The first injustice

Socio-economic inequalities in birth outcome

by

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Abstract

Adverse birth outcomes like preterm birth and infant mortality are unevenly distributed across socio-economic groups. Risks are usually lowest in groups with high socio-economic status and increase with decreasing status.

The general aim of this thesis was to contribute to the understanding of the relation between socio-economic status and birth outcomes, focussing on maternal education and class, studying a range of birth outcomes. More specific aims were to investigate the relation between maternal education and infant health, to study the combined influence of maternal childhood and adult social class on inequalities in infant health and to explore the contribution of maternal working conditions to class inequalities in birth outcomes. The studies are population based, focussing on singletons births 1973-1990.

During the period under study, educational differences in birth outcomes increased, especially between those with the lowest and highest education. The low birth weight paradox emerged, suggesting that the distribution of determinants for low birthweight infants differs for these groups.

Further, an independent association was found between maternal childhood social class and low birthweight and neonatal mortality, but not for postneonatal mortality. Since this was found for the two outcomes closest to birth, this indicates that the association is mediated through the maternal body.

Finally, there is a contribution of maternal working conditions to class inequalities in birth outcome. Lower job control, higher job hazards and higher physical demands were all to some degree related to increased risk of the following adverse birth outcomes: infant mortality, low birthweight, very low birthweight, foetal growth, preterm birth, very and extremely preterm birth. Working conditions demonstrated disparate associations with the birth outcomes, indicating a high complexity in these relationships.
Svensk sammanfattning

Riskfördelningen på hälsoutfall, såsom tidig födsel eller spädbarnsdödighet, är inte jämnt fördelat över socio-ekonomiska grupper ens i ett relativt jämlikt välfärdssamhälle såsom Sverige. Vanligen finns de lägsta riskerna i grupper med högre socio-ekonomisk status, och ökar gradvis med minskande socio-ekonomisk status. För spädbarn som överlever t.ex. en väldigt tidig födsel, kan det också återstå konsekvenser i form av sämre chanser till god hälsa eller optimal kognitiv utveckling.


Resultaten tyder på att utbildningsskillnaderna i födelseutfall ökade under den tiden, särskilt när man jämför barn till kvinnor med högst och lägst utbildning. Den så kallade låg-födelsevikts-paradoxen uppkom, som här innebär att barn med låg födelsevikt har lägre risk för spädbarnsdödighet när deras mödrar har lägre snarare än högre socio-ekonomisk status. Paradoxen indikerar att fördelningen av orsaken till låg födelsevikt skiljer sig åt mellan de två grupperna.

Vidare visades att även om moderns vuxenklass hade större inflytande på födelseutfall än vad hennes barndomsklass hade, fanns en association mellan hennes barndoms- och låg födelsevikt samt neonatal dödighet som var oberoende av hennes vuxenklass. Att denna oberoende association uppkom för de två födelseutfall som är närmast födseln, men inte för postneonatal dödighet, tolkas som att dessa utfall medieras via moderns kropp.

Slutligen tyder våra resultat på att moderns arbetsvillkor starkt bidrar till klassskillnader i ett flertal olika födelseutfall. Lägre grad av jobbkontroll, högre grad av risker och högre fysiska krav var alla mer eller mindre associerade med risk för spädbarnsdödighet, låg födelsevikt, väldigt låg födelsevikt, sämre fosterstillväxt, för tidig födsel, väldigt samt extremt för tidig födsel. De tre dimensionerna av arbetsvillkor hade olika samband med de olika födelseutfallen, vilket tyder på en hög komplexitet i relationerna.
List of publications

This thesis is based on the following papers:

**Study I**

**Study II**

**Study III**
Gisselmann, M.D. Infant mortality: To what extent can social class inequalities be explained by maternal working conditions? (Forthcoming as a book chapter in le Grand, Halldén and Hellgren (Eds.): *Ethnicity, Equality and Justice. Beyond the Paradigms of Recognition and Redistribution*, Cambridge Scholars Publishing)

**Study IV**
Gisselmann, M.D & Hemström, Ö. The contribution of maternal working conditions to socio-economic inequalities in birth outcome *(Submitted)*

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The overall aim of this thesis is to contribute to the understanding of the association between socio-economic status and the health of infants, and this is accomplished by a focus on maternal socio-economic indicators. The background for this interest is the persistent phenomenon that infants born to women with higher socio-economic status generally have more advantageous births outcomes, such as higher birthweight and lower mortality.

With the development of the Swedish welfare system, inequalities in birth outcome were thought to have disappeared and this was in fact stated in the Black Report (Black, 1980). But while the rates of perinatal and infant mortality are internationally low in Sweden (Vallin, Meslé, & Valkonen, 2001), the association between socio-economic status and birth outcomes such as infant mortality do not seem less obvious than in other countries as was suggested in the early 1990’s (Köhler, 1991).

Mechanisms of inequality are likely to be many and complex. In this thesis I have tried to apply the thinking of causal pathways. I view socio-economic indicators as being embedded in the structure of society, with each indicator possibly reflecting a different set of causal pathways, resulting in inequalities in birth outcome. This means that while class might work through its associations with working conditions to influence class inequalities in birthweight, education may work through abilities or knowledge to influence educational inequalities in preterm birth.

This thesis will merely start to outline possible causal pathways. These pathways are likely to change over time. The mechanisms resulting in inequalities in infant mortality in early 20th-century Sweden with a much higher rate are not necessarily the same as later in the century when the pattern of causes of death was different. In order to avoid the assumption that mechanisms are the same across societies and that their relative importance is the same independent of the patterns of outcome, the focus of empirical and theoretical work has been Sweden in the last quarter of the 20th century (1973-1990). This interest in pathways within Sweden entails that country comparisons will not be considered.

Why does an infant born to a mother with lower socio-economic status have a higher risk of for example preterm birth in our comparatively egalitarian and rich welfare society? Before this question is explored further I
will emphasise its importance, both in terms of what makes birth outcome different than many other health outcomes, and in terms of justice.

Theoretically, this thesis will try to extend earlier theorising by explicitly consider the link between maternal health and biology, and infant health. As a consequence of this, the entire maternal life course is interesting in the study of inequalities in birth outcomes. Also, the focus on the mother-infant link highlights the transfer of health between the generations. This point of transition is a biological link and, as will become clear in this thesis, is highly influenced by socio-economic factors.

Birth outcome differs from most health outcomes in that although the socio-economic indicators measured are those of the parent(s), the consequences of these indicators are extended to another individual. While this clarification might seem trivial, it is of significance for the issue of justice. Differences in health between social groups are often referred to as health inequalities. The term inequality may be used primarily to indicate differences between groups, and not necessarily to emphasise the case of moral judgment implied by the term inequity (Kawachi, Subramanian, & Almeida-Filho, 2002). I would argue, however, that socio-economic inequalities in birth outcome are unjust, regardless of which definition of equity is applied.

A commonly used reference in the area of justice is Rawls (1971), who suggests that there are some basic liberties that should be available to all: freedom of speech and thought, for instance. Daniels (1985) extends his theories to health care, arguing that this should be considered a special case because good health is required to enjoy the other basic liberties. In the research field of health inequalities, it is often argued that inequalities due to individual choices, like health behaviours, should not be considered unjust (Whitehead, 1991). What characterises an informed and free decision is however debatable, and does not seem to be independent of social structure (Vallgårda, 2006). Applying this line of argument to infants, who can not in any way be held responsible for their state of health, death before the age of one necessarily deprives them of even the basic liberties suggested by Rawls. Infants surviving disadvantageous birth outcomes, suffering impaired sight or hearing or learning difficulties, clearly do not have the same opportunities as healthier infants do. For these reasons, socio-economic inequalities in infant health must be considered unjust 1.

For infants and their parents, it is of the highest priority that any avoidable adverse infant health outcomes be eliminated.

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1 The title of the thesis, "The first injustice", was first used by Gortmaker and Wise 1997.
Outline of thesis

The purpose of the introductory chapters is to provide a context for this research project, and to make the studies more accessible to readers who are not familiar with the research area. The outline of the thesis is as follows:

Firstly, birth outcomes and socio-economic indicators are described and discussed. Secondly, socio-economic inequalities in birth outcome in Sweden and the other Nordic countries are described, and previous explanatory approaches are discussed. Thirdly, an explanatory framework of socio-economic inequalities in birth outcome is outlined. Finally the studies constituting the thesis are presented, followed by a discussion of the thesis as a whole. A short list of conclusions completes the introductory chapters.
What are socio-economic inequalities in birth outcome?

Social impact on infant health is widely recognised. Focus from a sociological perspective is often on the infant mortality rate, which has long been used as a measure of living standard in populations. Social researcher Harriet Martineau mentions a high proportion of infant deaths as “a most unfavourable symptom of society” (Martineau, 1838, p171), and it is still considered to be a valid measure of population health (Reidpath & Allotey, 2003). Also birthweight is used worldwide as a health indicator in infants (World Health Organisation, 2005).

As previously recognised, mortality outcomes do “not adequately reflect the disease burden in the living population” (Fritzell & Lundberg, 2006, p 9), and there is good reason to expand research on social inequalities in infant health to birth outcomes beyond both infant mortality and birthweight. I will return to this issue after a short presentation of the birth outcomes examined here.

Birth outcomes in this thesis

The birth outcomes studied in this thesis are defined in Table 1, and can all be found in the Swedish Medical Birth Register.

Mortality outcomes are classified according to the age of the foetus or infant, from late foetal death to postneonatal mortality. The most commonly used indicator in social research has been infant mortality, the death of infants born alive that dies before the first birthday. The major causes of infant death in the developed world, where infant mortality rates are low, are congenital malformation and problems related to preterm delivery (Nordström, Cnattingius, & Haglund, 1993). The death of a foetus after 28 completed weeks of pregnancy is classified as stillbirth (National Board of Health and Welfare, 2002) (the precise week differs between countries).

Gestational age refers to the length of time the foetus has grown inside the uterus. The shorter the gestational age, the higher the mortality risk. Those that survive a very preterm birth tend to have permanent deficiencies in growth and problems with visual and hearing impairment as well as neurocognitive development (Kramer, 2003; Slattery & Morrison, 2002). Problems related to cognitive development are the most common, and can in the
long run affect possibilities to achieve good school results and higher education (Colvin, McGuire, & Fowlie, 2004). There is a tradition in health research, in line with general welfare research in the Scandinavian countries, of focusing on disadvantageous rather than advantageous outcomes (Fritzell & Lundberg, 2006), and this has generally been the case for birth outcomes as well. Gestational age is often dichotomised into term and preterm, and the categories of very or extremely preterm are sometimes used as well.

Not all infants grow at the same rate during gestation, especially during the latter part of pregnancy. Researchers are interested in defining those infants with intrauterine growth restriction (IUGR), often indicated by a

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<td><strong>Extremely preterm</strong></td>
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<td><strong>Small-for-gestational-age (SGA)</strong></td>
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<sup>a</sup> Foetal death and stillbirth are considered interchangeable terms.
<sup>b</sup> Aims at pregnancy weeks as traditionally starting at the beginning of last menstrual period before conception (adding approximately 2 weeks before conception to foetal life)
<sup>c</sup> This definition varies between countries
definition of small-for-gestational-age (SGA). A definition of SGA means that the infant is either two standard deviations below the mean or belongs to the 10% with the smallest amount of foetal growth, in relation to others born the same week (Källén, 1995; Savitz, Hertz-Picciotto, Poole, & Olshan, 2002). Foetal growth restriction is associated with increased risk of foetal death, as well as mortality risk after birth. There is a difficulty in defining which of the SGA infants that are truly growth-restricted, an area in which diagnostic tools are making advances (Haram, Softeland, & Bukowski, 2006). Infants with the lowest foetal growth rate are not a specific group, but represent one end of a continuum. For many SGA infants it may be that they are constitutionally small, which should not be considered “truly” growth-restricted. Moreover, while most SGA infants are born at term, risk factors for SGA may not be the same for preterm and term SGA infants (Clausson, Cnattingius, & Axelsson, 1998).

Birthweight is a well researched birth outcome. Generally, lower birthweight is associated with higher mortality risk in the infant period. It has also been linked to an increased risk for various health problems in adult life, such as coronary heart disease (Godfrey & Barker, 2001), as well as more disadvantageous cognitive outcomes (Spencer, 2003). The concept of low birthweight is very common, referring to a birthweight less than 2500g, with lower weight categories sometimes being used as well.

In addition to the birth outcomes in this thesis, there are other pregnancy or reproductive outcomes. For instance the term pregnancy outcome which includes issues of fecundity (the capacity to give birth), fertility (actual reproductive outcome) and early pregnancy loss (Savitz, Hertz-Picciotto, Poole et al., 2002).

**Causes of disadvantageous birth outcomes differ**

Gestational age, foetal growth and birthweight are all interrelated and associated with mortality risk. It is believed that foetal growth rate might contribute to setting the time of delivery, thereby affecting gestational age. Also, gestational age and foetal growth rate can be seen as two major pathways to achieved birthweight, which they precede in time. Partly because birthweight can be seen as a result of gestational age and foetal growth, it has been criticized for being an imprecise endpoint (Wilcox, 2001). And indeed, when there is any interest whatsoever in aetiological processes and data are available, there seems to be no reason to settle with only studying birthweight. However, availability and reliability of birthweight have been high compared with the other two outcomes, both over time and worldwide. Birthweight may be seen as a composite measure of infant health, even if it is not necessarily on the causal pathway to adverse birth outcomes such as infant mortality or ill health later in life (Spencer, 2003).
Although the above birth outcomes are interrelated, there are good reasons to study them as separate entities. In the context of this thesis the prime reason is that their causes seem to be different, even though knowledge about aetiological processes behind birth outcomes is limited (Kramer, 2003), indicating that the pathways between socio-economic factors and birth outcomes may differ.

Research on birth outcomes needs to separate single births (singletons) from multiple births such as twins or triplets. Birth outcomes for multiple births are different in several ways from those of singletons; for example, they generally have lower birthweight, shorter gestational age and higher mortality which can be said to be caused by the multiplicity. For this reason only singletons are studied in this thesis.

Beyond the scope of this thesis, causes of adverse birth outcomes is of further interest because they may have different consequences later in life.

**Birth outcomes as health indicators**

Not all birth outcomes are strictly speaking health outcomes as such, but they can all be considered as health-relevant in that they are very strongly related to health and are therefore often used as health indicators. In addition to this, they are not only health-related but also seem to carry health potential. As described above, disadvantageous birth outcomes are related to adult health outcomes; we can thus talk about health potential.

With the concept of health status, we are usually referring to something we can measure in the present. We may define an infant as growth-restricted at term and use this as a health indicator. While it seems that something has happened to produce this result, we are not sure how or why, or even what has happened. But it does seem to indicate that something has happened inside the body, even if we are not be able to measure precisely what it is. In one line of research this is called “biological programming” (Barker, 1991), which can be perceived as quite deterministic, and in a wider context this relatively new research field has become known as “developmental origins of disease” (For further discussion on this, see “Mapping out an explanatory framework”). While the concept of health potential perhaps gives the impression that outcomes later in time is of interest, life course research has used the concept health capital (Kuh, Power, Blane, & Bartley, 2004), something that might seem to indicate that there is a longer life course to refer back to in time.

In this thesis, the concept of health potential will be used as something that has already happened in the body, and may influence health or susceptibility to health problems further from this insult in time as well, thus compatible with the concept of health capital. That foetal and infant life “provides a health potential which continues to act on later health during the entire life course has substantial credibility” (Elstad, 2000, p 95).
Socio-economic indicators

The most commonly used socio-economic indicators are income, education and social class. In empirical research it has occasionally been assumed that all these indicators measure the same underlying concept, for example status (see for example Marmot, 2004), and are therefore interchangeable. This thesis will use the term socio-economic status as a collective term for the socio-economic indicators, rather than referring to any specific concept of status or prestige. There have also been strong arguments raised against the presumed interchangeability of socio-economic indicators (Geyer, Hemström, Peter, & Vågerö, 2006); here they will be assumed to reflect different dimensions of socio-economic inequalities, thus causal pathways between an indicator and a specific birth outcome may vary.

Level of education is always tied to the individual. Education may increase cognitive abilities (Erikson, 2001), for example the ability to process information, in terms of amount and complexity. It may also increase the ability to solve problems. These abilities may improve decision-making or increase access to other resources. For example, a higher education will be necessary for many highly qualified jobs, which will generally be better paid and have healthier working conditions.

Income has been suggested as the best measure of material conditions (Erikson, 2001). It is often measured at a household level, which tends to elevate the income of married and cohabitants compared with singles, and household income is often adjusted for number of adults and children living in the household. As a resource, income can be considered a very general resource, because it is possible to transform it into other resources. Because of this characteristic, those with a higher income can be thought of as having more control over life (Erikson, 2001). It is also the most dynamic indicator, in that it varies over time more than the others do. In determining living standard it plays a large role in terms of housing, consumption and recreation. (Income is not used empirically in the studies constituting this thesis).

The most complex socio-economic indicator is social class. The socio-economic classification system in Sweden is intended to capture life chances, and it has been argued that it is close to Weber’s class theory (Fritzell & Lundberg, 1994). The starting point of the Swedish classification system is the occupational relation, with the first distinction made between employees and self-employed. From the latter the category of farmers can be extracted, providing two groups of self-employed: farmers and all other self-employed. Employees are divided into manual and non-manual workers. These groups can also be more finely categorised: manual workers can be split into more and less qualified, and into the service or manufacturing work sector. Non-manual workers are hierarchically classified into higher, middle and lower. This system has been applied in censuses in Sweden since 1980, and in this year the classification resulted in 18 groups, including 6 groups
not gainfully employed or unclassifiable for other reasons (Andersson, Erikson, & Wärneryd, 1981; Statistics Sweden, 1982).

The indicators are interrelated so that, for example, higher education is a common prerequisite for achieving occupations classified as higher social class. Therefore, the association between education and health, for example, can be seen as partly mediated by social class (Lahelma, Martikainen, Laaksonen, & Aittomaki, 2004). When using all three indicators in the same model, Geyer et al. find a remaining association with mortality for each indicator when the others are controlled for (Geyer, Hemström, Peter et al., 2006), which has previously been found for income (net of education and social class) and self-rated health (Fritzell, Nermo, & Lundberg, 2004).

The Swedish socio-economic classification in itself also contains criteria for level of qualifications normally required for a position, whereby level of education is quite strongly tied to social class – at least if the measurement of class is based on the individual occupation. As mentioned above, education is always measured on an individual level and income either on an individual or household level. How women’s social class should be measured is, however, a more controversial issue.

**Measuring social class for women**

In health-related research the individual-based concept of occupational class is sometimes used, for example when studying working conditions. In contrast, the concept of social class is used to denote more than simply aspects of work. This concept goes back to theorists such as Marx and Weber, and has been well debated since their time. It has been argued that social class is a characteristic of the household rather than the individual (Erikson, 1984a; Erikson, 2006). Concepts of class are usually based on occupation, which is assumed to reflect the position both on the market and at work (Erikson, 1984a). Historically, not all groups of women have had the same strong connection with the labour market as most men have. Whereas a large proportion of working class women have been in paid labour, the proportion of middle-class and especially upper-class women has been much smaller (Ohlander, 1994). In agriculture, women in farming families have generally not been considered to be gainfully employed (Erikson, 1984b). For married couples, social class has traditionally been considered best assessed using the occupation of the husband. Going back in time, this may have been an adequate reflection of life chances for the family, especially for the middle and upper classes (Farmers have probably worked together, and among manual workers women have often been single providers (Ohlander, 1994).

Since the latter part of the 20th century, it has been argued that social class is best assessed using the dominance method. According to this, the person with the dominant social class position should be used for classification of the entire household (Erikson, 1984a). Once both occupations have
been considered, this method ignores rather than takes into account the occupational class of the individual with the subordinate occupation (Heath & Britten, 1984). Because men generally have dominant labour market positions in Sweden, households with two adults are usually assigned the social class of the husband. Thereby, non-cohabiting women are also disproportionately assigned to the lower classes (Arber, 1997). While some women in the high non-manual class are highly educated and have high-status jobs such as medical doctors, others in the same category have low education and a manual job, or are unemployed. Since many relationships do not last a lifetime, and a woman’s education and work experience is more important for her labour market position than that of her husband, these factors must also be considered very important for a woman’s life chances after a separation.

In studying the relation between class and health, different ways of measuring social class give different results. An individual measure of class, compared with a household measure, has been shown to give a larger class difference in limiting long-standing illness for women (Arber, 1997), probably because this health outcome is highly associated with working conditions. A general measure like self-rated health, on the other hand, was shown to give larger differences with a household measure for women (Arber, 1997). This may reflect the importance of material living conditions (for self-rated health), which has been shown to be more related to the occupational class of a male cohabitant (Erikson, 1984a).

In the field of health inequalities, it has been suggested that a theoretical choice of indicator should be made based upon the explanatory pathway of the inequalities (Bartley, Sacker, Firth, Fitzpatrick, & Lynch, 2000). From the perspective of sociology, this may not be considered an optimal method (see for example Vågerö, 2000), since health inequalities are not necessarily the most important aspect of social class. In spite of this, the discriminatory power of indicators is sometimes used to strengthen the argument of a household rather than an individual measure (Erikson, 2006; Erikson & Goldthorpe, 1992).

Applying these arguments specifically to the study of birth outcomes, there are reasons to emphasise the maternal aspects of social class. Firstly, it can be argued that foetal and infant health are associated with maternal health. The maternal body accommodates the foetus, and the infant continues to be nourished straight from the maternal body after birth for as long as breastfeeding is practiced. Secondly, the mother is persistently the predominant caretaker during the largest part of infancy in Sweden. The paternal proportion of parental leave during the first year is increasing, but this thesis focuses on the time period 1973-1990 when only 5% of the days of parental leave during infancy were used by the father (Statistics Sweden, 2007). Using women’s own occupations as the basis for class will result in classes composed of women with more similar everyday living conditions. In this
thesis, women’s own occupational class is referred to as “social class” in Studies II and III, and as “class” in Study IV. The two last studies are focused on working conditions, which is a case when also advocates of the household method recommends using women’s own occupation (Erikson, 1984a); I recognise that this might underestimate the role of the household in terms of material living standard, according to the argument by Dale et al (Dale, Gilbert, & Arber, 1985).
Previous Nordic research

Research relying on historical statistics estimates that infant mortality in Sweden around the year 1750 was over 200 per 1000 births. This had been reduced by 50% already in the late 1880s, and had decreased to around 60 per 1000 births around 1920 (Rydell, 1976). According to this estimate, most of the decrease (about 75%) in infant mortality occurred before medicine intervened with its modern therapeutic arsenal. Improvements have been attributed mainly to better living standards; nutrition, housing, water, hygiene and education are usually mentioned. All this is believed to have increased infants’ survival ability and reduce contamination by disease agents (Köhler, 1991; Rydell, 1976). With the reduction of infant mortality, the domination of postneonatal deaths until the 1930’s is followed by a domination of neonatal deaths (Figure 1).

In international comparisons, birth outcomes in Sweden have been amongst the most favourable in the world since the 1950s. The internationally low level of infant mortality (Table 2) has especially been lauded in Swedish Public Health Reports (National Board of Health and Welfare, 1994; 1997; 2001).

![Figure 1. Infant and perinatal mortality in Sweden 1915-1977. Source Karlberg & Erikson (1979), reproduction by National Library of Sweden.](image-url)
That infant health also varies within the Swedish population according to socio-economic status was already documented eighty years ago when Rietz, a German researcher, noted that the infant mortality rate decreased with increasing paternal income (Rietz, 1930).

Modern research shows socio-economic differences in infant mortality in an area of Stockholm during the years 1878-1925 (Macassa, 2004). Recent studies also show how social class differences in diarrhoea mortality rates for children under 2 increased when the higher classes improved their living conditions, and how the gap decreased when the lower classes were also reached by these improvements (Burström, Macassa, Öberg, Bernhardt, & Smedman, 2005; Burström & Öberg, 2006).

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<td>Denmark</td>
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<td>Norway</td>
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<td>Netherlands</td>
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<td>Sweden</td>
<td>21.9</td>
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Source: Vallin, Mésle, & Valkonen (2001)
The Nordic countries are all relatively egalitarian, and have low levels of disadvantageous birth outcomes. Patterns of socio-economic inequalities in birth outcome seem similar in the Nordic countries, and research has generally been carried out on the entire population due to the medical birth registries in these countries from around 1970.

In the next section is a short presentation of descriptive results from studies of socio-economic inequalities in birth outcome in the Nordic countries for the years 1992-2006. In a series of studies, a Swedish research group explored socio-economic differences in birth outcome using an indicator of privileged versus underprivileged (Ericson, 1984; Ericson, Eriksson, Källén, & Zetterström, 1990; 1993; Ericson, Eriksson, & Zetterström, 1984). This classification was a composite measure, based on a mixture of socio-economic and social indicators such as income, cohabiting status and maternal occupation. Because interpretations and comparisons are difficult, these studies will not be included in the presentation.

In some of the Swedish studies below, social class is based on household or cohabitant occupation rather than maternal occupation; when this is the case it will be noted in the text.

Mortality

The most frequently studied birth outcome in the social sciences is infant mortality. At least ten studies show higher risks for infant mortality for infants born to women with lower education (Arntzen, Magnus, & Bakketeig, 1993; Arntzen, Moum, Magnus, & Bakketeig, 1996a; 1996b; Arntzen, Samuelsen, Daltveit, & Stoltenberg, 2006; Bakketeig, Cnattingius, & Knudsen, 1993; Cnattingius & Haglund, 1992; Gisselmann, 2005; Haglund, Cnattingius, & Nordström, 1993; Helweg-Larsen, Olsen, & Madsen, 1999; Hemminki, Merilainen, Malin, Rahkonen, & Teperi, 1992; Olsen & Madsen, 1999; Valkonen, Martelin, Rimpelä, Notkola, & Savela, 1993). Most studies separate neonatal and postneonatal mortality, with the median of odds ratios at 1.4 and 1.8, respectively, although not all odds ratios are statistically significant. In some studies only the lowest educational category has a higher risk than the other groups, and in some there is a gradient. There are also some studies in which there is a gradient, but it is not carried on to the highest educational group (Haglund, Cnattingius, & Nordström, 1993; Hemminki, Merilainen, Malin et al., 1992; Valkonen, Martelin, Rimpelä et al., 1993), with odds ratios around 1.4 for neonatal and 1.2-1.4 for postneonatal mortality.

There are consistently higher risks for infant mortality for infants born to manual workers than to non-manual workers, and this is often statistically significant (Arntzen, Moum, Magnus et al., 1996b; Gisselmann, 2006; Gissler, Rahkonen, Järvelin, & Hemminki, 1998; Helweg-Larsen, Olsen, & Madsen, 1999; Valkonen, Martelin, Rimpelä et al., 1993), as well as when
household (Haglund, Cnattingius, & Nordström, 1993) or mother’s cohabitant (Leon, Vågerö, & Olausson, 1992) was used to assign social class. Considering the different measures of class and the different reference groups, it is not clear how the odds ratios should be compared, but they vary between 1.2 and 1.6 for these studies and neonatal, postneonatal and total infant mortality.

One study includes income (probably maternal) as a socio-economic indicator. Contradictory to most findings, neonatal mortality seems to increase with increasing income, while there is no trend for postneonatal mortality (Arntzen, Moum, Magnus et al., 1996b).

**Foetal death** seems consistently related to socio-economic status. Lower maternal education was associated with higher risk for stillbirth in all the reviewed studies (Arntzen, Magnus, & Bakketeig, 1993; Cnattingius & Haglund, 1992; Haglund, Cnattingius, & Nordström, 1993; Hemminki, Merilainen, Malin et al., 1992; Olsen & Madsen, 1999; Valkonen, Martelin, Rimpelä et al., 1993) and median of odds ratios was 1.6. A manual social class was related to higher risk for foetal death than a non-manual class, both when this was based on maternal occupation (Helweg-Larsen, Olsen, & Madsen, 1999; Stephansson, Dickman, Johansson, & Cnattingius, 2001; Valkonen, Martelin, Rimpelä et al., 1993) and on household occupation (Cnattingius & Haglund, 1990; Haglund, Cnattingius, & Nordström, 1993) with odds ratios between 1.4 and 2.0.

**Perinatal death** seems to be a less common choice of birth outcome, but both lower maternal education (Hemminki, Merilainen, Malin et al., 1992; Valkonen, Martelin, Rimpelä et al., 1993) and manual, compared to non-manual, social class (Gissler, Rahkonen, Järvelin et al., 1998; Valkonen, Martelin, Rimpelä et al., 1993) has been linked to an increased risk for perinatal death (odds ratio 1.3).

**Birthweight**

Birthweight has persistently been shown to be associated with maternal education, so that lower education is related to a higher proportion of infants with low birthweight with odds ratios of 1.7-2.7 (Arntzen, Samuelsen, Magnus, & Bakketeig, 1994; Gisselmann, 2005; Helweg-Larsen, Olsen, & Madsen, 1999; Hemminki, Merilainen, Malin et al., 1992) or lower birthweight (Bakketeig, Cnattingius, & Knudsen, 1993; Koupilova, Vågerö, Leon, Pikhart, Prikazsky, Holcik et al., 1998).

Compared to higher or middle non-manuals, manual workers tend to have an increased risk of giving birth to infants with low birthweight (Gisselmann, 2006; Helweg-Larsen, Olsen, & Madsen, 1999) also when household class was used (Vågerö, Koupilova, Leon, & Lithell, 1999).

One study suggests a tendency for birthweight to increase with maternal, but not paternal, income (Arntzen, Samuelsen, Magnus et al., 1994).
Gestational age and foetal growth

A higher risk for preterm birth has been shown in infants born to women with lower education with an odds ratio of 1.6 (Hemminki, Merilainen, Malin et al., 1992; Koupilova, Vågerö, Leon et al., 1998), and to manual in comparison to non-manual workers (odds ratio 1.25) (indicated by household) (Vågerö, Koupilova, Leon et al., 1999). One study indicates that low maternal education increased the risk for SGA for preterm, but not full term, infants (Clausson, Cnattingius, & Axelsson, 1998).

Explanatory approaches

From the overview of the Nordic studies above, it is clear that the main interest has been socio-economic inequalities in infant mortality. A reason for this focus might be the long tradition of using this as a social indicator.

In the articles reviewed above, theoretical explanations are generally limited to a sentence or two in which possible reasons are stated. Living conditions, lifestyle and smoking, as well as occupation or work are the most commonly mentioned theoretical explanations, followed by stress, access to health care and material deprivation. Of these explanations, only the health behaviour smoking is sometimes described and discussed in more detail, and empirical explanation seems limited to this (see for example Haglund, Cnattingius, & Nordström, 1993). That is, other factors are adjusted for but are not considered mediating factors.

Some conclusions can actually be drawn from these studies, even if they were not made by the authors. For example, from a study interested in the influence of marital status on birth outcome, it is clear that educational differences are not erased when social class or income is adjusted for. This in fact increases the odds ratios, while class differences on the other hand decrease when education and income are adjusted for (Arntzen, Moum, Magnus et al., 1996b).

Explanations of inequalities in birth outcome within developed countries that have been discussed in other countries have been related to birthweight and selection effects. In the first case, the research question was how much of infant mortality differences were mediated by birthweight (Leon, 1991). Considering that birthweight is the result of both foetal growth and gestational duration, and that the causal factors behind these are not identical, adjusting for birthweight perhaps does not contribute much to the understanding of the causal pathways between socio-economic factors and infant mortality. A discussion of selection effects in relation to birth outcome was based on an article showing that women with better “personal qualities” in term of physique, health and height were upwardly mobile in their marriages, and that they also gave birth to infants with better life chances.
(Illsley, 1955). However, the main interest in the selection debate was perhaps the gradient in adult health rather than the explanation of inequalities in infant health per se (see for instance Blane, 1985; Blane, Harding, & Rosato, 1999; Fox, Goldblatt, & Jones, 1985; Rahkonen, Arber, & Lahelma, 1997), and the significance of health selection could vary by outcome.

From a medical point of view, there has – naturally and rightly so – been a focus on the prevention of disadvantageous birth outcomes for the individual, mainly through identification of “risk factors”. However, some of these can not be considered as such from an aetiological or sociological perspective, and would better be called risk indicators than risk factors. An example of a problem with relevance for the aetiological perspective is prior preterm birth, which is regarded as a risk factor for another preterm birth. However, this does not reveal anything about why there was a prior preterm birth, or why another might occur. An example of when a sociological perspective is relevant is the issue of first parity, the firstborn infant to a woman. Infants of parity one are usually smaller than laterborns, and have an elevated mortality risk. However, having a first birth is not a medical problem, and there are even indications that firstborns have other advantages in terms of educational achievement (Modin, 2002a; Walldén, 1992) and lower mortality in adulthood (Modin, 2002b). In addition to this, parity is not independent of socio-economic status (see demographic factors, below). An example of when this is problematic is the determination of SGAs. If parity is not considered, a higher proportion of firstborns than laterborns are categorised as SGA. This confusion about risk indicators and risk factors has had an unfortunate tendency to be carried over to both overviews and empirical research (see for example Kramer, 1987; 2003). Also, the medical perspective usually focuses on the most disadvantaged rather than on the whole scale of social stratification (see for example Kramer, Seguin, Lydon, & Goulet, 2000).

Demographic factors

There are at least two demographic factors of prime interest for socio-economic differences in birth outcome: maternal age and parity. Mortality usually has a u-shaped association with maternal age, so that infants born to very young mothers as well as those born to mothers of higher age have increased risks. For example, recent results with data of high quality showed that the risk of foetal loss is significantly higher when maternal age exceeds 35 (Andersen, Wohlfahrt, Christens, Olsen, & Melbye, 2000). A maternal age exceeding 35 is also linked to higher risk for SGA (Clausson, Cnattingius, & Axelsson, 1998), as well as very and mildly preterm birth (Ancel, Saurel-Cubizolles, Carlo Di Renzo, Papiernik, & Breart, 1999). Parity is also associated with birth outcome. Infants of first parity tend to have higher mortality than those of second parity, and there is a slight increase with higher parities. Birthweight tends to be lower for the firstborn than for higher pari-
ties. While the increased risk for disadvantageous birth outcome with increased maternal age is assumed to be caused by the aging process itself, there are indications that the increased risk for younger women might be more social in origin (Markovitz, Cook, Flick, & Leet, 2005). Moreover, associations between socio-economic indicators and birth outcome have been shown to vary across parities, the relation between maternal education and post-neonatal mortality for instance (Arntzen, Moum, Magnus et al., 1996a), indicating complex associations.

This is of interest here because maternal age and parity are not evenly distributed over socio-economic indicators. Women with a working-class background or lower adult socio-economic status tend to give birth at younger ages than do women with a non-manual background or higher adult socio-economic status. Maternal age and parity are often adjusted for because researchers are looking for differences beyond these factors. From a sociological perspective, they can also be viewed as part of the socio-economic differences. Although these factors can make a contribution, it does not seem to be very large and how it affects socio-economic differences is not always apparent. The younger mothers, more common in manual classes, will give birth to infants with a higher mortality risk, but so will the older mothers who are more common in the non-manual classes. The extent to which these factors act as mediator of inequality, or can be considered confounding, depends on the composition of the population under study and on the research question at hand. Therefore, demographic factors are considered here, although another option would have been to include them in the explanatory framework outlined in the next chapter.
Mapping out an explanatory framework

The purpose of this chapter is to map out a suggested explanatory framework for socio-economic inequalities in birth outcome. This may begin to answer the question of how socio-economic status exerts an influence on birth outcome. To a lesser extent, the relative importance of pathways will be commented on.

As is the case with socio-economic differences in health in general (Lahelma, 2006), those in birth outcome have not been explained all too well (Slattery & Morrison, 2002). From a sociological perspective, there has been an interest in welfare institutions (Wennemo, 1993), access to care (Gortmaker & Wise, 1997) and racial differences (see for example North & MacDonald, 1977). The birth outcome in focus has been infant mortality, and interest has rarely been extended to gestational age or foetal growth, for example. As was concluded above, the mediator receiving the most attention in inequalities in birth outcome within the Nordic countries seems to have been smoking. During the time period when most of the Nordic articles in the review were published, there was a great interest in the empirical explanation of health inequalities in adults. Factors found to be important for adults included working conditions in adult life and living conditions in childhood such as economic difficulties (Lundberg, 1991a; 1993). Thus, fields and disciplines of research have not been brought together, and the explanations commonly applied to adult health inequalities do not seem to have been applied to birth outcome to the same extent.

One reason for the scarcity of sociological explanations for health inequalities among infants might be that the link between maternal and infant health has not been explicitly dealt with. If this is not considered, there is no rationale for applying explanations for adult health inequalities.

The link between maternal and infant health

Already 60 years ago, it was suggested that maternal and child health should be studied together, especially for birth outcomes early in the life of the infant (Morris & Heady, 1955), and this has again been pointed out in more modern times (Wise, 2003). Nonetheless, there is a complexity in the association between maternal and infant health. On the one hand, maternal and infant health are not the same outcome. A known factor detrimental to infant
health, which is a likely mediator of socio-economic inequalities in infant health, is smoking (Kramer, Seguin, Lydon et al., 2000; Nordström, 1995). Smoking certainly influences maternal health, but not to the same extent as it influences infant health, and not via the same mechanisms. On the other hand, the maternal body mediates many birth outcomes, measured at time of birth: birthweight, gestational age, and foetal growth, for example. Although neonatal and postneonatal deaths entail more time outside the womb, a large part of the causes of these deaths precede birth in time, such as congenital malformation and immaturity-related causes. With the practice of breastfeeding, the maternal body may continue to exert an influence on infant health after birth. Thereby, many outcomes are mediated via the maternal body, and are very likely to be influenced by maternal health. This has been expressed as “during pregnancy and early childhood, children literally “embody” (biologically incorporate) the social status of their mother” (Koenen, Lincoln, & Appleton, 2006, p 3000). This will be addressed in Study II.

Thus, there is complex duality of infant and maternal health, and this link needs to be addressed in the context of socio-economic inequalities in birth outcome. For example, when considering how socio-economic status might influence infant health, we may at least theoretically try to separate influence mediated through the maternal body from that which is not.

The framework

When the link between maternal and infant health is acknowledged, the entire maternal life course is of interest for birth outcome. The socio-economic circumstances over the life course might be thought of as a social career. Just as individuals have a socio-economic career, they can have a health career (Vågerö, 1998; Vågerö & Illsley, 1995). If your social career includes school results, educational choices and attainment, as well as occupational career, every step of the way can be affected by your physical and mental health. Likewise, success in your social career can have a positive impact on your health, while drawbacks tend to increase the risk for health problems, as well as stress-related unhealthy behaviours such as smoking and alcohol intake. Thus, social and health development are intertwined.

The explanatory framework presented here is intended to be an outline rather than a complete description of all possible pathways. Along the pathways sketched here, infant health may be affected by maternal socio-economic factors, directly and via maternal health. Socio-economic indicators are not methodically presented separately, mainly because this would increase the ambition and size of this chapter. Pathways of special relevance to the discussion of the studies in this thesis are somewhat more elaborated than others.
In order to assist the reader, a simplified model is provided. The orientation follows the co-evolution of health development and social development over the life course, as proposed by Vågerö and Illsley (1995). Some things fall outside the model, such as ecological factors that rather provide a context for the model, while others seem involved with all the boxes in the model (see for example the section on stress below). In the model, “health” refers to health potential or capital as described above. The endpoints chosen for the boxes are imprecise, but hopefully the model will serve its illustrative purpose. In the text below, pathways (represented by arrows) in the model will be referred to with numbers in brackets.

Figure 2. Pathways of maternal co-development of social and health careers and the influence on infant health.
Ecological factors providing a context

It may be that some factors do not vary enough within Sweden, but still have an influence on the level of disadvantaged birth outcomes. A comparison between 18 OECD countries indicates the importance of public policy for infant mortality rate (Wennemo, 1993). Studies in, for example, the US have shown associations between income inequality and neonatal mortality (Mayer & Sarin, 2005), infant mortality and low birthweight (Shi, Starfield, Kennedy, & Kawachi, 1999). It has also been found that in states where women’s political participation was higher, economic and social autonomy were associated with birth outcomes such as low birthweight and infant mortality (Koenen, Lincoln, & Appleton, 2006). While the importance of context must be researched at a higher aggregate level, the interest of this thesis lies within a population. What determines the health of a population as a whole is not necessarily comprised of the same factors that determine the distribution within the population (Rose, 1985).

During the past decade, the research area of neighbourhood context has received a great deal of interest. That the community might contribute to individual health over and above individual socio-economic risk factors has been shown in several studies for adults (Kølegård Stjärne, 2005; Robert, 1999) as well as for birth outcome (Farley, Mason, Rice, Habel, Scribner, & Cohen, 2006; Messer, Kaufman, Dole, Savitz, & Laraia, 2006). Unemployment level among adult men have been shown to influence the rate of very low birthweight in Sweden and Norway (Catalano, Hansen, & Hartig, 1999).

Pathways of contextual influences that have been presented include an underinvestment in infrastructure, not only in that which is directly health-related such as access to high quality care (Shi, Starfield, Kennedy et al., 1999), but also in social, physical and human infrastructure (Daly, Duncan, & Lynch, 1998). Another suggested pathway is stress, for example due to economic situation (Catalano, Hansen, & Hartig, 1999), also at a community level (Culhane & Elo, 2005).

Moreover, it has been argued that there is a stress originating from inequality per se, that it is a stressor in itself to occupy a subordinate position in a hierarchical social system. The proposed mechanism entails that individuals with lower social status feel that they are less respected (Wilkinson & Pickett, 2006) due to this. Every contextual system does not affect all members of a society in the same way; rather, it depends on what situations are implied by the positions. In other words, the stress or health consequences are not given (Sapolsky, 1998). The pathway of stress is presented separately in a section below, since it is interesting as a mechanism in this context.
Maternal socialisation, social selection (1)

According to socialisation theory, the early and continued socialisation of individuals forms their behaviours, attitudes and tastes (Bourdieu, 1990). According to these preferences they choose diverse ways into the labour market, developing various strategies according to their social class, and end up being exposed to dissimilar working conditions and health behaviours (Singh-Manoux & Marmot, 2005). This theory includes elements of Bourdieu's theories of taste. He suggests that individuals are provided with a set of dispositions, guiding our tastes and choices in accordance with our previous experiences. In this way we have internalised the social world, and thus our past stays with us in the form of “habitus” (Bourdieu, 1990). The theory of socialisation can seem extremely inclusive. However, it could be argued that it plays down the importance of material conditions, and it has been criticised for not recognising the importance of social structure (Kendall & Jianghong, 2005).

In this framework, socialisation concerns the mother, and may be viewed as an underlying process. The theory is especially useful in its acknowledgement of the reproduction of socio-economic inequalities. An example will be given on education, the reproduction of which is very important in this process.

Children growing up in non-manual households, or whose parents are more educated, go on to higher education and arrive at non-manual positions to a much higher degree than other children do. Swedish research has identified two important steps in this process. Firstly, children from families with a higher socio-economic status achieve higher grades in school. Secondly, independent of these grades, a larger proportion of these children choose to go on to higher education (Erikson & Jonsson, 1993). Their actual achievement may be a result of higher priorities given to schoolwork, as well as better parental capabilities to support their children’s schoolwork in higher socio-economic families. Reasoning behind the choice of educational path is thought to mainly be differences in aspiration (Jonsson, 2004). Qualitative research has indicated that interpretation of grades varies with parental socio-economic status: while higher socio-economic status adults interpret lower grades as their children having not performed according to their full potential, lower socio-economic status adults make the interpretation that their children are not able to do better (Jönsson, 1993).

The influence of socialisation is thus multifaceted. In the case of education, it can be viewed as a process of social selection whereby those with socio-economically advantageous backgrounds achieve higher socio-economic status in their adult life to a greater extent. The influence of childhood socio-economic status in inequalities in birth outcome is explored in Study II.
Health in early maternal life: socio-economic inequalities (2)

Inequalities in mortality by parental socio-economic status are present already in infancy, and are also found in childhood (Vägerö & Östberg, 1989; Östberg & Vägerö, 1991). In the 1980’s, class differences in mortality in Sweden were found to be larger for 1-19-year-olds than for 25-65-year-olds (Östberg, 1996). Social class differences in health status in childhood seem to vary by outcome. A study examining three psychosomatic complaints in Swedish schoolchildren found that headaches, but not stomach aches or difficulties falling asleep, were significantly related to the social class of the household (Östberg, Alfvén, & Hjern, 2006). A study of traffic injuries showed that children with a manual background have between 20% and 30% higher risks in comparison with children in middle and higher non-manual families (Hasselberg, Laflamme, & Ringbäck Weitoft, 2001). According to the theory of biological imprinting, susceptibility is present in the body and even if it is not measurable with today’s indicators, health potential may still be important in childhood.

Health in early maternal life: biological imprinting (3)

Several theories are concerned with how childhood health might be of importance for adult health. One is that health in early life is of specific importance for adult health due to its timing in the developmental process. In utero and during infancy there are several critical and sensitive periods of development. If development has been negatively affected at this time point, this can not be compensated for later (Power & Hertzman, 1997). A focus of interest here has been the influence of early life on adult circulatory health outcomes (Barker, 1991). Some researchers interested in the foetal programming hypothesis claim that there is a functional adaptation (Barker, 1991; Worthman & Kuzara, 2005). The argument is that if you experience a specific environment in utero, for example nutritional restriction, this will give information about the environment in which you will be born into and the systems in your body will adapt to this. The outcome will be favourable if this is indeed what the environment is like, but if there is a mismatch it will be detrimental to your health. However it might not be justifiable to interpret all adjustments as something that necessarily have a predictive value; they should perhaps be seen more as compromises in development necessary for survival (Jones, 2005; Leon, 2004). In the well known example of low birthweight and adult health problems, it has yet to be shown that the original insult would give a better outcome in the case of starvation for it to be of adaptive value.

Maternal foetal development is of interest as there are indications that the ability to maximise a pregnancy outcome is formed during this period (Lumey & Stein, 1997; Misra, Astone, & Lynch, 2005). It has been shown,
for example, that infants born to women who had a birthweight of less than 2000g have a higher risk of perinatal mortality (Skjaerven, Wilcox, Oyen, & Magnus, 1997). (This influence can also be considered intergenerational, which will be discussed in another section below.)

Theoretically, this influence of foetal development could in fact be limited to maternal reproduction capability. However, early maternal childhood growth has been linked to the birthweight of the infant, independent of the mother’s own birthweight and adult height (Martin, Smith, Frankel, & Gunnell, 2004), implying that this is not the case and thereby extending interest to health later in the maternal life course.

Health in early maternal life: accumulated health (3)

The theory of accumulated health states that health insults add up over the life course, to gradually increase risks of ill health (Montgomery, Bartley, Cook, & Wadsworth, 1996). This would mean that ill health in childhood would be detrimental to adult health status. It has been suggested that ill health in adults with lower education can be partly explained by childhood health in a cumulative fashion (Kuh & Ben-Shlomo, 2004). One study showed that 5-10% of the higher risk for individuals with a low education was explained by childhood illness when adjustment was made for socio-economic group (van de Mheen, Stronks, Looman, & Mackenbach, 1998b).

This would be a biological pathway supporting the theory of accumulative health. The concept of something being cumulative is also used in another sense, referring to cumulative disadvantage over the life course by way of social pathways of continuous disadvantage (Graham, 2001; Kuh, Power, Blane et al., 2004). This theory would include (1), (7) and probably (8) and (9).

Socio-economic status in early maternal life (4)

To give an example of how social difficulties in childhood have been shown to influence adult health, results from a Swedish study with a representative sample of the Swedish population are presented (Lundberg, 1993). Dissention in the family and economic difficulties were among other dimensions associated with a higher risk for adult ill health. Even when both these items were in the same model, they were significantly associated with general physical health, aches and pains, as well as mental health. Thus, to the extent that economic difficulties are more common in families with lower socio-economic status, they may mediate socio-economic inequalities in adult health.
Health selection from childhood to adult socio-economic status (5)

Because of the importance of childhood for the pathway into adult socio-economic status, it is worth considering the theory of health selection in two steps. The selection from childhood to adulthood is sometimes referred to as intergenerational (see for example Lundberg, 1991b), since the measurement of childhood socio-economic status is usually based on parental indicators. Intra-generational selection, which exists within the adult life, will be considered in the next section (6).

This theory of health selection concerns the influence of childhood health on adult socio-economic status: individuals with better health would arrive at a higher socio-economic status, whereby health is causing the difference rather than the social factors being causal. There is evidence that physical health does go hand in hand with upward social mobility (Blane, Smith, & Hart, 1999; Illsley, 1955). For example, Swedish data have shown that taller people are more upwardly mobile than shorter people (Nyström Peck, 1992). While this process seems stable, it must be considered how this affects the health gradient to assess whether it actually produces health differences. It has in fact been suggested that this health selection is indirect, in that it is probably other factors such as family values that are behind both the better health and the upward mobility (West, 1991), which follows from the influence of childhood socio-economic status on that in adulthood, presented above (1). It has been pointed out that when health selection has been considered important, it has been with reference to younger ages, when social mobility is higher, and that the influence of this on the health gradient in adult health ought to be diminished over time (Fox, Goldblatt, & Jones, 1985). Social mobility in Sweden has been shown to be quite high before the age of 35 (Jonsson & Erikson, 1997), and this would include the majority of women giving birth.

Health selection in adult life (6)

The original theory of health selection is perhaps more applicable to selection from childhood, but this distinction is not necessarily always made. Since the original Black Report (Black, 1980), the importance of health selection for inequalities in adult health has generally been considered small, and rather as decreasing than increasing differences between social classes (Blane, Harding, & Rosato, 1999; Blane, Smith, & Hart, 1999; Rahkonen, Arber, & Lahelma, 1997). This is because the health of the lower childhood socio-economic status individuals who are upwardly mobile, has been found to be better than that of those who remain in a position (or are downwardly mobile), but worse than that of the higher socio-economic status individuals they replace (Blane, Harding, & Rosato, 1999).
In addition to the original health selection theory, there are other selection factors more limited to adulthood, and these seem to more undoubtedly decrease the health gradient. According to “the healthy worker effect”, those able to attain and maintain a job, are healthier than those who don’t (Dahl, 1993). Furthermore, a selection out of physically demanding jobs, both out of the labour market and into lower non-manual jobs that are less physically demanding, has been shown (Östlin, 1988).

It seems relevant here to provide an example of how the proposed framework could be extended and could benefit from separating the socio-economic indicators. Selection out of physically demanding jobs might not increase differences between manual and non-manual classes. However, effects on income may be considerable and would in thus increase health inequalities over income groups.

Adult socio-economic status and adult health: living conditions (7)

A definition of level of living often used in Swedish research on welfare is given by Fritzell and Lundberg (2006) as the possibility for people to control their own lives with the help of their own resources. They mention for instance knowledge, economic resources and physical energy. In a given context, the individual may use these to exert influence on her living conditions (Erikson & Åberg, 1987). Here, material living standard and working conditions will be considered.

Material factors such as income or financial difficulties are often found to be of importance for social class inequalities in adult health (Laaksonen, Roos, Rahkonen, Martikainen, & Lahelma, 2005). Some of the effect of the material factors has been found to be mediated via psychosocial pathways or health-related behaviours (van Oort, van Lenthe, & Mackenbach, 2005). It should be noted that material circumstances, or material living standards, refer not only to deprivation or poverty. Swedish research has claimed that both absolute and relative income are associated with health outcomes, and that the relations are independent of each other and might be of varying importance for individuals depending on their position in the income distribution (Åberg Yngwe, 2005).

Physical working conditions have been shown to be important for adult health, through repetitive strain injuries, accidents and all kinds of hazardous exposures, and have been shown to be the single most important explanation for socio-economic inequalities in health in Sweden (Lundberg, 1991a). Likewise, more recent studies empirically explaining socio-economic inequalities in self-rated health with working conditions found physical demands to be the most important explanatory factor (Borg & Kristensen, 2000; Schrijvers, van de Mheen, Stronks, & Mackenbach, 1998).

Working conditions are likely to contribute to socio-economic inequalities in birth outcome as well. Occupational research has shown that maternal
exposure to various work environments may affect time to pregnancy (Rylander, Axmon, Toren, & Albin, 2002), birthweight (Farrow, Shea, & Little, 1998), gestational age (Sanjose, Roman, & Beral, 1991) and foetal growth (Seidler, Raum, Arabin, Hellenbrand, Walter, & Schwartz, 1999). A Swedish study showed differences in low birthweight rates for some occupations in 1981, and possibly in perinatal deaths and malformations (Ericson, Eriksson, Källén, & Zetterström, 1987). In a meta-analysis it was concluded that physically demanding work was the factor most clearly associated with preterm birth and small-for-gestational-age (Mozurkewich, Luke, Avni, & Wolf, 2000). Studies III and IV will explore the mediating role of working conditions in class inequalities in birth outcome.

Adult socio-economic status and adult health: lifestyle and behaviours (7)

Further from the social structure and closer to the individual is health-related behaviour (Lundberg, 2003). It is well known that dietary and exercise habits, as well as smoking and the use of alcohol, are not only related to health but also vary by socio-economic status so that in general (but not always) the lower the socio-economic status, the more the likelihood of behaviours detrimental to health. These behaviours are established in childhood, and childhood socio-economic status has sometimes been shown to have an independent effect on adult health behaviours (van de Mheen, Stronks, Looman, & Mackenbach, 1998a), and sometimes to change (diet) with change of socio-economic status in adult life (Mishra, Pryne, Paul, Greenberg, & Bolton-Smith, 2004).

Whereas moderate intake of alcohol has been difficult to relate to the birth outcome of interest here (Henderson, Gray, & Brocklehurst, 2007), there are indications that this may influence cognitive outcomes later in life (Huizink & Mulder, 2006), ADHD for instance. The issue of alcohol consumption during pregnancy should therefore not be disregarded, especially since the increased alcohol consumption in Swedish women in childbearing ages seems to have increased (Bergman & Källmén, 2003), and also seems to be higher among pregnant women that previously thought (Göransson, Magnusson, Bergman, Rydberg, & Heilig, 2003).

Smoking has been shown to both decrease birthweight (Wen, Goldenberg, Cutter, Hoffman, Cliver, Davis et al., 1990) and increase the risk of mortality (Wilcox, 1993). From the early 1970s and onwards, smoking has been more prevalent in women with lower socio-economic status, and over time it has decreased much less in these groups than in others (National Board of Health and Welfare, 1997). This makes smoking an important mediating factor in socio-economic inequalities in birth outcome. As mentioned above, smoking
has been the most commonly used empirical explanation for socio-economic inequalities in birth outcome in Nordic studies.

From a sociological perspective, two important issues regarding smoking need to be addressed, both relating to the determinants of smoking rather than the direct detrimental effect it has on maternal health and birth outcome. Firstly, the majority of women with lower socio-economic status (for example those in the manual classes) do in fact abstain from smoking and the choice of taking up or not quitting smoking is unlikely to be at random. It has been argued that smoking behaviour starts in adolescence, where it can be considered a marker of those experiencing less academic success and not aspiring to further education (Koivusilta, Rimpela, Rimpela, & Vikat, 2001). Secondly, smoking is known to increase with experienced stress, from working conditions, for example (Johansson, Johnson, & Hall, 1991). Adult life also presents socio-economic differences relating to stress (see also the section on stress below). Individuals with lower socio-economic status experience more stressful events and have worse coping strategies (Bosma, van de Mheen, & Mackenbach, 1999; Kristenson, Eriksen, Sluiter, Starke, & Ursin, 2004; Stronks, van de Mheen, Looman, & Mackenbach, 1998). In that it is so tied to the social structure, smoking can not be seen exclusively as an individual choice. If we look at women of low education and compare those who smoke to those who do not, the smokers are likely to be more disadvantaged. The significance of this, is that when controlling for smoking we probably control for more than just the toxic effect of smoking, and might even see reductions in health differences for outcomes where smoking is not even on the causal pathway.

Health behaviours are sometimes equated with factors such as BMI. This will here be regarded as a health indicator and discussed under (8). For reasons of simplicity, other issues of weight and nutrition are placed there as well.

**Direct references to maternal health indicators (8)**

In the illustrative model, arrow (8) represents all the ways maternal health or body can have an influence on infant health, in other words all influence that can be considered to be mediated by the maternal body. It has been claimed that “To some extent, poor pregnancy outcomes are a manifestation of chronic disease processes that are already underway in young women” (Rich-Edwards & Grizzard, 2005, p 532). Here I will present the association between some maternal health indicators and birth outcomes. In a later section the health transfer between mother and infant will be attended to.

In a comparatively rich country such as Sweden with high living standards, restricted caloric intake is seldom due to financial restraints. Maternal nutritional status might nevertheless be interesting. For example, women with a lower BMI at the beginning of pregnancy have increased risks of giv-
ing birth to SGA (Clausson, Cnattingius, & Axelsson, 1998) and preterm infants (Ancel, Saurel-Cubizolles, Carlo Di Renzo et al., 1999). This could be due to either constitutional differences or caloric intake. The increasing rate of anorexia nervosa is not likely to influence socio-economic inequalities in birth outcome at a population level – firstly, because reproductive functions are repressed early on in the disease (Wolfe, 2005), and risks for adverse birth outcome to women with a history of anorexia nervosa have not been greatly elevated (Ekeus, Lindberg, Lindblad, & Hjern, 2006); secondly, because anorexia nervosa is presently more common among women from higher socio-economic status families (Nevonen & Norring, 2004).

Higher BMI is considered a risk factor with regard to birth outcomes, for example preterm and especially very preterm births (Ancel, Saurel-Cubizolles, Carlo Di Renzo et al., 1999). Obesity is linked to pregnancy disorders and an increased risk for several birth outcomes (King, 2006; Yu, Teoh, & Robinson, 2006), and hypertension and pre-eclampsia are especially associated with higher rates of very preterm SGA (Clausson, Cnattingius, & Axelsson, 1998). Higher BMI is more common in women with lower socio-economic status (Ball, Mishra, & Crawford, 2002; Rahkonen, Lundberg, Lahelma, & Huuhka, 1998), and could be a mediating factor in socio-economic inequalities in birth outcome.

Of more recent interest is the possible impact of micronutrients on optimal birth outcome, whereby intake may vary between socio-economic groups, but evidence is still weak concerning the extent to which micronutrients might have an impact on birth outcome (Kramer, Goulet, Lydon, Seguin, McNamara, Dassa et al., 2001). It might also be relevant to stress here that maternal and foetal nutrition are not one and the same. Because the foetus receives nutrition from the placenta, foetal nutrition may be problematic even though maternal nutrition is adequate (Harding, 2001).

**Socio-economic factors after birth (9)**

All ways in which parental socio-economic status may influence infant health *not mediated* by the maternal body are considered under this heading. Theoretical possibilities of mediators exemplified here are sleeping position and breastfeeding. An infant sleeping on its stomach has an increased risk of death classified as Sudden Infant Death Syndrome, and if the propensity to make sure infants do not sleep in this position is higher in higher socio-economic groups this could mediate inequalities. To the extent that breastfeeding is viewed as a possible choice for all mothers, this is another theoretical mechanism. If breastfeeding in Sweden today improves infant health, and is carried out to a higher extent in higher socio-economic groups which is suggested (Flacking, Hedberg Nyqvist, & Ewald, 2007), this would mediate inequalities. However, this can not be considered to be entirely not inde-
dependent of maternal health in the respect that the infant feeds direct from the maternal body.

Arrows (8) and (9) will be included in all studies in this thesis, since together they represent the two possible pathways through which infant health can be influenced by maternal socio-economic status.

Access to care

Access to care has been included to illustrate how something may be both interesting for the influence of maternal health and applicable to socio-economic environment after birth.

According to the theory of different access to health services or the “inverse care law” (Hart, 1971), individuals with a lower socio-economic status have less access due to more restricted financial resources, or experience of less respectful treatment, or a systematic discrepancy in judgment of symptoms. The health care system in Sweden is constructed so as to be equally accessible by all. The patient’s fee is low and more advanced medical care is virtually free of charge. In spite of this, however, there seems to be socio-economic differences in use of medical care.

In a review of several Swedish studies, it was found that people with lower socio-economic status in comparison to those with higher status made fewer primary care visits (“öppenvårdsbesök”) in relation to their health status. Less research seems focused on hospital visits, but there are indications that individuals with higher income were more likely to receive hospital care (Burström & Force, 2001).

Therefore, there might be differences in socio-economic status in received care. However, it seems unlikely that there are any major inequalities in maternal care during pregnancy, which is used by nearly 100% of pregnant women (National Board of Health and Welfare, 2005), and should cover the entire socio-economic scale. Neonatal care in Sweden is internationally outstanding, and early infant care is clearly initiated at the hospital. There may be socio-economic differences in how the health care system is approached after the hospital stay, but seemingly, no study of maternal or infant care was found.

Stress – an important link?

This paragraph will describe an interesting branch of research that seems involved in most of the boxes in the illustrative model. It is presented here not only because maternal stress seems relevant to birth outcome, but it also seems especially important for the link between maternal and infant health.

Pathways from stress to adverse outcomes have been conceptualised as a disturbed balance in the body. The body was made to handle stress, but primarily acute stress, in situations that must be dealt with immediately
(Sapolsky, 1998). When the body has a constant stress alert turned on, less energy is invested in the immune system and repairing processes in the body. This has been described as stress response turning into an allostatic load, which is detrimental to several dimensions of health, such as cardiovascular health and the immune system, increasing one’s general vulnerability to all health problems (McEwen & Norton Lasley, 2004).

The relation between stress and socio-economic status seems twofold. Firstly, it has been shown that stressors are much more prevalent in the lives of families with a lower socio-economic status, for example those experiencing hardship or economic difficulties. Secondly, response to stressors is affected by how the mind interprets the stressor, and it has been claimed that psychological coping abilities with stressors are better in higher socio-economic status families (Kristenson, Eriksen, Sluiter et al., 2004; Stronks, van de Mheen, Looman et al., 1998). One study showed that part of the association between childhood class and adult health was explained by variation in coping strategies (Bosma, van de Mheen, & Mackenbach, 1999). However, to this it should be added that besides the psychological dimension, material and possibly other resources are likely to be more available in these families, which also ought to have a very practical impact on available strategies for dealing with stressful situations.

Reviews seem to agree that the link between stress and preterm birth is well established (Gennaro & Hennessey, 2003; Hobel & Culhane, 2003; Hogue, Hoffman, & Hatch, 2001), but there seems to be less support for the association with foetal growth (Hobel & Culhane, 2003). However, if stress shortens length of gestation, it will indirectly decrease birthweight and increase mortality risk. Long-term stress has been specifically proposed as a pathway for socio-economic inequalities in birth outcome (Kramer, Goulet, Lydon et al., 2001; Morello-Frosch & Shenassa, 2006; Rich-Edwards & Grizzard, 2005).

In addition to the direct effect it seems to have, stress is linked to adverse health behaviours such as smoking as mentioned earlier. The importance of this mechanism may vary with the general level of inequality in a society (see “Ecological factors”).

**Transfer of health between generations**

The reproduction of socio-economic status inequalities likely involves an intricate pattern of biological and social pathways. In the illustrative model, maternal childhood is viewed from a life-course perspective. An alternative perspective is to think of the mother’s childhood as having been influenced by her parents, her infant’s grandparents. Socio-economic inequalities in birth outcome are of further interest and importance because infant health constitutes a *point of health transfer* between generations. In the creation of
a new individual, a starting point of health potential (or capital) is received by this individual, and this is not independent of parental socio-economic status. In this discussion, the concept of epigenetic inheritance is useful. The phenomenon of epigenetic inheritance has long been acknowledged in cancer research, for example, but it was only quite recently that strands of research from several disciplines were brought together, realising they were working around a new central concept (Pray, 2004). Epigenetic inheritance comprises, for example, the on or off switch of genes, through the inheritance of the amount of molecular groups on the histon; a broader definition includes the setting of hormonal systems, the HPA axis being the most researched (Jablonka, 2004). The term “epi” means “beyond” or “besides, implying that besides the genetic code, influence of parental environment with its limitations or abundances can be inherited by the next generation.

That the environment may influence across generations is a possible way to interpret changes in population health that have occurred much faster than a change of the genetic code – the adaptation process of which takes much more than just a few generations to evolve. For example, populations in developed countries such as Sweden have become taller over the past century. This can not be a genetic change, but is believed to have been brought about by an improvement in living standards. Following this, it may very well be the case that children in families with better living standards – generally approximated by higher socio-economic status – have had the possibility to fulfil their genetic potential to a greater degree than other children have. Short adult height, then, has been claimed to be a reflection of growth during the childhood period, for example (Peck & Lundberg, 1995). A later study was able to link the birthweight of infants to their mothers’ height in childhood (as a marker of social and nutritional exposure) independent of maternal childhood socio-economic status or adult height (Martin, Smith, Frankel et al., 2004). Thus, when a study showing that shorter mothers with a manual background in comparison to those with a non-manual background have higher proportions of disadvantaged birth outcome, this could be due to their having reached a smaller proportion of their genetic potential (Krieger, Chen, & Selby, 2001).

I would suggest that this transfer between generations, the process of which could be argued to end with the cutting of the umbilical cord, should be conceptually separated from what is often referred to as reproduction of health. The concept of reproduction could rather be reserved to signify processes by which human agents become socialised into behaviours and predispositions (1).

This section concludes the outline of an explanatory framework, and is followed by a presentation of the specific aims and the studies of this thesis.
As previously stated, the general aim of this thesis is to contribute to the understanding of the association between mother’s socio-economic status and the health-related birth outcome of their infants. This is accomplished through a focus on maternal education and class, studying a range of birth outcomes. Below is a brief presentation of Studies I-IV, summarizing the specific aims, data materials, results and interpretations of these. The studies in their entirety are found after the introductory chapters.

Specific aims

- To explore the association between maternal education and infant health in Sweden (Study I)
- To investigate the combined influence of maternal childhood and adult social class on infant health (Study II)
- To investigate how maternal childhood and adult social class influence birth outcome closer compared to further from the birth of the infant (Study II)
- To explore the extent to which maternal working conditions might contribute to social class inequalities in birth outcome (Studies III & IV)

Data

MEGA Database, Studies I-III

This database was constructed specifically to enable the simultaneous investigation of maternal childhood and adult class in relation to infant health. Registers used for the database are the Swedish Censuses (1960, 1970, 1980, 1985), the Education Register (1990) and the Medical Birth Register (1973-90). In order to collect maternal childhood class, women’s birth years had to
be 1946-60, resulting in registration of parental class in the 1960 census. The population is thereby defined as all births 1973-90 to women born 1946-60 partaking in all the censuses 1960, 1970 and 1980. All infant deaths to this population were used as numerators. Of the women in the population, 10% were randomly selected as denominators (and multiplied by 10). The random collection of 10% of women was dictated by Statistics Sweden, in order to protect the integrity of individuals. Our data were all anonymous, without personal identification numbers.

The MEGA Database was compared to all single births in Sweden for the period 1973-90 from the Social Mobility Database (see next section). The MEGA material was found to have slightly lower very and low birthweight rates, but the same neonatal mortality rate. Maternal ages were slightly lower in MEGA than in the reference database, and the proportion of births at the beginning and end of the period was smaller. Due to the inclusion criteria of 1960, no immigrants arriving after this year are included in the MEGA database. This might contribute to the differences, although results from previous research suggest that this contribution may be small (Koupilova, Vågerö, Leon et al., 1998; Rasmussen, Oldenburg, Ericson, & Gunnarskog, 1995).

![Figure 2. Distribution of births over maternal age groups at three time periods, for the MEGA and the Social Mobility Databases](image-url)
Social Mobility Database, Study IV

This database is a combination of selected variables from many registers. In this thesis, information from the Swedish 1980 and 1990 censuses were used, along with data from the Medical Birth Register (1980-2002) and the 2002 Educational Register. These registers were used in their entirety, whereby no selection was introduced.

Completeness and quality of registers

The Medical Birth Registry in Sweden started in 1973, and the number of registered parameters has since been expanded. Several evaluations have been made, which suggests that the general quality of the data is high (Cnattingius, Ericson, Gunnarskog, & Källén, 1990; Källén & Källén, 2002). The later, more thorough, evaluation has also acknowledged the fact that not all variables are registered with the same precision. In this thesis no analyses have been made with variables considered to be doubtful.

The Educational Register (Svensk utbildningsnomenklatur) is also of high quality, updated yearly and with missing data below 2% (for 16-65-year-olds) (Statistics Sweden, 1993), but misclassifications of about 15% (Statistics Sweden, 2006). For women, however, only about 1% is missing, and data on people aged below 45 years, which is the group studied in this thesis, is more reliable than for older groups (ibid).

The Swedish censuses are considered to be of very high quality, with high accuracy and completeness.

Results and interpretations

Study I: Maternal education

Specific aims: To explore the association between maternal education and infant health. To explore changes in the relation over time. To explore the possible presence of the low birthweight paradox.

Results: We found that infants of women with less than three years of secondary school in comparison with those born to women with the highest (university or college) education had significantly higher risk of low birthweight, and neonatal as well as postneonatal mortality. The excess risk for the group with lowest in comparison with the highest education was 30% for infant mortality and 67% for low birthweight when all years were taken together. Over time, differences between infants of women with the lowest (up to compulsory) and highest education increased for all outcomes. This devel-
Development brings about the so-called low birthweight paradox (see “Discussion” for an explanation).

Interpretation: With the decreasing proportion of women only achieving low education, the group becomes increasingly composed of generally disadvantaged women; this is likely what is reflected in the increasing differences in birth outcome. The low birthweight paradox suggests that the distribution of determinants for low birthweight infants differs for women with low and high education.

Study II: Maternal childhood and adult social class

Specific aims: To investigate the combined influence of childhood and adult social class on infant health. To explore whether the influence of childhood class is independent of adult class. To compare the influence of class on birth outcome closer to and further from time of birth.

Results: Maternal childhood class was associated with both low birthweight and infant mortality. A manual background, in comparison to a non-manual background, implied between a 12% and 17% higher risk of low birthweight, neonatal or postneonatal mortality. The increased risk of manual class was higher for adult class, up to around 60% for some classes. Manual workers in the manufacturing sector had the highest risks, irrespective of level of qualification. When adult class was included as well, an independent effect of childhood class remained for low birthweight and neonatal, but not postneonatal, mortality. A manual childhood class increased the risk for these adverse outcomes by about 10%. The odds ratios were higher for outcomes closer to birth. The influence of maternal adult class was stronger than that of maternal childhood class.

Interpretation: Because the influence of childhood class is independent of adult class for the outcomes closest to birth, we interpret this as support for a biological pathway via maternal health. That is, something in the maternal childhood has an influence on maternal biology, which in turn affects infant health. Theoretically, maternal biology might be influenced in childhood or later. There could be something in the mother’s childhood circumstances that have a lingering effect on her reproductive system, or her childhood might predispose her to behaviour and attitudes that remain in adulthood, for example a propensity to smoke or not quit smoking during pregnancy.
Study III: Maternal working conditions and infant mortality

Specific aims: To explore the relation between working conditions and infant mortality. To estimate the extent to which working conditions might contribute to social class inequalities in infant mortality.

Results: Lower job control and higher physical demands were associated with a higher risk for infant mortality. Results for job hazards were ambiguous. No association was found between psychological demands or social support and infant mortality. Three of four classes of manual workers, as well as self-employed, had a significantly (or borderline significant) higher risk for infant mortality than did the reference group, higher non-manual workers. This was reduced by 28-58% when job control, physical demands and job hazards were simultaneously controlled for, rendering all class differences statistically insignificant. Job control had the strongest association with infant mortality, and was the largest single explanatory dimension of working conditions.

Interpretation: Social class inequalities in infant mortality are influenced by maternal working conditions. There is good reason to further explore working conditions as contributors to socio-economic inequalities in birth outcome.

Study IV: Maternal working conditions and birth outcome

Specific aims: To explore the relation between psychological and physical working conditions and a large number of birth outcomes. To estimate the extent to which these factors might contribute to class inequalities in low and very low birthweight, small-for-gestational-age, as well as very and extremely preterm births.

Results: The lowest level of job control was associated with a higher risk for eight of nine adverse birth outcomes, and for five of these there was a risk gradient over levels of job control. Higher levels of physical demands and job hazards were associated with higher risks for adverse growth and gestational outcomes. There was only one significant association between physical demands and (neonatal) mortality. For most adverse birth outcomes, all manuals and lower non-manuals had significantly higher risks than did the reference category, middle non-manuals. Higher non-manuals had lower odds for all outcomes (significant for two), and self-employed had higher odds ratios for all outcomes (significant for three). The three dimensions of working conditions contributed to different degrees to the different birth outcomes. Job control explained a considerable proportion of all adverse birth outcomes, and for low birthweight, SGA, all preterm and very preterm
birth this was still significant when the other dimensions were in the same model. In spite of its contribution, job control was not significant in any model for very low birthweight or extremely preterm birth. Job hazards contributed mostly to very low birthweight and extremely preterm birth; it was also significant when the other working conditions were in the same model. Physical demands explained a considerable proportion of low birthweight as well as all preterm and extremely preterm births, but were only significant in relation to the first two outcomes.

*Interpretation:* The dimensions of working conditions showed disparate associations with the birth outcomes, indicating a high complexity in the relations. An important issue is the timing of present legislation. According to our results, measures need to be taken earlier on in pregnancy to avoid adverse influence of working conditions, which result in socio-economic inequalities in birth outcome.
In the studies of this thesis, I have described and analysed the relation between two maternal socio-economic indicators, education and social class, and a range of birth outcome. All studies find socio-economic inequalities in all studied birth outcomes, contradicting some earlier statements on infant health in Sweden (Black, 1980; Köhler, 1991). The general approach of this thesis has been exploratory, because while the basic association between socio-economic indicators and some birth outcomes today is well described in the Nordic countries, as shown above, empirical attempts to explain this in any depth have been more rare. One of the reasons for this could be that an explicit explanatory framework has been missing.

The framework presented here may serve as a beginning of a discussion, and the most important aspect in this is probably the importance of maternal health (potential or capital). The proposed framework represents a sociological interpretation of the field of socio-economic inequalities in birth outcome. This framework has developed during the work on this thesis, and it is from here that the studies constituting the thesis have emerged: Firstly, the exploration of the low birthweight paradox and the way to study and interpret the influence of maternal socio-economic status in childhood; Secondly, the extension of infant health outcomes from a focus on infant mortality and birthweight to the investigation of a larger range of birth outcomes.

Although the general approach in the work on this thesis has been exploratory, I have tried to specify certain aspects of the association between maternal socio-economic status and birth outcome. In the exploration of the low birthweight paradox in Study I, with regard to larger maternal educational inequalities, I will argue that this knowledge is important for the interpretation of differences in birth outcome. In Study II a maternal life-course perspective is introduced, whereby adult class is found to be of greater importance for infant health. For the outcomes closer to birth, however, there is an independent influence of childhood, implying that this association might be primarily mediated through the maternal body. As an attempt to initiate the exploration of mechanisms between adult socio-economic status and birth outcomes, working conditions were investigated in relation to social class in Studies III and IV. There are indications in Study IV that some aspects of work may be detrimental to infant health, and that this is important earlier in pregnancy than what is presently stated in health policy and legislation in Sweden.
Socio-economic status, individuals and households

An important issue in social research is how we choose socio-economic indicators and what we believe they entail, not only in relation to whether social class should be household or individual-based, as discussed above. Strong arguments have been made against using explanatory power as a main principle for choosing socio-economic indicator, for example because this would mean that the measure is a composite one (Erikson, 2006). A more pragmatic way could be to explicitly consider what we believe the measure already “contains”, or is associated with, a question that arises in the study of childhood class (Study II). Inequality seemed stronger for post-neonatal than neonatal mortality when only adult class was used. When both childhood and adult class were in the model, inequality seemed higher for neonatal mortality. Thus, any indicator that is associated to a higher degree with childhood class might result in higher inequality for neonatal than post-neonatal mortality. In other words, it matters what indicator of socio-economic status we use. It has even been claimed that standard indicators of socio-economic status do not have the same meaning in all social groups (Braveman, Cubbin, Egerter, Chideya, Marchi, Metzler et al., 2005), and this discussion is not likely to end there.

In order to maintain a focus in this thesis, it has been limited to maternal socio-economic indicators. However, there is no reason to believe that socio-economic influence on birth outcome is limited to maternal indicators. It has been shown, for example, that maternal and paternal education are independently associated with infant mortality (Arntzen, Samuelsen, Bakketeig, & Stoltenberg, 2004). Including maternal partner opens up many new aspects to study. Married individuals and cohabitants generally have better health outcomes than do single adults, and there are indications that this is the case for infant health as well (Arntzen, Moum, Magnus et al., 1996b; Leon, Vågerö, & Olausson, 1992). As mentioned previously, material living standards is probably better in a household with two incomes. It has also been claimed that class-mixed and homogenous couples are dissimilar with regard to behaviour, for example (Leiulfsrud & Woodward, 1987); women’s health behaviour has in fact been shown to be influenced by the social class of her partner (Bartley, Martikainen, Shipley, & Marmot, 2004). Not all aspects of having a partner are positive, unfortunately. Difficult issues exist concerning parenting with regard to violence by fathers, regarding both children and their mothers (Eriksson, 2004). It is suggested that marital violence increases the risk of preterm birth (Moutquin, 2003) and low birthweight (Bullock & McFarlane, 1989), and since this is suggested to be more common in lower socio-economic groups (Gazmararian, Adams, Saltzman, Johnson, Bruce, Marks et al., 1995), this could possibly be a contributor to inequalities in birth outcome. Another area of potential interest is secular changes in paternal care of infants: if paternal status was more important 50
years ago, perhaps for material reasons, is it now more important for reasons connected to fathers’ increased care for and participation in the lives of their children?

Confounders and mediators

The relative importance of specific mediators is likely to vary with the chosen indicator of socio-economic status and the specific birth outcome. Maternal smoking, for example, shows a steeper gradient across educational categories than social classes (Nordström & Cnattingius, 1996), and its detrimental effect on foetal growth seems larger than that on gestational age (Kramer, Goulet, Lydon et al., 2001). Therefore, it will probably explain more of the educational gradient in foetal growth than of the class gradient in preterm birth.

Maternal height is sometimes adjusted for in analyses of birth outcomes. Taller mothers, for example, have a smaller proportion of SGA (Clausson, Cnattingius, & Axelsson, 1998). However, achieved maternal height can be viewed as a composite measure of the outcome of social circumstances, achieved growth in foetal life, infancy, childhood and adolescence. While this measures health status or health potential, it is also associated with social class. If maternal height is adjusted for in an analysis between SES and birth outcome, it may be viewed as a pathway rather than a confounder (Morton, 2004).

The explanatory factors from the Nordic studies referred to above are quite similar to those suggested already 60 years ago by British researchers, who concluded that no main explanatory factors had been identified (Morris & Heady, 1955). Future research could empirically try to estimate the relative importance of material living conditions and working conditions, for example. This should perhaps start with a discussion of what is actually implied by “living conditions”, a somewhat all-inclusive concept sometimes drifting towards a measure focused almost exclusively on material living conditions (see for example how "shared conditions" on page 502 becomes "standard of living" on page 508 in Erikson, 1984a).

Perhaps women’s working conditions as a determinant of birth outcomes have been underestimated in relation to material living conditions. Earlier, the relation between maternal working conditions and infant health have been thought to be generally limited to risks of mutagen and teratogenic effects during pregnancy (Arbetsmiljökommissionen, 1989). When the link between maternal and infant health has been discussed previously, access to general health care for women has been mentioned (Wise, 2003). However, general health is not only a function of high-quality health care. If general working conditions in a country affect women’s health, and this is important for birth outcome as has been suggested (Morris & Heady, 1955; Rich-
Edwards & Grizzard, 2005), this may influence the level of adverse birth outcomes in a country. Especially so since, for example, our results indicate that this is important early in pregnancy, when policies to protect infant health are not applicable. In 1980 in Sweden, a law was passed under the Work Environment Act granting women with heavy physical work demands and specified kinds of chemical exposure a leave of absence from week 30 of pregnancy (National Social Insurance Board, 1988). In Study IV extremely preterm births (born before 28 weeks) were significantly associated with both maternal class and working conditions, implying that work-related policies on pregnancy need to be improved.

Future research may be directed towards working conditions on an aggregated level. Results from the Second European Survey indicate that physical working conditions are harsher in southern Europe than in the Nordic countries, for example, which is likely to be due to the areas’ disparate positions in the industrialisation process (Eklund, Englund, & Wikman, 2001), and these countries’ generally have higher infant mortality, for example (see Table 2). Recent studies have shown that the physical environment for women in Sweden has actually deteriorated since 1981 with respect to ergonomic load (Hemström, Krantz, & Roos, 2006), and between 1996 and 1999 in respect to sickness benefits for work-related health problems (Vikenmark & Andersson, 2002). It would also be of interest to study how this might influence birth outcome.

The relevance of the low birthweight paradox

Measuring inequality in birth outcome over time can be problematic when the level of adverse outcome decreases substantially, which was the case for infant mortality during the 20th century. This is because if we use logistic regression and obtain odds ratios, relative differences can become very large when absolute levels are quite small. Presenting absolute differences has thus been recommended as a solution (Lundberg, 2003), and provides good illustration and may be accomplished, for example, by showing figures for one parity and a specific maternal age group. However, drawing comparisons with odds ratios can produce interesting results as well; an example of this is the low birthweight paradox.

In Study I education inequalities in infant mortality increased over the study period, especially when comparing infants of the most educated women to those of the least educated women. With the decreasing proportion of women who only achieve a low education, the group becomes increasingly composed of generally disadvantaged women; this is likely what is reflected in the increasing inequalities in birth outcome. A similar explanation was offered for the educational difference in mortality in adult men and women during the period 1986-2003 (Statistics Sweden, 2004). When
separating births into birthweight categories, however, it can be observed that for infants with low birthweight the mortality risk is lower for those born to women with a low education. This phenomenon is referred to as the low birthweight paradox. When this was first found in relation to smoking (low-birthweight infants born to smoking women had lower mortality) it was promoted as an advantage for smokers (see Wilcox, 2001). Increasing knowledge about the issue revealed that this was because smoking decreased the birthweight of the infants, and although mortality increased as well, it did not increase to the same level of an infant who weighed less due to causes other than smoking. Therefore, the cause of the paradox is likely that causes of low birthweight are differentially related to mortality risk, and that the relative importance of these determinants varies across populations.

Without this knowledge we could wrongly assume that it is an advantage for infants born to women with lower socio-economic status to have low birthweight. Or, when only low birthweight infants are studied, it might be concluded that there are no socio-economic inequalities — or that they are reversed if the paradox appears. An extension of this research, attempting to clarify what we find when comparing infants born to women with different socio-economic status, could be to go beyond birthweight. As stated earlier, birthweight is an imprecise endpoint. Preliminary analysis of the Social Mobility Database implies that there is a gestational age paradox (data not shown), and there might also be a “foetal growth paradox”.

The dynamic character of health inequalities

Research has shown that both inequalities and their causes vary over time and between countries, which can be illustrated with infant mortality, for example (Newland, 1981). This is a dynamic association, so that to the same extent that the significance of social class in a society changes, so can the health consequences be expected to change (Leon & Walt, 1998). The dynamic character of the association is also evidence that health inequalities can be reduced (Graham, 2001).

That the ability to maximise a pregnancy outcome may go back at least one generation to when the mother herself was a foetus (Misra, Astone, & Lynch, 2005) opens up a whole range of possible research perspectives. There are indications in Study II that something in maternal childhood is associated with her birth outcome in adult life. For low birthweight and neonatal mortality this was independent of adult social class, which implies that the pathway is via maternal health. This would imply that childhood class is manifested in the mother’s body, influencing the health of her infant. An interesting question regarding maternal working conditions remains: to what extent is the influence of maternal working conditions on infant health po-
tential mediated through the maternal health potential/body (8) and to what extent does it influence birth outcome directly (9)?

With the development of the epigenetic concept, we can discuss biological heritage that is not genetically driven. For example, it was mentioned above how population height has increased with population health, much faster than genetic codes change with evolution. When this happens, there is reason to believe that more advantageous groups in the population increase their health before more disadvantageous groups do. For example, the low level of infant mortality enjoyed by infants born to women with higher education in the early 1970’s was enjoyed by infants born to women with lower education in the late 1980’s (data not shown). Thus, the health of the more advantaged can be seen as goals that everyone has the possibility to reach.

This has been claimed to be a fundamental social cause of inequalities in health, whereby resources are always greater for those with higher socio-economic status, allowing them to improve their health first (Link & Phelan, 1996). However, while they seem to improve their health first, the theory is probably a simplification as it does not distinguish between resources and how this may influence socio-economic inequalities in specific health outcomes. The question of confounders or mediators is relevant here as well: In relation to developmental origins of disease, social class differences are sometimes presented as problematic because they are a confounder in this process (Terry & Susser, 2001). In the framework of this thesis, developmental origins of disease are rather viewed as a possible mediator, a pathway in the processes of inequality.

Children born to those who were malnourished or starved only 100 years ago in Sweden probably did not achieve their full health potential during their time in utero or early childhood. Today, an effect of this may still be lingering in the infant health of their children. The extent to which this affects the socio-economic health gradient in birth outcome is obviously extremely difficult to analyse.

The co-evolution of health development and social development has an impact across generations. A birth outcome can be seen as a point of health transfer between generations. The new individual has not yet been socialised into the complex social world we live in. Still, socio-economic differences that have an influence on one generation of women are manifested as a biological starting point for their children. In Sweden and other countries with very low infant mortality and smaller socio-economic inequality, infant mortality is probably not the most interesting outcome to pursue. The other birth outcomes, such as gestational age and foetal growth, are of more interest here. This is because while mortality is the most adverse outcome, the survivors will grow up and be affected by social circumstances in their adult lives. Thus, the birth outcome of the survivors is perhaps of even more interest, in the complex web of health and social factors.
Socio-economic inequalities in birth outcome have been in focus in this thesis. Some conclusions can be drawn from this research:

- Birth outcome is of special interest because it constitutes a point of health transfer between maternal and infant health, and is heavily influenced by maternal social context.

- We have shown that there were educational differences in birth outcome in Sweden in the late 20th century, and that in comparisons of infants of the most educated women to those of the least educated women, inequalities seem to increase.

- The low birthweight paradox is of significance in the interpretation of inequalities. Also, it suggests that the distribution of causes of low birthweight have varying associations with infant mortality, and that the proportion of these causes vary across educational groups.

- To our knowledge, the simultaneous exploration of the influence of maternal childhood and adult social class has not been performed before. Results indicate that a mother’s childhood social class affects her biology, so that her infant’s health is also influenced.

- Working conditions have previously been used to explain social class differences in adult health, but not in infant health. That maternal working conditions seem to influence social class inequalities in birth outcome makes this a possible area for policy change and reduction of inequality.

- An important policy implication is that adjustment of working conditions is important much earlier in the pregnancy than what is presently considered appropriate.

- The co-development of health and social careers has an impact across generations. Socio-economic differences that have influence on one generation of women are manifested as a biological starting point for their children.
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