and mortality but a significant association between income inequality and mortality age 1-14 (Pritchard and Williams, 2011). The five widest income inequality countries had the worst mortality rates, whereas the four with narrowest, among them Sweden, had the lowest rates.

Regidor et al (2011) came to similar conclusions in their study on the evolution of infant mortality since the late 19th century among 17 “wealthy countries”. They classified the countries according to political traditions, family policies and infant mortality transition. They also considered the role of income inequality and public health expenditure. The results suggested that Social Democratic and Scandinavian countries had the lowest infant mortality rates and also that higher income inequality was associated with higher mortality rates.

1.1.2 The Scandinavian countries

Both the psychosocial and the neo-material interpretations predict that the health in egalitarian (with respect to income inequality) countries such as the Scandinavian, have better health. This is in line with most empirical findings from these countries.

Previous studies from Scandinavian countries did not find any association between income inequality and health outcomes (Blomgren et al., 2004; Gerdtham and Johannesson, 2004; Martikainen et al., 2004; Osler et al., 2002; Osler et al., 2003; Leigh and Jencks, 2007)

The results from Scandinavian studies published in recent years show divergent results.

A Norwegian study using data where individuals were nested within Norwegian regions and multilevel modelling, the authors found an association between income inequality at the Norwegian regional level and mortality from all causes among more than two million individuals aged 25 – 66 during 1994 – 1999 (Dahl et al., 2006). They found a strong effect of income inequality on mortality for individuals in more disadvantageous social positions.

In an attempt to analyse whether relative income (defined as the deviation from the average in which the individual lived) was associated with mortality in Norway during the 1990s, Elstad et al (2006) used a large data set comprising 1.88 million people aged 30 – 66 in 1990, derived from administrative registers. Applying logistic models and adjusting for individual level covariates, the authors concluded that low relative income constituted an additional mortality risk among those with middle or low *absolute* incomes and predominantly in the larger municipalities.

Kravdal (2008) used a fixed model approach to investigate the associations between income inequality at the municipality level and mortality where municipalities were included as dummies together with time (1980 – 2002) in discrete time hazard regressions. The data comprised all people 30 – 79 years in Norwegian municipalities which means 500 000 deaths among 50 million person-years under exposure. He found an association between income inequality and mortality over and above individual income but the association was more complex when the municipality dummies were included. The effect remained to some extent among younger people whereas among older men there seemed to be beneficial effects from income inequality.

Elstad (2011) considers the possibility that welfare structures and the overall socioeconomic context may be important factors that might correspond to the level of income inequality and at the same time be part of the processes that affect health. Applying this idea to a data set comprising 1.6 million individuals nested within 35 residential regions in Norway and analysing how mortality 1994 - 2003 relates to income inequality at the regional level together with an extensive set of contextual and individual factors, he found that there was association between income inequality and socioeconomic characteristics in the regions and also to mortality. However, the socioeconomic context did not explain the association between income inequality and mortality, suggesting that the level of income inequality adds independently to higher mortality levels in Norwegian regions.

In a register study limited to refugees aged 25 – 60 between 1990 and 1994 in Sweden, which is a bit more than 65 000, the effect from income inequality at the municipality level on the risk of hospitalisation was investigated (Grönqvist et al., 2012). The authors found no effect from income inequality.

In a recent paper Rostila et al (2012) approached the question of the appropriate choice of aggregate level and also whether welfare spending was associated with self-rated health. They used data from a large survey performed 2002 in the 22 municipalities within Stockholm county, including a bit more than 28 000 residents aged 18-84. Interestingly, they found an association between high and very high

income inequality at the municipality level and self-rated poor health, using a hierarchical logistic regression. Such an association was not apparent when measuring income inequality at the lower aggregate level. They also found that the association at the municipality level ceased when adjustment was made for spending on social goods, suggesting that such spending could account for the association between income inequality and self-rated health at the municipality level.

Edvinsson et al (2013) studied whether there was an association between income inequality, measured as the Gini coefficient, at the municipality level and all-cause mortality among the 65 – 74 age group, including almost 800 000 people nested within all 290 municipalities 2006. The authors used a hierarchical logistic model for their analysis and found a positive association between income inequality and mortality, even when municipality mean income and individual level income were adjusted for.

Thus, even in the relatively egalitarian Nordic welfare systems there are divergent findings regarding the question whether income inequality is detrimental for health.

1.2 INTERPRETATIONS OF THE EMPIRICAL FINDINGS

The diversity of conclusions from the numerous studies on income inequality and health has caused a sometimes heated debate of which is the appropriate interpretation. Currently, there are no signs of a consensus about the role of income inequality in the production of health. So far, there are at least four different “streams” in the debate: (a) a rejection of the income inequality hypothesis, which seems to be the position taken from many economists; (b) an underpinning of the income inequality hypothesis, clearly stating the existence of a “true” association between income inequality and health mainly by psychosocial mechanisms; (c). a more sceptic attitude to the income inequality hypothesis, seeing income inequality as a result from historical, political and economic development in a given society and thus income inequality being but one of several other factors that may affect health, and (d) in recent years, more explicit suggestions to integrate the different interpretations into a consistent theory to better explain the role of income inequality, for example the including the political systems or welfare systems into the analyses of associations between income inequality and health.

In the following I will first describe the suggestion that there is no “true” association, thereafter the suggestion that there is a “true” effect, the latter being roughly divided into *the psychosocial* and *the neo-material* interpretations of which the latter connects to what I have called *the third factor* interpretation. Lastly, I will account for the suggestions to integrate the interpretations.

1.2.1 There is no “true” association.

Judge (1995) presented a critique of Wilkinson’s proposal presented in his BMJ paper 1992, claiming that a reanalysis of the updated LIS database cast doubts whether income distribution was associated with the life expectancy among the richest nations in the world. However, Wennemo (1993), also using the updated LIS database, concluded that income distribution and relative poverty seemed to be more important for the variation of infant mortality among the rich countries than the level of development.

Wagstaff & Doorslaer (2000) found strong support for the AIH, no evidence consistent with the RIH (nor DH), no support for RPH and some support for the IIH, albeit crucially dependent on how well controls for other variables, especially

individual level income, are made. Once this is properly done the association between income inequality and health seems to disappear.

Going through the evidence Deaton (2003) concludes that income inequality in itself is not a major determinant of population health. He argues that there is no robust correlation between income inequality and life expectancy among the rich countries, correlations across the states and metropolitan areas in the USA is “almost certainly the result of something that is correlated with income inequality, but that is not income inequality itself”, the rapid rise in income inequality in the 1980s has not been associated with any slowdown in the rate of mortality decline. He suggests that it is individual low income that is important and not income inequality.

Three Swedish macro economists reviewed the evidence in the studies and arrived at a conclusion similar to that of Deaton (Bergh et al., 2012).

Blakely et al (2002) found no association between income inequality at the US metropolitan area (MA) level and self-rated health, once adjustment for MA average income was made or income at the individual level. The result seems to support the Absolute Income Hypothesis.

Some critics to the income inequality hypothesis argued that the association at an ecological level analysed with cross-sectional aggregate data, might be an artefact from the well-known curvilinear relationship between health and income at the individual level (Gravelle, 1998). However, this hypothesis was contested empirically in a paper where the authors used simulation to test whether the association could be explained by individual level income only, or if there was a residual effect from the ecological level (Wolfson et al., 1999). The authors found that the association could not be fully explained by the individual level income data and concluded that there remains a significant association between income inequality and mortality “over and above anything that could be accounted for by any statistical artefact.”

This did not convince Gravelle who in a response pointed to the possibility of several unobserved variables correlated with income inequality and called for better data and analyses (Gravelle, 1999).

1.2.2 There is evidence for a “true” association, but no firm conclusion about the nature of the association

The bulk of studies on the association on income inequality and health seems to suggest that there is at least some substance to the proposition but no consensus about what are the mechanism or pathways. This standpoint seems to be more frequent among social epidemiologists. I will use the terminology suggested by Lynch et al (2000) to describe the different interpretations.

1.2.2.1 The psycho-social environment interpretation

In his BMJ paper 1992 Wilkinson consider four possible explanations for the relation between income inequality and mortality (Wilkinson, 1992). Two of them concern possible intervening variables, a possibility that he dismisses with reference to the very high correlation coefficients in his findings. The third possibility is that sickness might be the cause of poverty, a possibility which Wilkinson also dismiss on the ground that research has shown reverse causality to explain just a minor part of differences in mortality between social classes, but also because that would imply that changes in income distribution would be determined by autonomous changes in health, which implies a denial of contribution of economic factors like unemployment, taxes, benefits etc., to income distribution. The fourth possibility is that income distribution impact on mortality, often called “the income inequality

hypothesis”. He argues that the association between income inequality and mortality has to do with *relative* rather than *absolute* income. Later he refined this argument by suggesting that the population health is related to income inequality through the effects from income distribution on individual social welfare and on the quality of the social environment, i.e. the relations between people in a given society (Wilkinson, 1999a). He gives three arguments (Wilkinson, 1997). Firstly, income differences among groups *within* societies are associated with social status whereas differences among groups *between* developed societies are not (differences then measured as average per capita incomes). Secondly, based on observations from empirical studies suggesting that mortality seems to be lower in societies where income differences are smaller, he interprets these findings as attributable to the reduction of the burden of relative deprivation. Thirdly, the absolute material standard in developed societies has less influence on health due to the improvement in material living standards in affluent societies.

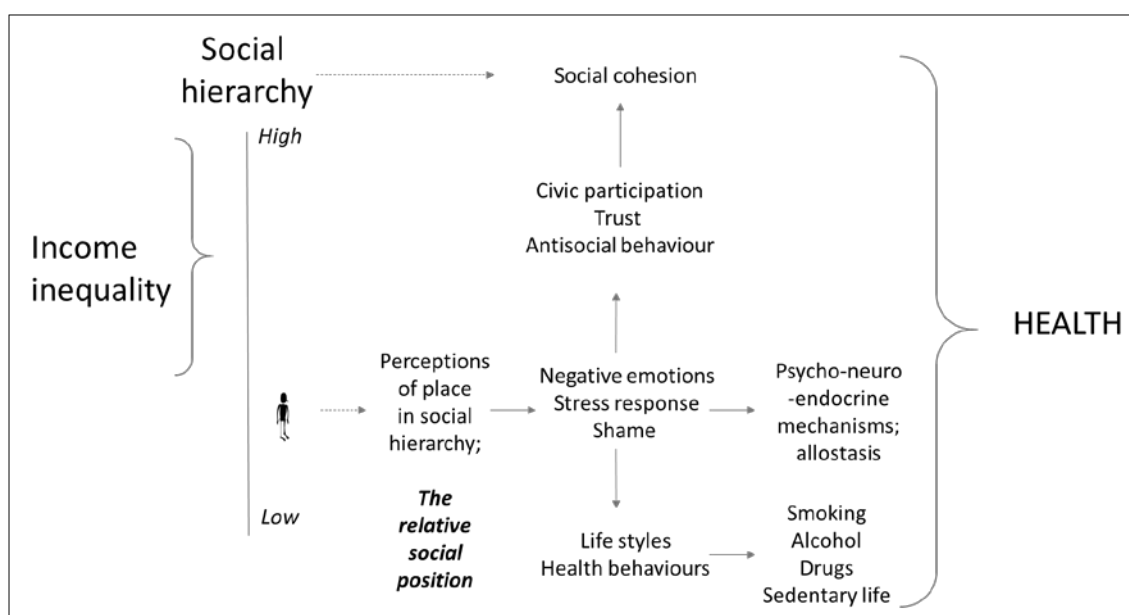


Figure 4 Graphical outline of the psychosocial environment interpretation of the income inequality hypothesis according to Wilkinson (Wilkinson, 1997).

In the psychosocial environment interpretation it is the income distribution that is the driver behind social stratification, “To oversimplify, Muntaner and Lynch believe that income distribution is determined by relations between classes whereas I come closer to believing that income distribution determines class (or, rather, position in the hierarchy and social distance)” (Wilkinson, 1999a).

Social relations and social cohesion

An increase in social hierarchy (represented by wider income differences), Wilkinson argues, tend to be “closely accompanied by a move toward less supportive and more conflictual social relations is an extremely potent mix for health” (Wilkinson, 1999a), referring to reports and research papers on large mortality disparities between high and low social status groups or between groups who are poorly socially integrated compared to those with richer social networks and support. He also implies that wider income distribution not only affects the perception of increased relative deprivation but also the social relations as well.

Research on the role of social capital and social cohesion seemed to support Wilkinson's proposition. Analysing data from 39 US states in a cross-sectional ecological design, to find out how income inequality was related to measures of social capital and mortality, Kawachi et al found a strong correlation between income inequality and both measures of social capital (group membership, $r=-0.46$ and lack of social trust, $r=0.76$) (Kawachi et al., 1997). Both measures were associated with mortality, coronary heart disease, malignant neoplasms and infant mortality. The authors concluded that income inequality is associated with increased mortality via disinvestment in social capital. The role of social cohesion has formed the basis for one important line of research.

Kaplan et al (1996) reported high correlations between income inequality at US state level and age specific rates of low birth weight, homicide, violent crime, work disability, expenditures on medical care and police protection, indicating that the social environment or social cohesion is mediating the association between income inequality and mortality. Another part of the puzzle was the study on Italian regions by Putnam et al (1992), who found strong correlations between people's involvement in local communities and income inequality and referred to the egalitarian relations essential to the development of community life as being "horizontal relations" rather than the "vertical relations" that they found in the south of Italy, characterised by a "patron - client" relation. Wilkinson reflects that the reason social inequalities and friendship are inversely related to health is that they are the two opposite principles of social organization:

"Social status, rank, or pecking order is, after all, about power, coercion, and access to resources without regard for the needs of others. In contrast, friendship is about mutuality, reciprocity, sharing, and a recognition that the needs of others are needs for us. These are, in effect, the two opposite principles of social organization. Measures of income inequality and the quality of social relations, of the relative strength of vertical and horizontal relations, are measures of the extent to which the social order is based on power or mutuality, coercion or sociality, antagonism or cooperation, reciprocity or competition, order-giving and order-taking or a more inclusive pluralism." (Wilkinson, 1999a).

Physiological responses and allostasis

Psychosocial factors, acute and chronic stress at individual and contextual levels are related to a number of diseases, for example ischemic heart disease. Living under long-term social stress leads to a number of physiological reactions such as elevated cortisol levels. These are usually adaptive processes that serve to maintain homeostasis in the body in response to environmental challenges, but can result in long-term dysregulation of physiological systems in the face of recurrent or persistent social stress (Beckie, 2012; McEwen and Gianaros, 2010). Animal studies, epidemiological studies, and clinical studies imply that such factors may have significant effects on the organic manifestations of coronary artery disease (Kölegård Stjärne et al., 2002; Krantz and McCeney, 2002; Marmot and Brunner, 2005; Chandola et al., 2008). Laboratory studies have shown that detrimental psychosocial factors induce a number of physiological effects. Stressors are known to trigger hemodynamic, endocrine and immunologic mechanisms which provoke the progression of atherosclerotic processes in the arteries (Everson-Rose and Lewis, 2005). This dysregulation has been labelled "allostatic load", which is, among other things, associated with depressive disorders (McEwen, 2003). The concept of allostatic load provides a pathway that links neuroendocrinal processes to socioeconomic status (Seeman et al., 2010). Higher levels of disadvantage are

associated with higher risk for attempted suicides albeit the association is modified by cultural settings, the choice of indicators, data and measures (Burrows and Laflamme, 2010).

Health behaviours

In their ecological study, Kaplan et al (1996) also found a correlation between US state level income inequality and life styles. The correlation between income inequality, measured as the proportion of total household income received by the less well off 50 percent, and proportion sedentary was -0.34 (p-value 0.03); the corresponding correlation with proportion current smokers was -0.35 (p-value 0.02).

In a study based on data from Costa Rica the association between income inequality, proximal determinants and cause specific mortality for 14 causes, mostly known to be associated with health behaviour, was examined (Modrek and Ahern, 2011). The authors argued that Costa Rica is a fairly homogenous society, making the structural, institutional mechanisms suggested as causal, less plausible and that this setting might be used to “test” the psychosocial interpretation. Income inequality (measured with the Gini-coefficient) was measured at the canton level, comprising an average population about 50 000. Mortality data was based on cause-specific mortality registers. Independent covariates were retrieved from survey data. The cause-specific mortality was associated with income inequality for those aged 15 – 60 which the authors interpret as suggesting that inequality might impact health behaviour of the working aged population in Costa Rica.

Although there is evidence supporting the psychosocial interpretation, one may wonder what causes the income distribution. This question is a cornerstone in the other major interpretation, the neo-material.

1.2.2.2 The neo-material interpretation

This interpretation suggests that the association between income inequality and health reflects individual lack of resources and under-investment of community welfare institutions (Lynch et al., 2000). The welfare institutions are seen as important aspects of living conditions that increase health protecting resources and reduce health-damaging exposures. Income inequality is seen as a manifestation of “a set of background historical, political, cultural and economic factors” (Lynch et al., 2000; Lynch, 2000), thereby implying that a particular income distribution should be seen as a result of a certain political, historical and economic context which also produce a distinct context of welfare infrastructure with respect to education, public health, services, housing, transportation etc. These processes affect the resources available for individuals, at a private but also at a collective level (Lynch et al., 2000).

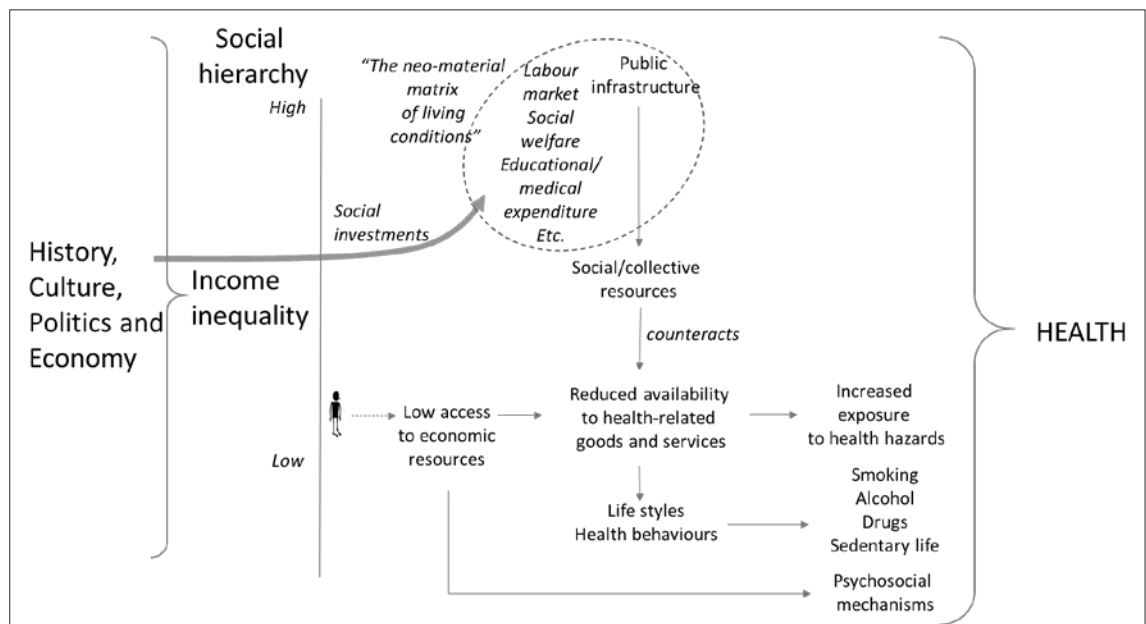


Figure 5 The neo-material interpretation according to Lynch et al. (Lynch et al., 2000; Lynch, 2000)

Importantly, while the neo-material interpretation acknowledges the significance of *perceptions* of inequality and experiences from the relative position, the neo-material interpretation puts emphasis in the material world, proposing that people's perception of inequalities are derived from their material living conditions (Lynch et al., 2000). As an illustration to the difference between the psychosocial interpretation and the neo-material, the authors present an "airplane metaphor":

"Differences in neo-material conditions between first and economy class may produce health inequalities after a long flight. First class passengers get, among other advantages such as better food and service, more space and a wider, more comfortable seat that reclines into a bed. First class passengers arrive refreshed and rested, while many in economy arrive feeling a bit rough. Under a psychosocial interpretation, these health inequalities are due to negative emotions engendered by perceptions of relative disadvantage. Under a neo-material interpretation, people in economy have worse health because they sat in a cramped space and an uncomfortable seat, and they were not able to sleep. The fact that they can see the bigger seats as they walk off the plane is not the cause of their poorer health. Under a psychosocial interpretation, these health inequalities would be reduced by abolishing first class, or perhaps by mass psychotherapy to alter perceptions of relative disadvantage. From the neo-material viewpoint, health inequalities can be reduced by upgrading conditions in economy class. Of course, this simplistic metaphor assumes that conditions in first class and economy class are independent—in the real world, improvements in economy are often resisted by those able to travel first class." (Lynch et al., 2000)

There are two major "pathways" of how income inequality might affect health. One is the lack of resources held by individuals, the other is about public investments in the social infrastructure, the "neo-material matrix of living conditions."

Lack of individual resources

Individual resources provide opportunities to buy clothes, healthy food, housing or other goods and services that are health promoting or risk-reducing. Individuals with lower incomes, as compared to others along a social gradient, do have fewer

opportunities to buy such goods and services and thereby are more restricted in their choices. The reduced availability of goods and services may lead to increased exposure to health hazards and/or reduced access to health promoting factors.

The reduced availability to health-related goods and services may also affect life styles and health behaviours in a negative way, possibly interacting with psychosocial mechanisms.

Lower incomes might well influence health via psychosocial mechanisms (Lynch and Smith, 2002; Lynch et al., 2004; Lynch et al., 2001).

The neo-material matrix of living conditions

The public infrastructure – types and quality of education, health care, transportation, environmental controls, food availability, housing, recreational and cultural facilities, etc. – forms a structural matrix of contemporary life influencing health (Lynch et al., 2004), probably especially important to the health of the most disadvantaged groups. Such collective resources may to a certain extent compensate for lack of personal resources.

Wilkinson seems to accept the idea that cultural processes might add on top of the effects of relative deprivation (Wilkinson, 1999b) which can lead to less egalitarian societies developing less supportive social environments which in turn is detrimental for health (Wilkinson, 2000b). But he fiercely argues that the primacy of the psychosocial interpretation gives a better understanding of why inequality is harmful to health, although in later writings he seems to modify his standpoint slightly (Wilkinson and Pickett, 2006).

1.2.2.3 The third factor interpretation

The psychosocial and neo-material interpretations are suggested being the mechanisms by which income inequality might exert its health-damaging effect in the population. The third factor-interpretation differs from the other interpretations in two distinctive ways.

Firstly, it proposes that income inequality might not exert any health-damaging effect at all, but rather that the statistical associations might be due to a third factor(s) that affect both income distribution and health but without being causally linked (Muntaner and Lynch, 1999; Coburn, 2000; Forbes and Wainwright, 2001).

Secondly, it launches a fierce criticism against the psychosocial interpretation in that social cohesion rather than political change is the major determinant of health and that class relations are ignored (Muntaner and Lynch, 1999).

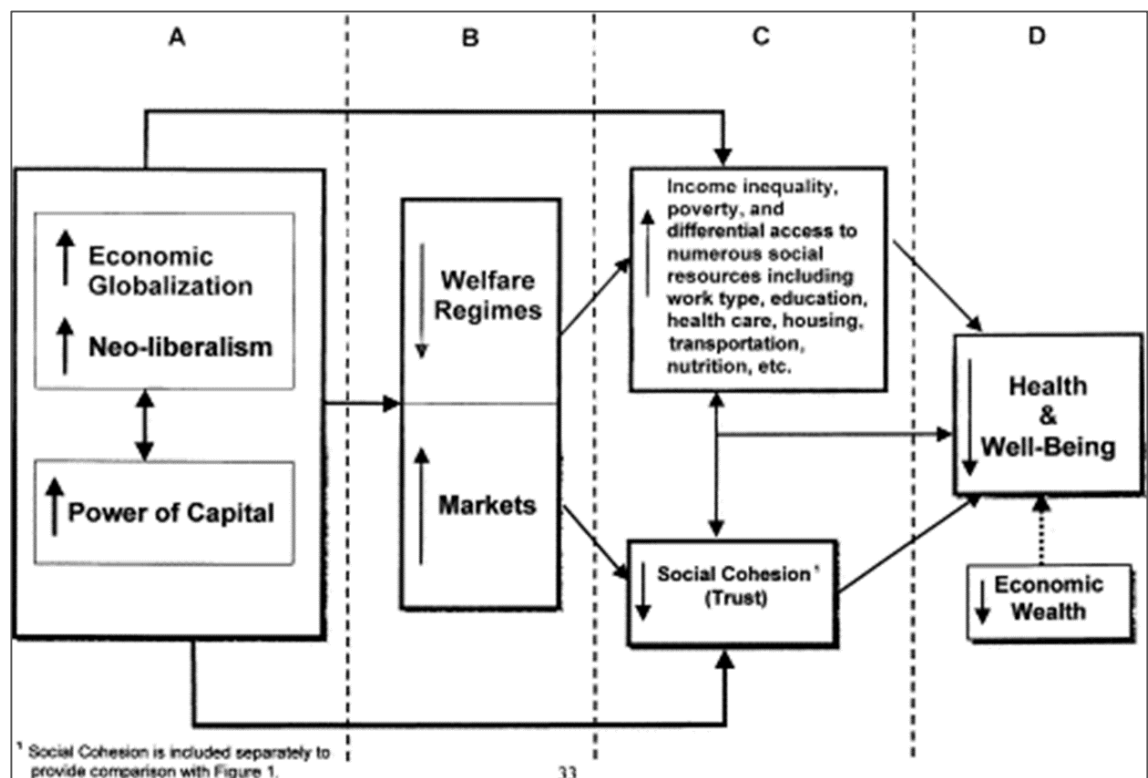


Figure 6 The Class/Welfare regime model according to Coburn (Coburn, 2004). Reprinted from *Social Science & Medicine* 58(1): Coburn, D., *Beyond the income inequality hypothesis: class, neo-liberalism, and health inequalities*. p. 41-56, with permission from Elsevier.

Coburn explicitly suggest that neo-liberalism produces both income inequality and ill health (Coburn, 2000).

In figure 6 Coburn outlines his interpretation of the income inequality model in which there are two major dimensions of society, the degree of hierarchy which he labels “the vertical separation”, and social cohesion, labelled “the horizontal separation”, which determine average health status, either via major trajectories more or less directly affecting health, or via intermediary inequalities of other kinds and possibly other intermediary trajectories. Referring to much the same criticism suggested by the proponents of the neo-material interpretation Coburn concludes that income inequality is a consequence of fundamental changes in class structure which has produced many health-relevant social inequalities, among them income inequality.

“Welfare measures in turn reflect basic social, political and economic institutions tied to the degree to which societies take care of their citizens or leave the fate of citizens up to the market i.e., neoliberalism. Income inequality is a consequence, not the determinant, of societal ‘types’.” (Coburn, 2004)

In the “Class/Welfare model” (figure 6) Coburn extends the income inequality model, which is contained under C and D in the figure to also include current neo-liberal economic globalization (A in the figure) which through its effects on changing markets and Welfare regimes (B in the figure) affects levels of inequalities of different kinds but also the level of social cohesion which in turn influence health. The global economic change may also directly affect the level of inequalities as well as the level of social cohesion.

One important part of the third factor-criticism is the references to the role of welfare regimes as important, but largely ignored in the psychosocial interpretation, explanatory factors. Coburn concludes from his account for the links between welfare

states, income inequalities and health, that “countries pursuing neo-liberal policies display far greater social inequalities and show more people in absolute or relative poverty than do more Social Democratic nations” (Coburn, 2004).

However, Wilkinson was not too impressed by this criticism. In a commentary to Coburn's suggestion, Wilkinson starts acid:

“Coburn criticises what he calls the ‘startling lack of attention to the social/political/economic context of SES or income inequality - health status relationships’. But in Britain during the Thatcher period, when income differences widened so dramatically, there was never any doubt as to the political responsibility. Even those who thought governments only partially to blame for the adverse trends were in no doubt about their failure to take effective countermeasures. When Coburn criticises the research effort saying, ‘Health matters have for too long been viewed as somehow separate from the societies in which they are, in fact, embedded’, and goes on to say that he ‘hopes to bring the social back in’, it sounds like a voice from the past. He says ‘income inequalities are, apparently, viewed as beyond the reach of reform activities’, but research has focused on them precisely because they are inescapably affected by government policies.” (Wilkinson, 2000a)

He goes on saying that the weakness of claiming the primacy of the neo-liberalism is that it limits the analysis to a historically specific period but widening income inequalities “seem likely to be damaging, almost whatever their source” (Wilkinson, 2000a), thereby implying that the psychosocial interpretation provides a universal explanation of the association between income inequality and health.

In fact, this claim is at the core of the criticism from proponents of the third factor-interpretation. They argue against the uni-dimensional perspective in which income inequality is perceived as the fundamental determinant of health inequalities (Wainwright and Forbes, 2000). Instead they argue that it is necessary to consider much broader, contextual frameworks that are sensitive to historical changes and more explicitly focussing on inequality-generating mechanisms (Muntaner et al., 2011; Muntaner and Lynch, 1999; Muntaner et al., 1999). Such broader frameworks may include social class relations, the role of welfare regimes, ideologies and distribution of power and resources (Navarro et al., 2003; Navarro and Shi, 2001).

1.2.3 Integration of interpretations

It is not an easy thing to decide which interpretation provides the appropriate answer to if and how income inequality is health damaging. Each of the interpretations seems to provide some substantial argument. It is also worth noting that the interpretations overlap in different aspects. The perceived relative position which in the psychosocial interpretation is a key, is perceived in a material context which is at the heart of the neo-material interpretation. The neo-material interpretation assumes a broad historical, cultural, political and economic background, much as in the third factor-interpretation.

Several papers in recent years consider the influence of welfare systems and politics in their empirical studies, not least in the Scandinavian context (see above, section 1.2).

Lundberg et al (2010) suggest in their review of social policies, income redistribution, individual income and the linkages to health that a proper understanding of the reasons how income, income inequality and health are associated requires an integrated approach. The authors suggest that the reason why income is important to

health is that it serves as a *resource* which enable people to control and direct their living conditions. People with higher incomes tend to occupy higher social status, thereby commanding more material and intangible resources which generate greater scope for action. This is likely to affect health both via a material pathway, “the direct consumption effect” and via a “direct status effect”. Lower incomes are suggested being linked to poorer health because it restrains people from buying goods and services that might be health promoting or forces them to buy cheaper goods and services which might lead to increased risk exposure – a direct consumption effect. Lower incomes might also lead to restraints from participating in society or groups they would like to participate in because they cannot afford the goods or services that are common in that particular group, a combined consumption-status effect.

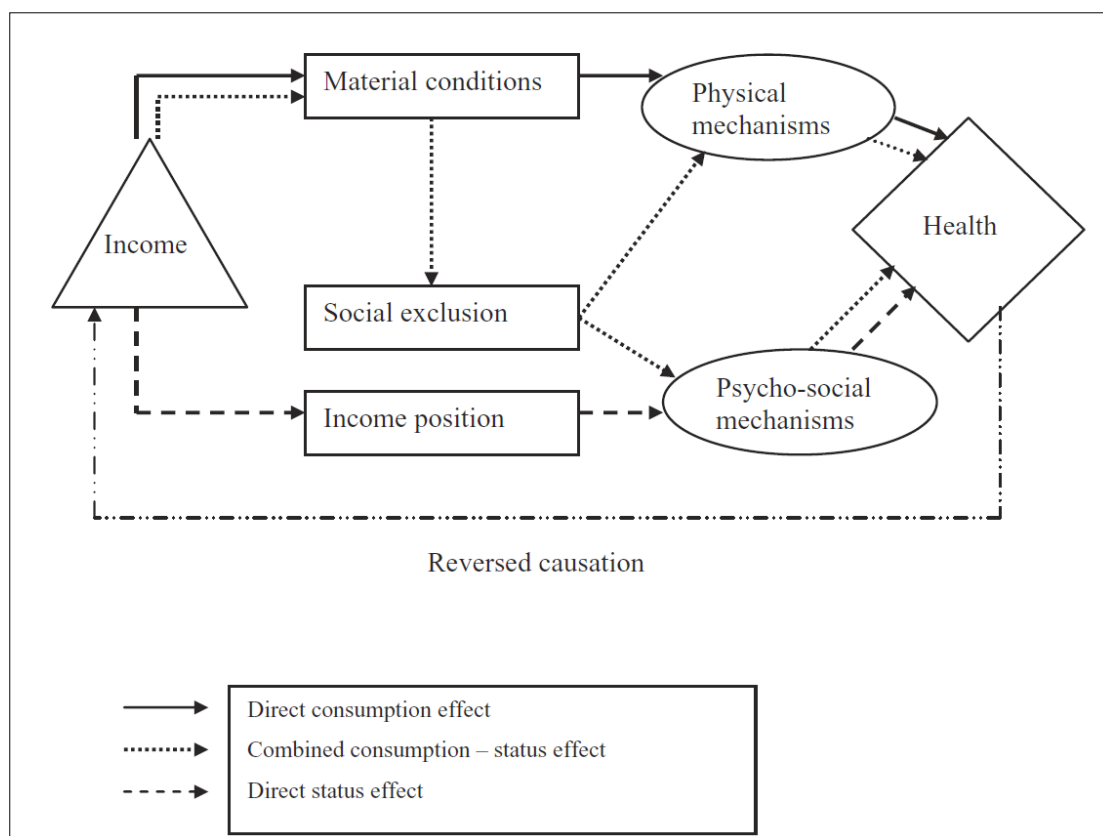


Figure 7 A conceptual model for three pathways linking income to health. Reprinted from Lundberg, O., et al., *The potential power of social policy programmes: income redistribution, economic resources and health*. *International Journal of Social Welfare*, 2010. **19**: p. S2-S13, with permission from Blackwell Publishing Ltd.

2 THEORETICAL FRAMEWORK

2.1 THE PROBLEM

The proposed interpretations suggest that there is an (indirect) causal relationship between income inequality at the area level and the health of the individual. The major interpretations see income inequality as a marker for a social context – larger income inequality expresses larger societal inequality which in turn is associated with health via psychosocial (Wilkinson and Pickett, 2006) and/or neo-material mechanisms (Lynch et al., 2004).

But why did the suggested association between income inequality and health tend to appear only in the US and in the UK if a social gradient is the *primus motor*? Such a gradient exists also in other high income countries, as in the Scandinavian. If social underinvestment is detrimental to health we would expect to find such an association during the “roaring nineties” in Sweden. However, there was no obvious association even though the income inequality in Sweden was increasing (and still is).

It calls for an analysis on if and how income inequality is associated with people’s health and also with potential interacting individual and contextual factors.

But it is far from obvious how the problem should be conceptualised and understood; there is reason to hover around a theoretical or conceptual model for the analysis.

First, I will present some conceptual starting points, then present the framework on which I have based my studies.

2.1.1 Methodological individualism or methodological collectivism?

There is a long tradition in social epidemiology of studying how individual level factors can affect the health of the individual. The literature on poverty and health is extensive. The strengths of the associations are often analysed with more or less sophisticated statistical models in which explanatory factors or exposures (explanans) are put in equations together with one or more confounders. This corresponds to “a” in figure 1.

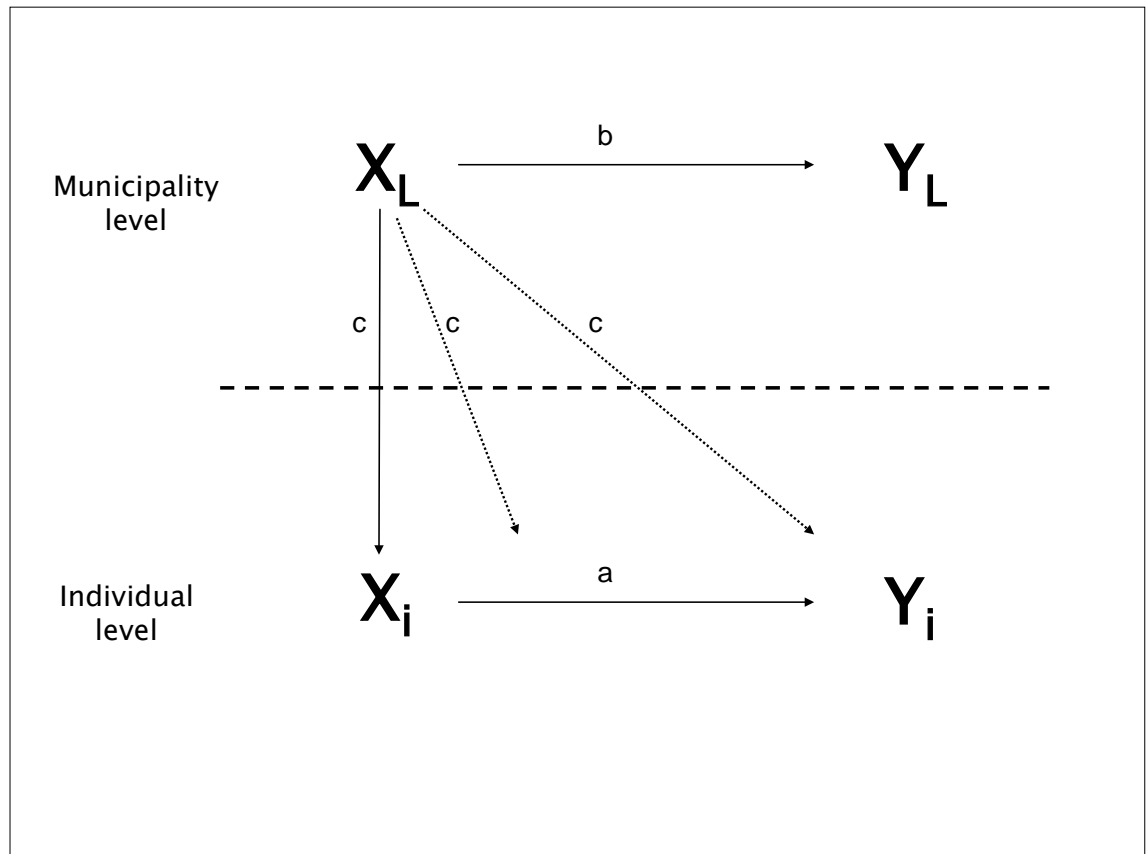


Figure 8 The relationship between explanans (X) and explanandum (Y) at the individual- and area levels.

Income inequality, i.e. a phenomenon occurring over the head of the individual and one that is out of the reach for the individual to change by himself, is proposed to actually worsen the health of the individual.

It is an open question if it is income inequality (X_L) that increases the risk to die for a certain child (Y_i). There might be other unobserved factors at the individual level (other X_i) or at the area level (X_L) or between the area level and the individual level (denoted by “c” in figure 1) that affect the risk.

This argument states a kind of methodological collectivism, i.e. that there are “objective social forces” that explains what happens at the individual level. It seems to be the case with the psycho-social explanation as well as with the neo-material; phenomena at the societal level impact on the health of the individual. But what about the role of individuals? The objection from those advocating a methodological individualism would be that

“Every such technical or organisational change [e.g. income distribution at area level. My remark, GH] is the result from individual decisions based on these actors’ ambitions to improve their living conditions.” (Johansson, 2003: My translation [GH])

That seems to be a relevant objection. Income distribution emerges when individuals with different incomes settle down in certain areas, presumably to “improve their living conditions”. It seems reasonable to regard individuals as autonomous and reflecting agents who by their actions and intentions (but also capabilities to act) try to find a good life for their own and their families.

2.1.2 The conceptual model

One implication from the debate is that it is important to understand what happens within the units in which income inequality is measured. This implies a simultaneous analysis on the relations between units at which income inequality is measured, intermediate levels (for example neighbourhoods) within such units and individual level covariates.

The principal conceptual model for the analyses in the thesis is shown in figure 9.

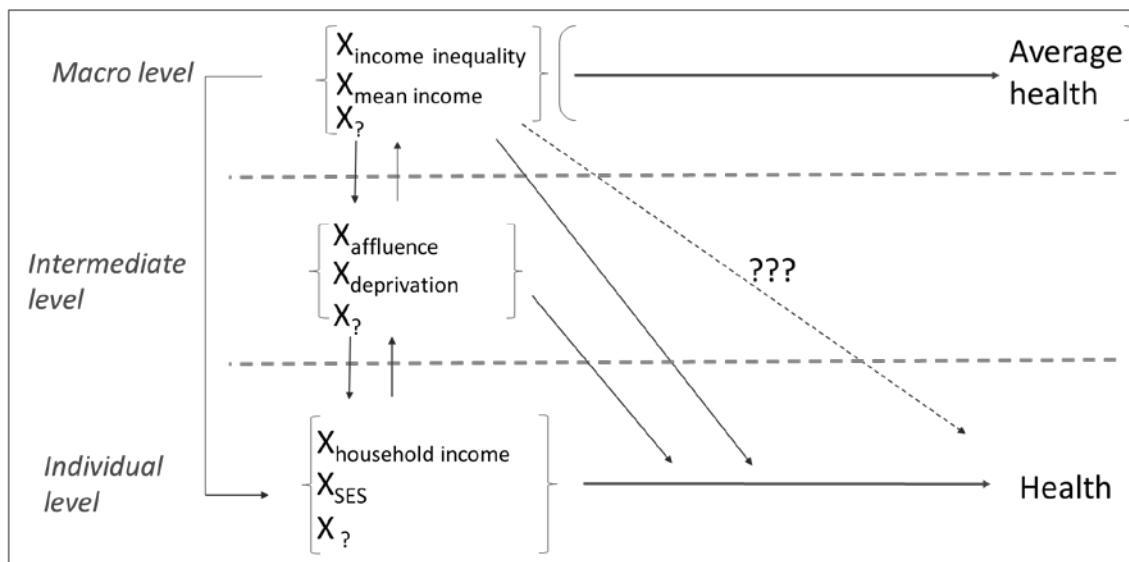


Figure 9 Conceptual model for the analyses.

I am interested to see whether there is an association between income inequality at the macro level on individual level health. I am not particularly interested in the macro level income inequality and macro level health (in large brackets). The macro level association might be directly influencing the individual level independent variables (which would implicate that the level of income inequality affects people's income or socioeconomic status (SES) or it could be that people's income determines the level of income inequality, the latter probably being more reasonable).

It is also possible to think that individual level variables influence the intermediate level situation, for example in terms of degree of homogeneity in the neighbourhood areas, or that the intermediate level situation influence the individual level variables.

The intermediate level situation might influence the degree of macro level income inequality but also other macro level variables.

It is also important to consider the possibility of a differential effect from income inequality on individuals' health, such that income inequality might be more harmful to disadvantaged people than for affluent people.

Even if it is theoretically possible that income inequality might have a direct effect on individual's health, it is hardly plausible, but for the sake of completeness this possibility should be included as well.

2.2 MULTILEVEL ANALYSIS

One of the core notions in social epidemiology is the question of how individuals are affected by the contexts in which they live. There has been much debate on how to analyse how individual and contextual factors should be modelled to represent the data properly. The simple approach is when the outcome at one level is explained by

variables at the same level, e.g. when individual-level outcomes are explained by individual level variables or group level outcomes are explained by group-level variables (cf. ecological studies). Another situation is when the outcome at one level is explained by variables at a lower level, for example when differences in disease rates are explained by characteristics of individuals composing the groups or when individual-level outcomes are explained by group level characteristics. A more complex situation is to explain variation in the dependent variable at one level as a function of variables at various levels, considering interactions at a certain level as well as between the levels (Diez-Roux, 2000). This is a situation that describes the research problem in this thesis and is also a situation where multilevel analysis (MLA) is an appropriate choice as the analytic tool (Snijders and Bosker, 2012).

During the last fifteen years MLA has become a standard for analyses within social epidemiology where group level factors might affect individual level outcomes or when differences in the properties of the groups to which individuals belong are interesting (Duncan et al., 1998; Leyland and Groenewegen, 2003; Diez-Roux, 2000; Subramanian et al., 2003).

2.2.1 What is special with multilevel analysis?

MLA allows a partitioning of the total variation in the outcome measure into the part due to individual level differences and the part due to group level differences (Snijders and Bosker, 2012). In a situation where the study population is nested within groups (e.g. individuals nested within geographical areas) a partition of the total variation into the individual and group levels may be important. Basically, MLA can be seen as an extension of the ordinary least squares regression (OLS). In an OLS regression we may estimate the mean relationship between e.g. some health outcome and household income, as in figure 9.



Figure 10 Hypothetical relation between income and some health outcome. (a) where there is no group effect; (b) where health is dependent on group but independent on income; (c) where health is dependent on both group and income. Adapted from (Leyland and Groenewegen, 2003).

Applied on the situation where individuals are nested within groups we should assume that there is no variation in the health outcome between group level units. The algebraic notation of the OLS regression is

$$y_i = \beta_0 + \beta_1 x_i + e_i \quad (1)$$

where β_0 is the intercept of the regression line, β_1 denotes the slope of the regression line associated with x and e_i is the residual for the i :th individual. However, the assumption that there is no variation between groups might be too restrictive. Consider the situation where the proportion of socioeconomically disadvantaged individuals are higher in some areas and that the proportion of affluent individuals are

higher in other areas. It is reasonable to assume a variation between areas due to the composition of individuals. But it might also be reasonable to think that the context in which individuals are living also has an effect per se on the individual's health. An OLS regression analysis will not capture this and might even lead to erroneous estimates. There are two options to include the contextual effect in the analysis (Snijders and Bosker, 2012). Firstly, all data can be aggregated to the group level and regress the aggregated health outcome on the average household income within the groups. This is an ecological analysis which opens for the “ecological fallacy” if we try to infer the outcome at the group level to associations at the individual level. It also means that information will be lost (Subramanian et al., 2003; Snijders and Bosker, 2012).

Secondly, group level data might be disaggregated to the individual level, i.e. characteristics of the groups are assigned to each individual in the groups. This opens for the risk of the “atomistic fallacy” where inferences from the individual level outcomes are transferred to the group level (Diez-Roux, 2000; Diez-Roux, 2002; Leyland and Groenewegen, 2003). If characteristics are used which are not defined at the individual level, e.g. income inequality at the area level, this might also lead to difficulties in interpreting the results of the analysis. Another caveat with this approach is that the disaggregation to the individual level leads to the “miraculous multiplication of the number of units” (Snijders and Bosker, 2012). This might violate the assumption of independence. If there is a clustering within the groups, i.e. if two individuals in a certain group tend to be more similar than two individuals from two different groups, the point estimate will overestimate the precision. Consider the situation where all individuals are grouped according to some characteristic. Then all the variation is at the group level and basically this means that the effective number of units under study is the number of groups.

In the figure above situation (b) describes the situation where the average health differs between the areas but is independent of the income; situation (c) describes the situation where the average health differs between areas *and* is dependent on household income at the individual level. These situations are better analysed with a regression equation allowing the intercept and slope to vary. The algebraic notation for an equation that evaluate (b) is

$$y_{ij} = \beta_{0j} + \beta_1 x_{ij} + e_{ij} \quad (2)$$

where i denotes the individual and j the area. The corresponding notation for (c), where both the intercept and the slope may vary, is

$$y_{ij} = \beta_{0j} + \beta_{1j} x_{ij} + e_{ij} \quad (3)$$

If the coefficients β_{0j} and β_{1j} depends on j , it is preferable to consider how the hierarchical structure influences the effects from individual and group level variables on the health outcome. In this situation the random coefficient models are useful.

3 AIMS

The overarching aims are to a) explore the association between income inequality and different health outcomes in Sweden as a relatively egalitarian country during the 1990's and early 2000's, b) to suggest and discuss mechanisms which might generate such an association and which might contribute to a better understanding of the diversity in findings.

The specific research questions are:

- To analyse whether there is an association between income distribution in Swedish municipalities and risk of death in the total Swedish population 40–64 years. (study 1)
- To test the hypothesis that manual workers are at higher risk of death than are non-manual employees when living in municipalities with higher income inequality. (study 2)
- To disentangle the effects of income inequality and residential segregation, measured as parish level homogeneity, on AMI. (Study 3)
- To test the hypotheses that
 - a) increasing income inequality at the municipality level increases the risk for Acute Myocardial Infarction (AMI); (Study 3)
 - b) the association between income inequality and AMI is mediated by the level of residential segregation; (Study 3)
 - c) groups with lower compared to those with higher social position are at greater risk for AMI when living in more disadvantaged areas and the risk ratio between disadvantaged and affluent groups increases with increasing affluence in the area. (Study 3)
- To test the hypothesis that income inequality at the municipality level, as a marker of social stratification within the municipalities, would be associated with risk of attempted suicide. (study 4).

4 DATA AND METHODS

4.1 DATA

The empirical studies for this thesis used data which were linked between authority-administered registers using the personal identification number assigned to each resident in Sweden.

Data on parish (as a proxy for neighbourhood) level and municipality level were derived from the census data by aggregating the appropriate variables to the parish or municipality levels.

4.1.1 The mid-age data set

The mid-age data set used in studies 1-3 was based on Swedish national official records containing information on social and economic circumstances linked through the unique personal identification number. Mortality data were obtained by linkage with the national cause-of-death register and for diagnoses the National Patient Register was used. The study population consisted of all people 40–64 years of age in the 1990 Swedish census with the same code for parishes (parts of municipalities) in 1985 and 1990 censuses, thus presumed as having lived in the same area for at least 5 years until 1990, altogether 2,573,708 people in 284 municipalities.

4.1.2 The adolescent cohorts

The study population consists of all individuals living in Sweden at age 16 and born 1972 or 1977 (N= 213 395). The unique personal identification number used in Sweden enabled linkage between different registers. Data on attempted suicides were obtained by linkage to the national in-patient register at the National Board of Health and Welfare. Data on migration and socioeconomic conditions were obtained from censuses and data on parental economy and occupation from Statistics Sweden and by linkage to the Multi-Generation Register.

4.2 MEASURES

4.2.1 Individual level

4.2.1.1 *Income*

The income measure at the individual level was the disposable household income per unit of consumption. This is an income measure that is made up by individual incomes in each household, adjusted for taxes and transfers and also for size and age composition of the household members. Information on the income measures was obtained through linkage to Sweden's Total Enumeration Survey in 1990.

4.2.1.2 *Socioeconomic status*

Data on socioeconomic status were obtained from the 1990 Swedish census. Socio-economic status was defined according to a classification used by Statistics Sweden, which is primarily based on occupation, but also takes industrial sector and position at work into account. Unskilled manual workers are usually defined as manual workers with less than 2 years of post-comprehensive school education; skilled manual workers have 2 years or more of post comprehensive school education; low level non-manual employees have less than 2 years of post-comprehensive school education; medium level non-manuals have 2 – 6 years of post-comprehensive education and high level non-manual employees have more than 6 years of post-comprehensive education. Those "without gainful occupation" comprise a

heterogeneous group with respect to living circumstances, e.g. students, retired, long term unemployed.

4.2.1.3 Immigrant status

Origin of birth was also obtained from the 1990 Swedish census and was grouped according to whether individuals were born in Sweden, Western Europe, Eastern Europe, Southern Europe, Africa, Asia or Other countries. These data were used for study 3.

In the 4th study a slightly different measure was used to characterise the ethnic status. The child was categorised according to the parent's origin of birth – if both, only one or none of parents were born outside Sweden.

4.2.2 Parish level

In studies 3 and 4 the parish is used as an intermediate level between the individual level and municipality level. The Swedish parishes are old ecclesiastical divisions without any current administrative function. However, residential registers are based on parishes which make them useful for dividing the larger municipalities into smaller units. They are traditionally linked to residential areas within the municipalities giving some opportunity to study the extent of for example residential segregation.

In this thesis the parish level is used to measure the extent of homogeneity in areas within a municipality, according to the idea that a smaller area with a high level of homogeneity could reflect a higher level of residential segregation measured at a higher level, for example municipalities. Study 3 used measures of homogeneity with respect to income, ethnicity and social allowances.

4.2.2.1 Income

Income at the parish level was calculated in two measures. One measuring the proportion of households within the lowest income quintile in each parish, which is lower than 74 400SEK in 1990. There were between 10 and 71 percent of low income households within the parishes. The other income measure was the proportion of households within the highest income decile, which means an income more than 132 400SEK. There were between 1 and 52 percent of such households within the parishes.

4.2.2.2 Ethnicity

In study 3 the proportion of native born Swedes was used, which was defined as those residents born in Sweden and with both parents born in Sweden. The range was between 54 and 100 percent.

4.2.2.3 Social allowances

Social allowance in Sweden is an income from transfer to those individuals or households without any other income. The social allowances are means-tested which means that it is the families with the poorest income who will receive social allowances. This is to guarantee a minimum standard of living even if there is no other income. Social allowances can be transferred for shorter or longer term. The available data did not allow an identification of those households receiving long term support. The proportion of households receiving social allowances varied between 4 and 16 percent in the parishes 1990.

4.2.3 Municipality level

4.2.3.1 Measures of income inequality

One of the criticisms of the early studies on income inequality and health concerned the choice of indicator which was proposed to influence the findings (Judge, 1995). Kawachi & Kennedy (Kawachi and Kennedy, 1997) compared six indicators of income inequality (the Gini coefficient, the Robin Hood-index, the decile ratio, the proportions of income earned by the bottom 50, 60 and 70 percent of households, the Atkinson index and the Theil's entropy index) on total mortality rates in the US states. The authors concluded that they were highly correlated with a Pearson correlation coefficient of more than $r > 0.94$ and from this perspective the choice of indicator did not seem to be very important. However, they also proposed that the choice of indicator should be made on a theoretical basis, since the different measures actually measure different aspects of the income distribution. For example Cowell (Cowell, 1977) has shown that the Gini coefficient is less sensitive for a transfer from an affluent household to a less well-off household if the two households are in the middle of the distribution than if they are at the extremes. The indicators based on proportions, for example the Robin Hood-index, fail to register transfers between two households if both are below (or over) the threshold (Cowell, 1977; Sen, 1992).

Two measures of income inequality were used. One is the 90/10 percentile ratio or the p90/p10-quotient, the other is the Gini coefficient. There was a very high correlation between the two indicators (Pearson correlation coefficient $r=0.93$).

The percentile ratio

The percentile ratio or the p90/p10-quotient is simply the ratio between the 90th and the 10th income percentiles. It is obviously more sensitive to changes in the distance or range within the income distribution but fail to catch changes within the middle of the distribution.

The Gini coefficient

The Gini coefficient is a well-established measure of income inequality within a geographical area. It has several appealing characteristics of which perhaps being insensitive for outliers and measuring inequalities within the entire income range, not just as a ratio between high and low incomes (Cowell, 1977).

The Gini coefficient ranges from 0, which denotes total equality, to 1, which implies that all income is concentrated to one person. The Gini coefficient is approximately given by

$$G = 1 - \sum_{i=0}^{k-1} ((y_{i+1} + y_i)(x_i - x_{i-1})) \quad (4)$$

where G is the Gini coefficient, y is the cumulative proportion of the total income, x is the cumulative proportion of the total population, k is the number of individuals within the population in the area. Figure 11 illustrates how the Gini coefficient relates to the Lorenz curve.

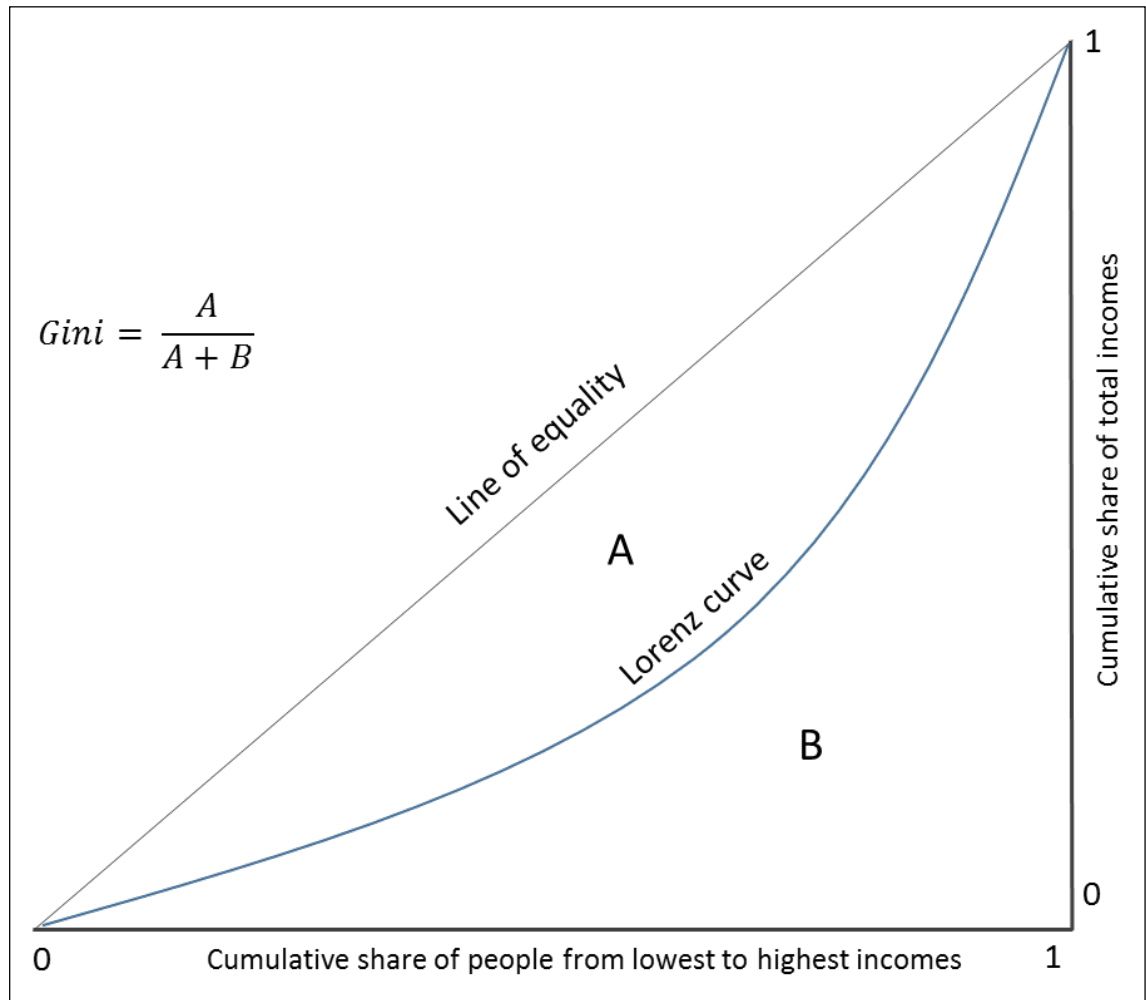


Figure 11 The relation between the Lorenz curve and the Gini coefficient.

The measure of income inequality was the Gini coefficient which was calculated for each of the 284 municipalities in Sweden in 1990 using the incomes for the entire population 20 years and older.

In study 4 we used family income from employment to calculate the Gini coefficient at the municipality level. This measure differs from the disposable income in that it is the sum of household members' income before tax and transfers. Thus, it gives a wider range of incomes and therefore a larger value to the Gini coefficient.

4.2.4 Outcomes

4.2.4.1 All-cause mortality

In studies 1 and 2 the all-cause mortality is used as the outcome. It could be criticised on the ground that it is a crude measure and does not enable an understanding of how income inequality is related to health since it measures different mechanisms. On the other hand it is a robust measure which enables comparisons between many different geographical entities.

4.2.4.2 Myocardial infarction

In the 3rd study acute myocardial infarction (ICD9 410) was used as the outcome. Evidence from animal studies, epidemiological studies and clinical studies suggest that psychosocial factors may have significant effects on the development of coronary heart disease (Brunner and Marmot, 1999; Chandola et al., 2008; Brunner et al., 1999). From laboratory studies it is suggested that acute and chronic stressors may

induce hemodynamic, endocrine and immunologic mechanisms that eventually provoke the progression of atherosclerotic processes in the arteries (Everson-Rose and Lewis, 2005). Data from the National Patient Register was used.

4.2.4.3 Attempted suicide

The 4th study used such attempted suicides among youth, defined as in-patient register diagnosis within ICD8 and ICD9 E950-E959, ICD10 X60-X84 (certain cases), ICD8 and ICD9 E980-E989, ICD10 Y10-Y34 (uncertain cases), as the outcome. The rationale is that social stratification might induce social stress, especially in groups with lower social status, which might increase the allostatic load (McEwen, 2003; McEwen and Gianaros, 2010) which in turn has been shown to be associated with distress and suicidality (Clarke et al., 2008).

However, attempted suicide is an “iceberg phenomenon” where only a fraction of all attempted suicides will be treated at a hospital. The real number is unknown. This means that the numbers of attempted suicides are underestimated which will lead to a bias if the ratios between the number of attempted suicides with a diagnosis and the true number vary systematically between the municipalities and parishes. This might be a problem when comparing the rural areas with the urban and possibly also socioeconomic groups (Burrows and Laflamme, 2010).

4.3 STATISTICAL METHODS

The analyses in the four studies deal with count data or, in study 4, dichotomous data. This is not well suited for an ordinary linear regression since the observations are discreet as in studies 1 – 3 or just can take either value 0 or 1 as in study 4. In other words, the dependent variables are not normally distributed given the explanatory variables. Therefore, we applied a hierarchical logistic regression to analyse the data in study 4 and a hierarchical Poisson regression to deal with the count data in studies 1 - 3.

4.3.1 Logistic models

The logistic regression is a standard regression analysis for dichotomous outcomes (Campbell et al., 2007; Gelman and Hill, 2007). The structure for a hierarchical logistic model is similar to the ordinary logistic model with the exception that under the hierarchical model the nested distribution of individuals within groups is taken into account. Let the probability of a case in a certain group j be denoted by p_{ij} . In a hierarchical logistic model the group considered as being randomly taken from a large population of groups. The probabilities of cases in the groups, p_{ij} , are considered as random variables which are defined in this population of groups.

Adding one or more individual level or group level explanatory variables to the model will change the probability of a case in a certain group. Consider an explanatory variable at the individual level, x_{ij} , and the probability of case for the i :th individual in the j :th group, p_{ij} , then the logistic hierarchical model expresses the log-odds as a sum of a linear function of x and a random group-dependent deviation, denoted as u_{0j}

$$\text{logit}(p_{ij}) = \beta_0 + \beta_1 x_{ij} + u_{0j} \quad (5)$$

A unit increase in the X -values within the same group will change the log-odds with β_1 or e^{β_1} in the odds. The u_{0j} is a random component describing the variation among group level units. In the 4th study it assumes a normal distribution with mean 0 and variance σ^2 .

4.3.2 Poisson models

The outcomes in studies 1 to 3 are measured as counts per person-years. In studies 1 and 2 we used mortality from all causes, expressed as the number of deaths per 100 000 personyears. In study 3 we used incident cases of myocardial infarction (MI) per 100 000 personyears. Therefore, it makes sense to consider a generalised linear model as the analytic tool.

In Poisson models the natural logarithm is often used as the link function for expected counts. For hierarchical data a hierarchical linear model can be applied for the natural logarithm of y_{ij} . In the studies 1 – 3 we used a Poisson model with the principal formulation

$$\ln(y_{ij}) = \ln(O_{ij}) + \beta_0 + \beta_1 x_{ij} + u_{0j} \quad (6)$$

Note the random intercept ($\beta_0 + u_{0j}$) which allows for the intercept to vary at the municipality level.

By applying the inverse transformation of the natural logarithm the expected counts can be estimated directly.

In the Poisson regression we can use an effect variable to model the expected value of the count. This is done by adding a variable O to the model. This variable is proportional to the expected counts since O in the three studies is the number of person-years for each of the unique combinations of the fixed variables in the model, following the aggregation procedure suggested in Snijders & Bosker (2012)

Consider again equation (6). This is equivalent to

$$\frac{y_{ij}}{O_{ij}} = e^{\beta_0} \times e^{\beta_1 x_{ij}} \times e^{u_{0j}} \quad (7)$$

where the left part is the incidence (counts per person-years).

5 RESULTS

5.1 STUDY 1: INCOME DISTRIBUTION AND MORTALITY: IMPLICATIONS FROM A COMPARISON OF INDIVIDUAL-LEVEL ANALYSIS AND MULTILEVEL ANALYSIS WITH SWEDISH DATA.

The aim of this study was to find out whether there was an association between income inequality and all-cause mortality in Sweden. We used a large data set on the entire mid-age population in Sweden (40-64 years) nested within all 284 municipalities in Sweden 1990. The disposable income per consumption unit in the households was used as a basis for the measurement of income inequality within municipalities. We used two measures of income inequality, the ratio between the 90th and 10th percentiles (p90/p10) and the Gini coefficient.

We wanted to compare the outcomes from an ordinary least squares regression with that of a multilevel regression with and without adjustment for individual level income and socioeconomic index (SEI). The results indicated that there was a significant and positive association between income inequality and all-cause mortality when we used the OLS regression (RR = 1.29; 95% CI [1.24;1.34]) but not when we used the ML regression (RR = 1.03; 95% CI [0.94;1.13]). This might suggest that there is a significant clustering within municipalities which is ignored in the OLS regression (since the municipality level variables are disaggregated to the individual level). However, this statement is challenged by the variation among municipalities being very small (the random component = 0.008 in the unadjusted model). In the OLS regression the relative risk is overestimated as compared with the point estimate in the unadjusted ML model (RR = 1.13 and RR = 0.87, respectively). The standard errors are larger in the ML models.

5.2 STUDY 2: ARE MANUAL WORKERS AT HIGHER RISK OF DEATH THAN NON-MANUAL EMPLOYEES WHEN LIVING IN SWEDISH MUNICIPALITIES WITH HIGHER INCOME INEQUALITY?

From a theoretical perspective there is no reason to think that a possible effect on health from income inequality will hit all socioeconomic groups in the same way. On the contrary, it makes sense to think that in areas with a higher degree of income inequality those at the lower end of the social ladder might be more vulnerable due to e.g. less relative access to resources to make a living (cf. the neo-material explanation) or a worse relative position in the social hierarchy (the psycho-social explanation).

Rather few studies have considered such a differential effect (Lochner et al., 2001) (Kennedy et al., 1998) (Kahn et al., 2000) (Subramanian et al., 2001).

This study aims to evaluate whether there is a differential impact, dependent on socioeconomic status, from income inequality at the municipality level. The results supported the hypothesis of a differential effect. The relative risk (RR) of death for high-level non-manual employees was decreasing with increasing income inequality (RR = 0.77; 95% CI [0.63;0.93]), whereas the corresponding risk for unskilled manual workers increased with increasing income inequality (RR = 1.24; 95% CI [1.06;1.46]).

5.3 STUDY 3: ASSOCIATIONS BETWEEN INCOME INEQUALITY AT MUNICIPALITY LEVEL AND HEALTH DEPEND ON CONTEXT. A MULTILEVEL ANALYSIS ON MYOCARDIAL INFARCTION IN SWEDEN

The differential effect from income inequality on all-cause mortality suggested by the results in study 2 inspired us to pursue the idea that income inequality might serve as a proxy for the degree of social stratification. We wanted to find out whether higher levels of income inequality at the municipality level is associated with higher levels of residential segregation within the municipalities. We did that by study how the association between AMI and income inequality changed when we added contextual factors at an intermediate, parish level (as a proxy for neighbourhood).

We found that there was an overall *inverse* association between income inequality and AMI which seemed to be explained by the degree of homogeneity regarding affluence at the parish level, at least to a large extent. The risk for AMI was higher and fairly constant for manual workers regardless of the degree of affluence at parish level, but the risk for non-manual employees decreased if they lived in parishes with a high degree of affluence. However, there was a residual effect from income inequality at the municipality level even after controlling for parish and individual level socioeconomic variables.

The interaction analyses revealed that there were systematic differences in the contexts within the municipalities which were related to the degree of income inequality at municipality level. The degree of affluence at the parish level was highest in the municipalities with the highest levels of income inequality, i.e. in the municipalities where the risk ratios for AMI among manual and non-manual workers were highest. For the proportion of native born Swedes at parish level, we noted that there were practically no parishes with a low proportion native born Swedes among the municipalities with low degree of income inequality. We also noticed that the metropolitan municipalities, i.e. the municipalities around the three largest cities in Sweden, Stockholm, Gothenburg and Malmö, more often had the highest levels of income inequality.

5.4 STUDY 4: PATTERN OF SUICIDE ATTEMPTS IN TWO BIRTH COHORTS OF SWEDISH MEN AND WOMEN: ROLE OF INCOME INEQUALITY AND ECONOMIC DEPRIVATION.

The fourth study aimed to clarify the possible association between income inequality, social stress and attempted suicides among youth. We hypothesised that income inequality, as a marker for social stratification, was associated with the degree of social stress which in turn is linked to the risk of attempted suicide. As in the third study we were interested in the role of contextual factors, especially the degree of economic deprivation, at the parish level within the municipalities.

We were especially interested in the role of economic activity at municipality level.

Interestingly, we found no overall association between income inequality and attempted suicide. However, once adjustment for economic region was made, there was a significant *inverse* association between income inequality and attempted suicide, strongest in the three metropolitan areas. Even if there was a strong association between the degree of economic deprivation at the parish level and attempted suicide it did not explain much of the association between income inequality and attempted suicide at the municipality level. Nor did the individual variables.

6 DISCUSSION

6.1 GENERAL CONCLUSION

The general conclusion from my studies is that there seems to be no consistent association between income inequality at the municipality level in Sweden and certain health outcomes which is consistent with earlier studies (Ross et al., 2005; Wilkinson and Pickett, 2006). However, there are some support for statistical associations in papers 2 – 4, but the associations are (a) dependent on individual socioeconomic status (study 2), (b) inverse when looking at CHD among mid-age people in the larger municipalities in Sweden (study 3), a finding which to a large extent seems to be related to the residential segregation of affluent people, (c) inverse when looking at attempted suicides among youth (study 4), especially in the metropolitan areas in Sweden, an association which seems to be less influenced by individual and contextual economic deprivation.

6.1.1 Heterogeneity at different levels

These diverse findings may be a consequence of my choice to measure income inequality at a relatively low geographical area which is said to be inadequate since they are too small to reflect the scale of the social hierarchy in society (Wilkinson and Pickett, 2006). However, this suggestion seems to rely on the assumption that a lower geographical level is less heterogeneous than at a higher level. This is a misconception. Lower, intermediary levels, for example a municipality, may or may not have a higher or lower level of inequality than the higher level in which the intermediary level is a part, for example a nation. Consider figure 12 in which hypothetical income data for individuals are plotted against four groups A - D, which can be municipalities and the aggregated incomes for the larger area A+B+C+D, which can be a nation. In these areas there are ten income-groups, from 0 to the highest, 10. The income distribution in area A is characterised as relatively equal, no extremely poor, no extremely rich and a gathering around medium incomes; area B is a poor area with many people in the bottom income groups and few people in the top; area C is the opposite to area B with many people being extremely rich and few poor; area D has many rich and many poor and few with middle range incomes. The corresponding Gini-coefficients reveal a huge variation of the income distribution, ranging from 0.183 to 0.443.

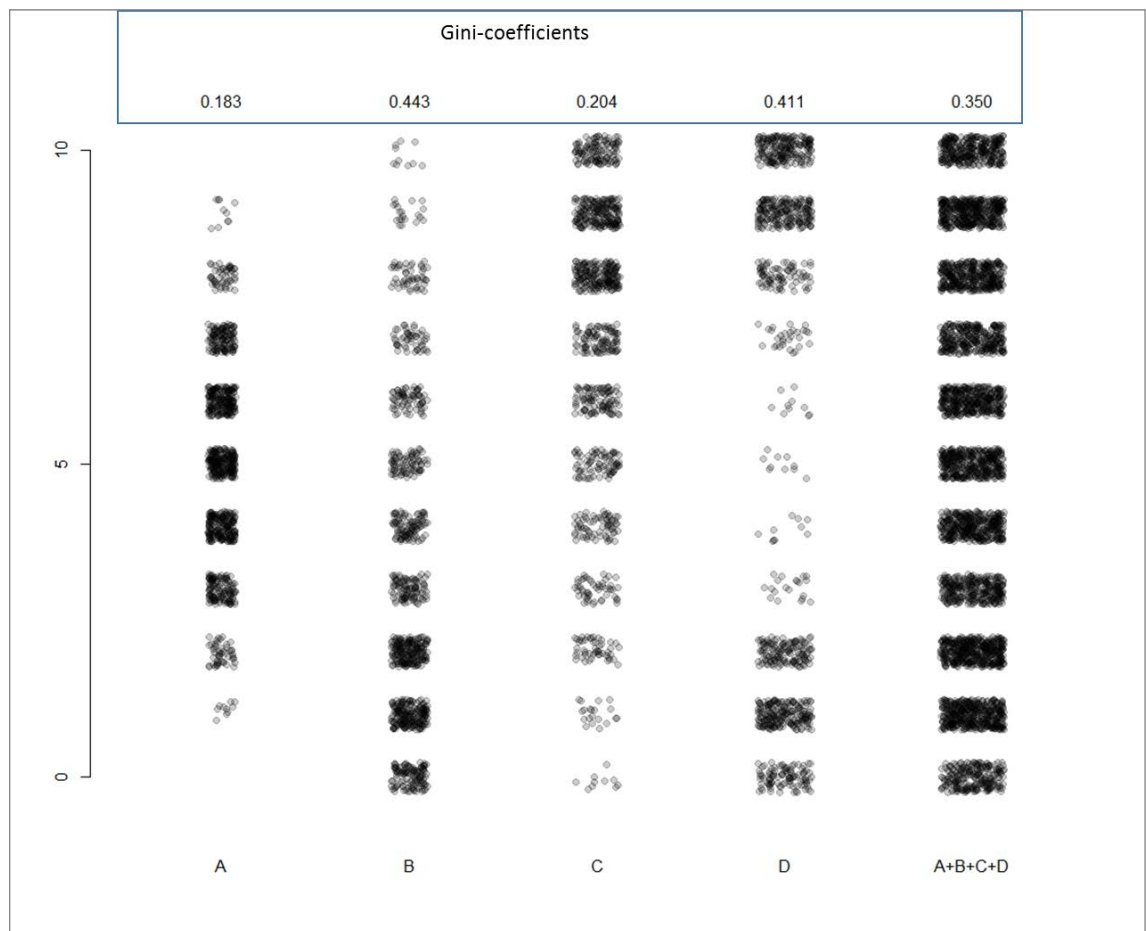


Figure 12 Hypothetical income distributions (y-axis) in four areas A – D and in the aggregated larger area A+B+C+D, together with their Gini-coefficients.

If we are instead interested in the income distribution in the entire nation we compare all people within the areas together, which renders a new income distribution with a Gini-coefficient somewhere within the range of area specific Gini-coefficients, in this case 0.350.

Thus, there is not necessarily an inverse relationship between the level of aggregation and the level of heterogeneity. As a consequence, if the degree of income inequality is a measure of the degree of social stratification in a certain area, a municipality might well be more stratified than the country in which the municipality is a part.

So why does the association between income inequality and health seem to exist only at nations if social stratification is a driver?

Whether a municipality is more or less stratified than the nation is an empirical question. Income inequality in Sweden in the early '90s was comparatively low (Ross et al., 2005; LIS-datacenter, jan 2014), the Gini-coefficient around 0.23 for disposable and equivalised household incomes. The range of Gini-coefficients among municipalities in 1990 was 0.18 to 0.31 and a skewed distribution with a mean Gini-coefficient 0.20.

In the five-country study (Ross et al., 2005) the 41 Swedish municipalities which were included had the lowest range of income inequality as measured with the median share, and also had the lowest mortality rates.

But it does not fit into the explanation that there is no association at the municipality level due to this level being too small to reflect the scale of social stratification since roughly half of the municipalities had a higher social stratification than at the national level. In the comparison of the five countries a number of Swedish cities had as high income inequality as in many UK and US cities but considerably lower mortality rates. This might indicate that there are different mechanisms involved than just income inequality.

My first study provided some (weak) support for an *inverse* association between income inequality and all-cause mortality in a mid-age population in Sweden during the 1990's ignoring individual level effect modification and/or confounding from unobserved variables. However, once adjustment for individual level household income was made the association disappeared.

But this study did not consider the possibility that there might be a differential effect from income inequality dependent on socioeconomic status. As Subramanian & Kawachi pointed out, for whom is inequality most harmful (Subramanian and Kawachi, 2004)? The literature has provided different answers in different settings. Some evidence suggests that affluent people might benefit from living in areas with higher income inequality (Kahn et al., 2000; Subramanian et al., 2001), some evidence that the health of poor or near-poor individuals is worse if living in more unequal areas (Kennedy et al., 1998; Lochner et al., 2001), still other evidence suggests only weak support for a differential effect (Subramanian and Kawachi, 2006).

The findings in my second study suggested that there was a differential effect dependent on socioeconomic position among people 40-64 years and connected to the labour market. This finding implies that the association between income inequality and health is valid only at higher levels of aggregation is more complicated. As has been noted richer people tend to live in municipalities with higher income inequality, which tend to be the municipalities within the three Swedish metropolitan areas. It brings up several questions. Which is the role of residential segregation, given the strong inflow into the metropolitan areas of both affluent and poor people, from the rural areas but also from abroad, during the last half century? Do areas with higher proportions of richer people mobilise resources to their own areas, as has been suggested (Massey, 1996)?

This finding challenges the suggestion that the association between income inequality and health was just apparent in the USA and, to a lesser extent, also in the UK but not elsewhere and also that the association only existed at the national levels or state level in the USA.

The notion that people with high incomes are the drivers behind income inequality at the municipality level in Sweden is important. We know that these people tend to live in the economically more active metropolitan areas – it indicates that it might be fruitful to consider the variation of income in relation to health *within* municipalities in more detail.

6.1.2 Residential segregation

Sweden, as most high-income countries, has gone through huge structural transformations since the industrialisation started in the mid-19th century (figure 13), the urbanisation being perhaps the most prominent characteristic from a demographic perspective.

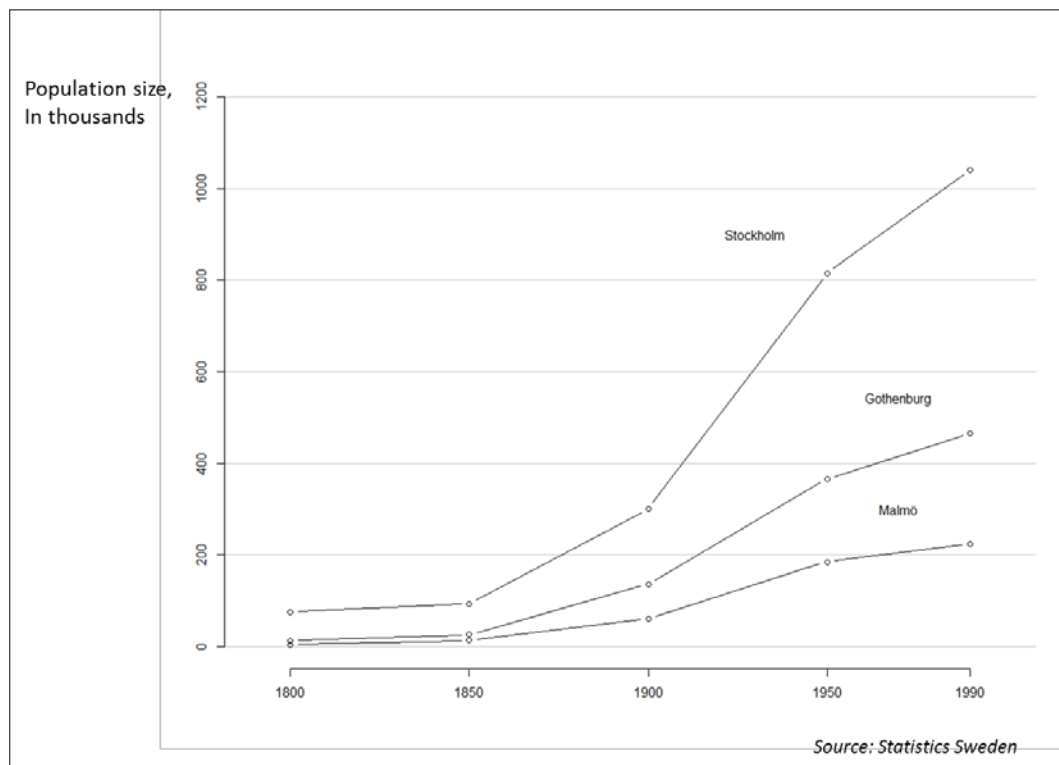


Figure 13 Population size in three current largest cities in Sweden 1800 – 1990. (Source: Statistics Sweden)

The growing economic prosperity within the three metropolitan areas, Stockholm, Gothenburg and Malmö, has attracted well-educated people with high incomes, students to the universities who eventually settled down and got well-paid positions in the rapidly growing industrial sector during the '50s and '60s. The same metropolitan areas also attracted people with considerably lower incomes and with lower levels of education, one of the major causes being the growing labour markets in these areas.

Affluent people, moving into the larger cities, apparently had more resources to choose their residential areas whereas poor people were referred to areas with affordable dwellings, which during the '60s and '70s were concentrated in the suburban areas of the larger cities thus forming the residential segregation in the metropolitan areas and larger cities in Sweden. Obviously, this in-migration into the larger cities is an important driver behind the development of income inequality – since people with the highest incomes tend to live in the larger cities, and the level of the lowest incomes is quite stable, it follows that the highest income inequality will be found in the larger cities.

Even if it can be assumed that there is a correlation between the degree of residential (economic) segregation and the degree of income inequality, it is not necessarily so. It is perfectly possible to find an area with high level of income inequality and low level of residential segregation, if affluent and poor people live together, i.e. live in areas with a high level of heterogeneity. Such a situation might modify a potential health damaging effect from income inequality thus rendering residential segregation an important factor to consider to explain the association between income inequality and health. Massey & Fischer (2000) suggested that residential segregation interacts with other structural societal transformations, for example income inequality, to determine the concentration of poverty.

Such transformations occurred in Sweden as a result of the urbanisation process, driven by the growing labour markets in urban areas with job opportunities and

possibilities to education. The relatively small disposable income differences, due to small nominal differences in wages, high taxes and transfers from the state to the households, have affected urban development and how residential segregation has developed due to available economic resources decide which housing options are available for the households (Andersson, 1999).

The economic upsurge during the '50s and '60s was shaken by the crisis in the wake of the oil shocks of the mid- to late-1970s, followed by welfare retrenchments and a turn to neoliberal policies (Hemerijck, 2012), for example manifested during the '80s in the deregulation of financial markets and under-financed tax reforms (Andersson, 1999). According to Andersson, "the housing and real estate market, and subsequently the financial system, almost collapsed; unemployment quadrupled from 2 to 8 per cent; the state's budget deficit exploded; and the Swedish krona lost 30 per cent of its value compared with the major European currencies" (Andersson, 1999). This led to the welfare sector coming under severe pressure with cutbacks in social welfare costs; the housing costs increased due to reduced subsidies and increased net costs for mortgages rose; the construction of new housing dropped to very low levels.

During the same years Sweden received the greatest wave of immigrants ever with more than 400 000 immigrants entering the country. The new citizens were hit by the economic downturn with full strength: unemployment among non-Nordic immigrants was more than 30 percent in 1996 as compared with 1990 when it was less than 5 percent.

During the '90s many of the socio-economic problems were perceived as linked to the ethnic residential segregation. Andersson mention three issues frequently addressed: the earlier consistent quality in the basic social institutions was becoming less consistent as the state decentralised control over state funding resources to local authorities; the high level of unemployment also affected the middle-class but was a lot worse in the poorer "million programme areas"; growing extreme right-wing activism and gang violence was said to be linked to the clustering of immigrant groups in certain residential areas (Andersson, 1999).

Clearly, these processes and phenomena indicate that the association between income inequality and health is reasonably a lot more complicated than the suggestion that income inequality (social stratification) is the *primus motor* of health, at least at the municipality level. It makes sense to consider the triangle of residential segregation, income inequality and health outcomes; what happens *within* the municipalities? That is the core theme of the 3rd and 4th studies.

The 3rd study was limited to the association between income inequality and myocardial infarction among the 41 municipalities with more than 50 000 citizens. We used parishes as the intermediate aggregate level, between municipalities and the individual level and found an inverse association between income inequality and myocardial infarction at the municipality level which to a large extent was reduced but not eliminate when adjustment for the level of affluence at the parish level was made. This study also revealed that among the 41 municipalities with the lowest income inequalities there were no parishes with higher proportions (> 45 percent) of households within the highest income quintile, and that in the municipalities with low levels of income inequality there were hardly any parish with low proportions of native born Swedes, i.e. the parishes with higher proportions of citizens born abroad were to be found among municipalities with higher levels of income inequality. Combined with the notion that the municipalities with high levels of income inequality tend to be located within the three metropolitan areas, these findings give some support to the idea that residential segregation and associated processes might

play important roles for an understanding of how income inequality might be associated with health.

These observations strengthen the hypothesis that income inequality at the municipality level in Sweden has to do with the degree of urbanisation. Clearly, the findings imply that the mechanisms are different from those at other aggregate levels, for example at country-levels.

In the 4th study we tried to deepen the analysis of the municipalities within the three metropolitan areas as compared to the other municipalities, by using the concept of “economic region” to assign the level of economic activity to the municipalities. I was surprised by the finding that there was a strong inverse relation between attempted suicide among youth and income inequality, primarily within the metropolitan areas but also within the larger economic regions. The distribution of the degree of economic deprivation at the parish level *within* the main cities and in their surrounding municipalities gives the three metropolitan areas different characteristics. The three main cities contain the largest number of parishes and the widest range of economic deprivation. The Stockholm metropolitan area consists of municipalities which are larger and have a wider range of income inequality than in the Gothenburg and Malmö areas. The municipalities surrounding Stockholm City tend to have larger and more deprived parishes than in the other metropolitan areas whereas the municipalities surrounding Gothenburg tend to be smaller but more affluent. This quite complicated web of associations at different levels strengthens the idea that it is important to look at processes *within* the municipalities to understand how income inequality is sometimes associated with health and sometimes not.

Our earlier studies were consonant with the idea that the process of residential segregation is an important driver behind income inequality at the municipality level. The mechanism would be that areas with higher economic activity reflect stronger labour markets and are characterised by an inflow of people – those with higher educational achievements and higher incomes, settling down in areas where there are many alike and those with considerably less resources more or less forced to settle down in areas with predominantly rented flats – over time developing a residential segregation and a growing income inequality within a given municipality.

However, there are several caveats and in the next section I will account for what I believe are the most important ones.

6.2 WEAKNESSES

6.2.1 Lack of data

We have had access to data predominantly at the individual level but also some data to describe compositional characteristics at the parish and municipality levels. This has enabled analyses on the entire population thus ruling out the possibility of sampling errors. Although the amount of data is enormous and contained quite detailed information on socioeconomic background data, we lacked data on qualitative characteristics of the parishes and municipalities, especially regarding the quality and efficiency of welfare institutions but also data on migration between cities and parishes. Available data contained small opportunities to make longitudinal designs in which we could incorporate time-varying variables such as incomes and employment status.

6.2.2 The choice of aggregate level

Another caveat might be the choice of aggregate level. We chose the municipality level with the rationale that municipalities in Sweden have a high level of autonomy

versus the state level, including the right to taxation, but also the responsibility to organise central parts of the welfare structures for their residents. However, such an argument seems to assume that a tentative effect from income inequality on health is operating through the welfare institutions, i.e. it seems to assume that the relevant interpretation is the neo-material interpretation. This might of course also be a relevant aggregate level assuming the psychosocial interpretation, but it is far from clear if the relations between people that constitute the degree of social cohesion or status are best caught at the municipality level. Another level for measuring income inequality might have been more appropriate. For example, it could be argued that people attach to each other to a large extent via their workplaces, thus implying that for example commuting areas would have been a better choice for measuring income inequality.

6.2.3 Parish as neighbourhood proxy

The parish level as proxy for neighbourhood might be less appropriate, given its heterogeneity. As said previously, Swedish parishes have no current administrative function. But residential registers are based on parishes which make them useful for dividing the larger municipalities into smaller units. They are traditionally linked to residential areas within the municipalities giving some opportunity to study the extent of residential segregation. However, there is a rather large variation of the degree of homogeneity at the parish level among the municipalities, which should render some caution against far-reaching conclusions regarding the socioeconomic character of the different parishes. As has been noted, there is a clear risk for non-differential misclassification of exposures at the parish level since contrasts between smaller (homogenous) residential areas will hide potentially important information (Stjärne et al., 2006).

Another danger using the parishes as an analytic level is that it might imply the primacy of the residential area as the salient unit of analysis and a playing down of other potentially important factors related to activities outside the residential area, for example work, study or leisure activities which might be as important as the residential area (Shankardass and Dunn, 2012).

6.2.4 Lag time

Assuming some lag time between exposure of income inequality and health effect, one of the remaining questions is how long the lag time is (Blakely et al., 2000). Rostila et al (Rostila et al., 2012) calculated Gini coefficients for 2000 and measured the effect on self-rated health 2 years later. In a US context, Subramanian & Kawachi (Subramanian and Kawachi, 2004) found some support to suggest that income inequality may exert its strongest effect up to 15 years when they used a measure of income inequality from 1980 on self-rated health. In another US study the authors used survey data from 2006 on self-rated health to investigate the lag time ranging between 0 and 25 years between state-level income inequality and two types of physical disability (Gadalla and Fuller-Thomson, 2008). They found the strongest effect for income inequality measured 20 years earlier.

The studies in this thesis have not explicitly included such a consideration even if the exposure is measured 1990 and the outcomes the following years. But the duration of exposure could also be important and unfortunately there is poor information on this in the data. However, from the prevalent literature it seems as if the lag time has some significance but also that income inequality may exerts its effects over a long time span.

6.2.5 The role of migration

The data provided poor control over people's migration between municipalities/geographic areas but also social mobility. Considering that income distribution is constituted by people's migration into their residential areas, the studies should ideally include data on such migration and mobility. Unfortunately, it does not provide other than quite rough data, not informative enough. However, since individual background data were based on the Swedish censuses it was possible to adjust for migration between 5-year intervals, 1980, 1985 and 1990 and at the parish level. Adjusting for such migration did not alter the estimates in any significant way. But this does not mean that migration and social mobility is not important. From a theoretical viewpoint it would be interesting to test empirically how in-migration into the larger cities affects the income distribution and the residential pattern over a longer time span and how that is related to different health outcomes.

6.2.6 The "small N problem", apparent in Swedish municipalities.

The mean population in Swedish municipalities is small. Measuring different health outcomes in these areas will lead to the "small N problem", referring to the risk that the estimates being the result of random fluctuation. This is not only a problem in the rural areas. There are quite a few small municipalities within the three metropolitan areas as well, often more extreme in terms of economic deprivation or affluence. This might cause a problem in several ways. One is of course that the outcomes rely on few observations. Another that the exposure also might vary at random. In the smaller municipalities it could be enough if a couple of people with high incomes (or low) are moving in to or out from the municipality, to change the income inequality measure significantly, especially since the variation in the size of Gini coefficients was rather small.

Another related problem in the 3rd and 4th studies where we used a three-level structure, the number of second level units is often small in these municipalities.

6.3 CONCLUSIONS

In my opinion the studies in this thesis indicate that for a better understanding of how income inequality (as one among other structural health determinants) may affect health we need better developed theories to tackle the complexity in which individual and contextual factors interact over the life course to affect people's health. The major interpretations are obviously too simplistic. As a matter of fact this was already during the 90's part of the discussion. For example, Judge commented in somewhat crispy wordings that

"In retrospect, it seems extraordinary that a predominantly monocausal explanation of international variations in life expectancy should ever have been regarded as plausible. It is much more likely that they are the product of many influences, which probably interact over long periods of time." (Judge, 1995)

My understanding of the original contributions by e.g. Lynch & Kaplan is that they actually from the beginning suggested that income inequality is a marker for structural characteristics in a given society (Lynch and Kaplan, 1997), indicating an awareness of the complexity. However, by stretching the arguments in the way the advocates for the psychosocial and the neo-material interpretations have done has convinced me that looking for *the* causal explanation is a dead end. To me, the psychosocial interpretation provides an understanding of how societal processes might enter the individual body and cause ill health in high income societies. But these psychosocial processes take place in a given material context within these

societies, with their specific historical, political and economical background. Given the huge diversity in the settings, designs, data sets, the level of aggregation and income inequality measures, outcomes and periods under study, reflecting the vagueness in many of the concepts used in the studies, the controversy calls for a synthesis of the interpretations which seems to be complementary rather than mutually exclusive.

This is consistent with recent research and commissions on health inequalities. For example, the Commission on Social Determinants of Health (2008) concluded that inequities in power, money and resources are at the heart of health inequalities and that “social injustice is killing on a grand scale”.

Income inequality is about the differential access to money as a resource to improve one’s living conditions. Money is of course a material resource which enables people to buy other things that may or may not be important to people’s health. But money is also a social resource as it provides the owner with a certain amount of social status, the more money you have access to the higher the social status.

Given the divergent findings in the four studies, it seems reasonable to think that these studies support the idea that income inequality exerts its health damaging effect on a higher level, such as nations or US states, but not at lower levels, such as the municipality level (Soobader and LeClere, 1999; Macinko et al., 2003; Subramanian and Kawachi, 2004; Lynch et al., 2004; Wilkinson and Pickett, 2006; Deaton and Lubotsky, 2009; Kondo et al., 2009). The divergent findings at the lower, municipality level, might be the result from other mechanisms than those operating at higher levels (Rose, 1985; Lieberman, 1985). This idea is elaborated by Fritzell (2005) who suggests that given the evidence, it is plausible that the income distribution is inversely related to the level of aggregation and thus can have opposite health effects. A low level of income inequality in a small area, e.g. a neighbourhood, might indicate a high level of economic segregation, which in turn could imply a higher level of income inequality at a higher level, e.g. the municipality of which the neighbourhood is a part. Indeed, this is the context of the 3rd and 4th studies.

It is possible that political processes might play an important role at the national level but at lower aggregate levels it is not clear if these units have enough political autonomy to influence the processes behind income inequality. It is also possible that income distribution at the local level is determined by the (local) labour market’s geographic structure (Stjärne et al., 2006).

The results in this dissertation suggest that (a) urbanisation determines the way income inequality evolves in the municipalities by mechanisms that differ from the way income inequality evolves at the national level and (b) access to individual and collective resources might “buffer” the effect from income inequality in different ways. The available data did not enable a deeper analysis on this important aspect but the findings in the study by Rostila et al (2012) seems to support this idea.

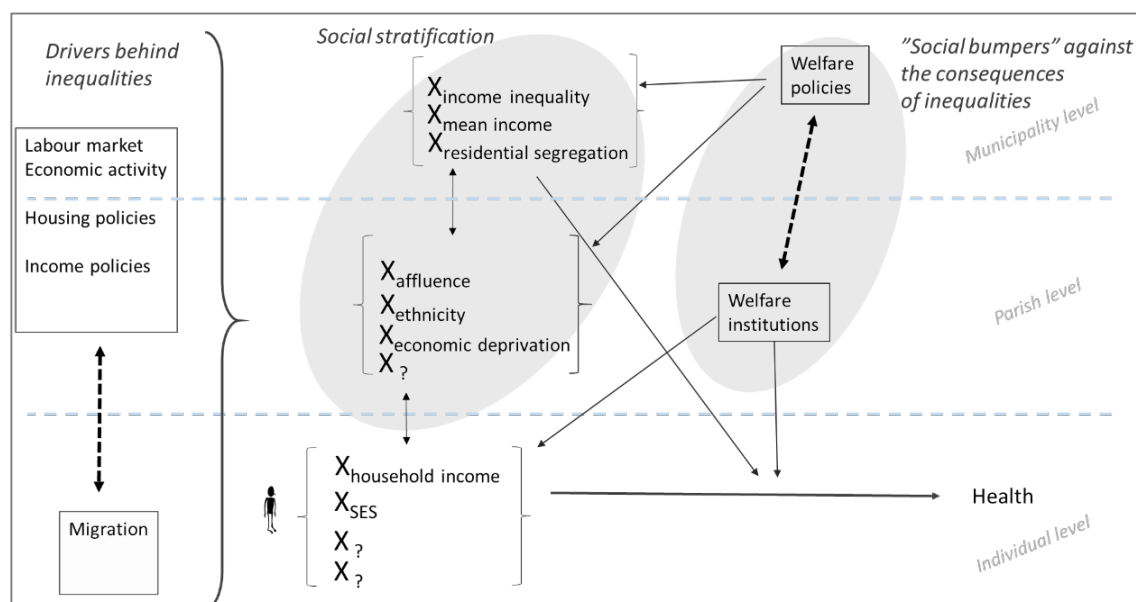


Figure 14 Speculative concepts of how income inequality (social stratification) relates to the drivers of inequality and to the “social bumpers” that modifies the negative effects from stratification at the municipality level.

Figure 14 is an attempt to catch the role of income inequality for individual's health within the Swedish municipalities in broader concepts. This is speculative since there is meagre empirical evidence from the studies. Rather, it should be seen as an attempt to move beyond the dualism between the psychosocial and the neo-material interpretations. This picture implies that these mechanisms are specific to the municipality level and are not valid at the national level.

6.4 THE POLICY IMPLICATIONS

As argued by Lundberg et al (2010), the question whether income inequality per se is health damaging or not might be an interesting academic question but the policy question is about access to resources. If the association between income and health is curvi-linear, then a redistribution of income will generate better health and simultaneously reduce the income inequality (cf figure 2 above).

Given that income inequality, even though we still do not fully understand how it relates to other individual and contextual factors which might have synergetic or buffering effects, seems to be a factor which has some relation to health (for example as a measure of the degree of social stratification), and given that income inequality in the longer term have increased in most parts of the high income countries, and given it is relatively easy to measure, income inequality is an important health determinant to monitor. Since the beginning of 1980's the income inequality in Sweden increased by more than 50 percent until 2011 (figure 15).

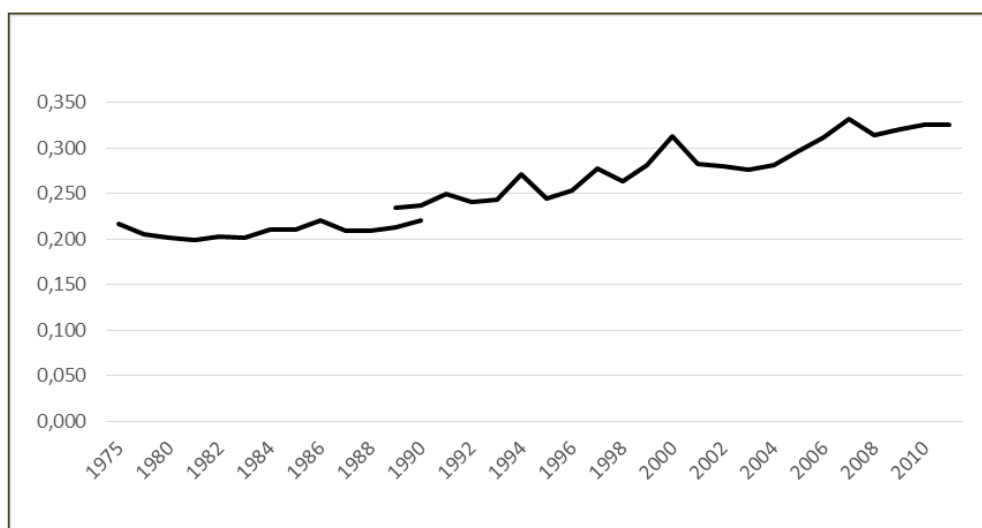


Figure 15 Income distribution in Sweden 1975 – 2011 as measured by the Gini coefficient of disposable household income. (Source: Statistics Sweden)

However, while such monitoring might measure the “social distance” between groups with lower income and higher, it is far from clear at which level such an exercise should be performed. As shown, there are reasons to believe that at the municipality level there are other mechanisms operating that might modify an association between income inequality and health. Therefore, the suggestion to use the concept of *command over resources* seems to me as a promising approach. This will require further research to better understand how individual level capabilities and collective goods and services interact to affect health.

6.5 IMPLICATIONS FOR FUTURE RESEARCH

My view is that the debate on which interpretation does the best job to clarify the causality between income inequality and health has come to a dead end. The numerous publications are often more descriptive than analytical. In my opinion, rather than a quest to find a single causal explanation, the research ought to integrate the different interpretations simply because they contribute with different aspects of how income inequality might be associated with health (Lundberg et al., 2010).

Another argument is that if research is focusing on finding a pathway from income inequality to health, without considering the wider socioeconomic context, possible intermediary factors may be overlooked if the wider socioeconomic context is ignored. The concept of *command over resources* enables the inclusion of both structural and individual factors into the analytic models, including the distribution of power.

Research should also consider that there are many municipalities, county councils and regions in Sweden that in the wake of the WHO Commission are launching programmes to tackle health inequalities within their populations. This opens an interesting possibility for social epidemiology to advance its research agenda on health inequalities. The public health administrations and practitioners will be dependent on knowledge of the drivers and buffers behind health inequalities and the distribution of their determinants for their success. Thus, there are common interests in the research community and public health administrations/practitioners for joint ventures to increase knowledge about the mechanisms that operate behind health inequalities.

7 ACKNOWLEDGEMENTS

Keeping the balance between being a doctoral student while being an administrator at a regional public health office has not always been an easy task. For one thing, the work with this thesis took longer than expected and often against the clock. But I am a slow traveller and it has always been a fascinating and learning walk along the scientific road. I am a privileged man to have met and come to know so many skilled people that have been willing to share their knowledge and bore with me these years.

Peter Allebeck, my main supervisor, extremely busy, but always excellent in guiding me through the doctoral studies. Brilliant in your skills to help me understand what I am doing but also what I ought to do.

Gunilla Ringbäck, my co-supervisor, you always came up with valuable remarks and thoughtful comments on my ideas, drafts and manuscripts but also provided invaluable help with the databases.

Gunnel Hensing, I am so grateful that you agreed to be my mentor during the doctoral project. Even though I have not worn your door down, it has been very good to know that you have been there to advise me when I needed.

Johan Jonsson, the former Director of Public Health in Region Västra Götaland, you made it possible for me to combine my duties at the secretariat with finalising my doctoral project and I cannot express my gratitude for your always encouraging attitude. But I would also like to thank you for being such a humble person and for your strong ethical compass, never hesitating to emphasize the need for solidarity and equity as the cornerstones of a sustainable society. That has inspired me a lot and still do.

Elisabeth Rahmberg, Johan's successor as Director of Public Health in Region Västra Götaland, I am grateful that you did not hesitate to give me the opportunity to continue my doctoral studies, even though you could not possibly be sure that what I have been doing would be to the benefit of the secretariat since you took office in just a little more than a half year ago. Thank you for believing in me.

Alastair H Leyland, I am a very happy man to have had the opportunity to get to know you and be invited to work with you during a number of weeks to draft the technical and statistical issues connected with my studies. But also for your hospitality and generosity while hosting me and showing my wife and me the charm and beauty of Glasgow and Scotland. I especially appreciate yours and Elizabeth's efforts to teach me about the "Celtic music". And yes, we still enjoy Cullen skink.

Peter Groenewegen, together with Alastair, you have taught me about the art of multilevel analysis. I have also enjoyed our short meetings and chats during the EUPHA meetings here and there. Thank you!

Sofia Löfving, colleague and co-author at the department of Social Medicine, I am impressed of your ability to handle the large and complex youth database. I wouldn't fix the data set without your skills! Thank you!

Dag Thelle, thank you for introducing me to the more advanced facets of social epidemiology and to help me get up and running at the very beginning of my project.

Stan Zammit and Dheeraj Rai, it has been a true pleasure to co-author the fourth paper together with you. Your contributions have been invaluable. But I am also grateful for talking to you during the KABRIS-meetings, your kind and hospitable way of being.

Glyn Lewis, David Gunnell and the colleagues at the KABRIS meetings in Bristol and London, thank you for having me there, listening and learning but also given the opportunity to discuss with you early drafts of my research ideas.

Colleagues at the department of Social Medicine at the Karolinska Institute, thank you for you always being kind and generous even though I have not been an everyday visitor. I have enjoyed the seminars and discussions with you very much.

Colleagues at the department of Social Medicine at Sahlgrenska Akademin, thank you for having me at your seminars, it has always been interesting experiences and to take part of your fruitful discussions.

Olle Lundberg, Johan Fritzell and Maria Kölegård, thank you for your generosity with sharing your knowledge and insightful thoughts on health inequalities and how to do research into them and on the role of income and income inequality in the Swedish and Nordic context.

My colleagues at the Secretariat to the Public Health Committee in Region Västra Götaland, thank you for bearing with me during these years, and especially during the past months when I have been occupied with finishing this project.

Johanna, Oskar, Emma and Maia, thank you for being my children (as if you had any choice) and for your patience with me when I have been occupied with thinking, writing or counting. Och Tove, i sommar borde vi lära Agnes meta krabbor, eller hur?

And my dear Eva, the comrade of my life, I know it has not always been easy but this project would not have been possible without your support and encouragement. I am indeed privileged to share my life with you.

Göran Henriksson

Varberg in January 2014

8 REFERENCES

- Andersson R. (1999) 'Divided Cities' as a Policy-based Notion in Sweden. *Housing Studies* 14: 601 - 624.
- Atkinson AB. (2003) Income Inequality in OECD Countries: Data and Explanations. *CESifo Economic Studies* 49: 479-513.
- Beckie TM. (2012) A systematic review of allostatic load, health, and health disparities. *Biol Res Nurs* 14: 311-346.
- Bergh A, Nilsson T and Waldenström D. (2012) *Blir vi sjuka av inkomstskillnader? : en introduktion till sambanden mellan inkomst, ojämlikhet och hälsa*, Lund: Studentlitteratur.
- Blakely TA, Kennedy BP, Glass R, et al. (2000) What is the lag time between income inequality and health status? *J Epidemiol Community Health* 54: 318-319.
- Blakely TA, Lochner K and Kawachi I. (2002) Metropolitan area income inequality and self-rated health—a multi-level study. *Social Science & Medicine* 54: 65-77.
- Blomgren J, Martikainen P, Makela P, et al. (2004) The effects of regional characteristics on alcohol-related mortality-a register-based multilevel analysis of 1.1 million men. *Soc Sci Med* 58: 2523-2535.
- Brunner E and Marmot M. (1999) Social organisation, stress and health In: Marmot M and Wilkinson RG (eds) *Social Determinants of Health*. Oxford: Oxford University Press, 291 p.
- Brunner E, Shipley MJ, Blane D, et al. (1999) When does cardiovascular risk start? Past and present socioeconomic circumstances and risk factors in adulthood. *J Epidemiol Community Health* 53: 757-764.
- Burrows S and Laflamme L. (2010) Socioeconomic disparities and attempted suicide: state of knowledge and implications for research and prevention. *Int J Inj Contr Saf Promot* 17: 23-40.
- Campbell MJ, Walters SJ and Machin D. (2007) *Medical statistics : a textbook for the health sciences*, Chichester, England ; Hoboken, NJ: Wiley.
- Chandola T, Britton A, Brunner E, et al. (2008) Work stress and coronary heart disease: what are the mechanisms? *Eur Heart J* 29: 640-648.
- Clarke DE, Colantonio A, Rhodes AE, et al. (2008) Pathways to suicidality across ethnic groups in Canadian adults: the possible role of social stress. *Psychol Med* 38: 419-431.
- Coburn D. (2000) Income inequality, social cohesion and the health status of populations: the role of neo-liberalism. *Soc Sci Med* 51: 135-146.
- Coburn D. (2004) Beyond the income inequality hypothesis: class, neo-liberalism, and health inequalities. *Soc Sci Med* 58: 41-56.
- Commission on Social Determinants of Health. (2008) *Closing the gap in a generation : health equity through action on the social determinants of health : final report of the commission on social determinants of health*, Geneva: World Health Organization.

- Cowell F. (1977) *Measuring inequality*, Oxford: Philip Allan.
- Dahl E, Elstad JI, Hofoss D, et al. (2006) For whom is income inequality most harmful? A multi-level analysis of income inequality and mortality in Norway. *Soc Sci Med* 63: 2562-2574.
- Daly MC, Duncan GJ, Kaplan GA, et al. (1998) Macro-to-Micro Links in the Relation between Income Inequality and Mortality. *The Milbank Quarterly* 76: 315-339.
- Deaton A. (2003) Health, inequality, and economic development. *Journal of Economic Literature* 41: 113-158.
- Deaton A and Lubotsky D. (2009) Income inequality and mortality in U.S. cities: Weighing the evidence. A response to Ash. *Social Science & Medicine* 68: 1914-1917.
- Diez-Roux AV. (2000) Multilevel analysis in public health research. *Annual review of public health* 21: 171-192.
- Diez-Roux AV. (2002) A glossary for multilevel analysis. *J Epidemiol Community Health* 56: 588-594.
- Duleep HO. (1995) Mortality and income inequality among economically developed countries. *Soc Secur Bull* 58: 34-50.
- Duncan C, Jones K and Moon G. (1998) Context, composition and heterogeneity: using multilevel models in health research. *Soc Sci Med* 46: 97-117.
- Edvinsson S, Lundevaller EH and Malmberg G. (2013) Do unequal societies cause death among the elderly? A study of the health effects of inequality in Swedish municipalities in 2006. *Glob Health Action* 6: 1-9.
- Elstad J. (2011) Does the socioeconomic context explain both mortality and income inequality? Prospective register-based study of Norwegian regions. *International Journal for Equity in Health* 10: 7.
- Elstad JI, Dahl E and Hofoss D. (2006) Associations between relative income and mortality in Norway: a register-based study 10.1093/eurpub/ckl018. Eur J Public Health: ckl018.
- Everson-Rose SA and Lewis TT. (2005) Psychosocial factors and cardiovascular diseases. *Annu Rev Public Health* 26: 469-500.
- Fiscella K and Franks P. (1997) Poverty or income inequality as predictor of mortality: longitudinal cohort study. *British Medical Journal* 314: 1724-1727.
- Forbes A and Wainwright SP. (2001) On the methodological, theoretical and philosophical context of health inequalities research: a critique. *Soc Sci Med* 53: 801-816.
- Fritzell J. (2005) Commentary: on form, comparability, and levels in the income and health relationship. *Int J Epidemiol* 34: 293-294.
- Gadalla TM and Fuller-Thomson E. (2008) Examining the lag time between state-level income inequality and individual disabilities: a multilevel analysis. *Am J Public Health* 98: 2187-2190.
- Gelman A and Hill J. (2007) *Data analysis using regression and multilevel/hierarchical models*, Cambridge: Cambridge University Press.

- Gerdtham U-G and Johannesson M. (2004) Absolute Income, Relative Income, Income Inequality, and Mortality. *Journal of Human Resources* 39: 228-247.
- Gravelle H. (1998) How much of the relation between population mortality and unequal distribution of income is a statistical artefact? *British Medical Journal* 316: 382-385.
- Gravelle H. (1999) Diminishing returns to aggregate level studies. *British Medical Journal* 319: 955-956.
- Grönqvist H, Johansson P and Niknami S. (2012) Income inequality and health: lessons from a refugee residential assignment program. *J Health Econ* 31: 617-629.
- Hemerijck A. (2012) Two or three waves of welfare state transformation? In: Morel N, Palier B and Palme J (eds) *Towards a social investment welfare state? : ideas, policies and challenges*. Bristol: Policy, 33-60.
- Johansson L-G. (2003) *Introduktion till vetenskapsteorin*, Stockholm: Thales.
- Judge K. (1995) Income distribution and life expectancy: a critical appraisal. *British Medical Journal* 311: 1282-1285; discussion 1285-1287.
- Judge K, Mulligan JA and Benzeval M. (1998) Income inequality and population health. *Soc Sci Med* 46: 567-579.
- Kahn HS, Tatham LM, Pamuk ER, et al. (1998) Are geographic regions with high income inequality associated with risk of abdominal weight gain? *Social Science & Medicine* 47: 1-6.
- Kahn RS, Wise PH, Kennedy BP, et al. (2000) State income inequality, household income, and maternal mental and physical health: cross sectional national survey. *British Medical Journal* 321: 1311-1315.
- Kaplan GA, Pamuk ER, Lynch JW, et al. (1996) Inequality in income and mortality in the United States: analysis of mortality and potential pathways. *British Medical Journal* 312: 999-1003.
- Kawachi I and Kennedy BP. (1997) The relationship of income inequality to mortality: does the choice of indicator matter? *Soc Sci Med* 45: 1121-1127.
- Kawachi I, Kennedy BP, Lochner K, et al. (1997) Social capital, income inequality, and mortality [see comments]. *Am J Public Health* 87: 1491-1498.
- Kennedy BP, Kawachi I, Glass R, et al. (1998) Income distribution, socioeconomic status, and self rated health in the United States: multilevel analysis. *British Medical Journal* 317: 917-921.
- Kennedy BP, Kawachi I and Prothrow-Stith D. (1996) Income distribution and mortality: cross sectional ecological study of the Robin Hood index in the United States. *British Medical Journal* 312: 1004-1007.
- Kondo N, Sembajwe G, Kawachi I, et al. (2009) Income inequality, mortality, and self rated health: meta-analysis of multilevel studies. *British Medical Journal* 339: b4471.
- Krantz DS and McCeney MK. (2002) Effects of psychological and social factors on organic disease: a critical assessment of research on coronary heart disease. *Annu Rev Psychol* 53: 341-369.

- Kravdal O. (2008) Does income inequality really influence individual mortality? Results from a 'fixed-effects analysis' where constant unobserved municipality characteristics are controlled. *Demographic Research* 18: 205-232.
- Kölegård Stjärne M, Diderichsen F, Reuterwall C, et al. (2002) Socioeconomic context in area of living and risk of myocardial infarction: results from Stockholm Heart Epidemiology Program (SHEEP). *J Epidemiol Community Health* 56: 29-35.
- Leigh A and Jencks C. (2007) Inequality and mortality: long-run evidence from a panel of countries. *J Health Econ* 26: 1-24.
- Leyland AH and Goldstein H. (2001) *Multilevel modelling of health statistics*, Chichester ; New York: Wiley.
- Leyland AH and Groenewegen PP. (2003) Multilevel modelling and public health policy. *Scand J Public Health* 31: 267-274.
- Liebertson S. (1985) *Making it count : the improvement of social research and theory*, Berkeley: Univ. of California Press.
- LIS-datacenter. (jan 2014) *Luxembourg Income Study Database*. Available at: <http://www.lisdatacenter.org/lis-ikf-webapp/app/search-ikf-figures>.
- Lochner K, Pamuk E, Makuc D, et al. (2001) State-level income inequality and individual mortality risk: a prospective, multilevel study. *Am J Public Health* 91: 385-391.
- Lundberg O, Fritzell J, Åberg Yngwe M, et al. (2010) The potential power of social policy programmes: income redistribution, economic resources and health. *International Journal of Social Welfare* 19: S2-S13.
- Lynch J. (2000) Income inequality and health: expanding the debate. *Soc Sci Med* 51: 1001-1005; discussion 1009-1010.
- Lynch J and Smith GD. (2002) Commentary: Income inequality and health: the end of the story? *Int J Epidemiol* 31: 549-551.
- Lynch J, Smith GD, Harper S, et al. (2004) Is income inequality a determinant of population health? Part 1. A systematic review. *Milbank Q* 82: 5-99.
- Lynch J, Smith GD, Hillemeier M, et al. (2001) Income inequality, the psychosocial environment, and health: comparisons of wealthy nations. *Lancet* 358: 194-200.
- Lynch JW and Kaplan GA. (1997) Understanding How Inequality in the Distribution of Income Affects Health. *Journal of Health Psychology* 2: 297-314.
- Lynch JW, Kaplan GA, Pamuk ER, et al. (1998) Income inequality and mortality in metropolitan areas of the United States. *Am J Public Health* 88: 1074-1080.
- Lynch JW, Smith GD, Kaplan GA, et al. (2000) Income inequality and mortality: importance to health of individual income, psychosocial environment, or material conditions. *British Medical Journal* 320: 1200-1204.
- Macinko JA, Shi L, Starfield B, et al. (2003) Income inequality and health: a critical review of the literature. *Med Care Res Rev* 60: 407-452.
- Mackenbach JP. (2002) Income inequality and population health. *British Medical Journal* 324: 1-2.

- Marmot M and Brunner E. (2005) Cohort Profile: The Whitehall II study. *Int. J. Epidemiol.* 34: 251-256.
- Martikainen P, Mäki N and Blomgren J. (2004) The Effects of Area and Individual Social Characteristics on Suicide Risk: A Multilevel Study of Relative Contribution and Effect Modification. *European Journal of Population/Revue européenne de Démographie* 20: 323-350.
- Massey DS. (1996) The age of extremes: concentrated affluence and poverty in the twenty-first century. *Demography* 33: 395-412; discussion 413-396.
- Massey DS and Fischer MJ. (2000) How segregation concentrates poverty. *Ethnic and Racial Studies* 23: 670 - 691.
- McEwen BS. (2003) Mood disorders and allostatic load. *Biological Psychiatry* 54: 200-207.
- McEwen BS and Gianaros PJ. (2010) Central role of the brain in stress and adaptation: Links to socioeconomic status, health, and disease. *Annals of the New York Academy of Sciences* 1186: 190-222.
- McIsaac SJ and Wilkinson RG. (1997) Income distribution and cause-specific mortality. *European Journal of Public Health* 7: 45-53.
- Modrek S and Ahern J. (2011) Longitudinal relation of community-level income inequality and mortality in Costa Rica. *Health Place* 17: 1249-1257.
- Muntaner C, Borrell C, Ng E, et al. (2011) Politics, welfare regimes, and population health: controversies and evidence. *Sociology of Health & Illness* 33: 946-964.
- Muntaner C and Lynch J. (1999) Income Inequality, Social Cohesion, and Class Relations: A Critique of Wilkinson's Neo-Durkheimian Research Program. *International Journal of Health Services* 29: 59-81.
- Muntaner C, Lynch J and Oates GL. (1999) The social class determinants of income inequality and social cohesion. *Int J Health Serv* 29: 699-732.
- Navarro V, Borrell C, Benach J, et al. (2003) The importance of the political and the social in explaining mortality differentials among the countries of the OECD, 1950-1998. *Int J Health Serv* 33: 419-494.
- Navarro V and Shi L. (2001) The political context of social inequalities and health. *Soc Sci Med* 52: 481-491.
- Osler M, Christensen U, Due P, et al. (2003) Income inequality and ischaemic heart disease in Danish men and women. *Int J Epidemiol* 32: 375-380.
- Osler M, Prescott E, Gronbaek M, et al. (2002) Income inequality, individual income, and mortality in Danish adults: analysis of pooled data from two cohort studies. *British Medical Journal* 324: 1-4.
- Preston SH. (1975) The changing relation between mortality and level of economic development. *Popul Stud (Camb)* 29: 231-248.
- Pritchard C and Williams R. (2011) Poverty and child (0-14 years) mortality in the USA and other Western countries as an indicator of "how well a country meets the needs of its children" (UNICEF). *Int J Adolesc Med Health* 23: 251-255.

- Putnam RD, Leonardi R and Nanetti RY. (1992) *Making democracy work : civic traditions in modern Italy*, Princeton, N.J.: Princeton University Press.
- Regidor E, Pascual C, Martinez D, et al. (2011) The role of political and welfare state characteristics in infant mortality: a comparative study in wealthy countries since the late 19th century. *Int J Epidemiol* 40: 1187-1195.
- Rice N and Leyland A. (1996) Multilevel models: applications to health data. *J Health Serv Res Policy* 1: 154-164.
- Rodgers GB. (2002) Income and inequality as determinants of mortality: an international cross-section analysis. 1979. *Int J Epidemiol* 31: 533-538.
- Rose G. (1985) Sick Individuals and Sick Populations. *International Journal of Epidemiology* 14: 32-38.
- Ross NA, Dorling D, Dunn JR, et al. (2005) Metropolitan income inequality and working-age mortality: a cross-sectional analysis using comparable data from five countries. *J Urban Health* 82: 101-110.
- Rostila M, Kölegård ML and Fritzell J. (2012) Income inequality and self-rated health in Stockholm, Sweden: A test of the 'income inequality hypothesis' on two levels of aggregation. *Social Science & Medicine* 74: 1091-1098.
- Seeman T, Epel E, Gruenewald T, et al. (2010) Socio-economic differentials in peripheral biology: Cumulative allostatic load. *Annals of the New York Academy of Sciences* 1186: 223-239.
- Sen A. (1992) *Inequality reexamined*: Clarendon Press.
- Shankardass K and Dunn JR. (2012) How goes the Neighbourhood? Rethinking Neighbourhoods and Health Research in Social Epidemiology. In: O'Campo P and Dunn JR (eds) *Rethinking social epidemiology : towards a science of change*. Dordrecht ; London: Springer, 137-156.
- Shi L, Starfield B, Kennedy B, et al. (1999) Income inequality, primary care, and health indicators. *J Fam Pract* 48: 275-284.
- Snijders TAB and Bosker RJ. (2012) *Multilevel analysis : an introduction to basic and advanced multilevel modeling*, London ; Thousand Oaks, Calif.: SAGE.
- Soobader MJ and LeClere FB. (1999) Aggregation and the measurement of income inequality: effects on morbidity. *Soc Sci Med* 48: 733-744.
- Stanistreet D, Scott-Samuel A and Bellis MA. (1999) Income inequality and mortality in England. *Journal of public health medicine* 21: 205-207.
- Stjärne MK, Fritzell J, De Leon AP, et al. (2006) Neighborhood socioeconomic context, individual income and myocardial infarction. *Epidemiology* 17: 14-23.
- Subramanian SV, Jones K and Duncan C. (2003) Multilevel Methods for Public Health Research. In: Kawachi I and Berkman LF (eds) *Neighborhoods and health*. Oxford University Press.
- Subramanian SV and Kawachi I. (2004) Income inequality and health: what have we learned so far? *Epidemiol Rev* 26: 78-91.
- Subramanian SV and Kawachi I. (2006) Whose health is affected by income inequality? A multilevel interaction analysis of contemporaneous and lagged

- effects of state income inequality on individual self-rated health in the United States. *Health Place* 12: 141-156.
- Subramanian SV, Kawachi I and Kennedy BP. (2001) Does the state you live in make a difference? Multilevel analysis of self-rated health in the US. *Soc Sci Med* 53: 9-19.
- Wagstaff A and van Doorslaer E. (2000) Income inequality and health: what does the literature tell us? *Annu Rev Public Health* 21: 543-567.
- Wainwright SP and Forbes A. (2000) Philosophical problems with social research on health inequalities. *Health Care Anal* 8: 259-277.
- Wennemo I. (1993) Infant mortality, public-policy and inequality - a comparison of 18 industrialized countries 1950-85. *Sociology of Health & Illness* 15: 429-446.
- Wilkinson RG. (1989) Class mortality differentials, income distribution and trends in poverty 1921-1981. *Journal of Social Policy* 18: 307-335.
- Wilkinson RG. (1990) Income distribution and mortality: a 'natural' experiment. *Sociology of Health & Illness* 12: 391-412.
- Wilkinson RG. (1992) Income distribution and life expectancy. *British Medical Journal* 304: 165-168.
- Wilkinson RG. (1996) *Unhealthy societies : the afflictions of inequality*, London: Routledge.
- Wilkinson RG. (1997) Socioeconomic determinants of health. Health inequalities: relative or absolute material standards? *British Medical Journal* 314: 591-595.
- Wilkinson RG. (1999a) Income Inequality, Social Cohesion, and Health: Clarifying the Theory--A Reply to Muntaner and Lynch. *International Journal of Health Services* 29: 525-543.
- Wilkinson RG. (1999b) Two pathways, but how much do they diverge? *British Medical Journal* 319: 956-957.
- Wilkinson RG. (2000a) Deeper than "neoliberalism". A reply to David Coburn. *Soc Sci Med* 51: 997-1000; discussion 1009-1010.
- Wilkinson RG. (2000b) Inequality and the social environment: a reply to Lynch et al [comment]. *J Epidemiol Community Health* 54: 411-413.
- Wilkinson RG and Pickett KE. (2006) Income inequality and population health: a review and explanation of the evidence. *Soc Sci Med* 62: 1768-1784.
- Wolfson M, Kaplan G, Lynch J, et al. (1999) Relation between income inequality and mortality: empirical demonstration. *British Medical Journal* 319: 953-955.