Socio-economic inequalities in childhood mortality in low and middle income countries

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Socio-Economic Inequalities in Childhood Mortality in Low and Middle Income Countries

Sociaal-economische ongelijkheid in kindersterfte in lage- en middeninkomenslanden

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For my mother, father and brother

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Thesis in brief

Worldwide more than 10 million children die each year before their fifth birthday (Black *et al.* 2003). Not only are these deaths concentrated in low and middle income countries; children of the poor and less educated within these countries too exhibit systematically higher mortality levels. Policy makers are learning that improving average population health is not enough. Monitoring and tackling inequalities in health between socio-economic groups within countries has become an increasingly important objective. Whereas research on socio-economic health inequalities is a well-established tradition in high income countries, it is only recently that such inequalities are being studied more systematically in relation to low and middle income countries as well. This has raised new issues regarding measurement and methodology, but also provides opportunities for contributing to existing debates. The first aim of this thesis is to contribute to the evaluation of measures to describe socio-economic mortality inequalities in low and middle income countries. Accurate and valid measurement of socio-economic mortality inequalities is a prerequisite for establishing the magnitude of the problem, for monitoring, and for unravelling its determinants. The second aim of this thesis is to contribute to the description and explanation of time and place variations in the magnitude of socio-economic inequalities in under-5 mortality. Not much is known about how socio-economic inequalities in under-5 mortality vary across countries or over time, and what the determinants of these variations are. Understanding why inequalities are larger in some populations than in others is a first step towards evidence based public health interventions. The availability of Demographic and Health Survey data for multiple time periods for a large set of low and middle income countries, the heterogeneity across these countries and the rapid changes that some countries are experiencing, provide a unique opportunity to contribute to the issues raised above.

1

General introduction

1.1 SOCIO-ECONOMIC INEQUALITIES IN CHILDHOOD MORTALITY IN LOW AND MIDDLE INCOME COUNTRIES

Childhood mortality levels have fallen substantially in most low and middle income countries during the second half of the last century (Ahmad *et al.* 2000; Cleland *et al.* 1992; Delaunay *et al.* 2001; Hill *et al.* 1998; Hill *et al.* 1989). Yet, childhood mortality levels remain very high in many countries and contrasts with high income countries are sharp (UNICEF 2004). Also within the developing world, countries vary in terms of their position in the epidemiological transition (Omran 1971). In Mali, 238 children per 1,000 life births die before their fifth birthday, while this is 105 in Kenya, 71 in Indonesia and around 33 in Vietnam (ORC Macro 2005). Recently, the rate of decline in childhood mortality has slowed down in almost all WHO regions (Ahmad *et al.* 2000). In some countries, childhood survival has even deteriorated (Agha 2000; Ahmad *et al.* 2000; Claeson *et al.* 2000; Rutstein 2000; UNICEF 2004; WHO 2003). Reducing childhood mortality levels in low and middle income countries is an important aim of national and international policy makers. Childhood mortality has lately received renewed research and policy attention. The Millennium Development Goals call for a two-third reduction in under-5 mortality between 1990 and 2015 (MDG Goal 4) (www.developmentgoals.org). Recent initiatives (including the Bellagio/Lancet Child Survival series (2003), two-yearly rolling reviews of progress in child survival (Bryce *et al.* 2005), the Lancet's neonatal survival series and maternal health series (2005; 2006), and the World Health Report 2005 (WHO 2005) which featured maternal and child health) aim to track progress towards achieving this goal, as well as to understand the determinants of the problem and barriers to success.

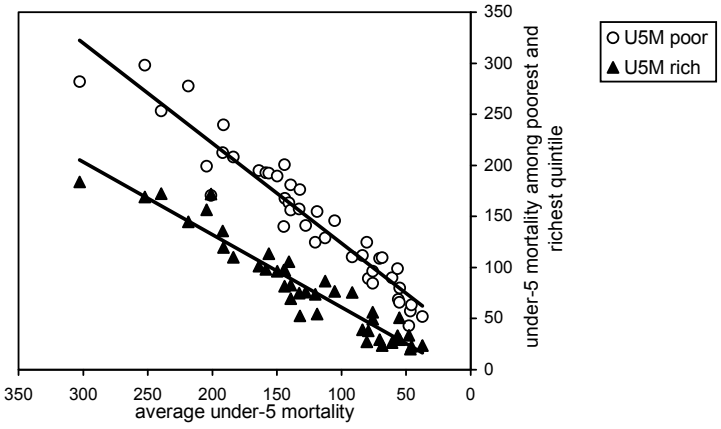
Inequalities within and between countries

Within low and middle income countries, poorer and less educated groups exhibit systematically higher childhood mortality levels than better-off citizens (Cleland *et al.* 1992; Cleland *et al.* 1988; Gwatkin *et al.* 2000). These socio-economic mortality inequalities are often substantial. For example, the number of under-5 deaths per 1,000 live births in the poorest quintile in Mali is 248 whereas it is 148 among the richest quintile (Gwatkin *et*

al. Forthcoming-a). In Viet Nam the figures are 53 for the poorest and 16 for the richest (Gwatkin *et al.* Forthcoming-b). In Indonesia, under-5 mortality is 90 per 1,000 among children of mothers with no education and 28 per 1,000 among children of mothers with completed secondary education or higher (Badan Pusat Statistik-Statistics Indonesia (BPS) *et al.* 2003). Inequalities in under-5 mortality between regions within countries are often also considerable. In rural areas in Indonesia, for example, under-5 mortality is 65 per 1,000 whereas in urban areas it is 42 (Badan Pusat Statistik-Statistics Indonesia (BPS) *et al.* 2003). So indeed, country averages disguise as much as they reveal (Gwatkin 2000).

Figure 1.1 illustrates the huge inequalities in under-5 mortality between and within low and middle income countries. For each country, the under-5 mortality rate among the poorest (white circles) and the richest (black triangles) population group is plotted against the average under-5 mortality level of that country. The graph shows that between-country inequalities in under-5 mortality are huge and that it is better to be relatively poor in a low mortality country than to be relatively rich in a high mortality country. At the same time, for each country, the poor exhibit systematically and substantially higher under-5 mortality rates than the rich. Whereas the causes of between country mortality inequalities have been rather extensively studied (*cf.* Anand *et al.* 1993; Caldwell 1986; Frey *et al.* 1999; Gupta *et al.* 2002; Halstead *et al.* 1985; Preston 1975; Pritchett *et al.* 1996; Shen *et al.* 1997), much less is known about socio-economic mortality inequalities within low and middle income countries.

Figure 1.1 Under-5 mortality among the poorest and richest population quintile, by average under-5 mortality, for 43 low and middle income countries, using Demographic and Health Survey data



Note: Wealth groups were defined on basis of the asset index (see Chapter 5).

Reducing socio-economic health inequalities within countries by improving health and survival chances among the socio-economically more disadvantaged, has become a main aim of national governments and international organizations (AbouZahr 2003; Braveman *et al.* 2003a; Evans *et al.* 2001; Irwin *et al.* 2006; Jong-wook 2005; Sen 2002; Victora *et al.* 2003; World Bank 1997). Social justice is the main argument used for aiming to reduce these inequalities (Alleyne *et al.* 2000; Anand *et al.* 2004; Braveman *et al.* 2003b; Levy *et al.* 2006; Sen 1999; Wagstaff 2001). Others have underpinned the importance of health equity through the argument that, with increasing global inter-connectedness and constraints on "common-pool global resources", health has become a global public good (Chen *et al.* 1999). Also efficiency arguments could perhaps be used to justify a focus on socio-economic mortality inequalities. As mortality levels are generally much higher among lower socio-economic groups, enormous gains in population health could be made if these within-country inequalities were reduced. This might be especially so in a context where the medical and technological knowledge is by and large available to reduce childhood mortality. Finally, instrumental arguments have been used to focus on research on and reduction of health inequalities. From this perspective, health is seen a capital input into economic development and health inequalities are seen as a cost to economic growth (Commission on Macroeconomics and Health 2001).

Previous research and current challenges

There is a long-standing tradition of research on socio-economic health inequalities in contemporary high income countries (*cf.* Chadwick 1842; Department of Health and Social Security 1980; Engels 1987 [1845]; Mackenbach *et al.* 1997b; M'Gonigle *et al.* 1936; Stevenson 1923). Early research in this field (Chadwick 1842; Engels 1987 [1845]) was often done by physicians engaged in social movements such as the Sanitary Movement, the Hygienistes, or Hygienisten (Mackenbach 1994). Their research focussed on the influence of living conditions on health. Attention for socio-economic health inequalities has ebbed and flowed since the 19th century (Mackenbach 1994). At the start of the 21st century, there is overwhelming evidence from high income countries that there are systematic and substantial health inequalities between social groups. These inequalities run across the entire social hierarchy (Department of Health and Social Security 1980; Marmot 2006; Marmot *et al.* 1991). This research field tends to focus on mortality and other health outcomes in adults and sometimes in old age (*e.g.* Huisman *et al.* 2005a), perhaps because childhood mortality levels are relatively low in these countries. Comparative research has sought to establish time (*e.g.* Mackenbach *et al.* 2003; Marang-van de Mheen *et al.* 1998; Martikainen *et al.* 2001) and place (*e.g.* Huisman *et al.* 2005b; Kunst *et al.* 1998b; Mackenbach *et al.* 2000)

variations in these inequalities. Explanatory research includes studies on specific causes of death (*e.g.* Avendano *et al.* 2005; Huisman *et al.* 2005a) and specific proximate mortality determinants such as smoking (*e.g.* Huisman *et al.* 2005b). There is, however, little systematic research on country level determinants of health inequality. There are some exceptions. These studies assess the effects of welfare state regimes in general or income inequality in particular (Davey-Smith *et al.* 2002; Kunst *et al.* 1998b; Mackenbach *et al.* in preparation; Van Doorslaer *et al.* 2004; Van Doorslaer *et al.* 1997).

In contrast, the field of research on socio-economic health inequalities in low and middle income countries is relatively new. The studies in this field tend to focus on childhood mortality, as this remains an important public health problem in these countries. Moreover, the availability of data on adult mortality continues to be constrained. A landmark paper by Caldwell (1979) describing the association between maternal education and childhood mortality in Nigeria greatly stimulated further research into this area. For the next decade and a half, research on social determinants of childhood mortality in low and middle income countries focussed on maternal education. These studies were part of a broader discussion on what the main determinant of improvements in population health in low and middle income countries is: social change (including female education), economic growth, or medical technologies (Caldwell 1986; Caldwell 1990; Caldwell 1993; Caldwell *et al.* 1983; Pendleton *et al.* 1985). These studies showed a strong association between maternal education and childhood mortality across countries. Also within countries, strong associations between maternal education and childhood mortality were found, using data from, among others, the World Fertility Surveys and its successor the Demographic and Health Surveys (Bicego *et al.* 1993; Cleland *et al.* 1988; Desai *et al.* 1998; Farah *et al.* 1982; Hobcraft 1993; Hobcraft *et al.* 1984; Joshi 1994; McDonald 1980). These studies have produced abundant evidence on the importance of maternal education as a determinant of childhood mortality. Reviews of the evidence suggested a linear relationship between maternal education and childhood mortality (Cleland *et al.* 1988) and the absence of a threshold effect (even a little maternal education makes a difference) (Hobcraft 1993). These studies also reported larger effects of maternal education in the post-neonatal period compared to the neonatal period (Bicego *et al.* 1993; Cleland *et al.* 1988). It was estimated that about half of the effect of maternal education can be accounted for by household economic status (Bicego *et al.* 1993; Cleland *et al.* 1988). There was debate, with contradictory evidence, on whether the effects of maternal education are larger in areas with or without easily accessible health care facilities (Bicego *et al.* 1993; Rozenzweig *et al.* 1982). Attention was given, in the above mentioned and other (*cf.* Ware 1984) studies, to the pathways through which maternal

education influences childhood mortality, with a particular focus on health related behaviours. Whereas most studies focussed on maternal education, some also paid attention to rural/urban residence, and husbands' education or occupation (*e.g.* Hobcraft *et al.* 1984).

In recent years, empirical research on social determinants of childhood mortality in low and middle income countries has been brought into the framework of and debate on socio-economic inequalities in health (Gwatkin 2000). Levels of childhood mortality are now explicitly compared between more and less socio-economically disadvantaged groups (*cf.* Gwatkin *et al.* 2000; Hoa *et al.* 1997; Macassa *et al.* 2003; Wagstaff 2000b), often from the perspective that mortality inequalities between these groups are socially unjust (*cf.* Alleyne *et al.* 2000; Wagstaff 2001). Established determinants of childhood mortality, such as health care use, are being examined with regards to their contribution to these mortality inequalities. Concurrently, there has been a shift in attention from maternal education to household economic status as a determinant of childhood mortality (*cf.* Wagstaff 2000b). New methods have been developed to measure household economic status, as income or expenditure data are often not available (Filmer *et al.* 2001; Gwatkin *et al.* 2000). The greater data availability, through the Demographic and Health Surveys (DHS) (see section 2.4) in particular, but also through Demographic Surveillance Sites (INDEPTH Network 2005), and the Living Standards Measurement Study (www.worldbank.org/lsms/), has greatly stimulated research in this field.

In at least two areas, the existing knowledge base of this relatively new research field needs particular strengthening. The first is the area of measurement of socio-economic mortality inequalities. Valid and reliable measurement of inequalities in childhood mortality is a prerequisite for descriptive and explanatory research and evidence-based policy making. The measurement of socio-economic characteristics and the summary measure of inequality are recurrent topics of debate, both in research on health inequalities in high income countries, as well as in the younger field of research on such inequalities in low and middle income countries. Secondly, comparative research on mortality inequalities in low and middle income countries remains scarce. Not much is known about how such inequalities vary across countries or over time, and what the determinants of these variations are. The scarcity of time-trend studies on health inequalities has been particularly noted (Braveman *et al.* 2002; Sastry 2004a). Similarly, little is known about how country characteristics, including public policies, contribute to time and place variations in the magnitude of mortality inequalities.

The increasing number of countries and time periods for which datasets with individual level information on both mortality and socio-economic characteristics have become available, provides a unique opportunity to contribute to research on the above issues. Especially the Demographic and Health Surveys program, which provides rich health-related data based on comparable surveys for many countries and several time periods, is particularly valuable. The heterogeneity of the countries included in this survey program, in terms of their epidemiological, economic, political, historical, social and cultural context is huge, much larger then in any set of contemporary high income countries. Comparative research using this dataset could provide a valuable contribution to the field of research on health inequalities, not only in low and middle income countries, but perhaps also in high income countries.

1.2 MEASUREMENT ISSUES

Valid and reliable measurement of socio-economic mortality inequalities is the basis for descriptive and explanatory research on which evidence-based policy making depends. It is precisely this measurement around which some of the most intense debates are staged. Long-existing and often-used measures are still being heavily debated, and new measures have been developed. The debates include two aspects of measurement, i.e. the socio-economic indicators and the summary measure to describe the magnitude of inequality. The availability of a large dataset for a wide range of low and middle income countries, allows for the empirical evaluation of existing and newly developed measures to describe socio-economic mortality inequalities.

First, the debate on the summary measure of inequality centres primarily around the discussion on whether absolute or relative inequalities should be the main focus of attention. This discussion is important, as the two measures often lead to very different outcomes, in, among others, the ranking of countries, observed time-trends, and the relative importance of risk factors (Boström *et al.* 2003; Clarke *et al.* 2002; Mackenbach *et al.* 1997a; Scanlan 2000). Moreover, a new kind of inequality measure has recently been developed, not measuring mortality inequalities between socio-economic groups but variations between individuals without a predefined social base for comparison. This measure uses a different interpretation of the term 'mortality inequality' that contrasts with conventional use. To what extent this measure captures socio-economic inequalities in mortality remained unknown at the time the research underlying this thesis was initiated. New insight into the

above issues can be gained through their empirical assessment using data for a broad set of low and middle income countries.

A second major issue is the measurement of socio-economic characteristics. This is a recurrent issue in research on high income countries (Rose *et al.* 2001), and maybe even more so in the relatively new field of research on health inequalities in low and middle income countries. The measurement of household economic status deserves particular attention. Since the mid-1990s, research and policy attention has shifted from maternal education to household economic status, as mentioned above. Yet, one of the major difficulties in low and middle income countries is the measurement of household economic status. Recently, new wealth measures have been developed (Bollen *et al.* 2002; Filmer *et al.* 2001; Gwatkin *et al.* 2000). Particularly those based on household ownership of assets provide potential for research on and monitoring of poor-rich mortality inequalities as they can be easily applied in large health surveys. The measure of household wealth developed by Filmer and Pritchett (2001) is being particularly widely used (Gwatkin *et al.* 2000). Yet, this measure has never been fully evaluated. Again, the Demographic and Health Surveys dataset provides a good opportunity to do so.

1.3 PLACE AND TIME VARIATIONS IN MORTALITY INEQUALITIES – THE VALUE OF COMPARATIVE RESEARCH

Not much is known about how the magnitude of inequality in childhood mortality changes over time or varies between countries and what the determinants of these varying levels of inequality are. Systematic and detailed description of such time and place variations is a first step towards explanation.

Two areas of study are of particular importance for a better understanding of socio-economic inequalities in childhood mortality in low and middle income countries. The first one concerns the question of how mortality inequalities develop along the epidemiological transition (Omran 1971). Many low and middle income countries have been experiencing substantial mortality declines since the mid 20th century, and, at least in the long-run, further declines may be expected. There are some indications that relative socio-economic mortality inequalities tend to increase in periods of overall gains in survival (Mackenbach *et al.* 2003; Marang-van de Mheen *et al.* 1998; Martikainen *et al.* 2001). Empirical evidence, particularly from low and middle income countries, remains, however, scarce. Similarly, it

remains unknown what happens with mortality inequalities when overall mortality levels increase, as is observed in several African countries. It is unknown to what extent this important public health problem is concentrated in particular socio-economic or regional groups. Comparative research on low and middle income countries can contribute to answering these questions.

The second area concerns the question of how country characteristics, such as public spending on health, state strength or level of economic development, influence the magnitude of mortality inequalities. Households are not autonomous units, and the effects of socio-economic conditions at the household level on childhood mortality are probably influenced by factors at higher levels of aggregation, including the country level. For evidence based policy making it is important to get a better understanding of the effects on mortality inequalities of variables like public spending on health and level of economic development. Such country characteristics can vary both across countries and over time. Therefore, both cross-national and time-trend analysis can contribute to a better understanding of the influence of these variables. The economic and demographic trajectories of countries have, in the last quarter century, dramatically diverged. Large parts of Asia have experienced tremendous economic growth and strong fertility and mortality declines. This is in stark contrast to the experience of Sub-Saharan Africa. Despite variation among countries in economic performance and population health, many countries in this part of the world have experienced stagnating or declining per capita income levels during the 1980s and 1990s (World Bank accessed 22-10-2006). Some African countries have seen substantial deteriorations in population health. It is important to get a better understanding of how such changes influence mortality inequalities.

2

This Thesis

2.1 AIMS

The research underlying this PhD thesis aims to contribute to the measurement and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through comparative research. Specifically, it hopes to contribute to evaluation of existing measures to describe socio-economic mortality inequalities, particularly such inequalities in low and middle income countries. It also aims to describe and contribute to the explanation of time and place variations in magnitude of these inequalities. More implicitly, it seeks to contribute to the development and evaluation of methodologies for explanatory comparative research on socio-economic health inequalities.

Regional inequalities in under-5 mortality will feature alongside socio-economic mortality inequalities in my study. The central focus in this thesis is, however, on the latter.

The specific aims of this thesis are:

1. to contribute to the development of valid, robust and meaningful ways of measuring socio-economic mortality inequalities;

2. to contribute to the description and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through cross-national analyses;

3. to contribute to the description and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through time-trend analyses.

In particular, the time-trend analyses will assess how socio-economic inequalities in under-5 mortality change (a) in a period of economic growth and strong mortality decline, and (b) in a context of economic stagnation and rising mortality levels.

2.2 APPROACH: INEQUALITIES BETWEEN SOCIAL GROUPS, NOT BETWEEN INDIVIDUALS

The starting point of the approach of my study is the prior categorisation of a population into social groups (for example into low and high educated) with the objective to assess mortality differentials between these groups. I thus step into a well-established tradition in this field (Chadwick 1842; Department of Health and Social Security 1980; Engels 1987 [1845]; Mackenbach *et al.* 1997b; M'Gonigle *et al.* 1936; Stevenson 1923).

An alternative is to measure the total variance in mortality between individuals in a population without any preconceptions about the dimensions along which mortality is unequally distributed (Gakidou *et al.* 2002; Gakidou *et al.* 2000). This is similar to what economists do when they use, for example, the gini index to measure income inequality (Le Grand 1987). This approach has been used in a few studies (Gakidou *et al.* 2002; Gakidou *et al.* 2000; Le Grand 1987) and received broader attention when it was applied in the World Health Report 2000 (WHO 2000).

Only a relatively small part of the total variation in health outcomes in a population is explained by socio-economic characteristics such as education or wealth. As Marmot (2001) explains: "An economist put it to me that the social gradient in health […] explained only a small part of total inequalities in health. The first problem was linguistic. As an economist he used the term inequality to apply to the total variance in health in the population. His conclusion was that the social group to which an individual belonged made a small contribution to the total individual variation in health. He is, of course, correct. But that conclusion applies to most explanations of individual differences in health. From the first Whitehall study of British Civil Servants, we calculated that only 7% of the individual level variance in lung cancer mortality could be explained by age, smoking and employment level […]. Another way of saying that smoking accounts for little of the individual differences in the occurrence of lung cancer, is to observe that most smokers do not die of lung cancer. Yet, the group differences are dramatic: 95% of lung cancer deaths in this cohort occurred in smokers." Similarly, social group differences in health outcomes can be dramatically large.

Reasons to follow the social group approach include both a social justice argument and its direct relevance for policy making (see also section 1.1), for example through targeting of interventions to disadvantaged groups. The total variance approach circumvents

the problem of comparability of social classifications over time and between countries (Le Grand 1987; Murray *et al.* 1999). Indeed, the lack of a standard way of classifying people into social groups, both between countries and over time, can hamper comparative research. However, the total variance approach leaves us in the dark about which categories of people are losing and which ones are gaining from social change. I agree with Braveman (2000) that, given the importance of social factors for population health outcomes, this is a reason to invest in research on social group classifications. Chapter 5 of this thesis aims to do so by evaluating an often used measure of household economic status.

In summary, the two types of approaches answer different questions (Le Grand 1987). Nonetheless, some might be inclined to interpret the total variance measure in terms of socio-economic mortality inequalities. The extent to which both approaches lead to empirically similar results, was unknown. This issue became more important when the total variance approach received broader attention through its application in the World Health Report 2000 (WHO 2000). For that reason I studied empirically the extent to which total mortality variance can be interpreted as reflecting socio-economic mortality inequalities (Chapter 3).

2.3 CONCEPTUAL FRAMEWORK

Understanding mortality inequalities

The conceptual framework used in this thesis is represented in Figure 2.1 (page 28). It shows the relationship between social and regional stratification on the one hand and inequality in under-5 mortality on the other hand, and the role of country level determinants in this relationship. The core structure is drawn from the framework described by Mosley and Chen (1984). Building on a model by Davis and Blake (1956), they combined socio-economic determinants of under-5 mortality on the one hand and biological determinants on the other hand, into an, at that time novel, framework. They argued that socio-economic determinants, such as maternal education, can only exert an effect on under-5 mortality through more proximate, or direct, determinants of mortality. This insight has become generally accepted. Socio-economic inequalities such as those in education or economic status are determinants of inequalities in under-5 mortality through their effect on more proximate mortality determinants. Below, each part of the framework will be discussed in more detail.

Social and regional stratification

Social stratification is the structuring of society into a set of (often hierarchically ranked) layers or social groups (Barnard *et al.* 1996, p.22). In most, or all, societies, people are hierarchically structured into social groups according to characteristics that are valued in that society (*cf.* Berkman *et al.* 2000a).

The hierarchical layering of society in high income countries is generally assumed to follow the lines of social class, socio-economic status or socio-economic position. These are theoretical concepts for which occupation, income and education are generally used as key indicators. As measures of position in the social hierarchy, they capture the real attributes of the group (i.e. in terms of resources of its members, such as income or educational attainment), as well as the social prestige or status ascribed to these groups, by the groups themselves (*e.g.* low or high self-esteem), and by others in society (*e.g.* being *viewed* as poor or uneducated, for instance leading to discrimination). In research on socio-economic health inequalities in high income countries, socio-economic status, socio-economic position and social class are the key concepts used, though there are differences in meaning and operationalisation between research traditions in the US, the UK, and continental Europe (Bartley 2004; Berkman *et al.* 2000b).

The above mentioned concepts have initially been developed for the study of social stratification in industrializing 19th and early 20th century Europe (Weber 1947). More recent developments in theory and operationalisation have been made (*e.g.* Goldthorpe 2000), again for research on high income countries. To what extent concepts like socio-economic status can be transferred, while retaining their meaning, to contemporary low and middle income countries –which themselves vary greatly in terms of social, economic, cultural and political context– remains an unanswered question. The specific characteristics associated with social prestige or status, differ between societies, and may range from gender, age, caste, ethnicity, marital status, the number and the sex of children, to religiosity, and skin colour (Barnard *et al.* 1996; Jansen 1996). Anthropological studies have shown that "inequalities of rank and status are also commonly found independently of the ownership of property" (Barnard *et al.* 1996). In the context of research on the heterogeneous set of low and middle income countries, it might, therefore, be more useful to see social stratification as a multidimensional concept, of which the specific dimensions and their relative importance can vary between countries and over time. Consequently, in this thesis, the concepts of socio-economic status, social position or social class will generally not be

used. Rather, I study two of the potentially many dimensions of social stratification, i.e. household economic status and maternal education as such, without the pretence that they are indicators of social stratification as a whole.

Household economic status is a theoretical construct, i.e. not directly observable, in contrast to educational attainment, and therefore deserves elaboration here. Household economic status or wealth can be defined as a household's command over or access to scarce material resources. Income and consumption are two often used indicators in high income countries. Household ownership of assets is often used as indicator in low and middle income countries, as data on income and consumption are often not available or not reliable (Montgomery *et al.* 2000). Asset ownership is increasingly often being used to study health inequalities in high income countries as well (*cf.* Avendano *et al.* submitted).

The use of household ownership of assets as an indicator of economic status is theoretically underpinned by Friedman's permanent income hypothesis (1957). According to Friedman, household income can be divided into transitory and permanent income. "The permanent component is to be interpreted as reflecting the effect of those factors that the unit regards as determining its capital value or wealth: the nonhuman wealth it owns; the personal attributes of the earners in the unit, such as their training, ability, personality; the attributes of the economic activity of the earners, such as the occupation followed, the location of the economic activity, and so on." (Friedman 1957 p.21 in Bollen *et al.* 2001). As, according to Friedman, consumption behaviour is determined by permanent income, household ownership of assets would be a valid indicator of such long-run economic status. In low and middle income countries, the assets that households have acquired are considered a good indicator of their 'long-run' economic status (Bollen *et al.* 2002; Filmer *et al.* 2001).

Many societies are not only characterised by social stratification, but also by regional stratification, i.e. the unequal distribution of scarce resources across geographical areas. Whereas social stratification ranks individuals or households into (hierarchically ranked) social layers, regional stratification captures stratification at the area level, including the community and provincial level. An important dimension of regional stratification in most societies is the distinction between rural and urban areas. Usually, scarce resources such as health care and education services are concentrated in urban areas. This has been related to an urban bias in development (Lipton 1977). Similarly, particular regions or provinces may be more dominant than others, economically, politically, and/or culturally. Social and regional stratification are often interrelated, with poorer and lower educated people often

living in more deprived areas. Similar to social stratification, regional stratification can result in mortality inequalities. Whereas social stratification along the dimensions of maternal education and household economic status are the central focus of attention in the research that underlies this thesis, regional stratification, in particular rural/urban residence, is given auxiliary attention. Social and regional stratification are determinants of mortality inequality through their effect on more proximate mortality determinants.

Proximate determinants

In low income countries, the major diagnostic groups of causes of under-5 mortality are neonatal disorders (an estimated 33% of under-5 deaths), diarrhoea (22%), pneumonia (21%), malaria (9%), AIDS (3%), and measles (1%) (Black *et al.* 2003). The cause of death pattern varies greatly between countries (Black *et al.* 2003). Social stratification can only influence inequalities in under-5 mortality through proximate mortality determinants. Below I will discuss some of the important proximate determinants of the above mentioned causes of death.

An important proximate determinant of under-5 mortality is malnutrition. It is estimated that malnutrition is an underlying cause in over half of all under-5 deaths (Black *et al.* 2003), and is known to interact with infections (Millard 1994). Exposure to disease pathogens comprises a broad group of other proximate mortality determinants. This includes, but is not limited to, exposure to vector-born diseases such as malaria, exposure to viruses such as HIV (through mother-to-child transmission), and pathogens that cause communicable diseases such as diarrhoea, and air pollutants, which increase the risk of pneumonia.

Malnutrition and exposure to disease pathogens, in their turn, are related to, among others, quality of water and sanitation facilities, housing conditions, breastfeeding and weaning practices, hygiene behaviour such as hand washing with soap (Curtis *et al.* 2003; Curtis *et al.* 2000) and other practices related to child care (Millard 1994; Mosley *et al.* 1984; Wagstaff *et al.* 2004). These can be factors at the individual (*e.g.* breastfeeding (Simondon *et al.* 2001)), the household (*e.g.* indoor air pollution) as well as at the neighbourhood or community level (*e.g.* quality of water and sanitation facilities in the community). Exposure to disease pathogens is, in social determinants of health research, usually measured through these latter types of variables rather than measuring direct exposure to pathogens at the level of the individual child.

Also specific characteristics of the mother, such as her age at childbirth, her nutritional status before and during pregnancy, as well as fertility characteristics such as parity and child spacing, are proximate determinants of under-5 mortality (Mosley *et al.* 1984; Wagstaff *et al.* 2004).

Finally, the use of preventive and curative health care can directly influence under-5 mortality risks. Important examples of such health care use include professional antenatal and delivery care, childhood vaccinations, and treatment of illnesses such as diarrhoea and respiratory infections (Mosley *et al.* 1984; Wagstaff *et al.* 2004).

Inequalities in under-5 mortality

Inequality in under-5 mortality between socio-economic groups (and between regions) is the dependent variable in this framework. The magnitude of this inequality is influenced by relationships A to H as discussed below.

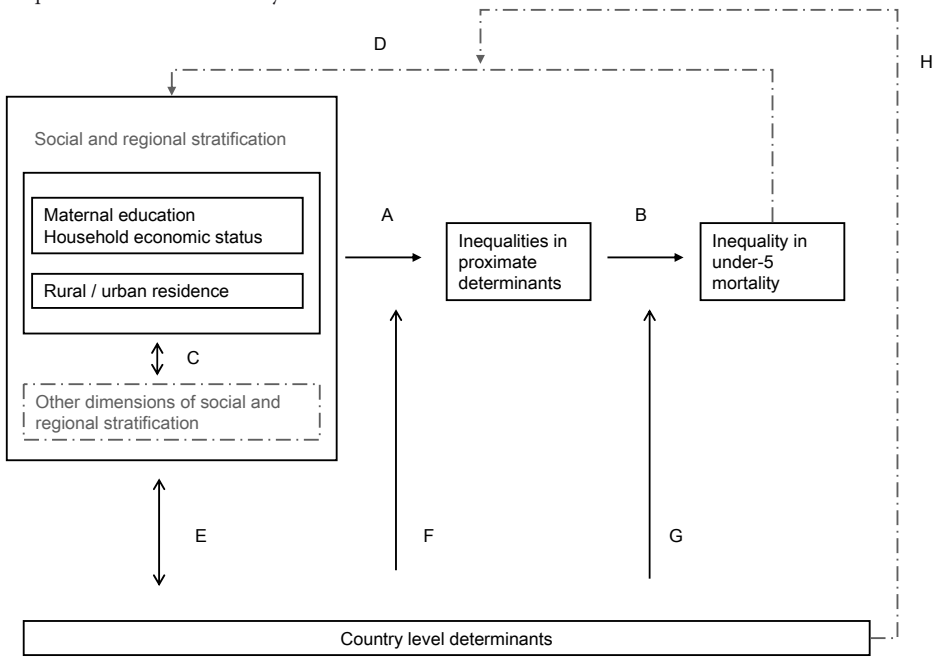
Relationship A The magnitude of socio-economic inequalities in proximate mortality determinants depends on (1) the magnitude of social inequalities along the dimension studied (for example income inequality), and (2) the strength of the association between this dimension of stratification and proximate mortality determinants (*cf.* Wagstaff 2000a). As (1) and (2) are not necessarily the same for different dimensions of social stratification, also the magnitude of inequality in proximate determinants and under-5 mortality is not necessarily the same for different dimensions of stratification (*cf.* Dalstra *et al.* 2002).

Relationship B The extent to which an unequal distribution of proximate determinants impacts on inequalities in under-5 mortality depends on (1) how unequally the proximate determinants are distributed, and (2) how strongly these proximate determinants influence under-5 mortality risks. The effect of proximate determinants on under-5 mortality is likely to vary between socio-economic groups. Proximate determinants may be expected to have a stronger impact on mortality levels among more disadvantaged children, as they tend to be more vulnerable due to previous illness episodes and higher levels of malnutrition.

Relationship C The strength of the association between a dimension of social stratification (*e.g.* household economic status) and proximate determinants is influenced by the extent to which, in this example, household wealth is associated with other dimensions of stratification that have an independent impact on proximate determinants. The key dimensions of

social stratification in my research, may be related to other dimensions not included, such as caste or ethnicity.

Figure 2.1 Conceptual framework, showing the relationship between social and regional stratification and inequalities in under-5 mortality



Relationship D Poor-rich inequalities in under-5 mortality can be due to the effects of poverty on ill-health, but also to the effects of ill-health on economic status (i.e. reverse causation). Out of pocket expenditures on health care can force poorer households to sell assets (Pryer 1989), can exacerbate poverty (Corbett 1989; Van Doorslaer *et al.* 2006), and can even be catastrophic, i.e. households having to cut basic expenditures over a period of time to cover the health care costs (Xu *et al.* 2003). Whereas illness can have important effects on household economic status, these effects tend to be particularly observed among the already poor, and therefore can not (fully) explain observed poor-rich inequalities in mortality. Obviously, only modifiable factors such as household resources can be affected by such reverse causation, whereas maternal education obviously can not be reduced once a certain level has been attained.

Country level determinants

Country level determinants are defined, for the purpose of this thesis, as those variables observed at the country level that may impact on the variables in the core of the conceptual framework and their relationships as described above. They include variables at the country level that influence the form and extent of social and regional stratification and/or the influence that this stratification has on inequalities in mortality, and/or the effects that such mortality inequalities have on social stratification (relationships E, F, G and H above). In other words, the relationships between social or regional stratification and inequalities in under-5 mortality are dependent on country context. Examples of country level determinants are income per capita, public spending on health, and policies on income redistribution.

Relationship E Country level variables can influence the form and extent of social and regional stratification. Government policies, for example on taxation, education and social security, can influence the magnitude of social stratification and the extent of upward or downward social mobility. Conversely, the form that social stratification takes (*e.g.* the magnitude of income inequalities, or extent of ethnic fragmentation) may also influence public policies (Bluedorn 2001; Deaton 2001; Easterly *et al.* 1997).

Relationship F Country level variables can also work as effect modifier on the relationship between social stratification and proximate determinants. The accessibility and affordability of health care services, for example, is under the direct influence of governments, through, for example, public spending on health. User fees, for instance, can deter health care use (Palmer *et al.* 2004). Another example is public provision of water and sanitation affecting the extent to which household economic status is a determinant of access to clean water. Whereas in most high income countries, access to clean water and a toilet is nearly universal, in many low and middle income countries, this is highly dependent on socioeconomic characteristics of households and communities.

Relationship G Country characteristics can also influence the effect that inequalities in proximate determinants have on inequalities in under-5 mortality. The extent to which, for example, health care use influences child mortality, is dependent on the quality of the health care obtained (Boerma 1996). Quality of care, again, can be influenced by government policies.

Relationship H The extent to which ill-health can have impoverishing effects is also under the influence of public policies. The proportion of households making catastrophic expenditures for health care varies strongly between countries, depending on the reliance of the health care system on out of pocket expenditures (Xu *et al.* 2003).

It is clear from the above framework that what happens at the individual and household level should be seen in a multi-level and multi-dimensional context (Millard 1994). A sole focus on individual or household attributes such as maternal education and maternal behaviour, not only precludes a fuller understanding of the determinants of socio-economic mortality inequalities. It may also lead to victim blaming (for example blaming 'ignorant mothers' for the death of their children (Kanji *et al.* 1991; Krieger 2001; Millard 1994; Nations *et al.* 1988; Scheper-Hughes 1984).

It should also be noted that countries are not autonomous units. Country level factors are often strongly influenced by the global context. One can imagine that international aid and debt service flows, or structural adjustment programs, can have an impact on inequalities in under-5 mortality. Similarly, the economic boom and subsequent crisis in many Asian countries was related to factors at the global level. I would argue, however, that these variables at the international level will usually exert their influence through variables at the national level. The interlinkage between global and national level determinants and their consequent impact on mortality inequalities is beyond the scope of this thesis.

Understanding time and place variations in mortality inequalities

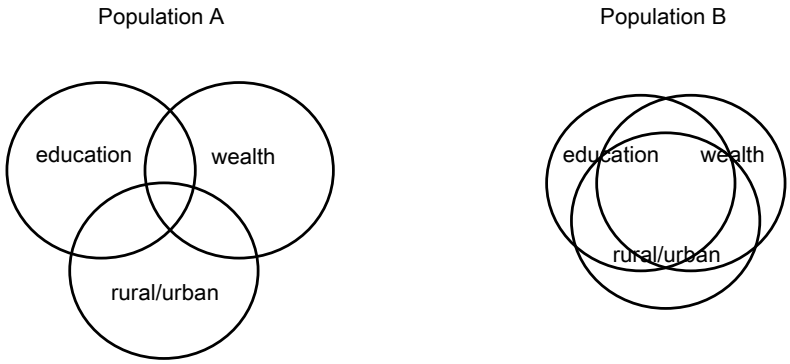
The causes of variation in the magnitude of mortality inequality between populations can be analysed at multiple points in the causal pathway, from proximate determinants, to stratification, to country level (and global level) determinants. Instead of going through the framework again step by step, I will focus on two issues, i.e. social stratification and the time-dependency of the relationships described in Figure 2.1.

Time and place variations in social and regional stratification

Differences in the extent and form of stratification may contribute to explaining variations in the magnitude of under-5 mortality inequality between countries and over time. First, the magnitude of stratification along the dimension under study is important. If, for example, mortality inequalities by household wealth are larger in one population than

in another, this might be partly due to differing levels of wealth inequality. Secondly, the extent to which, in this example, wealth is associated with other dimensions of social and regional stratification, such as education, rural/urban residence, or caste, which impact on under-5 mortality independently of wealth, could contribute to explaining the variations in the magnitude of mortality inequality. Figure 2.2 shows a Venn diagram (Kemeny *et al.* 1966 [1956]) for two hypothetical populations, A and B. The circles present variables, here three dimensions of stratification (i.e. wealth, education and rural/urban residence). The overlap of the circles indicates the extent of shared variance. Clearly, the shared variance is much smaller in population A than in population B. If all three dimensions of stratification have an effect on under-5 mortality independent of each other, I would expect, *ceteris paribus*, inequalities in under-5 mortality by household wealth to be smaller in population A than population B. In population B, the effects of wealth are to a larger extent compounded by the effects of a low educational attainment and of rural residence than in population A. In population A, household wealth varies to a large extent independently of educational attainment and rural/urban residence.

Figure 2.2 Venn diagram for two hypothetical populations, A and B, with each of the circles representing a dimension of stratification



Changes in the form and extent of stratification may also contribute to explaining time-trends in mortality inequality. Processes of inter and intra generational mobility, changes in income distribution, or processes like gender emancipation may all change the form and extent of social stratification in a society. If having no education becomes increasingly an exception, those with no education will probably become increasingly 'negatively selected' in terms of other dimensions of stratification. Processes of positive and negative selection are examined in the time-trend studies in this thesis.

Time-dependency

The relationships represented in Figure 2.1 are time-dependent. I will distinguish between three time axes, or processes of change. The first is epidemiological time, or the place of a country in the epidemiological transition (Omran 1971). The epidemiological transition is a gradual, long-term process of change, from a situation of high mortality, predominantly caused by infectious diseases, to a situation of low mortality, predominantly caused by non-communicable diseases. The extent to which inequalities in proximate determinants influence inequalities in under-5 mortality (Relationship B in Figure 2.1) may depend on the place of a country in the epidemiological transition. For example, socio-economic inequalities in hygienic behaviour will, most likely, have a stronger impact on inequalities in under-5 mortality in high mortality countries than in low mortality countries. Similarly, country characteristics, such as government interventions to promote hand washing with soap, will probably have a higher impact in high mortality countries (Relationship G). Such time-dependency is particularly important to take into account when interpreting data across countries that strongly vary in terms of mortality levels. At the same chronological time, countries can be in different positions with respect to epidemiological time.

The second "time axis" is the process of diffusion of innovations (Rogers 2003 [1962]). This refers to the systematic process of change in the level of specific interventions or innovations across a population. Generally, the scarcer or the newer an intervention or innovation, the more likely that it only reaches advantaged groups (in other words, influencing Relationship A in Figure 2.1).

Finally, many of the relationships in Figure 2.1 are dependent on chronological time, a third time axis. The time dependency of the relationship between national income and life expectancy has been demonstrated (Preston 1975). Similarly, one may expect the accumulation of knowledge on social determinants of health or the development of medical technologies like vaccines, to influence, for instance, the capacity of public spending on health to reduce mortality inequalities. The capacity of states to influence the relationship between stratification and health inequality will increase with the accumulation of such knowledge and evidence over time. Similarly, significant events along the chronological time axis, such as the declaration of Alma Ata and the primary health care movement, or the economic recession and structural adjustment programs of the 1980s, may work as effect modifier of the relationships shown in Figure 2.1. Evidence on associations or the ef-

fect of interventions described in historical studies of contemporary high income countries can therefore not necessarily be generalized to contemporary high mortality countries.

2.4 DATA

The Demographic and Health Surveys (DHS) are the main data source in the research underlying this thesis (www.measuredhs.com). DHS is a large survey program, set up in the mid-1980s with the aim of monitoring and evaluating population, health, and nutrition programs in low and middle income countries. These surveys are currently the best data source available for comparative studies on socio-economic inequalities in under-5 mortality in low and middle income countries. Vital registration systems are notoriously inadequate in most low and middle income countries, with almost no country with under-5 mortality rates over 25/1,000 having a virtually complete vital registration system (Lumbiganon *et al.* 1990; Morris *et al.* 2003; Ndong *et al.* 1994). Moreover, births in poorer households and by less educated mothers are less likely to get registered (UNICEF 2005). Therefore, household surveys are an important source of information on under-5 mortality.

The DHS are, mostly, nationally representative surveys among, usually ever-married, women aged 15-49 years (Macro International Inc. 1996). Nevertheless, particularly marginalized groups such as homeless people, refugees, or mobile people are probably excluded from the surveys, which might lead to a somewhat underestimated magnitude of socio-economic mortality inequalities. In most countries, between 5,000 and 30,000 women aged 15 to 49 years were interviewed. Response rates are very high, on average 95% among eligible women across all surveys held up to date, with the lowest response rate being 87% (own calculations using STATcompiler on (www.measuredhs.com). Since the start of the program, nearly 200 surveys have been carried out in over 70 low and middle income countries. For many countries, data for two or more periods are available. The DHS project is funded by the U.S. Agency for International Development.

The surveys include retrospective birth histories, with survival information on all individual children ever born to the respondents. Date of birth is reported in month and year. Age at death is generally reported in months for deaths at age two years or younger, and in years for deaths above that age. This information on births and deaths is reported retrospectively by the mother, and is therefore subject to reporting error. Reliability of reported birth histories should ideally be assessed using a gold standard, such as a complete vital registration

system, which generally is not available. One of the few studies in which birth history data reported in a DHS survey are compared with a complete longitudinal follow-up study of births and deaths showed that the under-5 mortality levels and trends were accurately estimated in the DHS survey (Garenne *et al.* 1994). The reliability of reported mortality data can also be evaluated through assessment of frequencies of missing data and observed mortality patterns. The average percent of incomplete birth dates in DHS is low, but varies strongly between countries (Macro International Inc. 1994). There is little evidence of serious underreporting of deaths, though there is substantial heaping of deaths at 12 months in many surveys (Macro International Inc. 1994). For these reasons, under-5 mortality data are generally more reliable than neonatal or infant mortality data. Unfortunately, I was not able to find information on the extent to which the reliability of birth history data was differential according to socio-economic characteristics of the mothers. I would expect the problem of missing data and age heaping to be more serious among lower educated and poorer mothers. Reliable cause-of-death information is not available in the DHS.

The fact that mothers are the providers of information on survival of their children implies that such information is not available for children whose mother has died. Childhood mortality in low and middle income countries tends to be higher among those children (Zaba *et al.* 2005). It has been estimated that child mortality will be slightly underestimated in countries with high mortality levels among mothers, for example in countries with a high prevalence of HIV (Mahy 2003). It has been advised that for these countries, childhood mortality should not be calculated for time periods earlier than five years prior to the survey (Mahy 2003).

DHS provides information on proximate determinants of under-5 mortality, including information on water and sanitation facilities, housing characteristics, health care use, and childhood malnutrition. Health care use and nutrition related variables are not available for children that have died.

The surveys also include information on indicators of social and regional stratification, including household ownership of assets, maternal education and rural/urban residence.

DHS uses standardized core questionnaires, which generally allow for comparisons across countries and between time-periods. Data on some indicators are generally more reliable and comparable across populations than on others (Boerma *et al.* 1991; Macro International Inc. 1994). Data on key variables used in this thesis, especially maternal education and

under-5 mortality, are relatively reliable and internationally comparable relative to some other variables, such as childhood morbidity. Recent morbidity, such as diarrhoea, tends to be underreported, especially by lower educated mothers (Boerma *et al.* 1991; Tsui *et al.* 1988). In each of the chapters of this thesis, I assess whether the findings can be explained by data problems.

For some of the studies reported in this thesis, I obtained individual and household level data from the DHS website (www.measuredhs.com). For other analyses, I used aggregated DSH data provided by the World Bank in their "Country Reports on Socio-economic Differences in Health Nutrition and Population" (Gwatkin *et al.* 2000). These reports give, for each country, health-related outcomes, including under-5 mortality and health care use, stratified for five, equally large, wealth groups. These reports have become an important source of information on poor-rich inequalities in child health in low and middle income countries. The definition of the wealth groups is discussed in more detail below.

The specific countries and time-periods studied varies across the different chapters of this thesis. Some chapters focus on one specific country (*e.g.* Indonesia) or a set of countries (African countries where mortality has recently increased). In other chapters, I used cross-sectional data for all available countries. For the latter analyses, I used the Country Reports mentioned above. These reports include countries in Africa, Asia, Latin America and North-Africa/the Near East, using Demographic and Health Surveys that were held during the 1990s.

2.5 INDICATORS

Socio-economic and regional characteristics

Maternal education and household economic status are the socio-economic characteristics of interest in this study. These are, in some cases, complemented with indicators of regional stratification.

Relatively broad categories of maternal educational attainment were used, where possible distinguishing four groups, i.e. no education, some primary education, primary completed and some secondary or higher.

Measuring household economic status in low and middle income countries is more problematic than measuring maternal education. Data on two often used indicators in high income countries, i.e. household income and expenditure levels, are often unavailable or unreliable (Montgomery *et al.* 2000). A review study has shown that household ownership of assets is the most frequently used indicator of economic status in health and fertility studies in low and middle income countries (Bollen *et al.* 2001). Also in this thesis, I used a measure of household wealth based on asset ownership. DHS includes information on household ownership of durable consumer goods, housing quality, water and sanitary facilities and other amenities. The core list of household assets included in the surveys for each of the countries is generic, while some details are country-specific. The household assets are combined into an index of household wealth, using an approach developed by others (Filmer *et al.* 2001; Gwatkin *et al.* 2000). In this approach, asset items are given weights derived through principal components analysis. Details on this method are described in Chapter 5).

The total survey-population in each of the countries is categorized into five, equally large, wealth layers. In other words, in each country, 20% of the population is categorised as poor, 20% as next-poor etc. Clearly, this way of categorizing provides a measure of the relative position of household members in the national wealth hierarchy. The absolute distance between wealth groups is not measured, although there are, obviously, absolute wealth differences between the subsequent wealth quintiles. The use of a measure of relative economic status is in correspondence with the conceptual framework used, where household wealth is seen a dimension of social stratification. Moreover, it corresponds with my focus on measuring mortality inequalities within countries, and comparing these inequalities between countries, rather on the mortality effect of, say, 1 extra dollar in income. Such international comparisons of mortality inequalities are arguably more problematic when using an absolute measure of wealth. The reason is that in terms of absolute wealth, there might not be much overlap between the populations of countries like Brazil (with a GDP per capita of 7,808 (PPP, constant 2000 international $)) and Niger ($716 PPP, constant 2000 international $) (World Bank accessed 22-10-2006). Whereas the upside of using wealth quintiles is that there is no need to take differences in group size into account in comparative analyses, the downside is that explaining differences in mortality inequalities between populations in terms of the magnitude of wealth inequalities is difficult. A measure of absolute economic status is, however, not readily available in DHS, and has problems of its own.

Whereas the focus of this thesis is on maternal education and household economic status as dimensions of social stratification, auxiliary attention is given to regional stratification. Rural/urban residence is the main dimension of regional stratification studied in this thesis. In Chapter 8, which focuses on Indonesia, regional stratification is studied in more detail, as regional stratification was hypothesized to be particularly important because of the sheer size and regional diversity of this country.

Proximate determinants

Following the conceptual framework described above, socio-economic and regional characteristics influence under-5 mortality via more proximate mortality determinants. In some chapters (*e.g.* 8 and 9), evidence on inequalities in proximate determinants is explicitly used to explain observed patterns in mortality inequalities. In other cases (*e.g.* Chapter 7), inequalities in proximate determinants are studied as key outcome of interest, the results of which should be interpreted within the broader framework of this thesis.

Proximate determinants were selected on basis of their known importance as determinants of under-5 mortality, as well as data availability and reliability in DHS. Depending on the specific question under study, I included indicators of health care use (i.e. full childhood immunisation coverage, measles immunisation coverage, professional antenatal and delivery care, medical treatment for diarrhoea and for acute respiratory infections), childhood malnutrition (i.e. stunting and wasting), use of modern family planning, and knowledge of basic home remedies (i.e. Oral Rehydration Solution).

Under-5 mortality

Inequality in under-5 mortality is the dependent variable in this study. Under-5 mortality, rather than infant (0-11 months) or child (12-59 months) mortality is used as the main health outcome, both for reasons of statistical power, as well as for reasons of data reliability. Also, in contrast to high income countries (where infant mortality is a more frequently used measure), in many low and middle income countries still a considerable proportion of children dies between ages 1-4 years.

The choice of the methods used to estimate under-5 mortality levels was driven by three factors: the specific research question under consideration, pragmatism, and a continued refinement of methods during the course of this study. For these reasons, the specific

measurement of under-5 mortality varies between the chapters of this thesis. Yet, in all analyses, direct estimates of under-5 mortality were used, i.e. using information on date of birth and death for individual children, rather than indirect estimates of mortality, which are only based on the sum of births and deaths per woman.

For pragmatic reasons, I used aggregated DSH data obtained from the Country Reports on Health Nutrition and Population (Gwatkin *et al.* 2000) for analyses in which data for many countries were needed (Chapters 3, 4, 6, and 7). In these reports, under-5 mortality is defined as the proportion of deaths under age 60 months per 1,000 live births of those born during the 10 years preceding the survey. The same method to calculate under-5 mortality was used in Chapter 5, as the specific research question required comparability of methods with those used in the above mentioned reports.

Much more refined methods were used for the time-trend analyses presented in Chapters 8 and 9. In both chapters, a period-based measure of under-5 mortality was used. This means that during a specific predefined time-frame, information on all children aged 59 months or younger is included. Exposure time and cases were observed during this time-frame, usually around five years prior to the survey. All children that were alive and aged 59 months or younger within the pre-defined time-frame, were considered exposed, i.e. contributed person-time. All deaths among children aged 59 months or younger during this time-frame were included as case. Children could enter the time-frame at birth (when born during the time-frame) or at any age until 59 months old (when born before the time-frame). Children that stayed alive after age 59 within the time-frame, were censored after age 59 months. In other words, this method includes both left and right censoring. This period-based measure of under-5 mortality gives a better estimate of the mortality level in the period under study than more common cohort-based measures of under-5 mortality. It not only gives better estimates of mortality levels in that period, the estimates are also somewhat more robust, as more children and deaths can be included in the analyses (information on all children that were alive and aged 59 months or younger during the time-frame, rather than only the children *born* in the time-frame).

More specifically, in Chapter 8, under-5 mortality was defined, using the above general method, as the number of deaths at age 59 months and younger per 5,000 person years. I used 5,000 person years to obtain rates that have a roughly similar interpretation to the probability of dying within five years after birth. Exactly the same information on person years and deaths was used to calculate inequalities in under-5 mortality, using a Cox

proportional hazards model. In Chapter 9, probabilities of dying at age 59 months or younger were estimated using Cox proportional hazards regression analysis, using similar inclusion criteria as described above.

The Demographic and Health Surveys are based on a cluster sampling scheme. Observations within clusters are likely to be more similar than those obtained through a simple random sample. In order to obtain correct confidence intervals around the hazard ratios and trend estimates presented in Chapters 8 and 9, I took this design effect into account by bootstrapping (Efron *et al.* 1993) the Cox analyses, keeping the number of clusters per survey year constant.

Generally, a time-frame of roughly five years was used to ensure reasonable statistical power while limiting the recall bias involved with long time-frames and to minimalise the potential problem of a positive correlation between maternal and child deaths (Mahy 2003).

Infant mortality (0-11 months) and child mortality (12-59 months) were included as additional outcome variables in some of the chapters (8 and 9) and in the Annex, as the strength of the effect socio-economic characteristics on mortality can vary with the age of the child (Bicego *et al.* 1993; Cleland *et al.* 1988). It is important to remind that child mortality (referring to a specific age group) is distinct from child*hood* mortality, which is a more general term for mortality among young children. For infant mortality, 11 months was used as cut-off, as advised because of heaping of reported deaths at 12 moths of age (Macro International Inc. 1994).

2.6 MEASURES OF ASSOCIATION

A key feature of this study is that the under-5 mortality levels of socio-economically more deprived groups are compared with that of more advantaged ones, rather than focussing on the level of the poor or lower educated *an sich*. Extensive attention will be given in this thesis to the measure of association between socio-economic characteristics on the one hand and under-5 mortality on the other. The specific measure used varied with the specific research question in each of the following chapters.

Chapter 4 seeks to inform one of the key debates on inequality measures, i.e. whether absolute or relative measures of inequality are most meaningful. It critically examines the arguments used in previous studies by judging them against empirical patterns of socio-economic inequalities in health-related outcomes. The rate difference (absolute inequality) and rate ratio (relative inequality) are the two measures I assessed. These are fairly simple inequality measures which compare the two extreme groups in a socio-economic hierarchy, without considering the groups in the middle.

A more complex inequality measure, the relative index of inequality (RII), was used in Chapter 5. The RII is a summary measure of the differences in mortality experience between *all* socio-economic groups, and can be interpreted as the (estimated) ratio in odds between the hypothetically poorest and the hypothetically richest person or household in the population. The measure assumes a linear association between the socio-economic characteristic under study and mortality (Mackenbach *et al.* 1997a).

The studies presented in Chapter 8 and 9 used Cox proportional hazards regression to accurately estimate and test time-trends in under-5 mortality and mortality inequality. Time-trends in inequality in under-5 mortality were the focus of the study on Indonesia (Chapter 8). Inequalities were expressed in terms of hazard ratios, giving the ratio of the hazard of dying before age 60 months when comparing deprived with better-off subgroups, using the period-based measure of mortality as described above. I tested whether the magnitude of inequality between socio-economic groups changed statistically significantly over time.

A somewhat different approach was taken in the analyses of five African countries in Chapter 9. In a context of rising mortality levels –as in the countries under study– I considered it important to focus on trends in mortality and on whether these trends differ between socio-economic groups (i.e. inequality in trends), rather than on trends in inequality. Mortality inequalities themselves are a less good barometer for what is happening in a context of rising mortality levels, as declining inequalities could, for example, be accompanied by deteriorating mortality levels in all groups. Time-trends in under-5 mortality were estimated using a Cox proportional hazards model in which the hazard ratios between survey-years (year defined as linear variable) provided the annual percentage mortality change. I tested whether the mortality trends were significantly different between the various population groups.

The above measures were, in most chapters, complemented with a description of basic rates per group.

2.7 STRATEGIES OF ANALYSIS

My main strategies of analysis are described in this section. Details on the specific research methods are given in each of the subsequent chapters.

My study is a comparative one. Comparative research "strives to make larger inferences […] through some form of comparison, and uses concepts applicable to more than the country under study" (Landman 2003). Inequalities in under-5 mortality are the main outcome compared between countries and time-periods.

Comparisons have an important descriptive value. I used a comparative study design to describe general patterns in the magnitude of mortality inequalities and to uncover differences or inconsistencies that could not be uncovered when only one country/period were studied (Kohn 1987). Similarly, I used this design to assess to what extent specific findings for a particular country or time-period were generalizable to other countries or periods.

Comparative research is also the only way to examine why inequalities are larger in some populations than in others. Explanations of time or place variations in mortality inequalities can be sought at various points in the causal pathway (see Figure 2.1), i.e. at the level of country characteristics, social stratification, and at the level of proximate determinants. Whereas the study of cause-specific mortality has contributed to the understanding of socio-economic mortality inequalities in high income countries, I could not study this ultimate point in the causal pathway because of a lack of cause-of-death data in DHS. Whereas social stratification and proximate determinants can be studied using one country, variables at the population level (*e.g.* country characteristics) can arguably only be studied using a comparative study design (Diez Roux 2004; Lu 2001; Lu *et al.* 2005; Rose 1985; Schwartz *et al.* 1999).

The specific research designs used in this thesis are cross-national cross-sectional analysis (comparisons between countries at one point in time) and time-trend analysis (comparisons between time-periods for same country). The combination of the cross-sectional cross-national and the time-trend approach provides a check whether associations observed across

countries agree with the associations observed over time. This combination has rarely been used in the study of mortality inequalities in low and middle income countries.

Cross-national comparisons

In the cross-national analyses, I exploited the heterogeneity of the countries for which DHS data are available. By comparing a large number of heterogeneous countries I was able to examine whether there are general patterns and irregularities in inequality in under-5 mortality and mortality determinants. The external validity of the general patterns observed was enhanced by the size and heterogeneity, and therefore most likely the representativeness, of the set of countries in the study. The number countries and the heterogeneity across them in my study is much larger then would ever be possible in a study of high income countries.

I also used the analysis of multiple countries to assess the generalizability, or external validity, of some of my specific research findings (*e.g.* Chapter 5 and 9). Precisely because the countries studied are very heterogeneous in terms of historical, political, geographical, cultural, social and economical context, it was possible to assess whether findings for one country could be generalized to a much broader set of contexts.

Some of the explanatory cross-national analyses were quantitative in nature (Chapter 6). Quantitative cross-national comparisons (Przeworski *et al.* 1970) were used to assess the association between country characteristics and inequalities in under-5 mortality. Potential pathways were assessed by including various proximate mortality determinants in the analysis. Other explanatory cross-national analyses were more qualitative in nature (Chapter 7), and used an extensive literature research and collaboration with experts in the specific field to formulate explanations for patterns observed.

Time-trend analysis

Whereas I used cross-national analyses to describe and explain general patterns across a broad set of country contexts, I used time-trend analyses to describe and explain in more detail how under-5 mortality inequalities change in specific contexts. These contexts were purposefully selected on the basis of discussions in the literature and evidence on important changes in population health.

The first context I studied is one of rapid economic growth and improving child survival. This is the pattern of change that a number of countries, particularly in East and Southeast Asia, experienced during the 1980s and 1990s (with an economic crisis at the end of the 1990s). More generally, the long-term trend of declining under-5 mortality is a pattern that most countries tend to follow. Although there are some indications that relative inequalities in under-5 mortality increase in times of economic growth and overall gains in survival, evidence remains scarce. I tried to improve our understanding of how and why mortality inequalities change in such a context by describing and trying to explain time-trends in such inequalities for one country, i.e. Indonesia.

The second context I studied is one of deteriorating childhood survival and of economic stagnation. During the last 15 years of the 20th century, a number of countries have experienced increases in under-5 mortality (UNICEF 2004). These include countries in war, such as Afghanistan and Iraq, as well as several African countries. It is the latter countries on which I focus in Chapter 9. I combined time-trend analysis with cross-country comparisons to assess the generalizability of findings to other African countries that are experiencing increases in under-5 mortality.

Explanatory research on socio-economic mortality inequalities through time-trend analysis is based on the logic of, what is called, a "most similar systems" research design (Przeworski *et al.* 1970). By comparing time-periods for the same country, it is possible to hold a lot of factors constant (*e.g.* historical context, many cultural factors, geography, climate), that otherwise, in a cross-country comparison, might act as confounder to the relationships studied. This holds in particular if the timeframes studied are relatively short. For reasons of statistical power, it is not possible in a cross-country analysis to control for all these factors. In a time-trend analysis, it is possible to "control" for all these (often unknown) factors, and to focus on the variables that *do* change over time. Logically, changes in the magnitude of mortality inequalities in a country over time, are caused by variables that have changed over time (what period of time, depends on the time-lag of the factors involved) (Leon 2001).

2.8 OUTLINE OF THIS THESIS

Part I of this thesis aims to contribute to the development of valid, robust and meaningful ways of measuring socio-economic mortality inequalities. First, I examine in **Chapter**

3 the extent to which international variations in the size of inequality in mortality according to the inequality index reported in the World Health Report 2000 agree with international variations in the size of inequality according to well-established measures of socio-economic inequalities in mortality. **Chapter 4** seeks to contribute to the debate on whether relative or absolute measures of inequality are most meaningful for monitoring health inequalities. **Chapter 5** examines the extent to which the magnitude of poor-rich inequalities in health-related outcomes is sensitive to the specific set of asset items included in the measure of household wealth.

Part II of this thesis aims to contribute to the description and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through cross-national analyses. **Chapter 6** examines to what extent the association between under-5 mortality and well-known country characteristics, such as national per capita income and public spending on health, varies in strength between richer and poorer children within countries. **Chapter 7** focuses on inequalities in health care use as a proximate determinant of inequality in under-5 mortality. Specifically, it describes poor-rich inequalities in use of maternity care and seeks to understand these inequalities through comparisons with other types of health care.

Part III of this thesis aims to contribute to the description and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through time-trend analyses. **Chapter 8** describes and seeks to explain time-trends in socio-economic and regional inequalities in under-5 mortality in Indonesia during a period of rapid economic growth and mortality decline. **Chapter 9** examines a different situation, i.e. one of rising mortality levels and economic deterioration. This chapter aims to identify the socio-economic and geographical groups in which the under-5 mortality increase observed in Burkina Faso, Cameroon, Côte d'Ivoire, Kenya and Zimbabwe during the 1990s was most pronounced, and to explore the contribution of a number of proximate determinants of under-5 mortality to this differential mortality increase.

The **General Discussion (Chapter 10)** summarizes the main findings of the research underlying this thesis and critically assesses the approach taken. It also seeks to generate hypotheses for key findings in this thesis against the backdrop of the available literature, and highlights the contribution this thesis purports to make to describing and explaining time and place variations in the magnitude of under-5 mortality inequalities.

The **Annex** presents international overviews and comparisons of poor-rich inequalities in under-5 mortality and proximate determinants of under-5 mortality. The proximate determinants studied include indicators of health care use, childhood malnutrition and fertility.

Part I

Measuring socio-economic mortality inequalities

3

World Health Report 2000: inequality index and socio-economic inequalities in mortality

Houweling, T.A., Kunst, A.E., and Mackenbach, J.P.

Lancet 2001; 357(9269), 1671-1672

ABSTRACT

Background Monitoring of inequality in health has become an increasingly important task of development agencies.

Methods We compared the inequality index as published in the World Health Report 2000 with available evidence on socio-economic inequalities in mortality in 15 industrialised and 43 less-developed countries.

Results We found that the World Health Report index does not correspond with international variations in the size of socio-economic inequalities in mortality.

Conclusion These findings indicate that the index should not be interpreted as a reflection of socio-economic inequalities in health, nor should the index be used to replace the indices developed to monitor socio-economic inequalities in health.

3.1 INTRODUCTION

In the World Health Report 2000 (WHO 2000), the WHO published for the first time a ranking of 191 countries according to child mortality distribution within a population. The aim of this index is to measure all inequality in mortality across populations, without any preconceptions about the dimensions along which mortality is unequally distributed. Doing so, the index departs from established research that focuses on mortality differences between socio-economic groups. Nonetheless, many readers of the report might be inclined to interpret its index in terms of socio-economic inequalities in mortality. We question the extent to which there is an empirical association between the World Health Report 2000 inequality index and available estimates on socio-economic inequalities in mortality.

The objective of our analysis was to find the extent to which international variations in the size of inequality in mortality according to the report's index agree with international variations in the size of inequality according to well-established measures of socio-economic inequalities in mortality. We compared the World Health Report index with: (1) measures of socio-economic inequalities in premature mortality that are available for 15 high income countries; and (2) measures of socio-economic inequalities in under-5 mortality that are available for 43 low and middle income countries.

3.2 DATA AND METHODS

For a description of the World Health Report index, readers are referred to the actual report and one by Gakidou and King (Gakidou *et al.* nd). The main estimates of socio-economic mortality differences that are available in a comparable way for several high income countries are those concerning occupational (manual *vs.* non-manual) and educational (low *vs.* high) differences in mortality among men of 45-64 years of age (Kunst 1997). These data are available for 15 countries, and are regarded as a key indicator of inequalities in mortality in industrialised countries. For less-developed countries, estimates are available for differences between rich and poor in under-5 mortality (Gwatkin *et al.* 2000). This measure could be estimated in a comparable way for the 43 countries covered by the Demographic and Health Surveys II and III. Households were grouped into wealth quintiles based on an asset index developed by the World Bank (Gwatkin *et al.* 2000).

We used the absolute values, instead of country ranks, of the World Health Report's index. To compare with other indices, we recalculated the report's index values by subtracting them from 1, so that small numbers would indicate low inequality (with 0 indicating complete equality) and large numbers would indicate high inequality (with 1 indicating extreme inequality). In the World Health Report index, no preference is given to either a relative or an absolute approach. Therefore, we compared the recalculated index to both relative and absolute measures of socio-economic inequality in mortality.

3.3 RESULTS

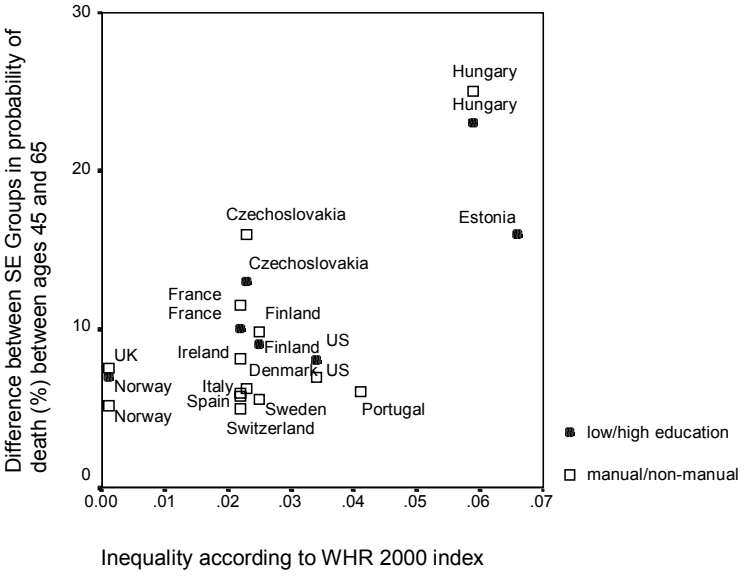
We found some correspondence among industrialized countries between the World Health Report index and both relative and absolute measures of socio-economic inequality in mortality (Figure 3.1). However, closer examination of the data shows that this correspondence is based on two outliers (Hungary and Estonia). When these two countries are excluded from analysis, the association disappears. France, for example, has small inequalities according to the World Health Report index, whereas socio-economic differences are substantial as compared with the rest of Western Europe. The two countries that are close to perfect equality according to the World Health Report index, UK and Norway, still experience considerable socio-economic inequalities in mortality.

There are many explanations for the large discrepancies between the two indices. In industrialised countries, inequalities in child mortality commonly show patterns that are distinct from the more important inequalities seen at higher ages. A higher degree of correspondence might be expected in the analysis of less-developed countries, for which both indices refer to the same age range and use the same data source. However, for these countries no consistent link is seen between the World Health Report index and measures of socio-economic differences in under-5 mortality. The World Health Report index correlates negatively with relative inequalities in mortality. The correlation with the poor-rich mortality rate ratio was –0.41 (p=0.006). However, the correlation with an absolute measure, the poor-rich difference in mortality, was positive and equally strong (r= 0.44; p=0.003).

The correspondence between the World Health Report index and absolute poor-rich differences in mortality is examined in the table. If both measures roughly correspond, do they also exhibit similar links with development indicators? Correlation analysis was done for 38 countries for which data on all development indicators were available. According to

the table, the report's index mainly reflects the overall under-5 mortality rate. This result might provide an explanation for the fact that the correlation between the report's index and poor-rich differences in mortality is in opposite directions for relative and absolute measures. Absolute poor-rich mortality differences are sensitive for overall mortality levels, whereas relative mortality differences are not.

Figure 3.1 Inequality according to World Health Report index versus absolute socio-economic inequalities in mortality: Industrialized countries



Pearson's correlation coefficients

	Occupational measure		**Educational measure**	
	Absolute	Relative	Absolute	Relative
Including all countries	0.60 (p = 0.022)	0.62 (p= 0.018)	0.80 (p= 0.032)	0.62 (p= 0.135)
Excluding Hungary and Estonia	0.06 (p= 0.843)	-0.02 (p= 0.950)	Too few countries	

The World Health Report index also correlates with a few other variables, such as gross domestic product (GDP) per capita and female literacy rate, but these correlations disappear when we control for under-5 mortality. By contrast, absolute poor-rich differences in mortality are not only correlated with the overall level of mortality; after control for this level, associations persist with inequality in immunisation, inequality in the delivery of care, and public expenditure on health as a percentage of GDP. The results for relative poor-rich differences show the same tendencies. All these correlates are indicators of the degree to which health care is made available and accessible to the poor.

Table 3.1 Correlation of World Health Report index and poor-rich inequalities with development indicators; 38 low and middle income countries

Indicators	Pearson's correlations with inequality measure			
	World Health Report index		Absolute poor-rich differences	
	No control	Control for overall under-5 mortality rate	No control	Control for overall under-5 mortality rate
Under-five mortality rate [a]	0.78 **	--	0.45 **	--
Fertility Rate [b]	0.64 **	-0.02	0.23	-0.29
Female literacy rate [b]	-0.63 **	-0.10	-0.29	0.09
GDP per capita [b]	-0.64 **	-0.22	-0.16	0.25
Public expenditure on health as % of GDP [b]	0.14	-0.18	-0.27	-0.49 **
Overall delivery care rate [a]	-0.50**	-0.15	-0.11	0.17
Absolute poor-rich inequality in delivery care [a]	0.11	0.03	0.37 *	0.36 *
Overall immunization rate [a]	-0.38 *	-0.10	-0.18	0.01
Absolute poor-rich inequality in immunization rate [a]	0.52 **	0.32	0.59 **	0.48 **

* $p < 0.05$, ** $p < 0.01$. Sources: [a] Gwatkin *et al.* (2000) [b] UNDP (1998)

3.4 DISCUSSION

Evidence on socio-economic differences in premature mortality has become available for more countries from all parts of the world. Monitoring these differences, both over time and between countries, gives support to policies that aim to improve the health of disadvantaged people. Unfortunately, despite its emphasis on inequalities in health, the World Health Report 2000 has not seized the opportunity to combine and disseminate this information for as many countries as possible. The new index that was included bears little relationship to socio-economic inequalities in mortality. Even though we would like to remain open for the potential values of this new index, we do share the fear of others (Braveman *et al.* 2000) that its applicability for monitoring and tackling inequalities in health may turn out to be very limited. We therefore strongly recommend that the World Health Report returns to the use of indices directly measuring the gap between the poor and the rich.

4

Using relative and absolute measures for monitoring health inequalities: experiences from cross-national analyses on maternal and child health

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conditionally accepted

ABSTRACT

Background As reducing socio-economic inequalities in health is an important public health objective, monitoring of these inequalities is an important public health task. The specific inequality measure used can influence the conclusions drawn, and there is no consensus on which measure is most meaningful. The key issue raising most debate is whether to use relative or absolute inequality measures. This chapter aims to inform this debate and develop recommendations for monitoring health inequalities on the basis of empirical analyses for a broad range of low and middle income countries.

Methods Wealth-group specific data on under-5 mortality, immunisation coverage, antenatal care and delivery care for 43 countries were obtained from the Demographic and Health Surveys. These data were used to describe the association between the overall level of these outcomes on the one hand, and relative and absolute poor-rich inequalities in these outcomes on the other.

Results We demonstrate that the values that the absolute and relative inequality measures can take are bound by mathematical ceilings. Yet, even where these ceilings do not play a role, the magnitude of inequality is correlated with the overall level of the outcome. The observed tendencies are, however, not necessities. There are countries with low mortality levels *and* low relative inequalities. Also absolute inequalities showed variation at most overall levels.

Conclusion Our study shows that both absolute and relative inequality measures can be meaningful for monitoring inequalities, provided that the overall level of the outcome is

taken into account. Suggestions are given on how to do this. In addition, this chapter presents data that can be used for benchmarking of inequalities in the field of maternal and child health in low and middle income countries.

4.1 INTRODUCTION

Reducing health inequalities between social groups within countries is an important public health objective. Monitoring of such health inequalities, therefore, is an important public health task. Comparisons are an integral part of monitoring. The aims of such comparisons are to assess whether health inequalities are smaller or larger compared to other countries (Mackenbach *et al.* 1997b), whether inequalities have increased over time (Mackenbach *et al.* 2003), or whether inequalities develop in the direction of predefined goals (WHO 1999b). Such monitoring is important, both in high income countries, and in low and middle income countries.

There is much debate about the inequality measure to be used for monitoring. There is consensus on the *importance of the choice* of the measure, since this may influence the conclusions drawn (Boström *et al.* 2003; Clarke *et al.* 2002; Mackenbach *et al.* 1997a; Scanlan 2000). However, there is less consensus on *which* measure is most meaningful. The key issue that has raised most recent debate is whether to use relative or absolute measures of inequality (Boström *et al.* 2003; Clarke *et al.* 2002; Scanlan 2000). According to some authors, extreme caution is needed when using relative measures to monitor inequalities. Increasing relative inequalities, it is suggested, are 'nearly inevitable' when the overall level of the outcome (*e.g.* mortality) falls. Similarly, ratios in *avoiding* the outcome would almost necessarily decrease. This would lead to "diametrically opposed interpretations" of patterns of inequality (Scanlan 2000). This latter problem is obviously avoided when using absolute measures of inequality, such as the rate difference (Clarke *et al.* 2002). Others, however, warn that using absolute inequality measures "almost inevitably" leads to smaller inequalities when overall levels fall, and that therefore ratio-based measures are more meaningful for monitoring purposes (Victora *et al.* 2000).

This chapter aims to inform this debate and develop recommendations for monitoring health inequalities on the basis of empirical analyses of health-related inequalities in a broad range of low and middle income countries. We examine to what extent relative and absolute inequalities on the one hand, and overall levels on the other, are indeed empirically related as suggested by the above mentioned authors. We also assess to what extent

any observed associations can be explained by mathematically-defined ceilings to relative and absolute inequality measures.

We examine the above issues by means of a cross-national analysis of 43 low and middle income countries for one health outcome (under-5 mortality) and three indicators of health care use (full childhood immunization, skilled antenatal care, skilled delivery assistance), using the Demographic and Health Surveys (DHS) dataset. DHS is the largest survey program in low and middle income countries with standardized questionnaires containing information on socio-economic characteristics, mortality, and health care use. A cross-sectional analysis of low and middle income countries is particularly suitable for answering the above questions because of the wide range of overall levels of health-related outcomes across these countries.

4.2 DATA AND METHODS

Data on poor-rich differences in under-5 mortality, full childhood immunization coverage, skilled delivery attendance and antenatal care for 43 low and middle income countries were obtained from World Bank Country Reports (Gwatkin *et al.* 2000). The Country Reports are based on DHS data (www.measuredhs.com). These are nationally representative surveys, for which usually between 5,000-10,000 women aged 15 - 49 years were interviewed. The data and indicators used have been described elsewhere in more detail (Gwatkin *et al.* 2000). We included those countries for which Country Reports were available at time of analysis.

Household wealth was the socio-economic characteristic used in this study. Wealth has been shown to be an important determinant of mortality and health care use. It is extensively used in the field of health inequalities research, especially in studies on low and middle income countries. Wealth was measured using an index based on household ownership of assets. The assets were combined into a wealth index using principal components derived weights (Filmer *et al.* 2001; Gwatkin *et al.* 2000). Despite its limitations (Houweling *et al.* 2003), this index is fairly widely used as measure of economic status in low and middle income countries (Bollen *et al.* 2002; Filmer *et al.* 2001). The total population in each of the countries was categorized accordingly into five, equally large, wealth layers.

First, scatter plots were used to assess the relationship between the overall level of the health-related outcomes and the magnitude of absolute and relative inequalities in these

outcomes. The simplest inequality measures were used, i.e. the rate difference (RD) and the rate ratio (RR) between the poorest 40% and richest 40% population group. We calculated the R-square of the best fitting curve through the scatter plots.

Then, we examined to what extent the empirical patterns of the RR and RD could be clarified by mathematically-defined ceilings to the RR and RD. We calculated these ceilings using a hypothetical population of which 50% is poor and 50% is rich. For example, if overall immunisation coverage is 100%, the RR cannot exceed 1, and the RD cannot exceed 0. If overall immunisation coverage is 90%, the maximum value of the RR is 1.25 (i.e. 100% coverage among the rich and 80% among the poor) and is 20 for the RD. For outcomes that never reach 100%, like under-5 mortality, we made an adjustment to calculate realistic ceilings. We assumed a minimum under-5 mortality of 5 per 1,000 live births and a maximum of 400/1,000.

4.3 RESULTS

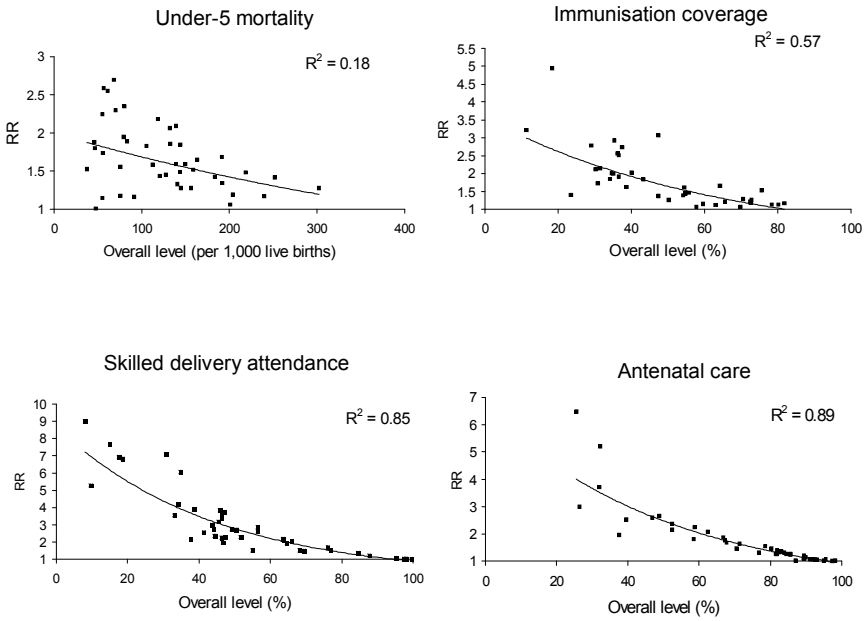
General tendencies

Both the RR and the RD are empirically related with the overall level of the outcomes studied. RRs tend to be higher at lower overall levels, as shown by the trend-lines in Figure 4.1a-d. The amount of scatter around the trend-line varied between the outcomes. Whereas for skilled delivery attendance and antenatal care the RR was to a high degree (up to 89%) explained by the overall level, the explained variance was quite low for under-5 mortality. For this outcome, mainly the range of the RR was larger at lower overall levels. So, although relative inequalities in under-5 mortality tend to be higher at lower overall levels, even at comparatively low mortality levels there were countries with low relative inequalities.

The relationship between the RD and the overall level has the shape of a reverse-u (Figure 4.2a-d), with low RDs at both high and low overall rates, and high RDs at intermediate levels. The exact pattern, however, varied between the outcomes. For antenatal care and skilled delivery attendance, the pattern approximated a fully reversed-u shape, whereas for other health outcomes, only the left (under-5 mortality), or right (immunisation) part were represented. The extent to which the RD was explained by the overall rate varied between health outcomes, from moderate (R^2=0.24) to very high (R^2= 0.88). A high R^2 implies that

there is little variation in the magnitude of the RD between countries with similar overall levels of the outcome.

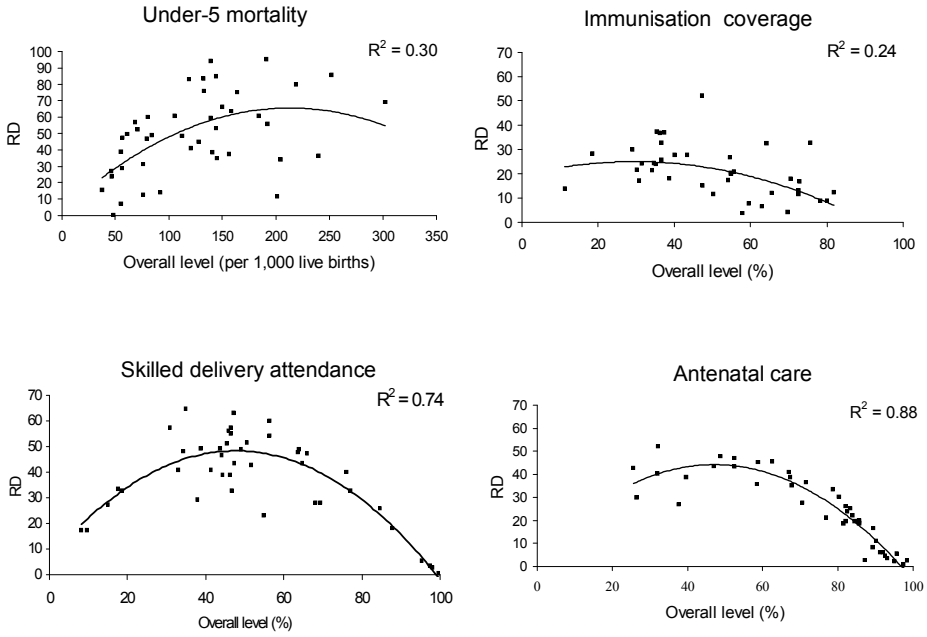
Figure 4.1a-d Rate ratio (comparing the poorest 40% and richest 40% population group) by overall level of the outcome: under-5 mortality, full childhood immunisation coverage, skilled delivery attendance, and skilled antenatal care, for 43 low and middle income countries.



Note: Exponential curves were fitted through the data.

The magnitude of the RR was sensitive to whether the outcome was defined positively or negatively. In Brazil, for example, poor women were over 20 times more likely not to be attended by a skilled person during delivery than rich women. However, as most deliveries in Brazil were attended by a skilled person, the poor-rich ratio in skilled attendance was only 1.38 (Figure 4.3). Whereas also the position of countries in terms of the magnitude of the RR was strongly sensitive to whether the outcome was defined positively or negatively, the country rankings were not necessarily diametrically opposed. The correlation coefficient of the ranking of countries was $r = 0.40$ for immunization, 0.32 for under-5 mortality, -0.02 for antenatal care, and –0.47 for delivery attendance. A negative coefficient means that low RRs when using a positive definition of the outcome were associated with high RRs when using a negative definition, and vice versa.

Figure 4.2a-d Rate Difference (comparing the poorest 40% and richest 40% population group) by overall level of the outcome: under-5 mortality, full childhood immunisation coverage, skilled delivery attendance, and skilled antenatal care, for 43 low and middle income countries.



Note: Parabolic curves were fitted through the data.

The ranking of countries was for some outcomes, i.e. skilled delivery attendance and under-5 mortality, highly sensitive to whether the RR or the RD was used (rank-correlation coefficient $r = 0.32$ and $r = 0.39$ respectively). For other outcomes, however, the ranking was more robust (immunization coverage: $r = 0.85$, and antenatal care: $r = 0.97$).

Mathematical Ceilings

The maximum values of the RR at given overall levels of health care use and under-5 mortality are shown in Figure 4.4. This mathematically-defined ceiling moves downwards with increasing overall levels. Figure 4.4 also shows the trend-lines of the RR derived from the empirical observations. The patterns of the observed values resemble the pattern of the mathematically-defined ceiling, with very low RRs at high overall levels. Yet, the ceiling cannot clarify why the RR still tends to increase below overall levels of 50%. For example, the RR tends to be lower at overall levels of 40% than at 10%, even though also at 40% there is no mathematical ceiling.

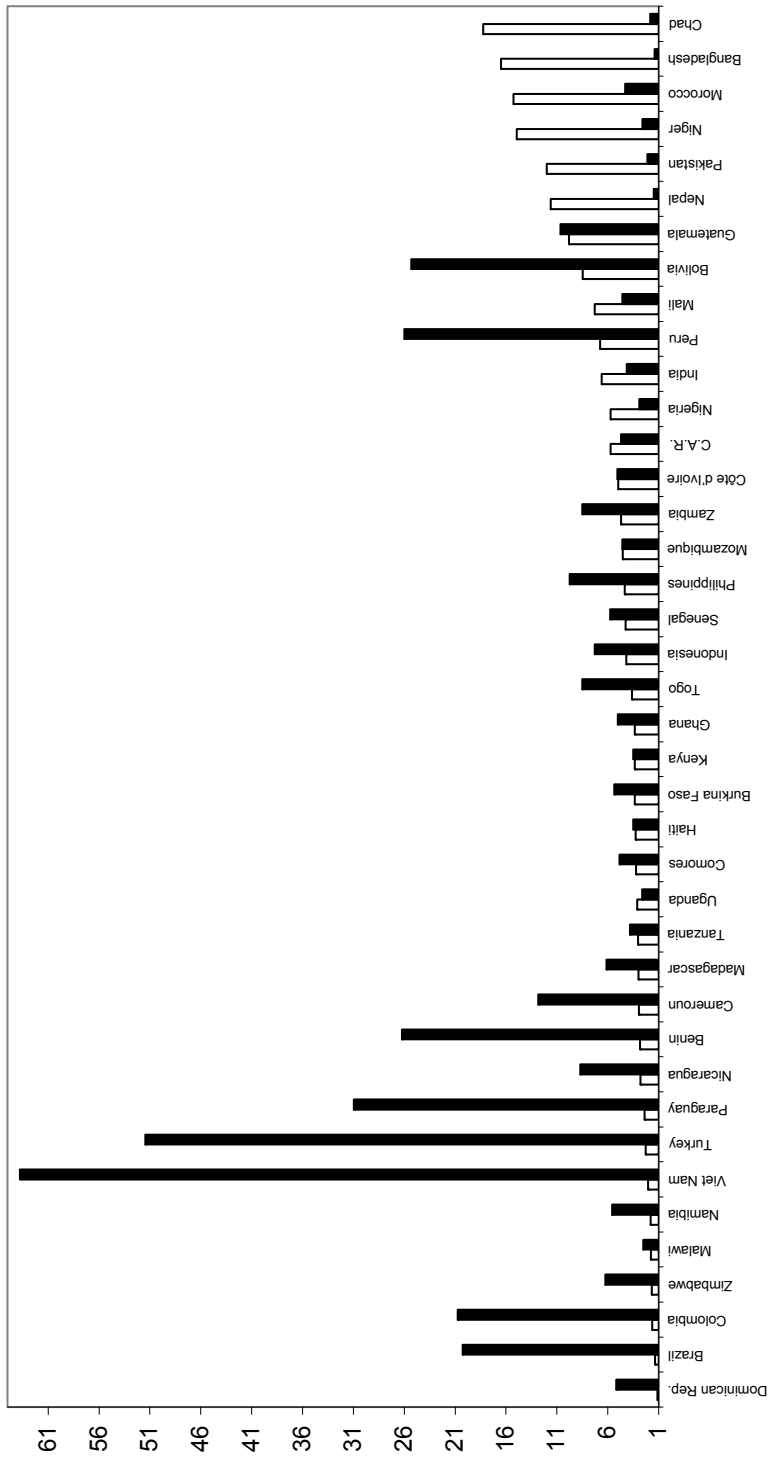
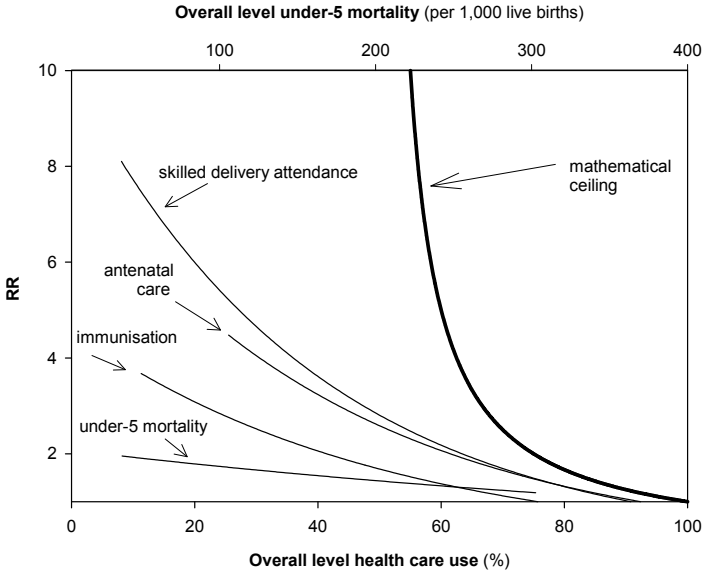


Figure 4.3 Comparing poor-rich rate ratios (richest 20% - poorest 20% population group) in skilled delivery attendance with poor-rich rate ratios in prevalence of no skilled delivery attendance.

Figure 4.4 Rate ratio (comparing poorest 40% and richest 40% population group) by overall level of the outcome, and mathematically defined ceiling to value of RR.



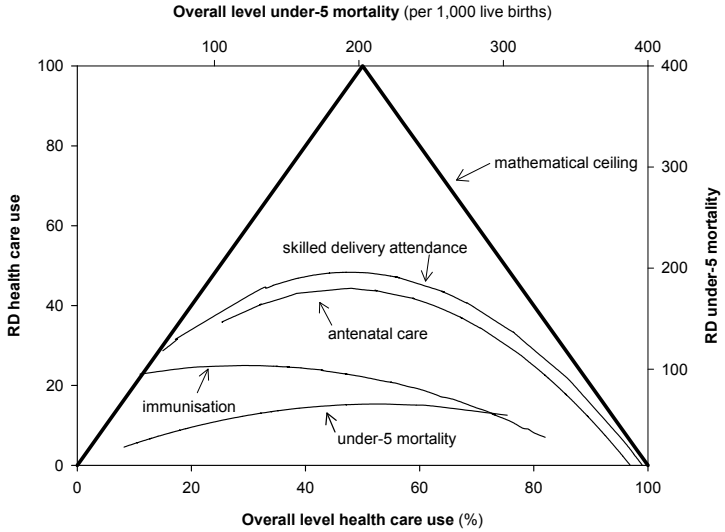
Note: The curves presented for the health-related outcomes correspond to those shown in Figure 4.1a-d. The upper x-axis gives the overall-level for under-5 mortality. The lower x-axis gives the overall level for immunisation coverage, antenatal care and skilled delivery attendance.

The mathematically defined ceiling of the RD is 0 at overall levels of 0% and 100% (Figure 4.5). From these two points, the ceiling increases linearly, and reaches a maximum of 100 at an overall level of 50%. The empirical trend-lines resemble the pattern of the mathematically-defined ceiling. The strength of this association, however, varied between health outcomes. For delivery attendance and antenatal care, inequalities tended to be rather close to the maximum. Conversely, for immunisation coverage and under-5 mortality, the RDs were systematically lower than the maximum, and the patterns were far from determined by the mathematical ceiling.

The empirically observed low RRs at high overall levels are therefore not surprising. Low RRs at high (>60-70%) overall rates are a *necessity*, not an accomplishment; as are low RDs at very high and very low overall rates.

The observed general patterns in which the RR and RD are associated with the overall level of the outcome cannot be fully clarified by the mathematical ceilings. These ceilings only play a role at high overall rates (for RR) or very high and low overall rates (RD).

Figure 4.5 Rate Difference (comparing poorest 40% and richest 40% population group) by overall level of the outcome, and mathematically defined ceiling to value of RD.



Note: The curves presented for the health-related outcomes correspond to those shown in Figure 4.2a-d. The upper x-axis gives the overall-level for under-5 mortality. The lower x-axis gives the overall level for immunisation coverage, antenatal care and skilled delivery attendance.

4.4 DISCUSSION

Our analysis shows that the magnitude of both relative and absolute socio-economic inequalities in health-related outcomes is empirically related to the overall level of these outcomes. Relative inequalities, using the rate ratio as measure, tend to be larger at lower overall levels (*e.g.* of mortality). Absolute inequalities, using the rate difference as measure, tend to be low at both very low and very high overall levels. This chapter demonstrates that the magnitude of the RR and the RD is bound by mathematical ceilings. These ceilings partly explain the empirical patterns described above. Low RRs at very high overall levels, for instance, are a necessity, not an accomplishment. They reflect the fact that rates in all wealth layers need to be very high in order to uphold a very high overall level. Yet, even where mathematically-defined ceilings do not play a role, the magnitude of absolute and relative inequalities is correlated with the overall level.

The above tendencies are not necessities. There are countries with low mortality rates *and* low RRs. Similarly, the RD showed variation around the trend-line at most overall levels. Moreover, the exact empirical patterns varied between the specific health-related outcomes,

showing that the relationship between relative and absolute inequalities on the one hand, and overall levels on the other, is not as rigid as is sometimes suggested.

Evaluation of methodology

Our results are based on DHS data, which uses standardized core questionnaires that generally allow for comparisons across countries. Although there is some uncertainty around the precise estimates for individual countries, it seems unlikely that this explains the systematic patterns observed. As DHS comprises a broad set of countries (representing various regions, and political, economic and cultural contexts), we expect that the patterns described are not dependent on the selection of countries for which DHS data are available. Also, we examined a broad set of outcomes. We expect an approximately similar range of patterns for other outcomes that are associated with socio-economic status.

A wealth index, based on household ownership of assets, was the socio-economic characteristic used in this study. When using maternal education, we found similar patterns (results available upon request).

Our empirical findings are based on a cross-sectional cross-national analysis, and are therefore directly relevant for international comparative studies. These cross-sectional results cannot necessarily be interpreted longitudinally. There are, however, indications that the observed tendencies of the RR and RD are also seen over time. In Western Europe, declines in total mortality among adults between the 1980s and 1990s were accompanied by increasing relative inequalities in mortality between socio-economic groups (Mackenbach *et al.* 2003; Marang-van de Mheen *et al.* 1998; Martikainen *et al.* 2001). In low and middle income countries, there is evidence that the decline in under-5 mortality between the 1970s and the 1990s was accompanied by declining absolute socio-economic mortality inequalities, and stable or widening relative inequalities (Cleland *et al.* 1992; Minujin *et al.* 2003).

Our findings are important, not only for international comparisons of low and middle income countries, but for all studies in which (health-related) inequalities are compared between populations. When comparing mortality inequalities between European countries (Vågerö *et al.* 1997), for example, or when monitoring time-trends in inequality (Scanlan 2000), differences in overall mortality levels need to be taken into account. Also when comparing health inequalities between age groups it is important to take into account the

fact that overall mortality rises with age. Indeed, relative inequalities tend to decline with age, while absolute differences increase dramatically (Huisman *et al.* 2004; Lopez *et al.* 1994; Marmot *et al.* 1996).

We used the most simple measures of relative and absolute inequality (the rate ratio and the rate difference) to illustrate the general tendencies and mathematical ceilings. Our findings can most likely be generalised to more sophisticated measures of relative and absolute inequality, such as the relative index of inequality (Mackenbach *et al.* 1997a), the slope index of inequality (SII) (Mackenbach *et al.* 1997a), and the generalized concentration index (Clarke *et al.* 2002). The mathematical ceilings to the concentration index have been described elsewhere (Wagstaff 2004). In a previous study we have reported a similar relationship between the SII and the overall level to the one reported here for the RD (Kunst *et al.* 2001).

Explaining the patterns

As mentioned above, the observed general patterns in which the RR and RD are associated with the overall level of the outcome cannot be fully clarified by the mathematical ceilings. Further interpretation and appraisal of the observed patterns can be enhanced by placing them in an explanatory framework. An example of such a framework is the diffusion of innovations theory (Rogers 2003 [1962]). According to this theory, innovations tend to reach the better-off first before trickling down to the lower classes. This would lead to high relative inequalities at the early phase of the diffusion process, and to a decline later onwards (Victora *et al.* 2000). Differential diffusion of innovations has been observed for a number of phenomena, such as the smoking epidemic in developed countries and the obesity epidemic (Huisman *et al.* 2005b; Monteiro *et al.* 2004). Indeed, the observed pattern of high relative inequalities at low levels of health care use and the low inequalities at high levels of health care use is conform expectations based on the diffusion of innovations theory.

Implications for monitoring health inequalities

Our study shows that not only the RR (Scanlan 2000), and not only the RD (Victora *et al.* 2000), but both are associated with the overall level of the outcome. Preference for either measure can therefore not be based on (supposed lack of) these general tendencies.

At the same time these tendencies are not necessities. Scanlan argues that increasing RRs are nearly inevitable as mortality rates decline (Scanlan 2000). Positive examples, however, demonstrate that keeping relative inequalities low when mortality levels decline, is attainable. This is important, both for policy makers and researchers, especially those who assume that rising inequalities with declining mortality levels are inevitable. Also the RD varies around the trend-line at most overall levels. This implies that both the RR and the RD are not entirely determined by overall levels and that both can be meaningful measures for monitoring inequality.

Conversely, small RRs at high overall levels are almost inevitable, as are low RDs at very low and very high overall rates. Ultimately, very low mortality levels are only attainable when absolute mortality inequalities are low. This should be taken into account when monitoring inequalities. The RR and the RD are therefore only useful for monitoring when the relationship of these measures with the overall level of the outcome is taken into account. Also when setting targets for reducing health inequalities, *e.g.* a 25% reduction in health inequalities in Europe (WHO 1999b), it is important to take into account the context in terms of overall rates, and to carefully consider the measure used for monitoring progress.

Whereas there are no standard recipes, we will give some suggestions on how the overall level of the outcome can be taken into account when monitoring inequalities.

When populations with similar overall levels of the outcome are compared, the RR and RD are both meaningful measures for monitoring. When using the RR, one should, however, be aware that its magnitude can be highly sensitive to whether the outcome is defined positively or negatively, as we demonstrated for skilled delivery attendance. For certain outcomes (*e.g.* mortality), a negative definition is conventionally used, whereas for others (*e.g.* immunisation) a positive definition is more common. We warn against uncritical use of common but arbitrary definitions of health-related outcomes in either positive or negative terms. Each definition describes another aspect of the empirical reality, and it can be meaningful to describe inequalities according to both.

When populations with different overall levels are compared, one can assess whether the population with smallest inequalities theoretically could, given its corresponding mathematically-defined ceiling, have reached the higher inequality observed in the population with which it is compared. If the magnitude of inequality of one of the populations seems

to be restricted by the mathematically-defined ceilings, such direct comparisons may not be very meaningful.

A solution to both of the above issues would be to use odds ratio (OR) based measures of inequality. These measures are not bound by mathematically-defined ceilings, and they are insensitive to whether the outcome is defined positively or negatively. While these are obvious advantages of the odds ratio, it has the disadvantage that it is hard to interpret by non-researchers (Walter 2000), who may tend to misinterpret this measure as a RR (Koolman *et al.* submitted). Moreover, while the insensitivity of the OR to positive or negative health outcomes makes it immune to arbitrary decisions on outcome measures, it does not stimulate the researcher to be explicit in choosing for either a positive or a negative outcome indicator. An explicit choice is valuable in cases where positive and negative indicators, such the immunisation rate versus the non-immunisation rate have different policy implications.

International patterns, as presented in this chapter, can also be used for monitoring. A country's performance in terms of health inequality can be assessed with reference to other countries with similar overall levels of the outcome. The trend-line, representing the average performance of countries at a given overall level, can be used as benchmark. Alternatively, the best possible attainment at a given overall level, or a predefined target may be used as reference. Finally, expectations based on the diffusion of innovations theory, can be used as framework for evaluating observed inequalities.

It can be useful to assess group-specific rates in addition to summary measures of inequality, for example when monitoring differential diffusion of innovations through a population. Again, it is important to take the overall level of the outcome into account. If not, group specific rates may become an indicator of the overall performance of a country, rather than being an indicator of its distribution. Group-specific rates can be benchmarked similarly as described above, using international comparisons.

Summarizing, both absolute and relative inequality measures can be meaningful for monitoring socio-economic health inequalities, provided that differences or changes in the overall level of the outcome are carefully taken into account. This chapter gives advice on how to take this overall level into account when monitoring these inequalities and presents data that can be used for benchmarking of inequalities in the field of maternal and child health in low and middle income countries.

5

Measuring health inequality among children in developing countries: does the choice of the indicator of economic status matter?

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ABSTRACT

Background Currently, poor-rich inequalities in health in low and middle income countries receive a lot of attention from both researchers and policy makers. Since measuring economic status in low and middle income countries is often problematic, different indicators of wealth are used in different studies. Until now, there is a lack of evidence on the extent to which the use of different measures of economic status affects the observed magnitude of health inequalities.

Methods This chapter provides this empirical evidence for 10 low and middle income countries, using the Demographic and Health Surveys dataset. We compared the World Bank asset index to three alternative wealth indices, all based on household assets. Under-5 mortality and measles immunisation coverage were the health outcomes studied. Poor-rich inequalities in under-5 mortality and measles immunisation coverage were measured using the relative index of inequality.

Results Comparing the World Bank index to the alternative indices, we found that (1) the relative position of households in the national wealth hierarchy varied to an important extent with the asset index used, (2) observed poor-rich inequalities in under-5 mortality and immunisation coverage often changed, in some cases to an important extent, and that (3) the size and direction of this change varied per country, index, and health indicator.

Conclusion Researchers and policy makers should be aware that the choice of the measure of economic status influences the observed magnitude of health inequalities, and that differences in health inequalities between countries or time periods, may be an artefact of different wealth measures used.

5.1 INTRODUCTION

Reducing poor-rich disparities in the health and survival of children within low and middle income countries has recently become a main target of national governments and international organisations (Evans *et al.* 2001; WHO 2000). A prerequisite for achieving this goal is to establish how large these differences are. To measure the magnitude of inequality in child survival, household level data on child mortality and economic status are needed.

Measuring household economic status in low and middle income countries poses considerable problems. Data on two frequently used indicators of wealth, household income and expenditure levels, are often unavailable or unreliable (Montgomery *et al.* 2000). Moreover, in countries where a large part of the population works in self-subsistence agriculture or the informal sector, expressing income or expenditure levels in monetary values can be extremely time-consuming and suffers important reliability problems.

In low and middle income countries, the assets that households have acquired are a good indicator of their 'long-run' economic status (Bollen *et al.* 2002; Filmer *et al.* 2001). The World Bank has developed a tool to measure the relative economic position of households using data on durable consumer goods, housing quality, water and sanitary facilities and other amenities (Gwatkin *et al.* 2000). These assets are combined into an index of economic status using principal component analysis (PCA). The PCA method has been shown to provide a measure of economic status that has a higher predictive value, at least with regard to fertility, then other proxies such as an index based on the value of goods owned, or occupation (Bollen *et al.* 2002). Using such an asset index, overviews of health indicators by population wealth quintile were made by the World Bank for countries included in the Demographic and Health Surveys program (DHS) (Gwatkin *et al.* 2000). These reports have become an important source of information on poor-rich inequalities in child health in low and middle income countries.

While many other studies on health inequalities also use household asset ownership as an indicator of economic status (Bollen *et al.* 1999), different researchers use different, often shorter, sets of asset items (*cf.* Bicego *et al.* 1993; Brockerhoff *et al.* 2000; Devin *et al.* 1996; Hoa *et al.* 1997; Justesen *et al.* 2000; Timæus *et al.* 1995; Yassin 2000) Unfortunately there is no information yet on the extent to which the use of alternative lists of asset items leads to different outcomes (Gwatkin 2003). For monitoring and intervention purposes, and for comparative and explanatory analysis it is important to know how large poor-rich

inequalities are, and consequently, how sensitive the magnitude of poor-rich inequalities is to the asset index used. Our study aimed to assess, for a broad set of countries, the extent to which the magnitude of health inequalities is sensitive to the choice of the asset items included in the index.

Two issues related to the selection of specific indicators will be addressed. First, some variables used in the World Bank asset index have, apart from being an indicator of economic status, a direct impact on child health and survival. In explanatory research it can be important to make a conceptual distinction between factors that work *directly* on health, such as the exposure to infections, for instance through unhygienic sanitary facilities, and more distant determinants that only work *indirectly*, such as household wealth (Mosley *et al.* 1984). Whereas the definition of 'direct' and 'indirect' depends on the specific health outcome studied, in an explanatory analysis one would generally prefer an asset index without direct determinants. We expect poor-rich differences in child survival to be smaller when direct determinants of survival, such as water and sanitation facilities, are excluded from the measure of economic status. The magnitude of change, however, is unknown. Therefore, it is important to assess this sensitivity.

The second issue is related to the fact that some of the variables included in the WB index are publicly provided or are dependent on the availability of infrastructure on community level, while the purpose of the index is to measure household –and not community– wealth. While we acknowledge the importance of community resources for child survival, it can be similarly important to be able to separate community from household effects. Electricity is the most obvious variable usually provided on a community basis, but the same can be true for water and sanitation facilities. We expect health inequalities to be smaller when community level indicators of wealth are not included in the asset index. Again, since at present we don't know the extent to which outcomes would change, it is important to assess this sensitivity.

On basis of the above considerations, we decided to construct three alternative indices to the WB index. In the first two alternative indices, important direct determinants of child survival (water supply/sanitation and housing standards respectively) are excluded. The third version also excludes electricity, an item that is strongly determined by supply factors at community level.

In this study we aimed to assess the extent to which the magnitude of inequality in health indicators is sensitive to the use of these three alternative measures of economic status. We analysed inequality with regard to under-5 mortality, which is an important indicator of child health in low and middle income countries. We also analysed inequality with regard to measles immunisation coverage, since not only health but also health care utilisation is an important outcome variable in inequality research and policy making. As water, sanitation and housing operate differently on health and health care utilisation, it is important to check sensitivity for both types of outcomes.

5.2 DATA AND METHODS

Data

The DHS program provides household level data on health, health care utilisation and ownership of assets for about 60 low and middle income countries in three subsequent periods. The data are based on nationally representative surveys. In most countries, between 5,000 and 10,000 women aged 15 to 49 years were interviewed. We obtained the most recent data (surveys held between 1991-1998) for 10 countries from the DHS website (www.measuredhs.com). Bolivia, Brazil, Indonesia, Cameroon, Chad, Kenya, Malawi, Pakistan, Tanzania, and Uganda were included in the study. These countries represented a broad range of contexts in terms of region and under-5 mortality rates. They were also representative of a wider range of countries in terms of the magnitude of mortality inequalities and the pattern of under-5 mortality rates across the quintiles (with both linear and non-linear patterns included) (Gwatkin *et al.* 2000). Furthermore, we chose countries with a relatively large sample size.

Methods

When constructing an index, one of the basic decisions concerns the weights that should be given to each of the index-items. "Equal weights have the appeal of simplicity and apparent objectivity, but these qualities only mask the fact that the imposition of numeric equality is completely arbitrary" (Filmer *et al.* 2001). the World Bank used factor scores derived through principal components analysis (PCA) as the weights of the items in its asset index. Factor scores are a measure of the strength of the association of an item with the first principal component. It is assumed that this first factor represents economic status.

Sample weights were not used during the PCA operation, but were used when constructing population wealth quintiles. Using this method, the World Bank made for each country a separate index. In our study, we adhered to this often-used method of PCA for constructing indices.

Before we compared the World Bank (WB) index with the alternative indices, we attempted to replicate the WB index by applying PCA, using SPSS 9.0, to the same items as The World Bank used. A fairly close replication of the World Bank results as reported by Gwatkin *et al.* (2000) could be achieved. Subsequently, a series of three alternative indices was constructed by leaving out the following items: 1) all water supply and sanitation items; 2) items under 1 plus all housing items; 3) items under 1 and 2 plus electricity. In alternative Index 3 for most countries only durable consumer goods were included. The alternative indices were constructed applying the same PCA method to the shorter list of items.

The indices were compared in the following respects. First, we calculated the percentage of variance in the asset items that could be explained by the first principal component. This indicates the extent to which the variation in asset items between households can be explained by one single measure of economic status. The second feature we examined was whether it was possible to stratify the population into five, about equally large, wealth groups. Quintiles are commonly used in social epidemiology and health economics to compare health outcomes of wealth groups. It allows for a precise description of the association between wealth and health along the whole wealth gradient.

Then, we studied the changes in the categorisation of households when using the alternative indices compared to when using the WB index. Using cross tabulations we calculated the percentage of households remaining in the same quintile, the percentage that moved to the adjoining two quintiles and the percentage that moved to the furthest two quintiles.

Finally, the alternative indices were compared to the WB index in terms of their association with under-5 mortality. We calculated the under-5 mortality rates for the five wealth groups for each of the indices. Under-5 mortality was defined as the proportion of deaths under age 59 months per 1,000 live births of those born during the last 10 years preceding the survey. To have an overall measure of the magnitude of inequality across all wealth groups, we computed the relative index of inequality (RII) for each of the asset indices. We compared the RIIs of the alternative indices with the RII of the WB index. The RII was calculated with logistic regression using a Generalised Estimating Equations (GEE) model

(using SAS 8.2) to correct for the fact that some mothers contribute more than one child to the set of observations, and that the children born to one mother are not statistically independent. The RII is a summary measure of the differences in mortality experience between *all* five wealth groups, and can be interpreted as the (estimated) ratio in odds between the poorest and the richest household. This estimate captures only the linear relationship between wealth and health (Mackenbach *et al.* 1997a).

We performed analogous analyses for coverage rates in measles immunisation. For pragmatic reasons we used the rate of children *not* immunised against measles as outcome measure. The use of this negatively stated measure facilitates comparison with under-5 mortality, also a negatively stated indicator. The rate of children not immunised against measles, here called "immunisation coverage" in short, is defined as the rate of children aged 12-23 months during the survey who were not immunised against measles. We calculated and compared this rate for all five wealth groups using each of the asset indices. We also calculated and compared the RII.

When examining sensitivity, a problem arises if the sizes of the wealth groups differ between the indices. The comparison between indices of group-specific rates is only possible when the groups that are compared are of the same size. If the group size is different, the change in rate could be an artefact, and conclusions can be stated with less certainty. When comparing the RIIs between the indices, different group sizes are generally not a problem as this measure takes into account the size and relative position of the wealth groups.

5.3 RESULTS

Table 5.1 shows the asset items that were included in the four indices for Indonesia. Similar lists of assets were used for the other countries.

The proportion of variance between households in the ownership of assets that is explained by the WB index is quite low (between 12 and 20%). The percentage of explained variance increased upon exclusion of items from the index to an average of 35% in the third, shortest, alternative index including only consumer goods (Table 5.2).

Using the WB index and Index 1 it was possible to distinguish five, equally sized, wealth groups for all countries (Table 5.3). When using Index 2 and 3, consisting of much shorter

Table 5.1 Asset items included in the indices (Indonesia)

	WB index	**Index 1**	**Index 2**	**Index 3**
electricity	X	X	X	
radio or tape recorder	X	X	X	X
television	X	X	X	X
refrigerator	X	X	X	X
bicycle	X	X	X	X
motorcycle or motorboat	X	X	X	X
car	X	X	X	X
gas stove	X	X	X	X
kerosene stove	X	X	X	X
electric stove	X	X	X	X
public toilet	X			
private toilet	X			
bush, field as latrine	X			
other latrine	X			
drinking water piped in residence	X			
drinking water piped into yard	X			
drinking river, canal, surface water	X			
drinking from public faucet (piped)	X			
drinking from well with pump	X			
drinking rainwater	X			
other drinking water	X			
drinking from protected well	X			
drinking from unprotected well	X			
dirt, sand, dung floor	X	X		
wood, plank floor	X	X		
ceramic, marble floor	X	X		
brick floor	X	X		
bamboo floor	X	X		
cement, ceramic tile floor	X	X		
other floor	X	X		
tile roof	X	X		
concrete roof	X	X		
asbestos or zinc roof	X	X		
wooden roof	X	X		
leaves roof	X	X		
other roof	X	X		
wall of bamboo or wood planks	X	X		
other wall	X	X		
bamboo wall	X	X		
clay brick wall	X	X		

X shows the items that were included in the respective asset indices

Table 5.2 Percentage of variance explained by the first factor

Country	WB index	Index 1	Index 2	Index 3
Bolivia	17	20	43	43
Brazil	13	15	40	43
Cameroon	20	29	38	36
Chad	19	30	39	38
Indonesia	14	17	31	32
Kenya	17	23	37	37
Malawi	18	24	25	27
Pakistan	20	27	38	40
Tanzania	16	24	36	36
Uganda	12	19	25	23

lists of items, this was not always possible. In these cases, some wealth groups became very large, while others small or even empty. An extreme example is Chad, where, when using Index 2 and 3 it became impossible to distinguish between the poorest 59% of the population. The reason is that none of the households in this group owned durable consumer goods or electricity, the only items included in Index 2 and 3. Only for Indonesia and Uganda it was possible to make a refined stratification when using all the indices. For Uganda this was dependent on the inclusion of one specific item in the index, i.e. food sufficiency. Upon exclusion of this item from the indices, heaping of the poorest 40% occurred when using Index 2 and 3.

The categorisation of the households into wealth groups was sensitive to the measure of economic status used (Table 5.4). The results are only shown for Indonesia and Uganda, the countries for which a refined stratification could be made using all the indices. For these two countries, on average 27% of the households was categorised into a different quintile when using Index 1. Largest changes were observed when using Index 2 and 3, where on average about 47% of the households had shifted to another quintile. Most of these households moved to an adjoining quintile, while on average 10% of all households moved to a further quintile. When considering all ten countries, at least 18% of the households was categorised into a different quintile when using Index 1 (results not shown).

For almost all countries, the magnitude of inequality in mortality was sensitive to the use of at least one of the alternative indices (Table 5.5). For four of the ten countries, we observed a minor (10-30%) change in RII, while for five other countries the change was substantial (>30%). While for five countries inequality decreased when using alternative indices, for some (2) countries inequality increased compared to the WB index, and for others (2)

Table 5.3 Percentage of household members in each wealth group

Country	Wealth Index	Wealth Group				
		Poorest	**Second**	**Middle**	**Fourth**	**Richest**
Bolivia	WB Index	20	20	20	20	20
	Index 1	20	20	20	20	20
	Index 2	27	11	25	17	21
	Index 3	10	26	26	18	21
Brazil	WB Index	20	20	20	20	20
	Index 1	20	20	20	21	19
	Index 2	20	20	31	1	29
	Index 3	20	20	31	1	29
Cameroon	WB Index	20	20	20	20	20
	Index 1	20	21	19	20	20
	Index 2	34	8	18	19	21
	Index 3	6	31	31	12	20
Chad	WB Index	21	19	20	20	20
	Index 1	22	19	19	20	20
	Index 2	a	59	a	27	15
	Index 3	a	59	a	27	14
Indonesia	WB Index	20	20	20	20	20
	Index 1	20	20	20	20	20
	Index 2	20	19	22	19	20
	Index 3	20	20	21	20	20
Kenya	WB Index	20	20	20	20	20
	Index 1	20	20	20	20	20
	Index 2	28	4	31	18	19
	Index 3	28	5	33	18	16
Malawi	WB Index	19	21	20	20	20
	Index 1	20	22	18	20	20
	Index 2	11	42	9	18	20
	Index 3	11	42	2	26	19
Pakistan	WB Index	20	20	20	20	20
	Index 1	20	20	20	20	20
	Index 2	23	24	11	22	20
	Index 3	37	a	23	21	20
Tanzania	WB Index	20	20	20	20	20
	Index 1	20	20	21	20	20
	Index 2	40	a	15	16	29
	Index 3	40	a	16	19	25
Uganda	WB Index	20	20	20	20	20
	Index 1	20	20	20	20	20
	Index 2	18	21	23	19	20
	Index 3	18	21	21	20	20

Notes: due to rounding off, the rows may not add up to 100%; a due to clustering of households into large groups, no households are categorised in this wealth category

Table 5.4 Change of households to other wealth groups when using alternative indices as compared to WB Index

Country	Wealth Index	% in same wealth group	% moving 1 wealth group	% moving 2 or more wealth groups
Indonesia	Index 1	73	27	0
	Index 2	53	38	9
	Index 3	50	37	13
Uganda	Index 1	72	24	3
	Index 2	56	35	9
	Index 3	54	36	10

Note: due to rounding off, the rows may not add up to 100%

there was a mixed pattern of an increase in inequality when using some alternative indices, and a decrease in inequality when using others.

Similar results were obtained when excluding those cases for which the change in RII could be an artefact. This is the case for some countries when using Indices 2 and 3, due to (a) the lack of a fine stratification of the population over five groups of equal size in combination with (b) a non-linear character of the association between mortality and the relative wealth measure. These cases are indicated in Table 5.5 and 5.6 within parenthesis.

The magnitude of inequality in immunisation coverage changed for all countries when using alternative wealth measures (Table 5.6). For five of the ten countries there was a minor (10-30%) change in RII, while for the remaining countries the RII was substantially (>30%) sensitive. Inequality decreased for five of the countries, when using an alternative index. For one country there was an increase, and for four countries a mixed pattern of increase when using some indices, and a decrease when using others (4). When excluding the countries where the RII estimates for Indices 2 and 3 may be biased due to reasons mentioned above, the conclusions remained roughly the same.

When comparing the non-artefactual changes in inequality in immunisation coverage with those in under-5 mortality, we saw that for most countries the magnitude of inequality of both under-5 mortality and immunisation coverage was sensitive. For one country (Uganda), nevertheless, inequality in under-5 mortality was not sensitive, while inequality in immunisation coverage was substantially sensitive. Furthermore, the direction of change in the two health indicators was not always the same. For Malawi and Bolivia, there was a decrease in inequality in mortality when using the 1st and the 3rd alternative index respectively, while the use of the same indices for immunisation gave rise to an increase in inequality.

Table 5.5 Under-5 mortality rates per wealth group and relative index of inequality (RII)

Country	Wealth Index	Under-5 mortality rates (per 1,000 live births)					RII (95% CI)	
		Poorest	Second	Middle	Fourth	Richest		
Bolivia	WB Index	135.1	106.0	93.4	39.8	32.2	6.30	(4.76, 8.34)
	Index 1	134.6	103.0	96.0	45.0	28.8	6.04	(4.58, 7.97)
	Index 2	130.1	99.3	94.2	44.1	32.7	5.89	(4.43, 7.83)
	Index 3	126.2	120.7	92.4	46.4	32.7	5.29+	(4.02, 6.96)
Brazil	WB Index	89.4	52.5	36.2	26.1	29.3	6.41	(4.02, 10.22)
	Index 1	88.3	49.4	36.6	27.2	33.0	5.55+	(3.51, 8.78)
	Index 2	89.8	47.7	38.7	a	27.0	[5.60+]	(3.66, 8.58)
	Index 3	90.6	47.5	38.7	a	26.8	[5.71+]	(3.73, 8.74)
Cameroon	WB Index	160.0	145.0	120.3	102.5	75.0	2.84	(2.08, 3.87)
	Index 1	174.9	144.4	113.1	95.4	72.4	3.34+	(2.41, 4.61)
	Index 2	146.9	168.0	115.4	99.7	74.4	2.77	(2.03, 3.78)
	Index 3	a	140.2	130.6	78.3	75.8	2.78	(2.02, 3.82)
Chad	WB Index	151.8	207.2	175.2	165.0	155.0	1.08	(0.91, 1.28)
	Index 1	146.8	186.4	232.5	154.4	153.7	1.00++	(0.85, 1.18)
	Index 2	b	184.6	b	157.3	133.9	[1.71++]	(1.40, 2.10)
	Index 3	b	184.2	b	157.4	132.4	[1.70++]	(1.39, 2.09)
Indonesia	WB Index	97.9	67.1	58.0	44.2	25.6	4.65	(3.55, 6.09)
	Index 1	94.4	67.5	59.6	42.6	32.2	3.89+	(2.95, 5.14)
	Index 2	89.7	75.3	62.8	37.1	31.5	3.90+	(3.03, 5.03)
	Index 3	81.2	82.1	65.6	39.4	31.9	3.34++	(2.61, 4.28)
Kenya	WB Index	128.0	120.9	79.3	72.9	54.6	3.29	(2.43, 4.46)
	Index 1	126.3	120.0	76.3	86.8	52.6	3.10	(2.29, 4.21)
	Index 2	112.0	141.6	87.8	106.6	52.3	[2.11++]	(1.57, 2.82)
	Index 3	112.3	141.1	84.8	104.9	53.1	[2.00++]	(1.50, 2.68)
Malawi	WB Index	220.0	203.4	225.5	214.6	159.2	1.31	(1.04, 1.64)
	Index 1	193.4	228.9	233.4	216.5	157.3	1.17++	(0.95, 1.45)
	Index 2	259.2	211.5	183.9	211.1	172.0	[1.49++]	(1.16, 1.90)
	Index 3	257.5	211.2	a	167.0	176.1	[1.50++]	(1.17, 1.91)
Pakistan	WB Index	116.2	133.8	120.7	110.5	68.7	1.80	(1.37, 2.37)
	Index 1	119.2	122.4	134.9	117.9	64.9	1.59+	(1.22, 2.08)
	Index 2	126.6	117.9	134.8	113.8	69.2	[1.83]	(1.39, 2.42)
	Index 3	118.3	b	133.3	99.3	71.7	[1.61+]	(1.22, 2.13)
Tanzania	WB Index	124.2	162.1	125.7	136.2	85.5	1.48	(1.20, 1.83)
	Index 1	121.4	157.9	151.3	121.1	86.0	1.49	(1.21, 1.82)
	Index 2	149.6	b	133.5	115.4	102.5	[1.91++]	(1.51, 2.41)
	Index 3	b	149.3	132.3	105.7	106.9	[1.82++]	(1.44, 2.30)
Uganda	WB Index	162.7	132.8	136.0	134.6	95.7	1.72	(1.38, 2.15)
	Index 1	157.4	145.3	133.6	129.3	98.5	1.76	(1.41, 2.19)
	Index 2	157.6	144.3	136.3	126.9	99.9	1.77	(1.42, 2.21)
	Index 3	157.6	144.2	135.2	130.3	98.9	1.76	(1.41, 2.20)

Notes: [] RII's in parentheses indicate that results may be an artefact due to a combination of population heaping and a non-linear association of under-5 mortality with wealth; a rates are not shown due to small sample size (smaller then 500), referring to the denominator, i.e. live births during the last 10 years preceding the survey; b empty cell due to heaping (see Table 5.2); + 10-30% change in RII compared to the WB index; ++ >30% change in RII compared to WB index

Table 5.6 Measles immunisation rates per wealth group and relative index of inequality (RII)

Country	Wealth Index	% children aged 12-23 months not immunised against measles					RII (95% CI)	
		Poorest	Second	Middle	Fourth	Richest		
Bolivia	WB Index	59.5	59.2	54.3	47.3	33.6	3.15	(2.02, 4.93)
	Index 1	58.6	62.6	51.0	48.0	33.3	3.30	(2.10, 5.18)
	Index 2	59.9	60.9	53.9	43.9	35.4	3.43+	(2.18, 5.41)
	Index 3	60.5	59.8	54.5	44.0	35.4	3.46+	(2.18, 5.48)
Brazil	WB Index	26.7	15.0	7.7	8.4	10.2	7.14	(2.76, 18.46)
	Index 1	26.4	14.4	7.5	10.9	8.4	6.55	(2.65, 16.17)
	Index 2	26.3	14.5	8.8	a	9.0	[5.87+]	(2.51, 13.74)
	Index 3	26.2	14.3	8.8	a	9.0	[5.98+]	(2.54, 14.06)
Cameroon	WB Index	58.0	59.7	56.5	39.2	23.5	7.02	(3.81, 12.94)
	Index 1	60.5	62.8	53.1	33.1	27.0	8.71+	(4.51, 16.82)
	Index 2	60.5	61.8	49.6	40.1	27.4	[6.92]	(3.72, 12.86)
	Index 3	a	62.0	48.9	44.3	27.3	[5.35+]	(2.89, 9.91)
Chad	WB Index	89.9	86.7	82.1	72.2	65.9	7.39	(4.43, 12.35)
	Index 1	84.9	90.0	81.9	76.6	64.8	5.45++	(3.22, 9.21)
	Index 2	b	87.3	b	73.6	60.1	10.23++	(5.93, 17.63)
	Index 3	b	87.4	b	73.6	59.2	10.70++	(6.20, 18.46)
Indonesia	WB Index	46.3	35.4	33.3	28.7	16.1	4.74	(3.24, 6.95)
	Index 1	45.7	36.0	30.4	30.6	18.3	4.13+	(2.81, 6.06)
	Index 2	43.2	42.3	29.4	27.6	18.2	4.55	(3.11, 6.65)
	Index 3	42.2	42.0	29.2	29.3	18.3	4.08+	(2.78, 5.98)
Kenya	WB Index	41.8	33.8	18.5	20.5	15.4	6.13	(3.43, 10.95)
	Index 1	39.7	35.5	20.6	20.5	15.3	6.02	(3.39, 10.66)
	Index 2	34.5	43.7	22.7	28.8	17.5	[2.80++]	(1.62, 4.83)
	Index 3	34.0	42.2	21.8	28.6	20.0	[2.35++]	(1.36, 4.08)
Malawi	WB Index	30.2	23.4	25.3	20.7	11.8	2.89	(1.55, 5.38)
	Index 1	32.1	20.8	26.7	19.0	12.0	3.26+	(1.77, 6.02)
	Index 2	26.3	26.8	21.4	19.4	15.8	[2.37+]	(1.22, 4.61)
	Index 3	26.3	26.8	a	18.7	17.6	[2.23++]	(1.13, 4.39)
Pakistan	WB Index	75.2	61.6	52.0	52.6	28.0	9.00	(5.13, 15.77)
	Index 1	76.9	62.0	52.3	51.7	28.3	9.48	(5.50, 16.33)
	Index 2	76.9	59.7	53.5	50.0	29.8	[9.96+]	(5.45, 18.21)
	Index 3	66.5	b	60.9	48.5	30.0	[7.01+]	(3.98, 12.31)
Tanzania	WB Index	40.6	30.6	30.2	18.0	13.4	5.80	(3.60, 9.35)
	Index 1	36.7	31.3	31.4	21.9	12.3	4.22++	(2.67, 6.68)
	Index 2	33.0	b	36.8	21.1	17.1	3.45++	(2.13, 5.57)
	Index 3	b	32.5	36.7	18.0	19.6	2.85++	(1.76, 4.62)
Uganda	WB Index	53.8	58.0	42.1	45.6	28.4	3.49	(2.29, 5.31)
	Index 1	50.5	51.5	48.2	49.9	27.8	2.47++	(1.64, 3.73)
	Index 2	54.4	46.7	48.9	46.1	34.0	2.18++	(1.45, 3.28)
	Index 3	54.4	46.7	47.9	47.1	34.0	2.11++	(1.40, 3.18)

Notes: [] RII's in parentheses indicate that results may be an artefact due to combination of population heaping and a non-linear association of immunisation coverage with wealth; a rates are not shown due to small sample size (smaller then 50) referring to the denominator, i.e. children aged 12-23 months at the time of the survey.; b empty cell due to heaping (see Table 5.2); + 10-30% change in RII compared to the WB index; ++ >30% change in RII compared to WB index.

5.4 DISCUSSION

This study shows that the ranking of households into wealth groups and the magnitude of poor-rich inequality in under-5 mortality and immunisation coverage are sensitive to the measure of economic status used. The size and direction of change, however, varied per country and alternative index, in some cases ranging up to a 60% change in observed inequality.

Our results seem to contrast to the findings of Filmer and Pritchett, who found that the ranking of households is robust to the items included (Filmer *et al.* 2001). However, their conclusions are based on the analysis of only one country (India). Furthermore, they did not analyse the sensitivity of the association of such ranking with a health outcome such as mortality.

Bollen and colleagues (2002) compared a broad set of proxies for economic status, including a PCA-based consumer goods index, education and occupation for two countries, using fertility as outcome variable. They concluded that the effect of economic status varied with the measure used, and that the PCA-based method was most predictive. Our in-depth comparisons of different PCA-based indices show that even for this specific type of measure, the specific indicators used influence the magnitude of observed inequalities. In addition, our analyses of a broad set of countries showed that the extent and direction of sensitivity varies between countries. Moreover, our findings for both mortality and immunisation demonstrate that sensitivity also can vary with the outcome measures studied.

Which weight should we attribute to the sensitivity observed? While observed inequalities changed for most countries, in many of these cases the order of magnitude remained the same: large inequalities remained large, small inequalities small. Moreover, the confidence intervals of the RIIs were large and overlapping. While this can not be interpreted as a lack of statistical significance -the RIIs have not been calculated on basis of independent groups- it does indicate that the importance of the sensitivity found should not be overestimated. Furthermore, the reliability of the retrospective surveys used is not such to allow for very precise estimation of poor-rich differences in health. So in many cases, the changes in inequality found when using alternative measures of economic status, are not alarming. However, in a number of cases the measure of economic status used did make an important difference, ranging up to a 60% change in RII. Therefore, it is important to be aware that the

measure of economic status used can affect observed poor-rich differences in health and health related outcomes.

We expect also for other low and middle income countries and health outcome measures inequality to be sensitive to the measure of economic status used. The countries included in our study are diverse in terms of region, average mortality levels and pattern of inequality (Gwatkin *et al.* 2000). Yet, since the size and direction of change varied by country, index and health indicators, it is difficult to predict this *a priori* for specific cases.

An issue that needs to be mentioned is related to the method of PCA for constructing indices. Even though PCA can be a useful measure for constructing composite indices, it may produce odd results when applied to short lists of items as in Index 2 and 3. In Cameroon, for example, the item 'bicycle' got a negative factor score. As a consequence, households owning only a bike, were categorised as poorer compared to households owning nothing. The question arises whether in such cases the asset index is still conceptually valid. While this problem could have influenced the results in such specific cases, it is not likely to have influenced our overall conclusions.

It also needs to be mentioned that the distinction between direct and indirect determinants is not always clear-cut. One could, for example, argue that since the type of stove owned can have a direct effect on respiratory illnesses, it should have been excluded from the alternative indices. The additional exclusion of these items, will, most likely, lead to even larger sensitivity than reported. Generally, in explanatory studies, it should be made explicit, for instance by using a conceptual framework, which factors are considered as direct and which as indirect determinants.

Finally, it must be remembered that in this study we examined poor-rich differences, and their sensitivity to the measure of economic status, in a descriptive way. It was not the purpose of this study to establish whether the wealth and health are causally related. Readers should keep this in mind when interpreting the results.

Explaining the results

Sensitivity of inequality to alternative constructions of the WB index is likely to be related to the low common variance of the items in the WB index. This low common variance can be explained by the fact that the WB includes a broad range of different items, each of

which has its own determinants besides economic status. Upon exclusion of items from this index, the common variance increased. The reason is that the new lists were shorter and consisted of more homogeneous sets of items. As a consequence, the categorisation of households into wealth groups changed, leading in its turn to different mortality rates per wealth group.

Even though the observed sensitivity is understandable, it is more puzzling why the use of alternative indices had different effects for different countries as well as for different outcome indicators. Below, we will forward some explanations.

We hypothesised that inequality in under-5 mortality would decrease upon exclusion of water and sanitation items from the WB index and would further decrease upon exclusion of housing items. This is because we expected that part of the relationship between wealth as measured by the WB index and under-5 mortality would be explained by variables that have a direct effect on child mortality, apart from their indirect effect as indicators of economic status (Bollen *et al.* 1999). For a number of countries we saw this expected decrease. This supports the hypothesis that for some countries part of inequality in mortality measured using the WB index can be attributed to direct determinants of health rather then to economic status alone.

This hypothesis, however, cannot explain the decrease in inequality in immunisation coverage observed for some countries upon exclusion of direct determinants of health from the index. The reason is that housing characteristics, and water and sanitation facilities only influence immunisation coverage as indicators of economic status, and don't have a 'direct' impact that is comparable to their effect on mortality. An alternative hypothesis would be that water and sanitation facilities and housing characteristics are also indicators for regional development or rural/urban residence. For instance, using the bush as latrine probably indicates rural residence, whereas using a private toilet is probably more related to urban residence. Therefore, the decrease in observed inequality in both mortality and immunisation may also in part be explained by the fact that the WB index captures rural-urban differences in both wealth and the health indicators.

We expected a further decrease in inequality upon subsequent exclusion of electricity from the index. Electricity can be an indicator of community wealth. Regional disparities in the availability of electricity probably run parallel to disparities in access to and quality of health care services and disparities in mortality. When excluding electricity from the asset

index, these regional disparities in wealth and mortality as measured through electricity, are given less weight. Doing so, one can expect a decrease in inequality in mortality. We saw that indeed for a number of the countries, inequality in under-5 mortality decreased upon exclusion of electricity from the wealth index. This may indicate that health inequality as measured by the WB index, through electricity, also captures for some countries some of the regional disparities in wealth and health.

The hypotheses above, however, cannot explain why in some cases inequality was not sensitive, and why in one case inequality in under-5 mortality increased, instead of decreased. Additional explanations therefore need to be sought.

Inequality in under-5 mortality was robust to changes in the measure of economic status used for Uganda. This is related to the fact that Uganda was the only country for which items on food sufficiency were included in the WB index. When doing an additional analysis, excluding food sufficiency from all four indices, the RII became slightly sensitive also for this country (the largest change in RII being 14%, from 1.68 when using the WB index to 1.77 when using Index 1). Sensitivity thus may depend on the specific items included in the asset index.

The slight increase in inequality in under-5 mortality in Cameroon upon exclusion of water and sanitation items could not be attributed to the above factors. As already mentioned, household ownership of assets is also determined by other factors besides economic status, such as local availability and preferences. These factors can act as confounders in the relationship between household wealth and child mortality. Apparently, these confounders are in some cases more difficult to disentangle than in others. Multivariate analysis would be needed to gain more insight into these relationships, and thus into the underlying mechanisms linking wealth and health.

Implications

Our study shows that researchers and policy makers should be aware that the choice between alternative indicators of economic status often does affect, and in some cases to an important extent, the observed magnitude of poor-rich differences in health and health-related outcome measures. It also shows that it is difficult to predict the size and direction of sensitivity.

This is important in the present context in which monitoring and tackling poor-rich inequalities in low and middle income countries have become increasingly important policy objectives, and in which many studies are being published on this issue. One of the major difficulties this new field is facing, is determining who is rich and who is poor. An index based on household ownership of assets is an often-used way to do so. Different researchers, however, use different sets of asset items. Our study shows that who is defined as poor and who as rich, varies with the asset items included in the index.

Our study implies that we should be extremely careful comparing results of studies using different indicators of economic status, as differences between countries and trends over time may in part be an artefact of the different indicators used. This is important both for monitoring health inequalities, evaluating the effects of policy interventions on these inequalities, and for targeting the poor in health policies. The choice of the measure of economic status should therefore be carefully made.

For descriptive and monitoring purposes we advise to use a comprehensive list of asset items such as used by the World Bank. A good alternative would be a much more extended list of consumer goods. In countries or regions where durable consumer goods are hardly accessible to anyone, or where investments in housing and amenities are given priority, the latter can be important indicators of economic status or wealth. Moreover, surveys such as the DHS only include a limited number of durable consumer goods, whereas items that the poor and inhabitants of rural areas are likely to own (*e.g.* chair, plastic recipients, animals, farming tools) are not included. In such cases, the inclusion of water, sanitation and housing items facilitates stratification of households at the lower end of the wealth ladder. For these reasons, it would generally be advisable to use a comprehensive list of asset items for descriptive and monitoring studies.

For explanatory studies, though, it can be important to analyse the different sets of asset items separately, and not to combine them into one index. It enables the assessment of the relative importance of different components of material wealth, especially water and sanitation versus housing versus consumer items versus indicators of community wealth. Estimates of the relative importance of these components can contribute to the detection of causal mechanisms that are most responsible for high child mortality among poor families. This information is important for intervention purposes, since it addresses questions such as: would it be more effective to invest in income generating projects or in housing, water and sanitation programs; and should development efforts be focussed on the household

level or the community level? For such explanatory studies it would be advisable to use multiple regression, path analysis or similar multivariate techniques.

For those designing new surveys intending to measure economic status in low and middle income countries, we advice to also include items that poor households are likely to own and indicators of economic status in rural areas, such as the ownership of land, animals, and farming tools. Also the inclusion of context-specific indicators of economic status, as shown by the example of 'food sufficiency' in Uganda, would be useful when aiming to make a refined stratification along the lines of economic status. The inclusion of 'rural' and context specific items can also be important for making a proper identification of target groups for health policies.

Conclusions

Since data on household income or expenditure are often unavailable or unreliable as measure of economic status in low and middle income countries, the use of an asset index is a good alternative to distinguish wealth layers within a population. Users of an asset index should, however, be aware that choice of assets influences the outcomes observed. Therefore, researchers should carefully select the items they include in the index, using the considerations mentioned above, and should be very careful when comparing results of studies using different indices.

Part II

Cross-national analyses

6

Determinants of under-5 mortality among the poor and the rich: a cross-national analysis of 43 developing countries

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ABSTRACT

Background Under-5 mortality is unacceptably high in many countries, the burden of which is mainly borne by the poor. Whereas country characteristics are known to influence under-5 mortality, it is unknown whether these have a different impact on the poor and the rich. We aimed to describe how the association between under-5 mortality and socio-economic, political, and health care factors varies in strength between richer and poorer children.

Methods Cross-national analysis of 43 low and middle income countries using wealth-group specific under-5 mortality rates as outcome. Relative effects were estimated using OLS regression; differences in associations between wealth groups were tested.

Results Higher national incomes were associated with lower under-5 mortality rates. This association was significantly weaker for the poor compared with the rich (p=0.014). Ethnic fragmentation was significantly more strongly associated with higher under-5 mortality among the poor compared with the rich (p=0.027). The association between public spending on health and under-5 mortality was stronger for the poor (p=0.0001). Skilled delivery attendance and immunization coverage among the poor were significantly more strongly related to public spending on health than such health care use among the rich (p=0.0001 and p=0.045, respectively). No differentials in the relative effect of female literacy, democracy and state strength were observed.

Conclusion Our results suggest that economic growth is associated with widening poor-rich disparities in under-5 mortality. Increased public spending on health might partly remedy this effect.

6.1 INTRODUCTION

Some populations are healthier than others. Low and middle income countries exhibit enormous variation in life expectancy and under-5 mortality levels. Under-5 mortality varies from 37/1,000 in Colombia to 303/1,000 in Niger. National-level determinants of population health explaining differences between countries and trends over time (McKeown 1976; Szreter 2002) have been extensively studied. Female literacy (Caldwell 1986, 1993; Cleland *et al.* 1988) and national income (Preston 1975; Pritchett *et al.* 1996) are well-known determinants, as are political development (Frey *et al.* 1999; Shen *et al.* 1997) and government commitment to health care (Anand *et al.* 1993; Caldwell 1986; Gupta *et al.* 2002; Halstead *et al.* 1985).

However, is what is good on average, also good for the poor? Poorer groups within low and middle income countries systematically exhibit higher under-5 mortality rates than richer groups (Gwatkin *et al.* 2000). Improving the health of the poor is a major objective of national governments and international organizations (Evans *et al.* 2001; WHO 1999a; World Bank 1997). Imperative to achieving this goal is identifying the causes of high mortality among the poor. These causes have usually been sought at the level of the household, for instance in health-related behaviour (Schellenberg *et al.* 2003). Much less is known about the extent to which national-level factors, like government health spending, differentially influence mortality levels among poorer and richer children.

Although all wealth layers may profit from, for example, higher levels of socio-economic development, not all may benefit equally. Benefit-incidence studies have shown that the rich often profit most from public investments in education and health (Castro-Leal *et al.* 2000). This unequal effect has, however, only rarely been studied in relation to health outcomes. Only scattered references occur in the literature, and these focus mainly on the differential mortality effects of public spending on health (Bidani *et al.* 1997; Gupta *et al.* 2003). It is important to answer the same question for a broader set of national-level determinants, as this may provide new insight into the causes of high mortality rates among the poor.

This chapter aims to describe to what extent the association between under-5 mortality and well-known socio-economic, political, and health care factors varies in strength between richer and poorer children within countries. Under-5 mortality is an often-used indicator of population health, and data on under-5 mortality are relatively reliable compared to

other measures of population health. Our hypothesis is that country-level determinants of population health interact with the relative position of individuals in the national wealth hierarchy. The importance of this relative position to health has been described in previous studies (Wilkinson 1996). As a corollary, the effects of these national-level determinants would vary between poor and rich children. On the basis of the existing literature we would expect socio-economic improvement to have stronger effects on mortality among the rich (Victora *et al.* 2000; Wagstaff 2002), and political development and government commitment to health care to have stronger effects on mortality levels among the poor (Bidani *et al.* 1997; Gupta *et al.* 2003). This hypothesis is tested on a cross-national dataset for 43 low and middle income countries, using observed wealth-specific under-5 mortality rates as dependent variable.

6.2 DATA AND METHODS

Data on under-5 mortality for 43 countries in Africa, Asia, and Latin America were obtained from World Bank Country Reports (Gwatkin *et al.* 2000). These reports give, for each of the countries, the under-5 mortality rate for the total population and stratified for five, equally large, wealth groups.

The Country Reports are based on data collected through the Demographic and Health Surveys (DHS) program (www.measuredhs.com). The DHS are nationally representative surveys, for which usually between 5,000-10,000 women, aged 15–49 years, are interviewed. The surveys include retrospective birth histories, which provide mortality data for individual children. The surveys also include information on household ownership of assets.

In the Country Reports, under-5 mortality was defined as the number of deaths under age 60 months per 1,000 live births of those born during the 10 years preceding the survey. Wealth was defined in terms of household ownership of assets. The assets were combined into a wealth index using principal components derived weights (Filmer *et al.* 2001; Gwatkin *et al.* 2000). This index has been shown to be a good measure of relative economic position in low and middle income countries (Bollen *et al.* 2002; Filmer *et al.* 2001). Wealth groups were constructed such that each consisted of 20% of the survey-population.

Table 6.1 Descriptive statistics for included outcome and predictor variables

	Mean	Mini-mum	Maxi-mum	Standard Deviation	No. of missing	Reference Year	Source
Under-5 mortality population average	126	37	303	63	0	1990–1998*	DHS [a, b]
Under-5 mortality rich	79	20	184	47	0	1990–1998*	DHS
Under-5 mortality next-rich	112	27	315	67	0	1990–1998*	DHS
Under-5 mortality middle	129	31	348	71	0	1990–1998*	DHS
Under-5 mortality next-poor	142	37	355	72	0	1990–1998*	DHS
Under-5 mortality poor	149	43	298	65	0	1990–1998*	DHS
Real GDP per capita (PPP$)	1748	524	4718	1236	0	1990	HDR 1993† [c]
Female adult literacy rate (% 15+)	53	9	99	27	0	1990	HDR 1993‡
Measure of democracy§	5.0	2	7	1.7	4	1980	Easterly *et al* .[d, e]
Index of ethnic fragmentation ||	0.59	0.01	0.93	0.29	7	1960	Easterly *et al.*
Tax revenue (% of GDP)	13.9	5.9	29.3	6.0	8	1990	WDI 2002 [f]
Public health expenditure p.cap. (PPP$)	41.8	8.4	137.3	36.9	0	1990	WDR 1993¶ [g]
Immunization coverage population average**	50	11	82	19	1	1990–1998*	DHS
Immunization coverage rich	66	23	95	15	1	1990 -1998*	DHS
Immunization coverage next-rich	56	17	93	19	1	1990 -1998*	DHS
Immunization coverage middle	50	6	85	22	1	1990 -1998*	DHS
Immunization coverage next-poor	46	9	80	21	1	1990 -1998*	DHS
Immunization coverage poor	38	4	83	20	1	1990–1998*	DHS
Skilled delivery attendance population average ††	52	8	100	23	0	1990 -1998*	DHS
Skilled delivery attendance rich	84	30	100	17	0	1990 -1998*	DHS
Skilled delivery attendance next-rich	66	9	100	25	0	1990 -1998*	DHS
Skilled delivery attendance middle	51	4	99	28	0	1990 -1998*	DHS
Skilled delivery attendance next-poor	42	3	100	28	0	1990 -1998*	DHS
Skilled delivery attendance poor	31	2	99	26	0	1990 -1998*	DHS

Notes: Included countries were: (Africa): Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Comoros, Côte d'Ivoire, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Senegal, Tanzania, Togo, Uganda, Zambia, Zimbabwe; (Asia): Bangladesh, India, Indonesia, Nepal, Pakistan, Philippines, Vietnam; (Latin America): Bolivia, Brazil, Colombia, Dominican Republic, Guatemala, Haiti, Nicaragua, Paraguay, Peru; (Other): Kazakhstan, Kyrgyz Republic, Morocco, Turkey, Uzbekistan. * Years in which the DHS surveys were conducted. † For 5 countries with missing data, the Human Development Report 1994 and 1996 were used (reference years 1991 and 1993). ‡ For 9 countries with missing data, the Human Development Report 1992 and 1998 were used (reference years 1990 and 1995). § Gastil's political rights index: 1 (most democratic) to 7 (least democratic); 1980 is the latest year available from the dataset used. || Gives the probability that two randomly selected individuals in a country will belong to different ethnolinguistic groups. ¶ For 2 countries with missing data, the Human Development Report 2002 was used (reference year 1990). ** Proportion of surviving children, aged 12-23 months at time of the survey, who received BCG, measles, three doses of DPT and oral polio vaccines. †† Proportion of deliveries attended by a medically trained person (i.e. doctor, nurse, or nurse-midwife) during the five years preceding the survey. a (Gwatkin *et al.* 2000), b (www.measuredhs.com), c (UNDP 1993), d (Easterly *et al.* 1997), e (www.worldbank.org/research/growth/ddeale.htm), f (World Bank 2002), g (World Bank 1993)

Countries for which Country Reports were available at the time of analysis, were included in our study (Table 6.1).

Explanatory variables

Three types of country characteristics are of particular importance for child survival: the level of socio-economic development, political development, and government commitment to health. Some of the indicators, such as democracy, are contextual variables by definition. For others, like a country's female literacy rate, there are indications that they exert a contextual effect on mortality, above and beyond their individual-level effect.

Socio-economic development, with GDP (Gross Domestic Product) per capita and female literacy rate as key indicators, is a well-known determinant of under-5 mortality. There is some empirical evidence that economic growth tends to be translated into faster mortality declines among the better-off compared with the poor, and that this might be explained partly by a faster adoption of new health technologies by the more wealthy (Victora *et al.* 2000; Wagstaff 2002). To account for the well-known curvilinear relationship between income and mortality (Preston 1975) we used the $\log_{10}$ of real GDP per capita [adjusted for Purchasing Power Parity (PPP)]. Although the individual-level effects of female literacy on child survival are universally acknowledged, there are indications that female literacy also has effects at the country level over and above those at the individual level (Caldwell 1993). High female literacy rates are thought to be associated with increased overall women's autonomy (Sen 1999). Also, they are assumed to reflect 'the capacity of a system to organize and mobilize to fulfil societal necessities' (Palloni 1981).

There is a lot of debate, both in scientific and political discourse, about the importance of governance for human development (UNDP 2002). Democracy and state strength are elements of governance that are of main concern. Some studies suggest an effect of democracy or political rights (Caldwell 1993; Frey *et al.* 1999; Sen 1999) and state strength (Shen *et al.* 1997) on child survival, though this has been debated by others (Frey *et al.* 2000). Our study is the first to empirically describe the strength of the association between democracy and state strength on the one hand, and mortality among poorer and richer children on the other. Democracy, through competition for political power, is thought to make 'politicians more likely to respond to people's needs', thereby being conducive to human development (UNDP 2002 p. 56). We have used one of the most, if not the most, often used indicators of democracy and state strength. State strength, measured by tax revenue as percentage of

GDP, indicates a state's capacity to extract resources, which can be used for public goods and services (Frey *et al.* 2000; Shen *et al.* 1997). Gastil's political rights index was used as measure of democracy (Easterly *et al.* 1997; Gastil 1990). To facilitate interpretation, we recoded the index from a 1 (most democratic) to 7 (least democratic) scale to a 0 (most democratic) to 1 (least democratic) scale.

Ethnic fragmentation, a socio-political country characteristic, has been reported to be associated with higher under-5 mortality levels (Filmer *et al.* 1999). Ethnic fragmentation, defined as 'the probability that two randomly selected individuals in a country will belong to different ethnolinguistic groups', is closely associated with measures of social polarization and conflict. It has been shown to foster rent-seeking behaviour and to impede decision-making about the provision of public goods (Easterly *et al.* 1997).

The effect of public spending on health on under-5 mortality levels is being debated. Whereas some studies find such an effect (Anand *et al.* 1993; Gupta *et al.* 2002), others find less or no support for this claim (Filmer *et al.* 1999). There are also studies that suggest that public spending especially impacts on mortality levels among the poor (Bidani *et al.* 1997; Gupta *et al.* 2003). We calculated public spending on health per capita (in PPP terms) by multiplying public spending on health as percentage of GDP by GDP per capita (PPP). The $\log_{10}$ of public health spending was taken, as this has been shown in previous literature to be the appropriate functional form (Gupta *et al.* 2002).

The data used are for 1990, unless otherwise stated (Table 6.1). Hence, the reference year of the explanatory variables falls roughly in the same period as the included birth histories.

Statistical analysis

The associations between the determinants and under-5 mortality were studied using OLS linear regression analysis, following the example of influential papers (Filmer *et al.* 1999; Gupta *et al.* 2001). First, the univariate relationship between mortality and each of the determinants was studied. Next, confounders that *a priori* were considered important –female literacy, ($\log_{10}$)GDP per capita, and region– were added to the model. Female literacy and GDP per capita are probably the most universally acknowledged country-level determinants of under-5 mortality, as well as being closely associated with the performance of countries in a range of other dimensions, including those studied here. 'Region' captures a whole set of, among others, historical, geographical and cultural factors, that are associated

both with under-5 mortality and with the explanatory variables studied. By adding dummies for regions as confounder to the model, we were able to adjust for this entire range of potential confounders.

The effects of the explanatory variables were expressed in relative terms, as is conventional in research studying health outcomes. Relative effects of the explanatory variables were obtained by using the $\log_{10}$ of under-5 mortality (U5M). Relative effects, measured in rate ratios, were calculated by taking 10 to the power of the (unstandardized) regression coefficients of the explanatory variables, yielding the factor by which under-5 mortality changes, given a change in the explanatory variable of 1 unit. As rate ratios > 1 are intuitively easier to interpret, the explanatory variables were coded such that 0 indicated the highest or most 'desirable' value, and 1 the lowest or least 'desirable' value. Since the $\log_{10}$ was used for GDP and health spending, the rate ratio in these cases indicates the factor by which mortality changes upon a 10-fold change in the explanatory variable.

First, we estimated the effects of the explanatory variables for the total population and per wealth quintile. The formula for the analysis of the effect of GDP per capita on under-5 mortality, corrected for female literacy (Flit) is presented as an example. Dummies for regions were handled in the model analogous to female literacy.

For every single wealth quintile we fitted

$$\log(U5M_i) = b_0 + b_1 \log(GDP)_i + b_2 Flit_i + \varepsilon \qquad \varepsilon \sim N(0, \sigma^2) \qquad (1)$$

where *i* stands for country.

This is exactly the same analysis as can be performed for the total population, and leads to the effect sizes and confidence intervals presented in Table 6.2.

Then, to test whether there was a linear trend in the effect of explanatory variables across wealth quintiles, we collapsed the five quintile specific datasets into one large dataset. If all parameters in the analysis using the collapsed dataset were made quintile-specific, the results would be identical to the ones estimated by using Equation (1). Instead, we restricted the quintile specific parameters b_{1q} in such a way that they lay on a straight line. This was done by replacing b_{1q} with $b_{11} + b_t(q - 1)$, where q is wealth class as a continuous variable. This construction in effect means that the differences between adjacent b_{1q}'s are constant

with value b_t. By adding, in the collapsed dataset, country as a categorical variable to the model, we ensured that differences in mean mortality level between countries are removed from the error term, thereby enhancing the power of the analysis. Again, the formula for the analysis of the effect of GDP per capita on under-5 mortality, corrected for female literacy is presented as an example.

$$\log(U5M_{iq}) = b_{0i} + [b_{11} + b_t(q - 1)] \log(GDP)_i + b_{2q}Flit_i + \varepsilon \qquad \varepsilon \sim N(0, \sigma^2) \qquad (2)$$

where b_{0i} represent different intercepts for each country, which is the same as adding country as categorical variable to the model.

The residual number of degrees of freedom for model 2 is 43*5 (number of observations) – 43 (different intercepts for country) – 1 (trend for GDP) – 4 (interaction parameters for Flit). As the different intercepts for country are merely nuisance variables (uncorrelated with the effects of interest), the model fits essentially five parameters with 167 residual degrees of freedom. This implies that the number of observations is adequate to fit the model reliably.

Two additional analyses were performed to explore two main findings in this chapter in further depth. First, we assessed whether the significantly stronger effect of GDP on richer groups (see Results section) could be explained by an unequal distribution of income within countries. For this purpose, income inequality was added as fourth confounder to the models for GDP. This was done for two measures of income inequality, the gini-index and the share of income or consumption of the richest to the poorest 20% population group.

Secondly, we assessed whether the significantly stronger effect of public spending on health on mortality levels among the poor (see Results section), could be explained by a stronger effect of such spending on health care utilisation in this group. For this purpose, we used public spending on health as an explanatory variable of (i) full childhood immunisation coverage, and (ii) skilled delivery attendance, using a similar line of analysis as described above.

To make optimal use of the data, the number of countries included was allowed to vary according to the number of missing cases per explanatory variable. The analyses were performed with GLIM4 (Francis *et al.* 1993).

6.3 RESULTS

The countries included varied widely, both in terms of level of development and in the extent of ethnic fragmentation (Table 6.1). Furthermore, the mean under-5 mortality rate among poorer children was much higher than that among richer ones.

In countries with a 10–fold higher GDP per capita, total under-5 mortality was on average a 4.4–fold lower (95% CI 3.1, 6.2) (Table 6.2). After adjustment for female literacy, the effect of GDP was 2.4 (results not shown). Additional adjustment for region further reduced the effect to 1.95 (Table 6.2), meaning that, after adjustment, a 10-fold higher GDP per capita was associated with an almost two-fold lower mortality rate.

Table 6.2 Relative effect of socio-economic development on under-5 mortality

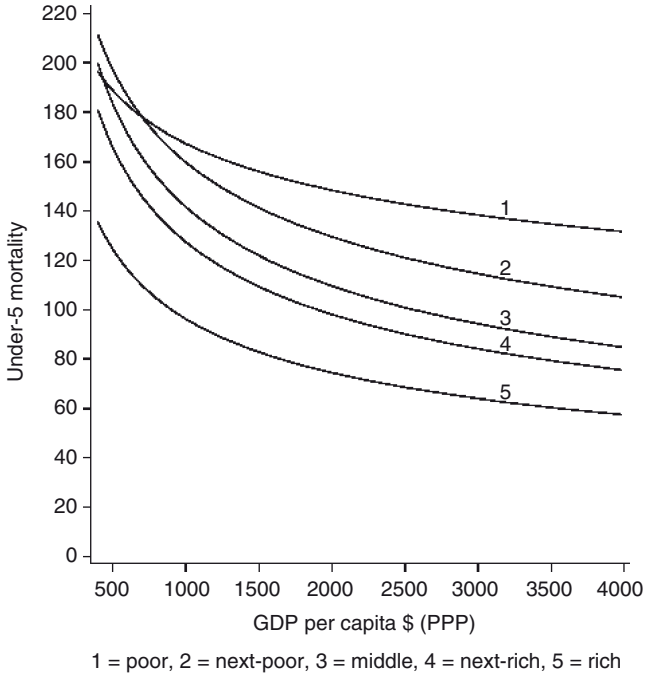
Wealth group	**Effects on under-5 mortality**				
	GDP per capita*			**Female literacy***	
	Univariate	Adjusted for female literacy, region (95% CI)	Adjusted for female literacy, region, gini-index (95% CI)	Univariate	Adjusted for GDP, region (95% CI)
Total	4.41 (3.13, 6.21)	1.95 (1.28, 2.97)	1.95 (1.27, 2.99)	4.90 (3.39, 7.10)	2.50 (1.71, 3.65)
Rich	5.99 (4.08, 8.81)	2.35 (1.45, 3.82)	2.35 (1.44, 3.83)	5.90 (3.85, 9.04)	2.20 (1.42, 3.42)
Next-rich	5.55 (3.77, 8.15)	2.39 (1.47, 3.89)	2.39 (1.47, 3.90)	6.04 (3.94, 9.26)	2.68 (1.73, 4.16)
Middle	5.00 (3.40, 7.35)	2.35 (1.45, 3.83)	2.35 (1.45, 3.83)	5.63 (3.67, 8.63)	2.77 (1.78, 4.29)
Next-poor	4.93 (3.35, 7.24)	2.01 (1.24, 3.27)	2.01 (1.24, 3.27)	5.61 (3.66, 8.59)	2.73 (1.76, 4.24)
Poor	3.35 (2.28, 4.93)	1.49 (0.92, 2.42)	1.49 (0.92, 2.43)	3.81 (2.49, 5.85)	2.25 (1.45, 3.49)
p-value trend test†		0.014	0.013		0.874

* Regression based estimates of under-5 mortality rate ratios indicating the decrease in under-5 mortality associated with a 10-fold increase in GDP per capita and an increase in female literacy from 0% to 100% respectively. † p-value for test on linear trend in the effect of the explanatory variable across wealth quintiles

There was a statistically significant linear trend in the effect of GDP per capita across wealth groups, showing weaker effects on under-5 mortality among the poor (p=0.014). This is illustrated by smaller reductions in under-5 mortality among the poor compared with the rich, upon increases in GDP (Figure 6.1). The lack of distinction in mortality levels among the poorest four groups at low levels of GDP is empirically observed in many African countries. The significantly weaker effect of GDP on mortality levels among the poor remained after adjusting for the income distribution within countries, measured using the

gini-index (Table 6.2). Practically the same was observed when using the share of income or consumption of the richest to the poorest 20% population group (results not shown).

Figure 6.1 Differential effect of GDP on under-5 mortality of the five wealth groups, controlled for female literacy and region, taking 50% literacy and Africa as reference groups



Higher female literacy rates were strongly and significantly associated with lower total under-5 mortality, also after adjusting for confounders. The adjusted effect of female literacy, however, did not vary significantly between poorer and richer children.

More democratic and ethnically homogeneous countries showed, in the univariate analysis, significantly lower total under-5 mortality rates (Table 6.3). After adjusting for confounding, only state strength was slightly, though significantly, associated with lower total under-5 mortality. The strength of this association was comparable across wealth groups. Although the effect of ethnic homogeneity on total under-5 mortality was not significant after adjusting for confounders, a significant linear trend in the effect was observed across wealth groups. Ethnic fragmentation was more strongly associated with higher under-5 mortality among the poor compared to the rich (p=0.027).

Table 6.3 Relative effect of political factors on under-5 mortality

Wealth group	Effects on under-5 mortality					
	Democracy*		State strength*		Ethnic fragmentation*	
	Univariate	Adjusted for female literacy, GDP, region (95% CI)	Univariate	Adjusted for female literacy, GDP, region (95% CI)	Univariate	Adjusted for female literacy, GDP, region (95% CI)
Total	2.14 (1.25, 3.67)	1.16 (0.86,1.56)	1.29 (0.98, 1.70)	1.17 (1.01, 1.35)	2.74 (1.64, 4.58)	1.11 (0.74, 1.66)
Rich	2.67 (1.47, 4.84)	1.17 (0.85, 1.62)	1.27 (0.94, 1.73)	1.13 (0.95, 1.33)	3.29 (1.84, 5.89)	0.84 (0.53, 1.31)
Next-rich	2.67 (1.47, 4.85)	1.24 (0.90, 1.72)	1.29 (0.95, 1.76)	1.13 (0.96, 1.34)	3.26 (1.82, 5.82)	1.05 (0.67, 1.64)
Middle	2.47 (1.36, 4.49)	1.26 (0.91, 1.74)	1.41 (1.04, 1.92)	1.24 (1.05, 1.47)	2.99 (1.67, 5.34)	1.05 (0.67, 1.65)
Next-poor	2.05 (1.13, 3.71)	1.08 (0.78, 1.49)	1.30 (0.96, 1.78)	1.16 (0.98, 1.37)	3.00 (1.68, 5.36)	1.21 (0.77, 1.90)
Poor	1.78 (0.98, 3.23)	1.12 (0.81, 1.55)	1.23 (0.91, 1.68)	1.16 (0.98, 1.37)	2.30 (1.29, 4.11)	1.17 (0.75, 1.83)
p-value trend test†		0.373		0.609		0.027

* Regression based estimates of under-5 mortality rate ratios indicating the decrease in under-5 mortality associated with a change from least to most democratic, with an increase in taxing from 0% of GDP to 10% of GDP, and with a change from extremely ethnically fragmented to ethnically homogeneous respectively. † p-value for test on linear trend in the effect of the explanatory variable across wealth quintiles.

Table 6.4 Relative effect of public spending on health on under-5 mortality and on full immunization coverage and skilled delivery attendance

Wealth group	Public spending on health per capita*					
	Effects on under-5 mortality		Effects on full immunization coverage†		Effects on skilled delivery attendance ‡	
	Univariate	Adjusted for female literacy, region, GDP (95% CI)	Univariate	Adjusted for female literacy, region, GDP (95% CI)*	Univariate	Adjusted for female literacy, region, GDP (95% CI)†
Total	2.41 (1.58, 3.66)	1.10 (0.75, 1.61)	1.33 (0.90, 1.97)	1.09 (0.56, 2.11)	2.42 (1.54, 3.82)	1.19 (0.70, 2.03)
Rich	2.32 (1.45, 3.71)	0.61 (0.40, 0.94)	0.95 (0.60, 1.52)	0.86 (0.40, 1.87)	1.38 (0.75, 2.53)	0.92 (0.44, 1.93)
Next-rich	2.54 (1.59, 4.05)	0.90 (0.58, 1.38)	1.23 (0.77, 1.97)	1.00 (0.46, 2.16)	2.18 (1.19, 4.00)	0.80 (0.38, 1.67)
Middle	2.61 (1.63, 4.17)	1.11 (0.72, 1.71)	1.54 (0.96, 2.45)	1.02 (0.47, 2.20)	3.10 (1.69, 5.69)	0.98 (0.47, 2.06)
Next-poor	2.73 (1.71, 4.36)	1.23 (0.80, 1.89)	1.61 (1.01, 2.58)	1.27 (0.59, 2.75)	3.80 (2.07, 6.99)	1.59 (0.75, 3.33)
Poor	2.28 (1.43, 3.64)	1.47 (0.96, 2.26)	1.77 (1.11, 2.83)	1.28 (0.59, 2.77)	4.43 (2.41, 8.14)	2.25 (1.07, 4.73)
p-value trend test§		0.0001		0.045		0.0001

* Regression-based estimates of under-5 mortality rate ratios indicating the decrease in under-5 mortality associated with a 10-fold increase in public spending on health per capita per capita. † Regression-based estimates of full immunization coverage rate ratios indicating the increase in full immunization coverage associated with a 10-fold increase in public spending on health per capita. ‡ Regression-based estimates of skilled delivery attendance prevalence rate ratios indicating the increase in skilled delivery attendance prevalence associated with a 10-fold increase in public spending on health per capita. § p-value for test on linear trend in the effect of the explanatory variable across wealth quintiles.

Public spending on health was slightly and not significantly related to total under-5 mortality after adjusting for GDP, female literacy and region (Table 6.4). However, the effects of public spending differed strongly and significantly between wealth groups, showing stronger effects on the mortality level among poor children (p=0.0001).

Health care use among the poor was significantly more strongly associated with levels of public spending on health than health care use among the rich. We observed this for full childhood immunization coverage (p-value for trend test = 0.045) and for skilled delivery attendance (p=0.0001).

6.4 DISCUSSION

Our study shows that national-level determinants of under-5 mortality can have a different effect on the poor and the rich. The association between national per capita income and under-5 mortality was significantly stronger among the rich compared with the poor. In contrast, the association between public spending on health and under-5 mortality was significantly stronger among the poor. Ethnic fragmentation was significantly more strongly associated with higher under-5 mortality rates among the poor compared with the rich. No differentials in the relative effect of female literacy, democracy, and state strength were observed.

Evaluation of data and methods

Our study describes, for low and middle income countries, how under-5 mortality rates vary with the national-level context. Differences between countries have often materialized over longer periods of time. We have described *those* tendencies that could be captured cross-sectionally, and have included no time-trends or lagged effects.

The large number of low and middle income countries for which comparable data on under-5 mortality in different wealth layers are available, combined with the heterogeneity of these countries in terms of mortality and its determinants, and the possibility to statistically adjust for important confounders, makes the quantitative cross-country comparative design used particularly valuable. The importance of international comparisons for the analysis of country-level effects has been underlined by others (Lu *et al.* 2005), and the quantitative cross-national study design used, is very common in development studies,

political sciences and sociology (Frey *et al.* 1999; Frey *et al.* 2000; Preston 1975; Pritchett *et al.* 1996; Shen *et al.* 1997). Such comparisons complement evidence that is available from time-trend analyses. The little information that is available on time-trends in low and middle income countries confirms some of our main conclusions. Relative socio-economic mortality inequalities, for example, appear to increase in periods of economic growth (Da-Vanzo *et al.* 1986; Vega *et al.* 2001; Wagstaff 2002).

Caution must, however, be exercised when interpreting the observed statistical effects as causal effects. In our analyses, we corrected for the two most probable confounders, female literacy rate and GDP per capita, and for a third, region, which captures a whole set of factors that could act as confounders. However, the possibility of uncontrolled confounding cannot be excluded. Unfortunately, a lack of wealth-specific mortality data for a larger set of countries inhibits the use of more elaborate models.

Reverse causation is less likely to be an alternative explanation for the observed differences in effect between wealth groups. The causal effect of GDP on population health has been demonstrated in previous research (Pritchett *et al.* 1996). Moreover, it seems unlikely that lower mortality rates among the poor would cause an increase in public spending on health or a decrease in ethnic fragmentation.

Our definition of wealth is a relative one, describing the position of children in the national wealth hierarchy. This was partly a pragmatic choice, as mortality data stratified by relative status are readily available for a large number of low and middle income countries, whereas for absolute economic status they are not. But even if such data would exist, it would probably remain difficult to assess, in a cross-national analysis, trends in effect across absolute wealth groups within countries. In many countries, the rich, in absolute terms, are virtually non-existent, whereas in other countries, the poor, in absolute terms, are almost non-existent. In Mali, for example, 73% of the population lives under the poverty-line of one dollar a day, whereas this is only 3% in the Dominican Republic (UNDP 2000). The importance of relative socio-economic position for one's health has been emphasized in earlier studies (Wilkinson 1996). More importantly, our approach is consistent with Rogers' influential diffusion of innovations theory (Rogers 2003 [1962]). According to this theory, societal changes spread unequally through a population, reaching higher socio-economic classes first before reaching the lower classes (Victora *et al.* 2000; Wagstaff 2002). If national income rises, for example, it would be the relatively rich that would first reap the benefits in terms of improved survival. The results of our cross-sectional analysis were consistent with

this hypothesis: the association between GDP per capita and under-5 mortality levels was stronger among the relatively rich.

We studied a broad set of countries, mostly in Africa, Asia and Latin America. However, as no data were available for Middle-Eastern countries at the time of analysis, our findings cannot necessarily be generalized to this region.

For the above reasons, it is important to interpret our results with some caution. At the same time, they are an important first step in the new research field of contextual determinants of population health and can be used as a basis for further research.

Furthermore, while research on health outcomes conventionally uses relative effect measures, such as rate ratios, effects expressed in absolute terms, such as rate differences, do not necessarily yield the same results (Boström *et al.* 2003). Illustrative is our finding of significantly stronger absolute effects of a country's female literacy rate on mortality levels among poor children (p=0.009) (results available upon request). So, whereas in relative terms, the effect of female literacy appeared the same for the rich and poor, absolute effects were significantly stronger for the poor.

Explaining the results

The stronger effect of national per capita income on mortality levels among the rich was not explained by the income distribution within countries. Our findings correspond to those of Victora (2000) and Wagstaff (2002) who postulate that the stronger effect of national income on the rich is possibly due to a faster assimilation of new health technologies by the better-off.

Ethnic fragmentation has been shown to be associated with high under-5 mortality in a previous study (Filmer *et al.* 1999). Our finding that ethnic fragmentation appears to have small, but significantly stronger, effects on the poor than on the rich is a new one. This was especially observed for Africa, where the degree of fragmentation differs greatly between countries. In ethnically fragmented countries, entitlements (Sen 1999) to material and other resources important for child survival, might be distributed along ethnical lines. In these countries, therefore, being poor, not only means having no money, but possibly also being deprived of entitlements to resources like health care. Our findings run parallel to

another study, which found that ethnic fragmentation in Africa is liable to result in high income inequality (Milanovic 2003).

Some studies have suggested that democracy has a role in reducing poor-rich inequalities in childhood mortality. As democratic governments have to listen to their electorate, public policies would be more pro-poor, particularly in countries where the majority of the electorate is poor. Our study is the first to show that if an association exists, it is comparable across wealth groups.

The effect of public spending on health on mortality rates is much debated. Our results support studies that find an effect especially on the poor (Bidani *et al.* 1997; Gupta *et al.* 2003). Preliminary results of a stratified analysis suggest that this applies equally to countries with a low and with a relatively high GDP per capita (results not shown). The significantly stronger effects of public spending on under-5 mortality among the poor are missed when only aggregate mortality levels are studied (Filmer *et al.* 1999). The observed negative effects on the rich, and maybe also the small effects on the total population, may have been affected by a special multicollinearity problem due to a strong association between GDP and public spending (r= 0.77). The stronger effect of public spending on health on poorer children is possibly explained by the significantly stronger responsiveness of the utilization of primary care among these households to increases in such spending.

Cross-national studies like ours give complementary insight into the effects of public spending in comparison to benefit-incidence studies, which often study one country or program. Benefit-incidence studies combine information about the costs of the provision of public services with the use of these services (Castro-Leal *et al.* 2000). Such studies reveal that the distribution of public spending tends to favour the better-off. Apparently, even though in monetary terms public spending favours the rich, the effects in mortality terms are likely to be larger for the poor. Further research would be needed to assess how this money is spent most effectively to the benefit of the poor, for example through selective or comprehensive primary care.

Implications

The well-known 'Preston-curve', showing the relationship between national income and life expectancy or child mortality (Preston 1975), can be refined with a flatter curve for poorer children within countries and a steeper curve for richer ones. Our findings suggest

that economic growth is, on average, associated with widening poor-rich mortality disparities in under-5 mortality. Increased public spending on health might partly remedy this effect. Our results suggest that such spending might be an important tool to improve child survival among the poor.

Although ethnic fragmentation itself is not amenable to change, our findings suggest that understanding social and cultural barriers to mortality reduction could be important when tackling the high mortality rates among the poor.

Conclusion

Differential effects on poorer and richer children of such a broad range of country characteristics have not been reported before. Our study shows that the conventional focus on average effects of national-level determinants of population health can conceal important differences in effect between subgroups. In addition, the primary focus in the existing literature on household level causes of high mortality among the poor may distract attention from important, and more structural, determinants at the national level. Households are not autonomous units. Therefore, the causes of under-5 mortality cannot be fully unravelled by zooming-in on household level factors alone. Zooming-out to country, region or even global-level determinants of under-5 mortality, and especially studying their interaction with the economic position of individuals, is of fundamental importance.

7

Huge poor-rich inequalities in maternity care: an international comparative study of maternity and child care in developing countries

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ABSTRACT

Background Progress towards the Millennium Development Goals for maternal health has been slow, and calls for accelerated progress in scaling up professional delivery care have been made. This chapter describes poor-rich inequalities in use of maternity care and seeks to understand these inequalities through comparisons with other types of health care.

Methods Demographic and Health Survey data from 45 low and middle income countries were used to describe poor-rich inequalities (by wealth quintiles) in maternity care (professional delivery care and antenatal care), full childhood immunization coverage, and medical treatment for diarrhoea and acute respiratory infections (ARI).

Results Poor-rich inequalities in maternity care in general and professional delivery care in particular are huge, and are much greater than those in immunization coverage or treatment for childhood illnesses. Public sector inequalities make up a major part of the poor-rich inequalities in professional delivery attendance. Even delivery care provided by nurses/midwifes is pro-rich in most countries. Whereas poor-rich inequalities within both rural and urban areas are large, most births without professional delivery care occur among the rural-poor.

Conclusion Poor-rich inequalities in professional delivery care are much larger than those in the other forms of care. Reducing poor-rich inequalities in professional delivery care is essential for achieving the MDGs for maternal health. The greatest improvements in professional delivery care can be achieved by increasing coverage among the rural-poor. Problems with availability, accessibility, and affordability, as well as the nature of the services and demand factors appear to contribute to the larger poor-rich inequalities in delivery

care. A concerted effort of equity-oriented policy and research is needed to address the huge poor-rich inequalities in maternity care.

7.1 INTRODUCTION

Over half a million women die each year during pregnancy, delivery or shortly thereafter (WHO 2005); the Millennium Development Goals (MDG) call for reducing maternal mortality by 75% by 2015 (United Nations 2000). Since maternal mortality is costly to measure (Campbell 1999), and professional attendance at delivery is assumed to reduce maternal mortality (De Bernis *et al.* 2003), the proportion of deliveries with a professional attendant is used as a progress indicator (www.developmentgoals.org). Progress towards the MDG for maternal health has been slow (Lawn *et al.* 2006) and calls for accelerated progress in scaling up professional delivery care have been made (Koblinsky *et al.* 2006).

Poorer groups within low and middle income countries use less health care (Gwatkin *et al.* 2000) and poor-rich inequalities in maternity care and maternal mortality have been demonstrated (Graham *et al.* 2004; Gwatkin *et al.* 2000; Ronsmans *et al.* 2006). Within-country inequalities in maternity care have, however, not been described in detail for a broad range of dimensions using an international comparative perspective. Nor have they been systematically compared with inequalities in other forms of care. A better understanding of the magnitude and the determinants of inequalities in professional maternity care may contribute to tackling these disparities and to reaching the MDGs for maternal health. They may also contribute to the MDGs for child health inasmuch as skilled attendance at delivery is an important contributor to neonatal survival (WHO 2005).

This chapter describes poor-rich inequalities in use of professional delivery and antenatal care for 45 low and middle income countries and compares these to inequalities in use of child health services. By presenting various aspects of inequalities in the use of maternity care, and by contrasting these to inequalities in the use of child health care, this chapter seeks possible explanations for the inequalities observed in maternity care.

7.2 DATA AND METHODS

Data on health care use, stratified for five wealth groups, were obtained for 45 low and middle income countries from World Bank Country Reports (Gwatkin *et al.* 2000). All

countries for which these reports were available at the time of analysis, were included in our study (Table 7.1).

Data for these reports were derived from Demographic and Health Surveys (DHS) conducted between 1990-1998 (www.measuredhs.com). These are nationally representative household surveys, which usually cover between 5,000-10,000 women aged 15–49 years. They include information on health care use and household ownership of assets. Table 7.1 defines the health care use indicators included in this study.

Table 7.1 Definition of indicators included in the study

Indicator	Definition
Professional delivery attendant	the percentage of births in the three or five years (depending on the country) prior to the survey that were attended to by a medically trained person, defined as a doctor, nurse or nurse-midwife. "Deliveries were defined as facility-based when they occurred in a public medical facility (government hospital, government health center, government maternity center, other country-specific public sector facilities) or a private medical facility (mission hospital/clinic, other private hospital/clinic)." [a]
Professional antenatal care	the percentage of births in the three or five years (depending on the country) before the survey for which a woman received at least two antenatal care consultation from a medically trained person, defined as a doctor, nurse or nurse-midwife. [a]
Full childhood immunisation	the percentage of "surviving children age 12-23 months who received BCG, three doses of DPT and oral polio, and measles vaccination. The figures are a combination of information recorded on the child's vaccination card, or, in cases where a card was not seen by the interviewer, as reported by the mother." [a]
Treatment diarrhoea	the percentage of "children with diarrhea in the past two weeks who were taken to any medical facility for treatment, defined as a private doctor, mission/hospital clinic, other private hospital/clinic, pharmacy, or a public facility (government hospital, government health center, or government dispensary)" [a]
Treatment acute respiratory infections (ARI)	the percentage of "children with a cough and rapid breathing in the preceding two weeks who were taken to any medical facility for treatment." Definitions for facilities are the same as for treatment of diarrhea [a]

Note: [a] (Gwatkin *et al.* 2000). Countries included in the study: Bangladesh, Benin, Bolivia, Brazil, Burkina Faso, Cameroun, Central African Republic, Chad, Colombia, Comoros, Côte d'Ivoire, Dominican Republic, Egypt, Ghana, Guatemala, Haiti, India, Indonesia, Kazakhstan, Kenya, Kyrgyz Republic, Madagascar, Malawi, Mali, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Paraguay, Peru, Philippines, Senegal, Tanzania, Togo, Turkey, Uganda, Uzbekistan, Viet Nam, Yemen, Zambia, Zimbabwe.

Household ownership of durable consumer goods, housing quality and water and sanitation facilities were combined into a wealth index using Principal Components derived weights (Filmer *et al.* 2001; Gwatkin *et al.* 2000). Wealth groups were constructed such that each consisted of 20% of the survey population, unless otherwise indicated. Despite limitations

(Houweling *et al.* 2003), this index has been used fairly widely as a measure of economic status in low and middle income countries (Bollen *et al.* 2002; Filmer *et al.* 2001).

The main inequality measures we used are the rate ratio and the rate difference. The rate ratio (RR) gives the ratio of health care use among the richest to the poorest group within a country, whereas the rate difference (RD) gives the absolute difference in health care use between these groups.

We estimated the distribution of the total number of births without a professional delivery attendant across the rural-poor, rural-rich, urban-poor, and urban-rich. This was done by calculating the total number of deliveries without a professional delivery attendant in each of the groups as a proportion of the total number of deliveries without such an attendant in the total survey population. For this analysis, the poor were defined as the bottom 50% of the total survey population.

To assess the relationship between the magnitude of poor-rich inequalities in health care use and the overall level of such use, we plotted, for each of the five types of health care, the RR in health care use against the overall level of health care use for the 45 countries. We fitted exponential curves through each of the scatter plots. For reasons of readability, Figure 7.8 only shows the exponential curves, and not the scatter plots themselves.

7.3 RESULTS

Maternity care

Figure 7.1 and Figure 7.2 show the proportion of births for whom professional antenatal care was received and the proportion of births attended by a professional, for the five wealth groups, ranked by each country's mean. Among the richest quintile, use of antenatal care and professional delivery care reaches levels of 80% or higher, irrespective of the average level in the country, with a few exceptions (Bangladesh, Nepal, Chad, Pakistan, Yemen). Use of these services is much lower among poorer women. Wealth and maternity care are linked across the entire wealth hierarchy within countries, with each progressively poorer group having progressively lower use. Importantly, poor-rich inequalities in professional delivery care are much larger than those in antenatal care. Whereas professional delivery care among the poor is below 30% in many countries, antenatal care is at least 30% in most

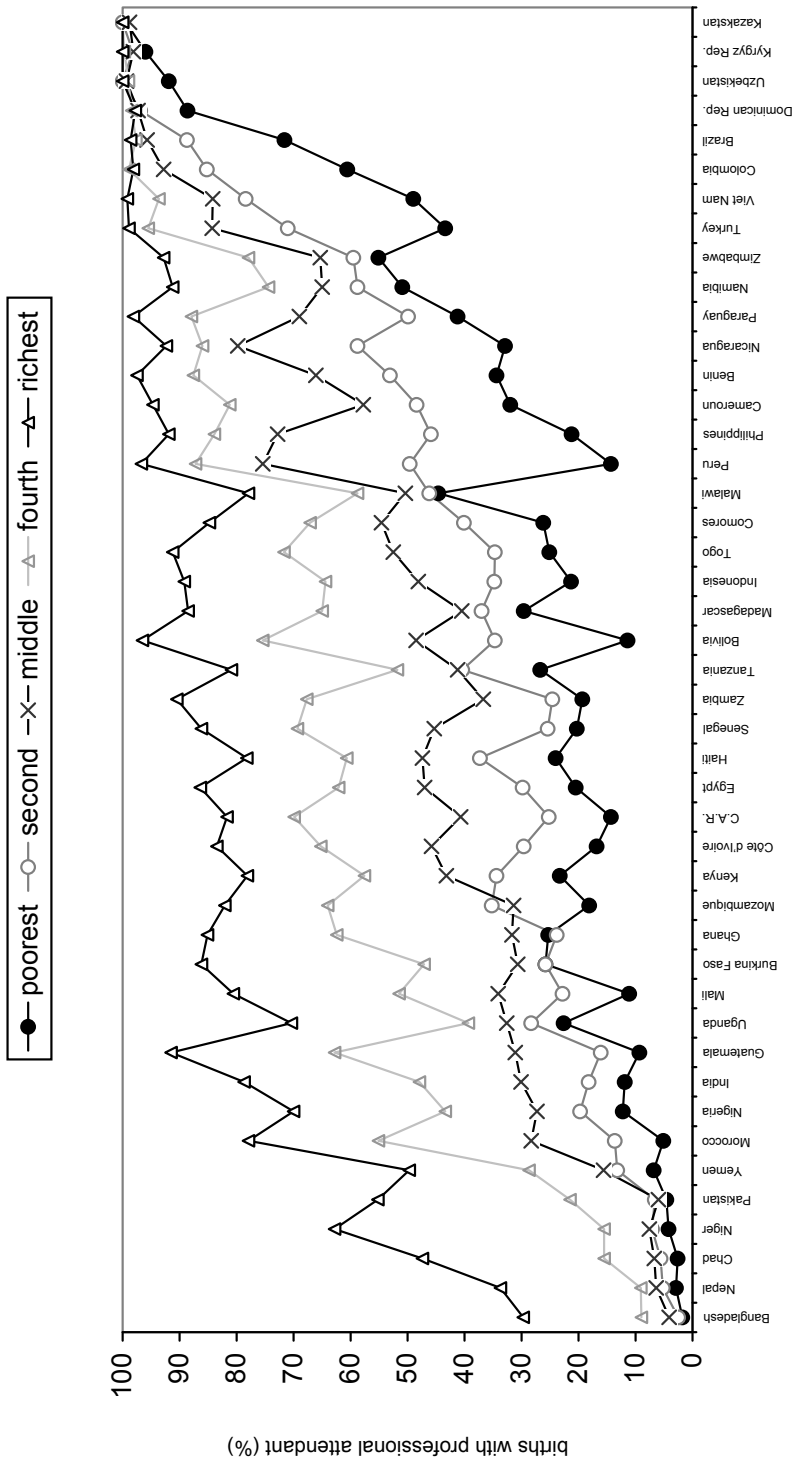


Figure 7.1 Percentage of births with a professional delivery attendant, for five wealth groups, ranked by country average, for 45 low and middle income countries

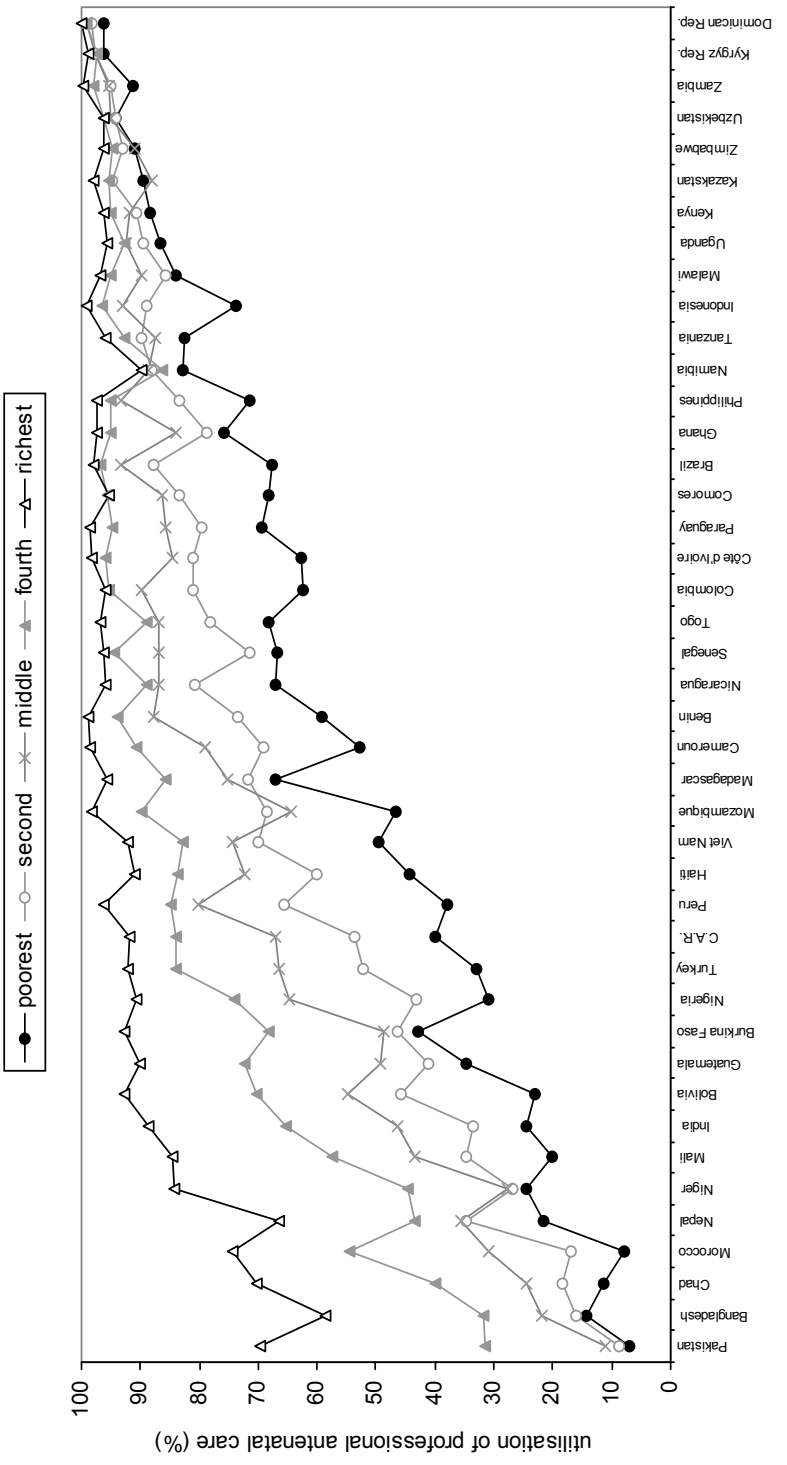


Figure 7.2 Percentage of births for which two or more antenatal visits to a medical professional were received, for five wealth groups, ranked by country average, for 45 low and middle income countries

countries. In order to further our understanding of these huge inequalities in professional delivery care, we describe various aspects of these inequalities below.

The absolute poor-rich gap in deliveries in public and in private facilities respectively is described in Figure 7.3. Use of both public and private facilities is lowest among the poorest. The Dominican Republic and Brazil are exceptions, with higher use of public facilities among the poor. The absolute poor-rich gap is largest in the public sector, in part because use of private facilities is low in all groups. Relative poor-rich inequalities are, however, larger in the private sector (results not shown), as also reported by others (Gwatkin *et al.* 2004). Professional delivery care is nearly synonymous with facility-based care in most countries, with a few exceptions like Indonesia, Madagascar and Haiti where home care with a professional is relatively common (results not shown).

Figure 7.4 shows the absolute poor-rich gap in delivery care by a doctor and by a nurse/midwife respectively. In many countries, hardly any women are attended by a doctor and inequalities in professional delivery care therefore mainly consist of those in attendance by a nurse/midwife (*e.g.* Niger, Burkina Faso, CAR, Mali, Chad). In countries where overall levels of professional delivery attendance are high, attendance by a nurse is higher among the poor (Kyrgyz Rep., Kazakhstan, Brazil, Colombia, Dominican Rep.) and attendance by a doctor is much higher among the rich.

Levels of professional delivery attendance among the rural-poor, rural-rich, urban-poor and urban-rich are described in Figure 7.5. Professional delivery attendance is much higher in urban compared to rural areas. Within urban and rural areas, the poor-rich gap in professional delivery attendance is large, despite comparing very broad wealth groups (poorest and least poor 50%). The rural-rich and the urban-poor have relatively similar levels of professionally attended deliveries in most countries.

Figure 7.6 describes the distribution of the total number of deliveries without a professional attendant by rural/urban wealth groups. This takes into account both the rate of under-coverage in the groups and the relative size of these groups within the total survey population. Most of the births without professional delivery care occur among the rural-poor (65% on average), followed by the rural-rich.

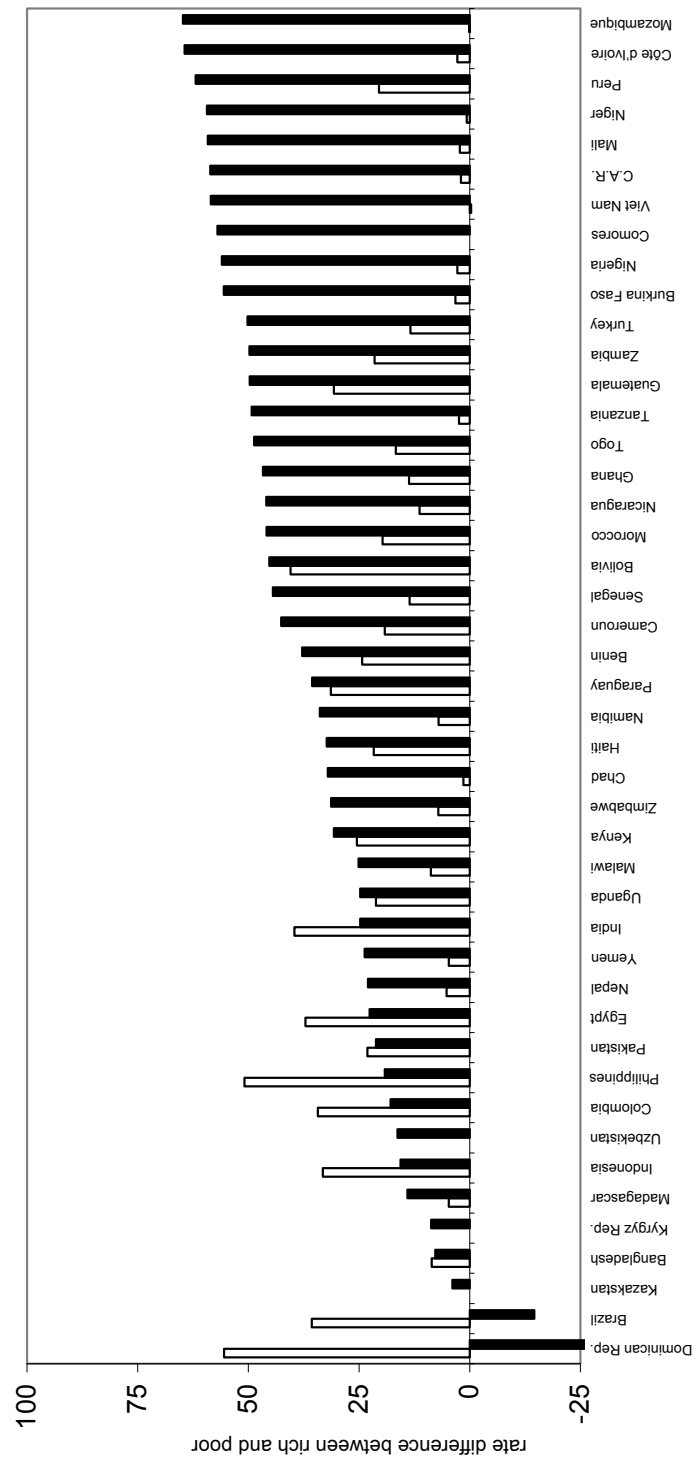


Figure 7.3 Absolute gap (rate difference, in percentage points) between the richest and poorest 20% wealth group: deliveries in public facility resp., private facility

Note: Negative bars indicate that the prevalence of deliveries in the specified facility type is higher among the poor. *Y*-axis was truncated at –25; the rate difference in percentage deliveries in a public facility was –47 for the Dominican Republic.

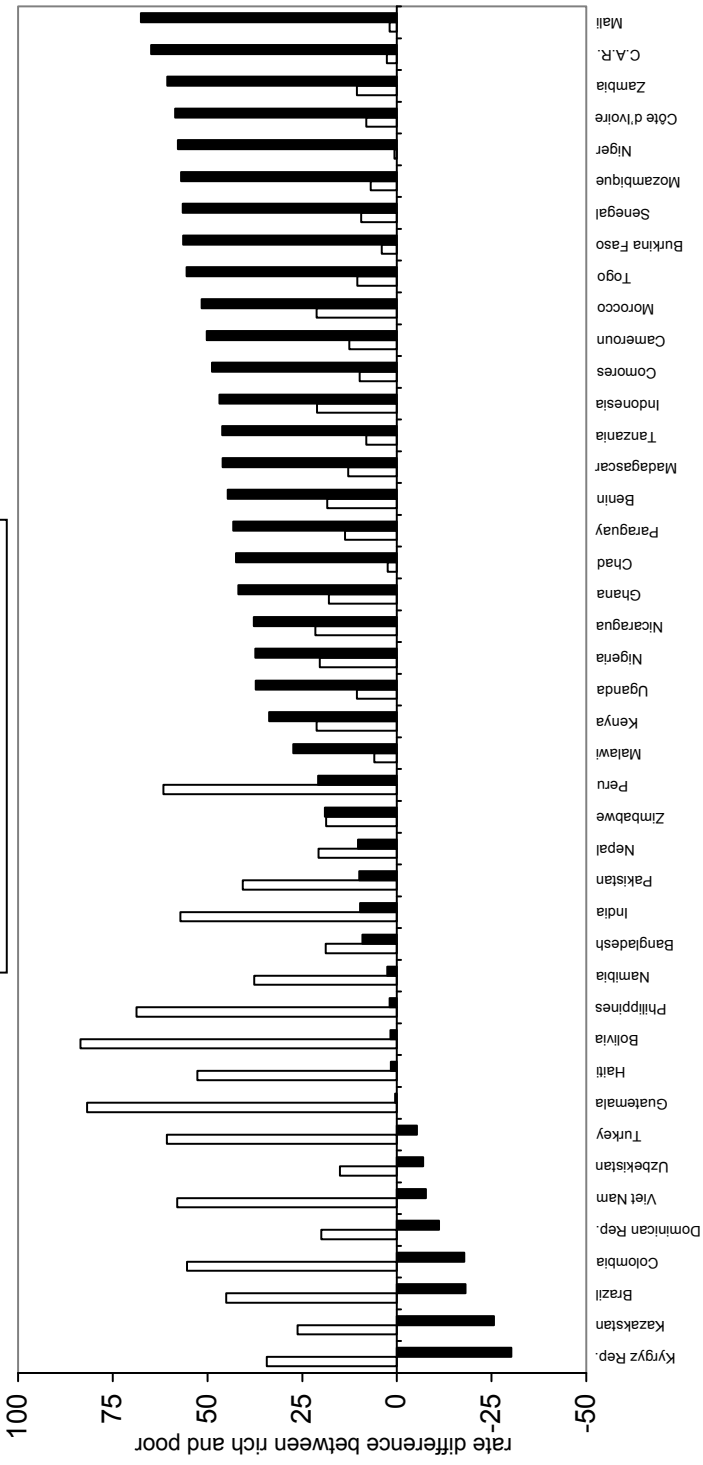


Figure 7.4 Absolute gap (rate difference, in percentage points) between the richest and poorest 20% wealth group: deliveries by doctor, by nurse or trained midwife

Note: Negative bars indicate that the prevalence of deliveries attended by the specified professional is higher among the poor.

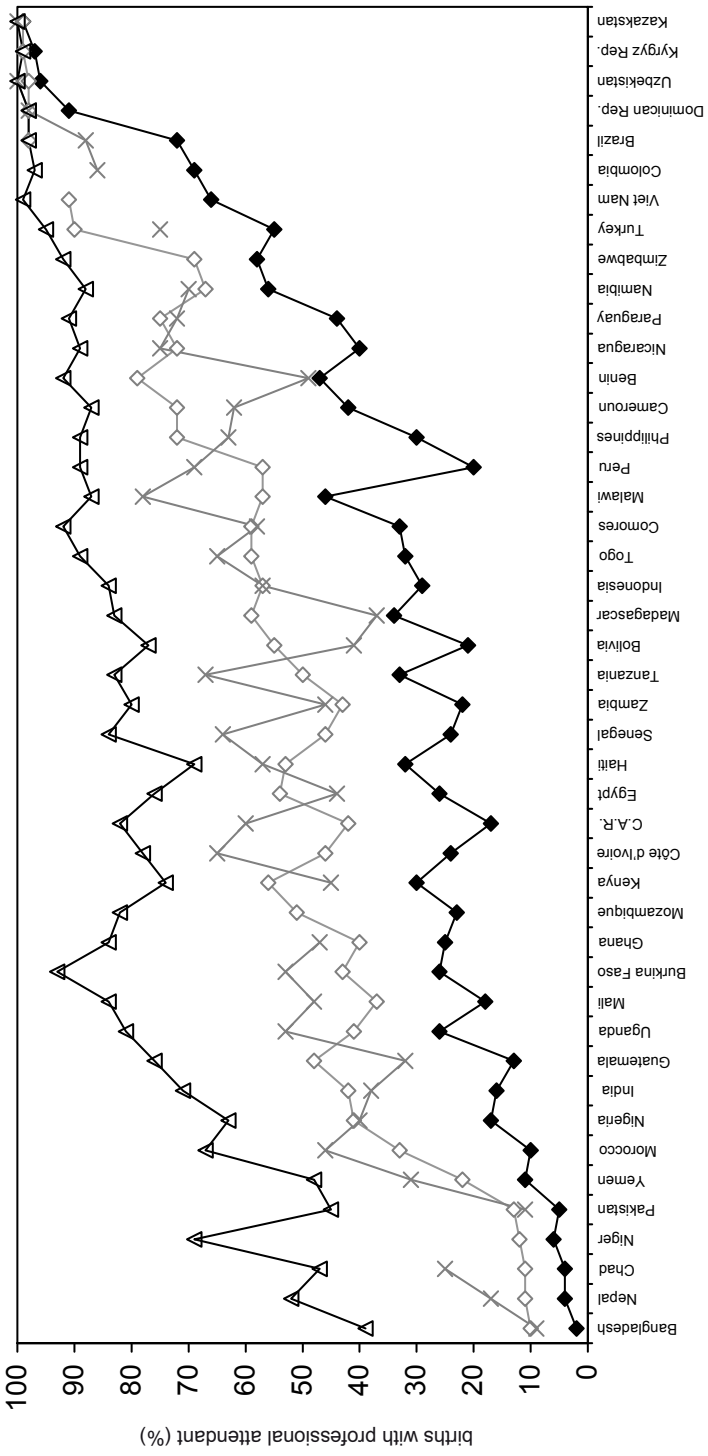


Figure 7.5 Percentage of deliveries with a professional attendant according to rural/urban residence and wealth, for 45 low and middle income countries

Note: poor is defined as the bottom 50% of the total population; rich is defined as the top 50% of the total population. Missing values are due to small denominators.

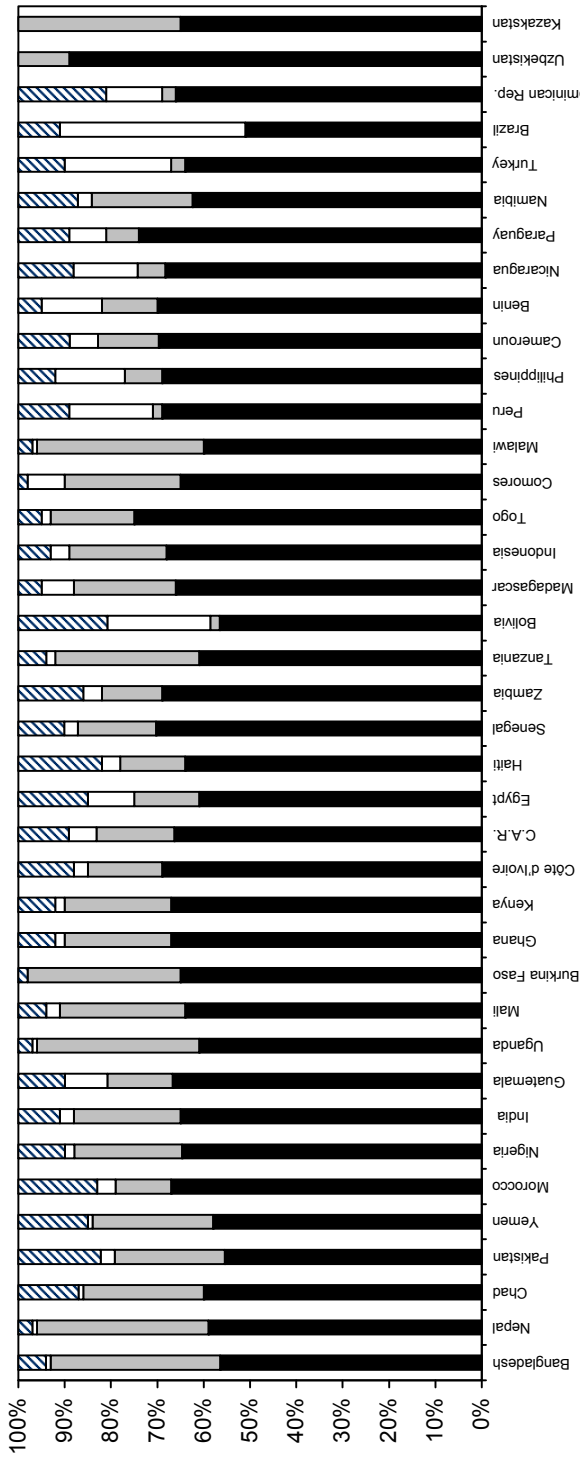


Figure 7.6 Distribution (%) of total number of births without a professional delivery attendant, according to rural/urban residence and wealth, for 45 low and middle income countries

Note: poor is defined as the bottom 50% of the total population; rich is defined as the top 50% of the total population. The countries are ranked by % deliveries without a professional attendant in the total population.

Child care

The median levels of use of maternal and child health care among the poorest and richest quintile across the 45 countries are shown in Figure 7.7. Among the poor, antenatal care is high and professional delivery attendance low compared to childhood immunisation and treatment for ARI or diarrhoea. Despite similar overall levels of professional delivery care and immunisation coverage (47% and 49% respectively), poor-rich inequalities in professional delivery attendance are much larger. Non-use of antenatal and delivery care (indicated by the striped bars) is almost completely concentrated among the poor, underlining the extent to which maternity care is unequally distributed. In contrast, non-use of immunisation and treatment of childhood illnesses is also high among the rich.

Figure 7.7 Median levels of health care use across 45 low and middle income countries, among the poorest and among the richest 20% wealth group

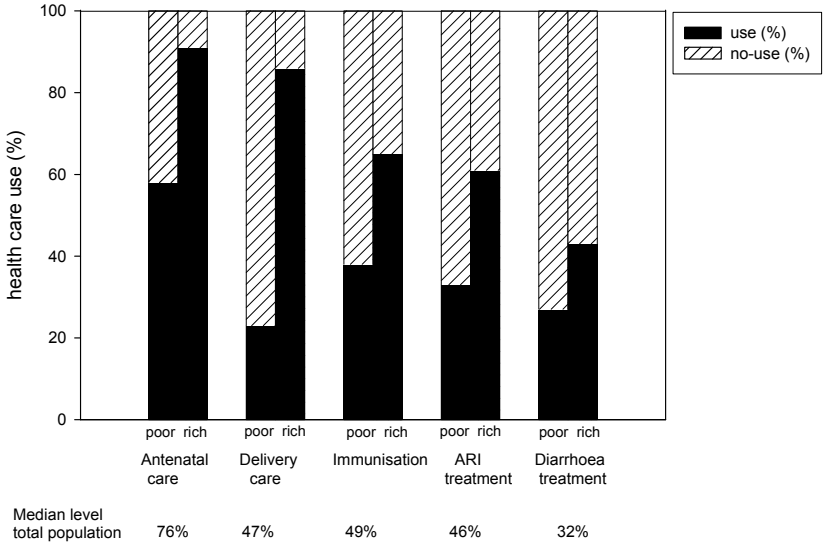
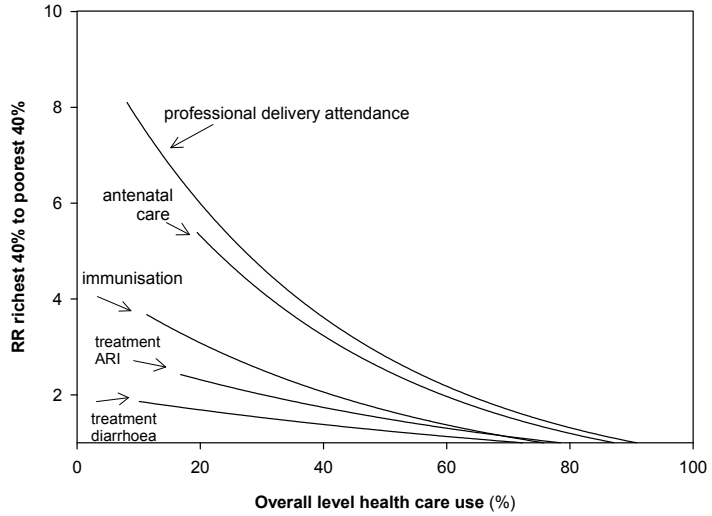


Figure 7.8 shows the relationship between the size of relative inequalities in health care use on the one hand and the overall levels of health care use on the other, across the 45 countries for five types of health care. The fit of the curves was good (R^2 varying between 0.62 and 0.79), except for diarrhoea ($R^2 = 0.29$). Relative inequalities tend to be larger in countries with lower overall levels of health care use. At all overall levels, inequalities in professional delivery attendance and antenatal care are systematically larger than inequalities in the other types of care. Also absolute poor-rich inequalities are systematically larger for professional delivery attendance and antenatal care (results available upon request).

Figure 7.8 Association between poor-rich rate ratio and overall level, for five types of health care use, based on data for 45 low and middle income countries.



Note: Exponential curves were fitted through the data for 45 developing countries for each of the five types of health care use (i.e. professional delivery attendance, professional antenatal care, full childhood immunisation, medical treatment of acute respiratory infections (ARI), and medical treatment for diarrhoea)

7.4 DISCUSSION

This chapter shows that inequalities in the use of professional delivery attendance are extremely large, and much greater than inequalities in immunization coverage and medical treatment for childhood illnesses, even when overall levels of health care use are taken into account. Very few of the poorest mothers get professional delivery care, irrespective of where they live, although some of them get antenatal care.

The burden of under-coverage of professional delivery care is concentrated in rural areas, particularly among the rural-poor. Whereas poor-rich inequalities within urban areas are large, the relatively small size of the urban population in general and the urban-poor in particular explains the relatively small public health impact of these within-urban inequalities. As countries become progressively more urban, however, these inequalities will become progressively more important.

Public sector facilities rarely address the poor-rich inequalities in professional delivery care. In absolute terms, poor-rich inequalities in the use of public facilities usually are

larger than private sector inequalities, suggesting that the public sector does not provide a safety net for the poor.

Our findings may stem from data artefacts. Differential reliability of morbidity data (with the poor underreporting mild forms of diarrhoea and ARI) might underestimate the poor-rich gap in medical treatment, but there is no reason to assume that poor women systematically under-report professional delivery attendance or over-report immunisation coverage (explaining larger poor-rich inequalities in delivery care than in immunisation coverage) (Boerma *et al.* 1991; Macro International Inc. 1993). Second, the wealth measure used might partly capture rural/urban residence, as it includes assets that urban people are more likely to own. Still, substantial poor-rich inequalities in health care use within urban and within rural areas can be demonstrated.

If the larger inequalities in maternity care are not artefacts, they might be explained by demand factors, supply factors, or the nature of the service needed and provided.

Demand factors

Pregnancy and childbirth are imbued with strong cultural meaning (Blanchet 1984; Jaffre *et al.* 1994; MacCormack 1994), and hence cultural factors may be more important determinants of uptake of maternity care than in other forms of care. Poorer women may prefer traditional birth attendants or family members (Ensor *et al.* 2004), particularly if childbirth is seen as a non-illness event where western medicine has little to contribute (Neema 1994; Thaddeus *et al.* 1994). Professional providers of maternity care may not be tolerant of cultural beliefs and practices (Jaffre *et al.* 1994). Sometimes, professional providers treat poor women with less consideration than richer/higher educated women (Cleland *et al.* 1988). Also, women may experience constraints on seeking care for themselves. Relatives, particularly husbands or mothers-in-law, may be heavily involved in the decision-making process (Cleland *et al.* 1988; Ensor *et al.* 2004; Thaddeus *et al.* 1994), and members of poorer households might be more inclined to use home-based delivery care. In some societies, this is related to norms of female seclusion. There is also evidence that families may be less willing to spend money on women's health, especially in South Asia (Kutzin 1993). Male doctors may be a barrier for seeking facility-based delivery care (Delaney 1991). Such cultural barriers may be fewer when it concerns health care for children (Blum *et al.* 2004). In contrast, richer, often better educated, women and their families may have a more modern world view, greater identification with the modern health care system, greater confidence

in dealing with officials, and greater ability and willingness to travel outside the community (Cleland *et al.* 1988), all of which may facilitate use of professional maternity care.

The argument that poor women or their families have a lower demand for professional delivery attendants assumes that they actually have a choice. In some settings, rural uneducated women deliver at home without professional care despite living in relative close proximity to maternity care facilities (Rasheed *et al.* 1990). Yet, evidence from other countries suggests that poorer women tend to stop using traditional maternity care in contexts where medically trained, accessible, affordable, and good quality professional care becomes available (Koblinsky *et al.* 1999), though they might be slower to take these up than rich women (Victora *et al.* 2000). This suggests that supply factors play an important role in explaining the huge poor-rich inequalities in maternity care.

Supply factors

Availability and accessibility Lack of availability and accessibility may be greater for professional delivery care than for other forms of care. Whereas the logistical requirements to provide full childhood immunisation coverage are high (*e.g.* cold chain), many countries have adopted mobile immunisation strategies that are therefore better able to achieve wide geographical coverage than strategies requiring fixed sites. Although some maternity care programs have attempted to reach out to women's homes, most professional delivery care takes place in facilities. The physical infrastructure requirements are higher for facility-based delivery than for the provision of vaccinations or the treatment of ARI/diarrhoea. Moreover, providers of treatment for ARI and diarrhoea can include lower level cadres, such as community health workers, who are more easily placed in remote or rural areas than doctors or nurses/midwives. Finally, more immunisations or treatments of ARI/diarrhoea can be done per provider per day than deliveries. Human resources and infrastructure for delivery care are seriously insufficient, with three times the current number of professionals needed to achieve universal professional delivery attendance (Koblinsky *et al.* 2006; WHO 2005). Indeed, the human resources crisis in the health care sector is particularly affecting professional delivery care services (WHO 2005). The scarce delivery care facilities that are available tend to be concentrated in urban areas (Wilkinson *et al.* 1993), whereas the bulk of the poor live in rural areas. A preliminary analysis in Mwanza, Tanzania, suggests that the mean distance to delivery services is 28 kilometres compared to 7-8 kilometres for treatment for sexually transmitted diseases, family planning and ante-

natal care (Slaymaker 2007). However, even within rural and within urban areas poor-rich inequalities in professional delivery attendance are large.

Affordability Lack of affordability might explain the large poor-rich inequalities in professional delivery attendance within urban and within rural areas. We are unaware of studies in which costs to households of maternity care and other forms of health care are systematically compared. Yet, vaccinations and basic treatment for ARI and diarrhoea at the primary care level tend to be inexpensive, or even for free. In contrast, the cost of delivery care can be an important barrier (Borghi *et al.* 2006; Kowalewski *et al.* 2002). Even where this service is officially free, hidden costs may add up to a substantial part of the monthly income, or even several times the monthly income (Nahar *et al.* 1998). Normal deliveries can cost households 3-26% of the annual per capita income (Borghi *et al.* 2006). Moreover, costs of facility-based delivery can be unpredictable (Kowalewski *et al.* 2002) and costs of severe complications can have a catastrophic impact on the household budget (up to 90-138% of annual per capita income) (Borghi *et al.* 2006) and this may act on demand (Borghi *et al.* 2003). In countries in economic and political turmoil, like Mongolia and Tajikistan, where levels of poverty have risen and health care systems have deteriorated, the use of professional delivery assistance has declined, and poor-rich inequalities in such care have increased (Falkingham 2003; Janes *et al.* 2004). There are some indications that costs are less a barrier for seeking antenatal care compared to delivery care (Prata *et al.* 2004).

Nature of the services

The mode of delivery and timing of the various health care services might influence the magnitude of poor-rich inequalities in the use of these services, both directly, and via their availability and accessibility.

Professional delivery attendance is highly dependent on individual-level care seeking, whereas immunisation is, at least in some settings, based on mass campaigns. There are indications that mass immunisation campaigns can improve coverage, reach a high proportion of children that are difficult to reach through routine activities, and can reduce poor-rich disparities in a short period of time (Zuber *et al.* 2001). Also outreach activities have been suggested to reduce socio-economic inequalities in immunisation coverage (Bishai *et al.* 2002).

Poor-rich inequalities might also be larger when services require action at a very specific point in time. Deliveries and treatment for ARI/diarrhoea are have a short time-window in which care can be sought. This contrasts to antenatal care (Amooti-Kaguna *et al.* 2000) and immunization, for which there is more time to seek care. Moreover, the onset and timing of labour is less predictable.

Conclusion

We found substantial inequalities in professional delivery care, that were greater than for other forms of care. A combination of the supply and demand factors and the nature of the service probably explains the much larger inequalities seen; the mixture of factors is likely to vary between countries. In some, accessibility/availability might be important. In Senegal, the Central African Republic, and Malawi, for example, professional delivery attendance among the urban-poor was much higher than among the rural-rich, suggesting that availability/accessibility in rural areas is a problem. In contrast, in Madagascar, Benin and Pakistan, professional delivery attendance among the urban-poor was as low as among the rural-poor, suggesting that other factors, such as costs, play a more important role. In other countries, cultural constraints might be more of greater consequence.

We were interested that the rural-rich and the urban-poor had similar levels of delivery attendance in many countries. It may be that money can overcome access difficulties in rural areas, or that the rural-rich are innovators. Further in-depth analysis of these population groups could help us further understand the determinants of poor-rich inequalities in maternity care use.

The huge inequalities in maternity care underline the need for effective provision of services. Over the past decades, strategies to increase demand for (Ensor *et al.* 2004; Lanata 2000; Manandhar *et al.* 2004) and improve availability (Koblinsky *et al.* 1999), accessibility (Thaddeus *et al.* 1994), and affordability (Chiwuzie *et al.* 1997; Fofana *et al.* 1997) of professional delivery attendants have been introduced. Countries varied in the approaches followed. Some, such as Indonesia, have focussed on improving the availability of a narrow range of maternity care services (home based midwifery in particular), whereas some others, such as Sri Lanka, Honduras, Cuba, and Kerala, have sought to improve the availability of a broader range of health services, including maternity care (Koblinsky *et al.* 1999; Ronsmans *et al.* 2001).

Interventions have focused mostly on improving average levels of professional delivery care, and their differential effects have often not been adequately studied. This chapter provided detailed evidence on poor-rich inequalities in professional delivery care, and sought to understand these huge inequalities through comparisons with other types of health care. Reducing the poor-rich inequalities in professional delivery care is essential for achieving the MDGs for maternal health. More evidence on what works to reach lower socio-economic groups, and how effective interventions can be scaled up to entire national populations, is needed (Ensor *et al.* 2004). Different contexts may require different interventions to reduce the inequalities, and factors influencing the transferability of interventions between contexts should be mapped. A concerted effort of equity oriented research, policy making, and monitoring is needed to reduce the huge poor-rich inequalities in delivery care described in this chapter.

Part III

Time-trend analyses

8

Mortality inequalities in times of economic growth: time-trends in socio-economic and regional inequalities in under-5 mortality in Indonesia, 1982-1997

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ABSTRACT

Objectives This study aims to examine time-trends in socio-economic and regional inequalities in under-5 mortality in Indonesia during almost two decades of economic growth.

Methods Under-5 mortality was calculated for the total population and for subgroups by maternal education, household wealth, rural/urban residence, and island group, using the 1987, 1991, 1994, and 1997 Indonesian Demographic and Health Surveys. Inequalities were calculated using Cox proportional hazards analysis.

Results Under-5 mortality declined substantially during the 1980s and 1990s. Educational inequalities in under-5 mortality decreased, though not statistically significantly, from a hazard ratio of 2.00 (95% CI 1.60, 2.50) to 1.52 (95% CI 1.27, 1.82). Inequalities between urban and not-electrified rural areas increased, from 1.84 (95% CI 1.48, 2.28) to 2.18 (95% CI 1.70, 2.80). Inequalities between the Outer Islands and the central islands of Java/Bali increased from 1.16 (95% CI 0.92, 1.46) to 1.43 (95% CI 1.17, 1.74). Irregular time-trends were observed for inequalities by household wealth. Trends in health care use were fairly similar for the low and high educated.

Conclusion These results for education show that socio-economic inequalities in under-5 mortality do not inevitably rise in times of rapid economic growth. Widening or narrowing of health inequalities in times of economic growth might depend on how equally this growth is distributed.

8.1 INTRODUCTION

Reducing socio-economic and regional disparities in mortality within countries is an important objective of national governments and international organizations (Braveman *et al.* 2003a; Evans *et al.* 2001; Victora *et al.* 2003; WHO 2000). Imperative to achieving this goal is identifying the conditions under which mortality inequalities decrease. Not much is known, however, about how inequalities change over time, and what the determinants of these changes are.

There are some indications that relative socio-economic inequalities in mortality tend to increase in periods of economic growth and overall gains in survival. The existing evidence pertains to both high income countries, where such mortality inequalities have tended to rise during the past centuries (Burstrom *et al.* 2005; Mheen 1998), and, more recently, during the past decades (Mackenbach *et al.* 2003; Marang-van de Mheen *et al.* 1998; Martikainen *et al.* 2001), and to some low and middle income countries (DaVanzo *et al.* 1986; Vega *et al.* 2001; Victora *et al.* 2000; Wagstaff 2002). Empirical evidence, however, remains scarce, and is mostly restricted to a limited set of socio-economic or regional determinants (Woods *et al.* 1995).

Further evidence can be provided by the analysis of time-trends in inequalities in countries experiencing rapid economic growth. The newly industrializing countries of Asia, which experienced sustained high economic growth since the 1970s until mid-1997, provide a valuable 'laboratory' for such research. The availability of Demographic and Health Survey data for Indonesia for four subsequent periods provides a unique opportunity to study such time-trends during almost two decades of economic growth. The particularly large sample sizes make the Indonesian Demographic and Health Surveys suitable for such an analysis.

Indonesia, the most populous country in Southeast Asia, was one of Asia's miracle economies (BPS *et al.* 2001). Its high economic growth was shared reasonably equally across wealth groups, with the ratio of household expenditures between the poor and the rich having remained similar since the 1970s (Hill 1996). Poverty rates declined substantially, and nutritional standards improved (BPS *et al.* 2001; Hill 1996). Government investments in education were accompanied by strong increases in female literacy. The number of health care facilities expanded (BPS *et al.* 2001; Hull *et al.* 1995). These changes were paralleled by strong declines in under-5 mortality. It is unknown to what extent this mortality decline has been equally shared across different groups within the country.

Our study aimed to describe trends in inequality in under-5 mortality in Indonesia between 1982 and 1997. Under-5 mortality is an often-used indicator of population health. Moreover, in low and middle income countries, data on under-5 mortality are relatively reliable compared to other measures of population health. We studied inequalities in under-5 mortality along the following dimensions: maternal education, household wealth, rural/urban residence, and island group.

The set-up of this study was guided by the conceptual framework described by Mosley and Chen (1984), in which distal determinants such as maternal education exert an effect on under-5 mortality via more proximate determinants such as health care use. The effects of distal determinants like maternal education may also be explained by their association with other distal determinants, such as household wealth.

8.2 DATA AND METHODS

Retrospective birth history data and data on determinants of under-5 mortality were obtained from the 1987, 1991, 1994 and 1997 Indonesian Demographic and Health Surveys. The Demographic and Health Surveys are nationally representative surveys among ever-married women aged 15-49 years. The sample sizes of the four Indonesian surveys are large: 11884, 22909, 28168 and 28810 women respectively. Response rates were high: 97% and above.

We defined under-5 mortality as the number of deaths under age 60 months per 5,000 person-years during the six years preceding the survey. Using person-years instead of births as denominator assured that exactly the same information was used as in the analyses on mortality inequalities, as explained below. We used 5,000 person-years to obtain rates that have a roughly similar interpretation to the probability of dying within five years after birth. Children could enter the time-frame at birth (in case they were born during the time-frame) or at any age until 59 months (in case they were born before the start of the time-frame). Data on age at death were available in months for deaths at age two years and below, and in years for deaths above that age. In the analyses, age at death in months was used where available. A six-year time-frame was used to ensure reasonable statistical power while limiting the recall bias involved with long time-frames. Adjacent time-frames partly overlap, which might lead to conservative estimates of changes over time.

Under-5 mortality was calculated for the total population and for educational, wealth, community, and island subgroups. Maternal education was categorized into four groups: 'no education', 'some primary education', 'primary completed', and 'some secondary schooling and higher'. Household wealth was measured using an index based on ownership of assets, consisting of durable consumer goods, water and sanitation facilities and housing quality. The assets were combined into a wealth index using weights derived through principal components analysis (Filmer *et al.* 2001; Gwatkin *et al.* 2000). Despite its limitations (Houweling *et al.* 2003), this index has gained fairly wide acceptance as a measure of economic status in low and middle income countries (Bollen *et al.* 2002; Filmer *et al.* 2001). The principal components analysis was performed on a pooled data-set containing all survey years, with households as units of analysis. Consequently, the weighting scheme for the assets was the same for all years. Households were categorized into wealth groups, each consisting of 25% of the total household population in the pooled data-set. By using the same cut-off points for all years to construct wealth groups, changes over time in wealth could be taken into account.

We distinguished three community types: urban, electrified rural and not-electrified rural. Rural/urban residence and the availability of electricity are known to influence child survival (Wang 2003). Electricity was measured at the household level. As electricity is often communally provided, it is associated with community-level availability and quality of infrastructure and services. Nevertheless, it may measure some household level effects in addition to community-level effects.

Finally, we distinguished between the islands of Java and Bali –the political and economic centre of Indonesia– and the more peripheral Outer Islands, consisting of all other islands.

Inequalities in under-5 mortality by educational attainment, household wealth, rural/urban residence and island group were estimated using Cox proportional hazards regression analysis. Inequalities were expressed in terms of hazard ratios, giving the ratio of the hazard of dying before age 60 months when comparing deprived with better-off subgroups. For each of the determinants, inequalities in under-5 mortality were calculated for four periods separately using one regression model including an interaction-term between predictor and survey year (survey year defined as ordinal variable). Overall time-trends in inequality were tested by including survey year as continuous variable (instead of as ordinal variable) in the regression model. The trend estimates give the factor with which the hazard ratio changes between the 1987 and 1997 survey when modelling a linear time-trend in effect.

Next, we assessed to what extent the observed inequalities could be explained by the other socio-economic and regional determinants studied. For this purpose we added maternal education, household wealth, rural/urban residence and island group to all the initial models. Both their main effects and their interaction effects with survey year were included, to allow for changes in their effect over time.

The Demographic and Health Surveys are based on a cluster-sampling scheme. Observations within clusters are likely to be more similar than those obtained through a simple random sample. To obtain correct confidence intervals around the hazard ratios and trend estimates, this design effect needs to be taken into account. Standard errors were obtained by bootstrapping the Cox analyses, keeping the number of clusters per survey year constant. For every model, 500 bootstrap replications were obtained (Efron *et al.* 1993).

For each mother, on average, 1.5 children were included in the study. This intra-household dependency had no noticeable effect on the standard errors. Cox analyses and bootstraps were done in S-PLUS 6.0.

Inequalities were also calculated for infant mortality (mortality under age 12 months) and child mortality (mortality between age 12-59 months) separately, as the strength of the effects of the studied determinants is known to vary with the age of children.

Finally, a first step towards explaining time-trends in inequality was set by calculating time-trends in health care use for educational and island subgroups.

8.3 RESULTS

During the 1980s and 1990s, the Indonesian population has become better educated and wealthier. This is reflected in an increase in the proportion of children born to mothers with at least some secondary education and a decrease in the proportion of children born in poor or next-poor households (Table 8.1). The proportion of children born in not-electrified rural areas fell by more than 50%.

Table 8.2 shows time-trends in under-5 mortality. Total under-5 mortality declined by 43% between the 1987 and 1997 survey. All socio-economic and regional groups experienced improvements in survival. Small deviations from the monotonic mortality decline are

Table 8.1 Distribution of children and number of deaths under age 60 months, by subgroup, Indonesia, Demographic and Health Surveys 1987, 1991, 1994, 1997

Subgroups	**% of children in category (number of deaths)**							
	1982-1987		**1986-1991**		**1989-1994**		**1992-1997**	
Maternal education								
No education	20%	(261)	17%	(317)	15%	(317)	12%	(166)
Some primary	44%	(500)	38%	(779)	34%	(613)	28%	(371)
Primary completed	20%	(165)	26%	(424)	28%	(452)	31%	(416)
Some secondary +	16%	(70)	19%	(157)	24%	(275)	29%	(212)
Household wealth								
Poor	28%	(394)	30%	(646)	29%	(670)	20%	(347)
Next-Poor	28%	(286)	27%	(469)	24%	(442)	23%	(280)
Next-Rich	25%	(224)	25%	(428)	25%	(387)	29%	(365)
Rich	19%	(92)	18%	(129)	21%	(152)	28%	(173)
Community type								
Not-electrified rural	49%	(580)	49%	(987)	39%	(839)	22%	(390)
Electrified rural	24%	(241)	22%	(329)	33%	(550)	52%	(554)
Urban	27%	(176)	29%	(361)	28%	(268)	26%	(219)
Island group								
Outer Java/Bali	40%	(435)	44%	(744)	43%	(793)	44%	(606)
Java/Bali	60%	(562)	56%	(933)	57%	(864)	56%	(559)
Total [a]	18205	(997)	33907	(1677)	39433	(1657)	37533	(1165)

[a] Total number of children and total number of deaths. As the number of missing values varies between variables, the total number of deaths also varies between the determinants.

possibly due to chance. The more substantial mortality increases between the first and second survey among children of higher educated, next-rich, and urban women appeared to be concentrated in the province of West Java (results not shown). The causes of this mortality increase remain unknown.

Children born to low educated mothers experienced stronger mortality declines than children of high educated mothers. Hence, the educational mortality gap decreased systematically. In 1982-87, children of low educated mothers were twice as likely to die before their fifth birthday compared with children of high educated mothers. This mortality gap decreased to a ratio of 1.52 in 1992-1997. The decrease was not statistically significant, as indicated by the 95% confidence interval around the trend estimate. When comparing the two extreme educational groups, 'no education' and 'some secondary plus', a not statistically significant decline in inequality was observed, from a ratio of 3.42 (95% CI 2.41, 4.85)

Table 8.2 Trends in inequality in under-5 mortality by socio-economic and regional groups, Indonesia, 1982-1997

Subgroup	Under-5 mortality rates (# deaths/5,000 person years)				% Decline between first and last period	Trend estimate (95%CI) [a]
	1982-87	1986-91	1989-94	1992-97		
Total	105.7	101.7	85.6	60.6	43	
Maternal education						
No education	137.9	110.3	113.1	74.9	46	
Some primary	121.3	123.3	92.8	68.3	44	
Primary completed	88.8	100.5	84.2	69.8	21	
Some secondary +	45.4	51.0	60.0	37.7	17	
Rate difference	92.5	59.3	53.1	37.2		
Hazard ratio [b]	2.00 (1.60, 2.50)	1.69 (1.45, 1.97)	1.58 (1.33, 1.89)	1.52 (1.27, 1.82)		0.88 (0.68, 1.13)
Household wealth						
Poor	151.3	135.0	119.9	93.1	38	
Next-Poor	109.3	103.5	96.1	61.9	43	
Next-Rich	94.7	103.8	79.0	64.8	32	
Rich	50.1	43.8	36.7	32.4	35	
Rate difference	101.2	91.2	83.3	60.7		
Hazard ratio [b]	1.70 (1.38, 2.08)	1.48 (1.26, 1.74)	1.78 (1.47, 2.16)	1.57 (1.27, 1.95)		1.04 (0.81, 1.33)
Community type						
Not electrified rural	126.9	124.0	112.4	92.7	27	
Electrified rural	108.2	89.1	84.3	55.1	49	
Urban	66.9	74.7	49.9	44.0	34	
Rate difference	60.1	49.3	62.5	48.8		
Hazard ratio [c]	1.84 (1.48, 2.28)	1.61 (1.25, 2.06)	2.24 (1.66, 3.01)	2.18 (1.70, 2.80)		1.36 (0.99, 1.86)
Island group						
Outer Islands	117.9	102.8	94.4	72.9	38	
Java/Bali	97.9	100.8	78.8	51.2	48	
Rate difference	20.0	2.0	15.6	21.7		
Hazard ratio [d]	1.16 (0.92, 1.46)	1.01 (0.84, 1.22)	1.21 (1.02, 1.45)	1.43 (1.17, 1.74)		1.27 (0.96, 1.67)

Note: To minimize residual confounding, we used narrow educational and wealth groups (consisting of 4 categories) when adjusting for education and for wealth. [a] The trend estimates give the (multiplying)factor with which the Hazard Ratio changes between 1987 and 1997 when modeling a linear time-trend in effect using data from all four surveys. [b] Hazard ratio (95% CI), comparing the two lowest with the two highest categories. [c] Hazard ratio (95% CI), comparing "not electrified rural" with "urban". [d] Hazard ratio (95% CI), comparing Outer Islands with Java/Bali.

in 1982-87 to 2.54 (95% CI 1.87, 3.46) in 1992-97. Mortality differences between the lowest three educational groups virtually disappeared in 1992-97.

An irregular pattern of change over time was observed for mortality inequalities according to household wealth. Nevertheless, absolute poor-rich inequalities decreased, due to stronger absolute mortality declines among poorer groups.

The relative mortality gap between urban and not-electrified rural areas widened. This increase was borderline significant. In 1992-97, under-5 mortality in not-electrified rural areas was 2.18-times higher than in urban areas (95% CI 1.70, 2.80). Mortality inequalities between not-electrified and electrified rural areas increased statistically significantly (results available upon request).

Mortality differences between Java/Bali and the Outer Islands were small or non-existent during the 1980s. These inequalities, however, emerged and increased during the 1990s, due to stronger mortality declines on Java/Bali. In 1992-97, under-5 mortality on the Outer Islands was 1.44-times higher than on Java/Bali (95% CI 1.17, 1.74). This increase was borderline significant.

Table 8.3 shows the extent to which the observed inequalities were explained by other factors. Educational mortality inequalities were partly (50% in 1992-97) explained by household wealth. However, the observed decline over time in educational mortality inequalities was not explained by household wealth (this decline was also observed after adding wealth to the regression model). This was checked and confirmed by using three alternative wealth measures, such as a regression model including all wealth indicators separately as dummies (results available upon request). Nor was the observed decline in inequalities explained by rural/urban residence or island group.

Mortality differences between poor and rich children were for about 50% explained by maternal education. In 1992-97, for example, the hazard ratio after adjustment for education (1.29) was about halfway between 1 (indicating no effect) and 1.57 (the univariate effect of wealth). Household wealth lost most of its statistically significant association with under-5 mortality after adjusting for education, rural/urban residence and island group, with 95% confidence intervals including 1 in three of the four periods.

Differences in under-5 mortality between urban and not-electrified rural communities were largely explained by household wealth, maternal education, and to a lesser extent by island group. Only in 1989-94, substantial inequalities remained after adjusting for the above-mentioned factors.

Table 8.3 Multivariate analyses: trends in inequality in under-5 mortality by socio-economic and regional groups, Indonesia, 1982-1997

	Hazard ratio's (95%CI): Univariate and after Adjustment			
	1982-87	**1986-91**	**1989-94**	**1992-97**
Maternal education	2.00 (1.60, 2.50)	1.69 (1.45, 1.97)	1.58 (1.33, 1.89)	1.52 (1.27, 1.82)
Adjusted for:				
Household wealth	1.62 (1.29, 2.04)	1.44 (1.23, 1.69)	1.27 (1.05, 1.53)	1.26 (1.04, 1.52)
Community type	1.80 (1.43, 2.25)	1.56 (1.32, 1.84)	1.38 (1.15, 1.64)	1.32 (1.10, 1.59)
Island group	1.97 (1.56, 2.49)	1.68 (1.44, 1.96)	1.58 (1.33, 1.88)	1.52 (1.28, 1.81)
All	1.62 (1.28, 2.04)	1.42 (1.21, 1.67)	1.26 (1.05, 1.51)	1.25 (1.03, 1.51)
Household wealth	1.70 (1.38, 2.08)	1.48 (1.26, 1.74)	1.78 (1.47, 2.16)	1.57 (1.27, 1.95)
Adjusted for:				
Maternal education	1.32 (1.08, 1.62)	1.18 (0.99, 1.41)	1.52 (1.21, 1.91)	1.29 (1.04, 1.60)
Community type	1.46 (1.13, 1.90)	1.27 (1.01, 1.59)	1.41 (1.15, 1.72)	1.23 (0.96, 1.57)
Island group	1.69 (1.40, 2.04)	1.49 (1.24, 1.80)	1.77 (1.46, 2.14)	1.51 (1.22, 1.88)
All	1.24 (0.97, 1.58)	1.09 (0.88, 1.35)	1.27 (1.03, 1.55)	1.06 (0.84, 1.36)
Community type [a]	1.84 (1.48, 2.28)	1.61 (1.25, 2.06)	2.24 (1.66, 3.01)	2.18 (1.70, 2.80)
Adjusted for:				
Maternal education	1.42 (1.13, 1.79)	1.26 (0.96, 1.64)	1.84 (1.38, 2.46)	1.70 (1.32, 2.20)
Household wealth	1.23 (0.93, 1.62)	1.14 (0.83, 1.57)	1.43 (1.05, 1.94)	1.44 (1.06, 1.95)
Island group	1.81 (1.46, 2.25)	1.63 (1.26, 2.11)	2.20 (1.66, 2.92)	2.02 (1.57, 2.60)
All	1.15 (0.84, 1.57)	1.06 (0.77, 1.46)	1.38 (0.98, 1.93)	1.19 (0.86, 1.63)
Island group	1.16 (0.92, 1.46)	1.01 (0.84, 1.22)	1.21 (1.02, 1.45)	1.43 (1.17, 1.74)
Adjusted for:				
Maternal education	1.12 (0.90, 1.39)	1.02 (0.85, 1.23)	1.24 (1.05, 1.47)	1.55 (1.26, 1.90)
Household wealth	1.13 (0.90, 1.42)	0.95 (0.79, 1.15)	1.12 (0.93, 1.34)	1.30 (1.05, 1.59)
Community type	1.10 (0.86, 1.40)	0.95 (0.78, 1.15)	1.07 (0.89, 1.29)	1.24 (1.01, 1.53)
All	1.10 (0.89, 1.37)	0.99 (0.82, 1.19)	1.11 (0.93, 1.33)	1.35 (1.10, 1.67)

Note: To minimize residual confounding, we used narrow educational and wealth groups (consisting of 4 categories) when adjusting for education and for wealth. [a] Comparing 'not electrified rural' with 'urban'.

The widening mortality gap between Java/Bali and the Outer Islands was partly explained by household wealth, and more strongly by rural/urban residence. Adjustment for education showed that the greater improvements in educational attainment on the Outer Islands dampened the trend of widening regional mortality inequalities. In 1992-97, a moderately large and statistically significant mortality gap remained between the island groups after adjusting for all factors.

Socio-economic and regional inequalities in child (12-59 months) mortality were overall substantially larger than those in infant (0-11 months) mortality, especially in later periods (Table 8.4). Educational inequalities appear to decline for both infant and child mortality. Neither trends were, however, statistically significant. Inequalities in child mortality by household wealth and between urban and not-electrified rural areas increased strongly and significantly. Time-trends in inequality in infant mortality by these factors were weaker and not significant. The gap between island groups in infant and child mortality increased over time, though the changes were not statistically significant.

Table 8.4 Trends in inequality in infant and child mortality by socio-economic and regional groups, Indonesia, 1982-1997

	Hazard ratio's (95% CI)				**Trend estimate (95% CI) [d]**
	1982-87	**1986-91**	**1989-94**	**1992-97**	
Infant mortality					
Maternal education [a]	1.80 (1.40, 2.32)	1.53 (1.30, 1.79)	1.43 (1.14, 1.80)	1.42 (1.15, 1.74)	0.88 (0.67, 1.16)
Household wealth [a]	1.78 (1.43, 2.23)	1.44 (1.17, 1.77)	1.51 (1.22, 1.85)	1.44 (1.14, 1.83)	0.87 (0.64, 1.19)
Community type [b]	1.82 (1.38, 2.39)	1.60 (1.26, 2.04)	2.00 (1.48, 2.70)	1.97 (1.50, 2.60)	1.21 (0.86, 1.71)
Island group [c]	1.08 (0.81, 1.43)	0.92 (0.76, 1.11)	1.13 (0.93, 1.38)	1.31 (1.04, 1.64)	1.24 (0.91, 1.70)
Child mortality					
Maternal education [a]	2.59 (1.82, 3.69)	2.22 (1.65, 3.00)	2.00 (1.53, 2.63)	2.04 (1.42, 2.94)	0.94 (0.62, 1.41)
Household wealth [a]	1.57 (1.14, 2.17)	1.59 (1.18, 2.14)	2.85 (2.02, 4.00)	2.26 (1.56, 3.29)	1.75 (1.14, 2.68)
Community type [b]	1.98 (1.32, 2.96)	1.67 (1.11, 2.52)	2.98 (1.92, 4.61)	3.16 (1.97, 5.07)	1.84 (1.09, 3.11)
Island group [c]	1.35 (0.95, 1.91)	1.29 (0.94, 1.77)	1.44 (1.08, 1.92)	2.10 (1.40, 3.13)	1.36 (0.89, 2.07)

[a] Comparing the two lowest with the two highest categories. [b] Comparing deprived rural with urban. [c] Comparing Outer Islands with Java/Bali. [d] The trend estimates give the (multiplying)factor with which the hazard ratio changes between 1987 and 1997 when modeling a linear time-trend in effect using data from all four surveys.

Health care use has, overall, increased (Table 8.5). Low educated mothers probably experienced somewhat stronger increases in antenatal care, tetanus vaccination, family planning and knowledge of oral rehydration solution. Conversely, higher educated mothers probably experienced a somewhat stronger increase in skilled delivery attendance. Educational inequalities in skilled delivery attendance, and measles and tetanus vaccination remained large.

Table 8.5 Trends in health care use by educational- and island groups, Indonesia, 1987-1997

	% Of population			
	Educational attainment		**Island group**	
	Low educated	High educated	Outer Java/Bali	Java/Bali
Measles vaccination coverage [a]				
DHS 1987	---	---	----	----
DHS 1991	47	67	47	66
DHS 1994	46	74	58	66
DHS 1997	56	78	70	72
absolute change between 1991-97[b]	9	11	23	6
Antenatal care [c]				
DHS 1987	---	---	----	----
DHS 1991	70	90	75	84
DHS 1994	78	94	84	90
DHS 1997	85	97	91	94
absolute change between 1991-97[b]	15	6	16	10
Skilled delivery attendance [d]				
DHS 1987	24	57	45	31
DHS 1991	20	51	38	33
DHS 1994	21	54	44	37
DHS 1997	26	61	52	47
absolute change between 1991-97[b]	6	10	14	14
Births with tetanus vaccination [e]				
DHS 1987	---	---	----	----
DHS 1991	46	71	48	67
DHS 1994	53	76	57	73
DHS 1997	60	80	68	77
absolute change between 1991-97[b]	14	9	21	10
Current use of modern family planning [f]				
DHS 1987	35	49	33	44
DHS 1991	38	50	37	47
DHS 1994	42	54	42	52
DHS 1997	45	55	45	55
absolute change between 1991-97[b]	8	5	8	8
Knowledge of ORS [g]				
DHS 1987	---	---	----	----
DHS 1991	76	95	81	89
DHS 1994	78	96	87	88
DHS 1997	83	96	90	92
absolute change between 1991-97[b]	7	1	9	3

Note: Low educated = no education or some primary, high educated = primary completed or higher. In DHS 1987, data were not available for a number of indicators. [a] Measles: % of surviving children age 12-23 months (at time of survey) with measles vaccination, by vaccination card or mother's report. [b] Measures the absolute change in rate between DHS 1991 and 1997. [c] Antenatal care: % of births in the five years before the survey for which a woman received at least one antenatal care

consultation from a medically trained person, defined as a doctor, nurse or nurse-midwife. [d] Skilled delivery attendance: % of births in the five years before the survey that were attended to by a medically trained person, defined as a doctor, nurse or nurse-midwife. [e] Births with tetanus vaccination: % pregnancies during which tetanus toxoid injections were given to avoid convulsions after birth. [f] Current use of modern family planning methods: % of married women aged 15-49 years. [g] Knowledge of ORS: % mothers having heard of ORS (oral rehydration) for treating children with diarrhoea.

On the Outer Islands, health care use (especially measles vaccination, antenatal care, and tetanus vaccination) improved considerably over time. Whereas in 1991 utilization rates were substantially lower on the Outer Islands than on Java/Bali, this difference was generally smaller or had disappeared in 1997.

8.4 DISCUSSION

Under-5 mortality declined substantially in Indonesia during the 1980s and 1990s. This decline appears to be unequally distributed across socio-economic groups and across regions. The mortality declines were possibly stronger among children of low educated mothers than children of high educated mothers. Hence, the mortality gap between the low and high educated possibly narrowed. Peripheral areas lag behind the mortality progress experienced by urban areas and the central islands of Java and Bali. Irregular time-trends were observed for relative inequalities according to household wealth. Absolute mortality inequalities generally decreased over time.

Educational inequalities in under-5 mortality nevertheless remained substantial during the last study period. Under-5 mortality was 2.5-fold higher among children of uneducated mothers than among children of mothers with some secondary education. Also regional inequalities were large. Indonesia, with a population of over 200 million, would achieve tremendous gains in under-5 survival if disadvantaged groups and regions would reach the same mortality levels as the better-off.

Differences in under-5 mortality between children of women with/without primary education virtually disappeared over time, suggesting that, under conditions prevailing in 1997, only improvements in female education beyond primary school level would substantially improve under-5 survival.

Evaluating the data and methods

When evaluating the observed decline in educational mortality inequalities, two issues should be considered. Firstly, there was not enough statistical power to exclude the possibility that this decline was attributable to chance variations. The limited statistical power is related to the necessary adjustment for cluster sampling in the Demographic and Health Surveys, an adjustment that many studies omit. Even with huge datasets like the Indonesian Demographic and Health Surveys, it remains difficult to precisely establish time-trends in inequality. Nevertheless, the systematic nature of the decline in inequality over four periods, and the similar pattern observed for infant and child mortality, does suggest this decline was real. Important to note, there are no indications that educational mortality inequalities increased over time. Secondly, the observed decline in inequality cannot be explained by a stronger negative selection of the low educated over time. Negative selection means that as having a low educational attainment becomes more an exception (Table 8.1), it is increasingly associated with characteristics that instigate high mortality. Such an increased selection would imply increasing, instead of decreasing inequalities.

The irregular time-trends in inequality according to household wealth are possibly due to problems with comparability of the wealth measure over time. It is not likely that the effect of wealth fluctuates strongly within short periods of time, perhaps except in the case of severe economic or societal disruption. Whereas the wealth index has gained fairly wide acceptance as measure of economic status in low and middle income countries, its usefulness in time-trend analyses appears to be restricted. Future research should pay attention to improving the wealth index in this respect.

Explaining the results

Stable or declining educational inequalities in under-5 mortality are remarkable, as they contrast to indications that mortality inequalities generally increase in times of rapid economic growth (DaVanzo *et al.* 1986; Vega *et al.* 2001; Victora *et al.* 2000; Wagstaff 2002). Especially educational inequalities can be expected to increase, as maternal education has been shown to be a crucial factor in adopting 'modern' health behaviour and taking advantage of new health technologies (Caldwell 1990; Cleland *et al.* 1988). We will discuss three explanations for the observed narrowing mortality gap. Thereafter, we will discuss explanations for the increasing regional inequalities.

Firstly, mortality inequalities might decline once the better-off have reached a (contextually defined) saturation point beyond which further improvements are not attainable (Victora *et al.* 2000). This, however, can not explain our results. Even if further mortality declines were difficult to attain among the highest educated, they *were* attainable among all other educational groups. Yet, also among these groups, a clear gradient was seen, with the lower educated experiencing stronger mortality declines.

Secondly, an increased availability of health care and family planning services may have contributed to faster declines in under-5 mortality among the low educated (Bicego 1990; Rozenzweig *et al.* 1982). In Indonesia, the network of community health centres that was set up throughout the country during the 1970s (BPS *et al.* 2001), was expanded with lower-level sub-centres and village health posts during the 1980s (Hull *et al.* 1995). Although health facilities have increased in quantity, there are important concerns over quality and accessibility for the poor (Hull *et al.* 1995). We found no strong indication that increased health care use contributed to the observed narrowing mortality gap. The trends in health care use only differed slightly between educational groups, and the strongest increases were not consistently concentrated among the lower educated. Another study showed that the total fertility rate declined most strongly, from 3.7 births in 1984 to 2.7 in 1997, among uneducated women, whereas it remained stable at around 2.6 births among the high educated (Central Bureau of Statistics (CBS) (Indonesia) *et al.* 1998). Lower fertility rates are, via longer birth intervals, associated with lower under-5 mortality rates (Barnum 1988; Setty-Venugopal *et al.* 2002). This may have contributed to the observed decline in educational inequalities in under-5 mortality in general, and in infant mortality in particular.

Finally, an equal sharing of economic growth across socio-economic groups may contribute to a faster mortality decline among the low educated. An equitable income distribution and the accompanying poverty decline have been lauded as one of the hallmarks of Indonesia's high economic growth (BPS *et al.* 2001; Hill 1996). The poor-rich ratio of household expenditure had not fundamentally changed since the 1970s, showing that both groups benefited about equally from the economic boom (Hill 1996). The poverty decline may have disproportionately benefited the low educated. Nevertheless, household wealth could not explain, in a multivariate analysis, the observed decline in educational mortality inequalities. Moreover, the availability of water and sanitation facilities did not change substantially (results available upon request). More specific mechanisms, such as an improvement in the nutritional status of mothers and young children, may have been at work. It has been estimated that malnutrition is an underlying factor in 54% of all child deaths in Indonesia

(Pelletier *et al.* 1995). Malnutrition has declined steadily during the economic growth period, thanks to the Green Revolution and the government's pro-active food policy (Hill 1996). Moreover, socio-economic differences in child malnutrition declined in Indonesia during the 1990s (Waters *et al.* 2004).

The small mortality differences between Java/Bali and the Outer Islands during the 1980s might have been partly related to the mildly equalizing fiscal flows between the centre and periphery during the mid-1970s till the early 1990s (Hill 1996). In the early 1990s, economic growth became more concentrated on Java (BPS *et al.* 2001). In rural Java/Bali, the prevalence of household poverty decreased somewhat faster and the percentage of children living without electricity declined much faster than in rural areas of the Outer Islands (results available upon request). Our multivariate analysis confirmed that the increasing mortality gap between Java/Bali and the Outer Islands might be partly explained by a faster rural development on Java/Bali.

Differential trends in health care use and fertility cannot explain the increasing mortality gap between the island groups. Improvements in health care use were much stronger on the Outer Islands than on Java/Bali. Others have shown that also declines in total fertility were stronger on the Outer Islands (Central Bureau of Statistics (CBS) (Indonesia) *et al.* 1998).

Summarizing, during the Asian economic boom, children of low educated mothers experienced at least as strong mortality declines as children of high educated mothers. Hence, the mortality gap between the low and high educated possibly narrowed. This was not a necessity, caused by 'saturation' in the mortality decline among the higher educated. Rather, the Indonesian economic and political context has probably been conducive to this development. The reasonably equitable distribution of economic growth across socio-economic groups in Indonesia (BPS *et al.* 2001; Hill 1996) may have prevented rising educational inequalities in mortality. The specific mechanisms that contributed to the observed decline in inequality are, however, uncertain. Whereas improvements in household wealth seemed not to explain the observed trend, improved nutritional status among low educated mothers and their children might be an explanation. Unequal economic growth between the central islands of Java/Bali and the more peripheral Outer Islands, and especially a faster rural development on Java/Bali, may have contributed to the increasing regional mortality inequalities. This suggests that the diverging trends in mortality inequalities by education and island group might be explained by the same mechanism, i.e. distribution of economic

growth. This distribution was comparatively equitable across socio-economic groups, thereby possibly preventing widening educational mortality inequalities. Conversely, a stronger concentration of economic growth on Java/Bali may have contributed to the increasing regional mortality gap.

Our results for Indonesia might be exemplary for a broader set of newly industrializing Asian countries. These countries have followed a similar development trajectory, with high economic growth, a rather equitable income distribution, and governments with 'development agendas' (BPS *et al.* 2001). Further research should determine whether this shared development trajectory was accompanied by shared time-trends in mortality inequalities.

The Asian economic boom was followed in mid-1997 by an economic crisis, which has severely affected economic well-being and possibly also health of the Indonesian population. The inequalities observed for 1992-97 may therefore not be fully applicable to the current situation. Mortality inequalities are, however, likely to have persisted, and may even have widened. The recent developments only further emphasise the importance of understanding how inequalities in mortality develop with a country's macro-economic conditions.

Implications

Our study implies that widening socio-economic mortality inequalities in times of rapid economic growth are not inevitable; declining inequalities may occur as well, certainly in absolute sense. What happens with mortality inequalities in times of economic growth might depend on how equally this growth is distributed. An equitable distribution of economic growth in general, and rural development in particular, might be important factors for preventing widening inequalities in under-5 mortality. Secondly, our results show that stable or declining inequalities according to one dimension can go together with increasing inequalities in another. This underlines the importance of monitoring mortality inequalities across a broad spectrum of socio-economic and regional dimensions. Further unravelling of historical trends in mortality inequalities is pivotal for a better understanding of the specific conditions that increase or impede an equal distribution of survival opportunities.

9

Rising under-5 mortality in Africa: who bears the brunt?

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ABSTRACT

Objectives This study aims to identify the socio-economic and geographical groups in which the recent under-5 mortality increase observed in several African countries was most pronounced, and to explore the contribution of a number of proximate determinants of under-5 mortality.

Methods Time-trends in under-5 mortality were assessed with Cox proportional hazards regression analysis, using Demographic and Health Survey data for Burkina Faso, Cameroon, Côte d'Ivoire, Kenya and Zimbabwe, for the late 1980s - 1990s. We tested for differences in time-trends between socio-economic and rural/urban subgroups, and described inequalities in time-trends in living conditions, malnutrition, and health care use.

Results Under-5 mortality increased substantially (ranging from 25% to 71% in 10 years) within the five countries. In Kenya, the increase was largest among children born to less educated mothers (test for difference between educational groups: p=0.074) and in rural areas (p=0.090). In Cameroon, the increase was largest among the higher educated (p=0.013), and in Zimbabwe among the higher educated (p=0.098) and in urban areas (p=0.093). For Burkina Faso and Côte d'Ivoire, we did not observe statistically significant differences between educational and rural/urban subgroups. The decline in skilled delivery attendance in Zimbabwe and Kenya was similar among the less and higher educated. The decline in immunisation coverage during the mid-1990s in Zimbabwe was largest in the group with the largest mortality increase, but was in Kenya as large among the less and higher educated. Whereas in Kenya the increase in malnutrition was largest in the group with the highest mortality increase, this was not the case in Zimbabwe.

Conclusion The recent increase in under-5 mortality in some African countries was highly concentrated in specific population subgroups. Exactly which groups were most affected

was highly variable. It cannot be assumed that lower socio-economic groups are always most vulnerable. Strategies to halt the under-5 mortality increase should be based on disaggregate information for individual countries.

9.1 INTRODUCTION

After a period of declining under-5 mortality, childhood survival has deteriorated recently in several African countries (UNICEF 2004; WHO 2003). In many cases the improvements made during the 1970s and early 1980s are being wiped out. Economic decline (Ahmad *et al.* 2000; UNICEF 2004), the HIV/AIDS epidemic (Adetunji 2000; UNICEF 2004; Walker *et al.* 2002), an increase in drug-resistant malaria (Snow *et al.* 2001; WHO *et al.* 2003), and armed conflict (UNICEF 2004) have been related to this mortality increase.

The above deteriorating trends refer to national averages of under-5 mortality. Children of poor and low educated mothers have, however, a much higher chance of dying in childhood than those of richer and more educated mothers (Bicego *et al.* 1993; Gwatkin *et al.* 2000). The pattern of mortality change over time may also differ between socio-economic groups. Mortality declines, it has been suggested, start earlier among higher socio-economic groups (Victora *et al.* 2000). There is, however, little evidence on differential mortality trends from low income countries and, to our knowledge, no study set within the context of mortality increase.

Already disadvantaged groups might be more vulnerable to the deteriorating circumstances discussed earlier, thereby increasing the already large mortality gap between socio-economic groups. If the Millennium Development Goal of a two-third reduction in under-5 mortality by 2015 is to be achieved, it is important to know which groups are most vulnerable to a mortality increase. By identifying the socio-economic and geographical groups in which the under-5 mortality increase is concentrated, our study hopes to contribute to priority setting in policies aimed at confronting this important public health problem.

This study aimed to investigate to what extent the increase in under-5 mortality observed in several African countries during the 1990s was concentrated in specific socio-economic or geographical groups. As urban areas can be highly heterogeneous, separate analyses are presented for lower and higher socio-economic strata within urban and within rural areas.

In order to understand the mortality changes among the socio-economic and rural/urban subgroups, we will explore the role of several proximate, modifiable, determinants of under-5 mortality. Specifically, we will describe time-trends in levels of health care use (i.e. childhood immunisation, delivery attendance by medical person) and acute and chronic childhood malnutrition for each of the socio-economic and rural/urban subgroups.

9.2 DATA AND METHODS

Data were obtained from the Demographic and Health Surveys (DHS) (www.measuredhs.com). These are nationally representative surveys among women aged 15-49 years. DHS includes retrospective birth history data, with survival information on all children ever born to the respondents, and information on determinants of mortality. All sub-Saharan African countries with at least 2 DHS surveys in the 1990s, showing an increase in under-5 mortality, were included in our study (Table 9.1). The countries vary distinctly in HIV-prevalence, from 6% in Burkina Faso, 13% in Kenya, to 25% in Zimbabwe (www.odci.gov/cia/publications/factbook/fields/2155.html).

First, we calculated the probability of dying under age 60 months for the total population and the educational and rural/urban subgroups. These probabilities were estimated using Cox proportional hazards regression analysis. All children that were alive and under 60 months within the pre-defined time-frame, were considered exposed. All deaths among these children were included. Children could enter the time-frame at birth (when born during the time-frame) or at any age until 59 months old (when born before the time-frame). Time-frames were generally no longer than the five years prior to the survey, to minimalise the potential problem of a positive correlation between maternal and child deaths (Mahy 2003).

Secondly, time-trends in under-5 mortality were estimated using a Cox proportional hazards model in which the hazard ratios between survey-years (year defined as linear variable) provided the annual percentage mortality change. We tested whether the mortality time-trends were significantly different between the lower and higher educated, and between rural and urban areas. Time-trends were also estimated for infant (<12 months) and child (12-59 months) mortality separately, as the strength of the effects of the studied determinants is known to vary with the age of children.

Demographic and Health Surveys are based on a cluster-sampling scheme. This design effect should be taken into account when calculating the confidence intervals. Standard errors were obtained by bootstrapping the Cox analyses, keeping the number of clusters per survey year constant. For every model, 1,000 bootstrap replications were obtained (Efron *et al.* 1993). Cox analyses and bootstraps were done in S-PLUS 6.0.

Finally, a first step towards explaining the mortality trends assessed whether changes in proximate determinants of mortality ran parallel with the observed mortality trends. The following determinants were studied: household living conditions, childhood malnutrition, full childhood immunisation coverage, and skilled delivery attendance. Data were obtained from the STATcompiler, on the DHS website, and were cross-checked with information in the Final Reports. We focussed on the most interesting comparison, between Kenya and Zimbabwe. The two countries showed very different patterns of mortality increase across educational and rural/urban subgroups (see below). They are also the only countries with three surveys.

Table 9.1 Distribution of children (number of deaths) under age 60 months, for the total population and educational and rural/urban groups, late-1980s/1990s for five African countries

Subgroups	Survey 1		Survey 2		Survey 3	
Burkina Faso			**1992/3**		**1998/9**	
Total*	NA	(NA)	9511	(810)	9656	(972)
Education						
No education	NA	(NA)	89	(740)	92	(915)
Some primary	NA	(NA)	5	(37)	4	(33)
Primary completed	NA	(NA)	3	(22)	2	(15)
Secondary +	NA	(NA)	3	(12)	2	(9)
Rural/urban						
Rural	NA	(NA)	86	(732)	90	(896)
Urban	NA	(NA)	14	(76)	10	(53)
Cameroon			**1991**		**1998**	
Total*	NA	(NA)	5709	(344)	6907	(499)
Education						
No education	NA	(NA)	45	(220)	37	(231)
Some primary	NA	(NA)	24	(65)	25	(116)
Primary completed	NA	(NA)	13	(20)	15	(69)
Secondary +	NA	(NA)	18	(39)	24	(84)
Rural/urban						
Rural	NA	(NA)	60	(227)	74	(378)
Urban	NA	(NA)	40	(115)	26	(98)

Côte d'Ivoire			**1994**		**1998/9**	
Total*	NA	(NA)	12585	(955)	3658	(354)
Education						
No education	NA	(NA)	70	(691)	67	(244)
Some primary	NA	(NA)	17	(158)	13	(54)
Primary completed	NA	(NA)	5	(47)	13	(45)
Secondary +	NA	(NA)	8	(59)	7	(11)
Rural/urban						
Rural	NA	(NA)	64	(672)	71	(258)
Urban	NA	(NA)	36	(283)	29	(68)
Kenya	**1989**		**1993**		**1998**	
Total*	12000	(511)	9873	(427)	9999	(528)
Education						
No education	31	(150)	22	(74)	14	(87)
Some primary	32	(192)	32	(192)	37	(254)
Primary completed	21	(106)	25	(106)	24	(112)
Secondary +	16	(64)	21	(56)	25	(75)
Rural/urban						
Rural	87	(433)	87	(372)	83	(452)
Urban	13	(77)	13	(55)	17	(74)
Zimbabwe	**1988/9**		**1994**		**1999**	
Total*	6243	(218)	7693	(288)	6526	(347)
Education						
No education	20	(59)	17	(46)	9	(32)
Some primary	43	(104)	33	(102)	24	(92)
Primary completed	21	(30)	22	(64)	24	(80)
Secondary +	16	(25)	28	(76)	43	(142)
Rural/urban						
Rural	73	(180)	77	(225)	69	(238)
Urban	27	(38)	23	(61)	31	(97)

*Total number of children (total number of deaths). As the number of missing values varies between variables, the total number of deaths also varies between the variables.

9.3 RESULTS

The countries were heterogeneous in terms of the distribution of exposed children across the educational categories, with 92% of children in Burkina Faso born to mothers without any education, as compared to 9% in Zimbabwe (Table 9.1). In all countries, the majority of children were born in rural areas.

Under-5 mortality increased substantially during the mid-1980s/1990s (Table 9.2), varying from an estimated 2.2% per year in Kenya to 5.5% in Côte d'Ivoire (i.e. a 25% and 71% increase in 10 years respectively). The increases were highly statistically significant in most countries. The point estimates per subgroup give some indication of differential trends (Table 9.2 and Table 9.3). In Burkina Faso and Kenya, the mortality increase was

Table 9.2 Under-5 mortality and annual change in under-5 mortality for the total population and educational groups, 1980s/1990s, for five African countries

Subgroups	Probability of death under age 5 years (per 1,000 live births)			Annual change (%) in under-5 mortality (95% CI)*	p-value†
Burkina Faso		**1989-93**	**1995-99**		
Total	NA	168	202	3.2 (1.1, 5.4)	
No education	NA	172	207	3.3 (1.2, 5.4)	0.452
Some primary	NA	158	180	2.5 (-6.8, 12.7)	
Primary completed	NA	137	127	-1.0 (-11.5, 10.8)	
Secondary +	NA	90	88	-0.2 (-10.9, 11.8)	
Cameroon		**1987-91**	**1994-98**		
Total	NA	102	140	3.3 (0.3, 6.3)	
No education	NA	151	175	0.5 (-2.9, 4.0)	0.013
Some primary	NA	78	130	5.8 (0.5, 11.5)	
Primary completed	NA	40	133	17.0 (7.1, 27.7)	
Secondary +	NA	58	95	5.7 (0.0, 11.8)	
Côte d'Ivoire		**1990-94**	**1994-99**		
Total	NA	145	168	5.5 (0.1, 11.2)	
No education	NA	154	176	4.9 (-2.0, 12.4)	0.751
Some primary	NA	134	179	9.3 (-0.7, 20.4)	
Primary completed	NA	129	168	8.7 (-3.3, 22.2)	
Secondary +	NA	103	71	-7.4 (-21.0, 8.5)	
Kenya	**1985-89**	**1990-93**	**1994-98**		
Total	87	99	105	2.2 (-0.1, 4.6)	
No education	94	89	142	4.8 (0.4, 9.4)	0.074
Some primary	102	141	132	2.8 (-0.1, 5.8)	
Primary completed	77	88	89	1.9 (-1.7, 5.6)	
Secondary +	60	59	58	-0.1 (-4.8, 4.9)	
Zimbabwe	**1984-89**	**1990-94**	**1995-99**		
Total	64	75	102	4.2 (2.2, 6.1)	
No education	91	81	126	1.9 (-3.0, 7.0)	0.098
Some primary	71	85	119	4.4 (1.3, 7.7)	
Primary completed	41	76	98	7.7 (3.6, 12.0)	
Secondary +	40	60	88	7.3 (3.2, 11.6)	

*Trend estimate, based on linear trend in mortality across all surveys. †p-value of test on difference between the lowest two and the highest two educational categories. Because of the skewed educational distribution in Burkina Faso and Côte d'Ivoire, for these two countries, the p-value gives the test on difference between the category 'no education' and the other three groups.

concentrated among the less educated and those in rural areas. In Côte d'Ivoire, mortality increased among all groups except the highest educated. In Cameroon and Zimbabwe, all groups experienced a mortality increase. The increase was strongest among the higher educated, and, in Zimbabwe, in urban areas. Absolute changes in under-5 mortality over time generally reflect the above mentioned relative changes.

Table 9.3 Under-5 mortality and annual change in under-5 mortality for the total population and rural/urban groups, 1980s/1990s, for five African countries

Subgroups	Probability of death under age 5 years (per 1,000 live births)			Annual change (%) in under-5 mortality (95% CI)*	p-value†
Burkina Faso		**1989-93**	**1995-99**		
Total	NA	168	202	3.2 (1.1, 5.4)	
Rural	NA	165	206	3.3 (1.2, 5.5)	0.167
Urban	NA	110	111	-0.2 (-4.5, 4.3)	
Cameroon		**1987-91**	**1994-98**		
Total	NA	102	140	3.3 (0.3, 6.3)	
Rural	NA	126	151	3.0 (-0.8, 6.8)	0.815
Urban	NA	96	111	2.4 (-1.0, 5.9)	
Côte d'Ivoire		**1990-94**	**1994-99**		
Total	NA	145	168	5.5 (0.1, 11.2)	
Rural	NA	156	174	5.7 (-0.8, 12.6)	0.457
Urban	NA	118	115	2.4 (-2.7, 7.8)	
Kenya	**1985-89**	**1990-93**	**1994-98**		
Total	87	99	105	2.2 (-0.1, 4.6)	
Rural	88	103	113	2.9 (0.3, 5.6)	0.090
Urban	99	102	88	-1.3 (-5.4, 2.9)	
Zimbabwe	**1984-89**	**1990-94**	**1995-99**		
Total	64	75	102	4.2 (2.2, 6.1)	
Rural	73	77	107	3.4 (1.1, 5.7)	0.093
Urban	41	66	91	7.3 (3.3, 11.4)	

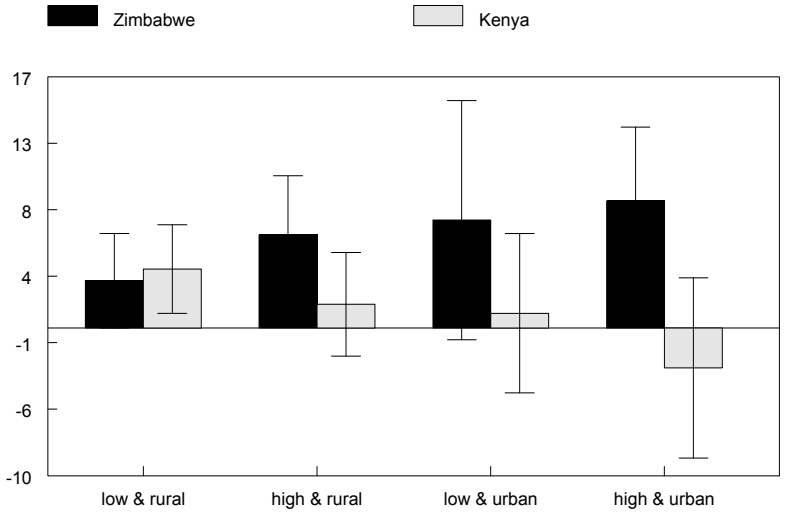
*Trend estimate, based on linear trend in mortality across all included surveys. †Test on difference between rural and urban

The difference in mortality trends between the two lower and the two higher educational groups was of borderline statistically significance for Kenya (p=0.074) and Zimbabwe (p=0.098), and statistically significant for Cameroon (p=0.013). As the distribution of children was highly skewed in Burkina Faso and Côte d'Ivoire, we compared the mortality trends between the categories 'no education' and 'some education' for these countries. No statistically significant differences were found. The stronger mortality increase in rural

areas in Kenya was of borderline statistical significance (p=0.090), as was the stronger increase in urban areas in Zimbabwe (p=0.093).

In Zimbabwe, there was a systematic gradient, with the smallest mortality increase among the lower educated in rural areas and the strongest increase among the urban-higher educated (Figure 9.1). In Kenya the reverse gradient from the one found for Zimbabwe was observed.

Figure 9.1 Change in under-5 mortality per year (%) by subgroup, Zimbabwe and Kenya, mid 1980s - 1990s



Low & rural = no education or some primary and living in rural area; High & rural = primary education completed or higher and living in rural area; Low & urban = no education or some primary and living in urban area; High & urban = primary education completed or higher and living in urban area.

The percentage increase in child mortality was larger than in infant mortality (Table 9.4). In Zimbabwe, child mortality increased by almost 14% annually among the secondary education group, in comparison with 1.5% among the group without schooling. The educational gradient in the mortality increase was much weaker for infant mortality. In Kenya, also, the gradient was stronger for child mortality; however, the largest increases were observed among the less educated.

Table 9.4 Annual change in infant mortality and child mortality, for the total population and educational and rural/urban subgroups, 1980s/1990s, for two African countries

Subgroups	Annual change (%) in infant mortality (95% CI)*	p-value†	Annual change (%) in child mortality (95% CI)*	p-value†
Kenya				
Total	1.9 (-0.4, 4.4)		2.9 (-0.6, 6.6)	
Education				
No education	3.1 (-2.2, 8.8)	0.257	7.7 (1.4, 14.4)	0.161
Some primary	2.7 (-0.6, 6.0)		3.0 (-1.8, 8.0)	
Primary completed	1.5 (-2.8, 6.0)		2.5 (-3.3, 8.8)	
Secondary +	0.2 (-4.7, 5.3)		-0.8 (-9.9, 9.2)	
Rural/urban				
Rural	2.5 (-0.4, 5.4)	0.215	3.6 (-0.4, 7.8)	0.301
Urban	-1.5 (-6.8, 4.1)		-0.9 (-8.0, 6.7)	
Zimbabwe				
Total	3.4 (1.1, 5.7)		5.9 (2.3, 9.5)	
Education				
No education	2.1 (-4.5, 9.2)	0.215	1.5 (-6.0, 9.6)	0.123
Some primary	3.3 (-0.4, 7.1)		6.6 (0.4, 13.1)	
Primary completed	6.8 (1.9, 11.9)		9.6 (2.2, 17.4)	
Secondary +	5.4 (0.7, 10.4)		13.7 (4.7, 23.4)	
Rural/urban				
Rural	2.7 (0.1, 5.4)	0.161	5.1 (1.0, 9.3)	0.331
Urban	6.6 (2.0, 11.3)		9.4 (1.7, 17.6)	

*Trend estimate, based on linear trend in mortality across all included surveys. †Test on difference between the lowest two and the highest two educational groups, and test on difference between rural and urban.

Determinants of under-5 mortality

The proportion of households without any toilet facility and the proportion with a dirt floor generally remained stable or slightly decreased among all educational groups in Kenya and Zimbabwe (results not shown). Household ownership of durable consumer goods and the availability of electricity generally remained stable or increased.

Malnutrition among 0-2 year olds has increased in Kenya and Zimbabwe (Table 9.5). In Kenya, chronic malnutrition, especially the prevalence of severe cases, increased among the lower educated. In Zimbabwe, acute and chronic malnutrition has increased across educational groups. Among the less educated, severe forms of malnutrition increased, whereas among the higher educated, moderate forms increased.

Table 9.5 Time-trends in childhood malnutrition, late-1980s / 1990s for two African countries*

Subgroups	Severe chronic malnutrition (%)†				Moderate + severe chronic malnutrition (%)‡				Moderate + severe acute malnutrition (%)§			
	Survey 1	Survey 2	Survey 3	change (abs)	Survey 1	Survey 2	Survey 3	change (abs)	Survey 1	Survey 2	Survey 3	change (abs)
Kenya												
Total	NA	10.0	12.7	2.7	NA	29.0	33.0	4.0	NA	4.6	6.1	1.5
No education	NA	12.9	21.4	8.5	NA	37.8	46.4	8.6	NA	9.0	8.8	-0.2
Primary	NA	11.2	14.3	3.1	NA	31.3	36.4	5.1	NA	4.2	6.4	2.2
Secondary +	NA	6.1	5.0	-1.1	NA	19.4	19.2	-0.2	NA	3.0	3.9	0.9
Zimbabwe												
Total	7.6	6.1	9.2	1.6	27.4	21.4	26.4	-1.0	1.6	5.5	7.1	5.5
No education	8.1	9.8	14.5	6.4	36.3	27.1	40.1	3.8	4.0	6.0	10.8	6.8
Primary	8.4	6.9	11.8	3.4	29.2	25.0	30.6	1.4	1.6	5.4	8.0	6.4
Secondary +	5.8	3.6	6.8	1.0	18.6	14.6	21.8	3.2	0.4	5.3	6.0	5.6

*Children born during the three years prior to the survey. †Stunting: height-for-age below -3 SD. ‡Stunting: height-for-age below -2 SD. §Wasting: weight-for-height below -2 SD

Table 9.6 Time-trends in health care use, late-1980s/1990s for two African countries

Subgroups	Deliveries attended by medical person*				Full childhood immunization coverage (%)†			
	Survey 1	Survey 2	Survey 3	Change (abs)	Survey 1	Survey 2	Survey 3	Change (abs)
Kenya								
Total	51	44	44	-6	44	78	60	16
No education	34	22	27	-6	29	63	53	24
Primary	50	40	36	-13	49	78	62	13
Secondary +	78	72	72	-6	47	88	79	32
Zimbabwe								
Total	71	69	73	2	67	80	64	-3
No education	46	42	43	-3	67	73	63	-4
Primary	71	63	63	-7	68	77	61	-8
Secondary +	90	87	85	-5	62	87	67	5

*Percentage of deliveries that were attended to by a medically trained person, defined as a doctor, nurse or nurse-midwife, during 3 years prior to survey. †Percentage of children 12-23 months who are fully vaccinated (i.e., those who have received BCG, measles, and three doses of DPT and polio (excluding polio 0))

In Kenya, immunisation coverage strongly improved among all groups between the first and second survey (i.e. in the early 1990s), but declined considerably thereafter (i.e. mid-1990s) (Table 9.6). Skilled delivery attendance declined over time. The declines in immunisation coverage and delivery attendance were about as strong (in absolute terms) among

the lowest and highest educated. Also in Zimbabwe, immunization coverage initially increased, and subsequently declined. This subsequent decline was stronger among the higher educated. Skilled delivery attendance declined somewhat among all groups.

9.4 DISCUSSION

Our study shows that under-5 mortality has strongly increased in a number of African countries. At the end of the 1990s, under-5 mortality in some countries was back to the level of two decades earlier. By identifying the groups where this reversal has been most pronounced, our study has enhanced the understanding of this urgent public health problem.

In Kenya, the increase in under-5 mortality was concentrated among the less educated and among those in rural areas, thereby increasing socio-economic mortality inequalities. In Zimbabwe and Cameroon, the mortality increase was largest among the higher educated, and, in Zimbabwe, in urban areas. In Burkina Faso and Côte d'Ivoire, the mortality trends did not differ statistically significantly between subgroups. In summary, there is a highly variable pattern to how the mortality increase is distributed across socio-economic and geographical subgroups. In all countries, under-5 mortality levels remained, however, highest among the less educated and those in rural areas.

When evaluating the above findings, the following issues should be considered. First, as DHS uses standardized questionnaires, it seems unlikely that our main results are explained by problems of data comparability. Secondly, whereas the observed mortality increases were often highly significant, statistical power was limited when determining the difference in trends between subgroups. Whereas the above are probably the best estimates available, it would be desirable if more powerful data sources become available for monitoring health inequalities (Korenromp *et al.* 2004). Finally, it should be stressed that, rather than making causal assertions, this chapter describes the concentration of the increase in childhood mortality in specific population subgroups. Such descriptions are important for targeting purposes. Moreover, monitoring of mortality inequalities across socio-economic and geographical groups is internationally recognized as an important public health task.

Explaining the results

Socio-demographic change

Female educational attainment improved at about the same rate in Kenya and Zimbabwe. Increased negative selection among the lower educated, with only the most marginalized having no education, may cause mortality rates to rise among this smaller group of uneducated. Similarly, as obtaining a high education became attainable for a much broader group, reduced positive selection may cause mortality to rise among the higher educated. It is unlikely, however, that selection effects fully explain the differences in mortality trends between the educational groups. More specifically, they cannot explain why the mortality increase was concentrated among the lower educated in Kenya, and among the higher educated in Zimbabwe. The mortality trends for the educational groups in Kenya and Zimbabwe were also not explained by increased urbanization. After adjustment for rural/urban residence in a multivariate analysis, the mortality trends remained virtually the same (results available upon request). Yet, statistical power decreased, probably due to multicollinearity. Finally, the stronger mortality increase among the higher educated in Zimbabwe cannot be explained by a change in ethnic composition. The white elite, probably highly educated, has been leaving this country. Yet, as in 1988 only 4.4% of the higher educated was white, it is unlikely that this influenced the mortality trends.

A number of other interrelated changes ran parallel with the observed mortality increase: economic decline, increasing childhood malnutrition, declining health care use, rising HIV prevalence, and increasing drug-resistant malaria. Armed conflict, mentioned by UNICEF as a cause of rising childhood mortality (UNICEF 2004), did not play a role in the countries/periods under study. Below, we assess to what extent the above changes may explain the very different mortality patterns observed for Kenya and Zimbabwe.

Economic decline

Zimbabwe experienced economic decline during the 1990s, and in Kenya, economic growth slowed down and stagnated. In both countries, poverty has increased, with higher levels of poverty among the less educated (Alwang *et al.* 2002; Central Bureau of Statistics *et al.* 2000). The indicators of living conditions in our study did not worsen, suggesting that economic deterioration does not immediately translate in a decline in household assets.

Nutritional status may be more sensitive to economic decline. Malnutrition is an important underlying cause of childhood mortality (Black *et al.* 2003). The increase in severe malnutrition in Zimbabwe and Kenya was concentrated among the less educated. This suggests that, although in Zimbabwe economic decline might have contributed to an overall mortality increase, it seems not to explain the stronger increase among the higher educated. Conversely, in Kenya, it might have contributed to a stronger mortality increase among the less educated.

Decline in health care use

We have mixed evidence on the possible contribution of health care utilization. The decline in skilled delivery attendance was not largest in the groups with the largest mortality increase. The strong increase in child (12-59 months) mortality suggests that other factors besides those surrounding birth are important. The decline in immunisation coverage during the mid-1990s might have contributed to the mortality increase. In Zimbabwe, the stronger decline in coverage among the higher educated might have contributed to the stronger mortality increase in this group. Whereas in Kenya, the decline was not concentrated among the less educated, the mortality effects might have been stronger in this group, through higher exposure to infections and higher levels of malnutrition (Bishai *et al.* 2003). Yet, immunisation coverage still improved during the early-1990s in Kenya and Zimbabwe, suggesting that other factors were responsible for the early mortality increase.

Changing disease ecology: AIDS, malaria

An increase in drug-resistant malaria (Brinkmann *et al.* 1991) may have contributed to the observed mortality increase. Malaria has been estimated to cause at least 20% of all deaths in under-fives in Africa (WHO *et al.* 2003). A doubling of malaria mortality has been reported for east and southern Africa between the 1980s and 1990s (WHO *et al.* 2003), and also in West Africa a resurgence of malaria appears to have contributed to changing mortality patterns (Delaunay *et al.* 2001). Chloroquine treatment failure has been reported to be higher in Kenya than in Zimbabwe. The burden of malaria is higher among the poor and in rural areas (WHO *et al.* 2003). We hypothesize that increased malaria mortality might partly explain the stronger mortality increase among the lower educated and those in rural areas in Kenya, but that it cannot explain the stronger mortality increase in Zimbabwe among the higher educated and those in urban areas.

There is evidence suggesting that the increase in childhood mortality in Kenya and Zimbabwe during the 1990s and beyond is at least partly due to HIV/AIDS (Zaba *et al.* 2004). In 1999, 20% of under-5 mortality in Kenya, and 35% in Zimbabwe, has been estimated to be attributable to HIV/AIDS (Walker *et al.* 2002). Unfortunately, there is little reliable information on the association between educational attainment and HIV-status. Seroprevalence data were included in nationally representative surveys in three sub-Saharan African countries (Kenya, Tanzania, Zambia). In these countries, HIV-prevalence was substantially higher among women with at least some education and in urban areas (Central Bureau of Statistics *et al.* 2000; Central Statistical Office [Zambia] *et al.* 2003; Tanzania Commission for AIDS (TACAIDS) *et al.* 2005); (Central Bureau of Statistics (CBS) [Kenya] *et al.* 2004). Yet, it has been argued that the increase in child mortality cannot be explained by HIV/AIDS alone (Walker *et al.* 2002). Moreover, the mortality decline in Kenya probably already decelerated during the 1980s (Obungu *et al.* 1994), before the start of the HIV/AIDS epidemic.

Conclusions

This article was born out of concern that the increase in under-5 mortality would be concentrated among the already most disadvantaged groups. Our results for Kenya support this concern. Possibly, the deteriorating economic conditions, the decline in health care use, and the increase in drug-resistant malaria had a stronger impact on lower socio-economic groups and rural areas. Even though similar patterns might have been expected for other countries, the mortality increase seems largest among the higher educated in Zimbabwe and Cameroon, and in urban areas in Zimbabwe. Further research is needed to assess to what extent HIV/AIDS has contributed to these opposite patterns.

Policy implications

Our study implies that the mortality increase observed in a number of African countries has been highly concentrated in specific subgroups. Strategies to halt the mortality increase should, therefore, not be based on average trends in national populations only. Although under-5 mortality levels remained substantially higher among lower socio-economic groups, it cannot be assumed that also the mortality *increase* is concentrated in these groups. Efforts to reverse the mortality increase should assess for individual countries, in which subgroups the mortality increase is concentrated, which factors are involved, and how policies to tackle the mortality increase can be targeted to these groups.

10

General discussion

The aim of the research reported in this thesis was to contribute to the measurement and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through comparative research. Specifically, it aimed to contribute to the evaluation of existing measures to describe socio-economic mortality inequalities, and to the description and explanation of time and place variations in the magnitude of these inequalities. More implicitly, it sought to contribute to the development and evaluation of methodologies for explanatory comparative research on socio-economic mortality inequalities. Two research strategies were used for these purposes, *viz.* cross-national cross-sectional analysis and time-trend analysis.

Below, the main results of the research reported in this thesis are summarized. Next, I will critically assess the approach taken along four, more general, key methodological issues in the field of research on socio-economic mortality inequalities. The third section seeks to generate hypotheses for key findings in this thesis against the backdrop of the available literature, and highlights the contribution this thesis purports to make to describing and explaining time and place variations in the magnitude of inequality in under-5 mortality.

10.1 SUMMARY OF THE FINDINGS

Measuring socio-economic mortality inequalities

The first aim of this study was to assess how valid, robust and meaningful some of the often used ways of measuring socio-economic health inequalities are. I assessed several inequality measures (i.e. World Health Report 2000 index, the rate ratio, and the rate difference), and one measure of household economic status (i.e. the asset index). Of these, the World Health Report 2000 index and the asset index have only been developed recently, and still required evaluation. Conversely, the rate ratio and the rate difference have been used already for a long time, and are among the most commonly used inequality measures. A long-standing debate about which of these two is most meaningful, has, however, never been solved.

First, I found that the World Health Report 2000 index is not a valid measure of socio-economic mortality inequalities. This index measures individual-level variation in mortality, in contrast to inequality between social groups. Using evidence from 15 industrialized and 43 low and middle income countries, I showed that this index does not correspond with international variations in the magnitude of socio-economic mortality inequalities. I concluded that the World Health Report 2000 index should not be used to replace already existing measures to monitor socio-economic inequalities in mortality.

Secondly, I concluded that the rate ratio and the rate difference can both be meaningful for monitoring socio-economic health inequalities, provided that the overall level of the health outcome is taken into account. Neither the rate ratio nor the rate difference is predetermined by overall levels of the health outcome studied. Yet, I demonstrated that the values that both the rate ratio and the rate difference can take are bound by mathematical ceilings. Low rate ratios at very high overall levels of the health-related outcome are, for example, a necessity, not an accomplishment. As the values that the rate ratio and the rate difference can take are bound by mathematical ceilings that vary with the overall level of the outcome, these overall values should be taken into account when monitoring.

Finally, I assessed to what extent the magnitude of observed poor-rich inequalities in health-related outcomes is sensitive to the precise measure of economic status used. A major difficulty in studying poor-rich inequalities in low and middle income countries is determining who is rich and who is poor. An index based on household ownership of assets is often used to define wealth layers within a population. Different researchers, however, use different sets of asset items. My study shows that who is defined as relatively poor and who as relatively rich, varies with the specific asset items included in the index. Also, the magnitude of socio-economic inequalities in health-related outcomes is often sensitive to the specific asset items included in the wealth index. In many cases, the extent of sensitivity found was not alarming. Yet, in a number of cases the indicators of economic status used did make an important difference, ranging up to a 60% change in the relative index of inequality. Unfortunately, it appears difficult to predict in which cases this important sensitivity will occur. Researchers and policy makers should therefore be aware that the choice of the measure of economic status can influence the observed magnitude of health inequalities, and that differences in magnitude of health inequalities between countries or time periods, may be an artefact of different wealth measures used. Especially the interpretation of relatively small variations in wealth-related health inequality across populations should be done with particular caution.

Cross-national analyses

The second aim of this study was to contribute to the description and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through cross-national analyses.

First, I examined to what extent the association between under-5 mortality and well-known country characteristics, such as national per capita income and public spending on health, varies in strength between richer and poorer children within countries. Whereas it is likely that these country-level determinants have a different impact on the poor and the rich, such differential effects, have not yet been reported for a broad set of factors.

Generally speaking, my analysis shows lower under-5 mortality rates in all wealth groups, including the poor, in countries that were more developed in socio-economic, political and health care terms. At the same time, the results show that the strength of the association can vary between the poor and the rich. National per capita income was significantly more strongly associated with under-5 mortality levels among the rich. This stronger effect remained after adjusting for the income distribution within countries. Conversely, public spending on health was significantly more strongly associated with under-5 mortality levels among the poor. Professional delivery attendance and immunization coverage among the poor were significantly more strongly related to public spending on health than such health care use among the rich. Furthermore, ethnic fragmentation was significantly more strongly associated with higher under-5 mortality among the poor. No differentials in the relative effect of female literacy, democracy and state strength were observed between wealth groups. The results suggest that economic growth is associated with widening poor-rich disparities in under-5 mortality. Increased public spending on health might partly remedy this effect. The stronger effect of public spending on health on mortality levels among the poor is possibly explained by a stronger responsiveness of health care use among poor households to increases in such spending combined with stronger mortality effects of health care use among the poor.

Secondly, I examined cross-national patterns in socio-economic inequality in health care use. These inequalities are a proximate determinant of socio-economic inequalities in under-5 mortality. I described poor-rich inequalities in the use of maternity care and sought to understand these inequalities through comparisons with other types of health care. The findings show that poor-rich inequalities in maternity care in general and professional

delivery care in particular are huge, and are much greater than those in immunization coverage and treatment for childhood illnesses. Public sector inequalities make up a major part of the poor-rich inequalities in professional delivery attendance. Even delivery care provided by nurses is pro-rich in most of the countries. Whereas poor-rich inequalities within both rural and urban areas are large, most births without professional delivery care occur among the rural-poor. The greatest improvements in professional delivery care can therefore be achieved by increasing coverage among the rural-poor. Problems with availability, accessibility, and affordability, as well as the nature of the services and demand factors appear to contribute to the larger poor-rich inequalities in delivery care. Reducing poor-rich inequalities in professional delivery care is essential for achieving the Millennium Development Goals for maternal health. A concerted effort of equity oriented policy and research is needed to address the huge poor-rich inequalities in maternity care.

Time-trend analyses

The third aim of this study was to contribute to the description and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through time-trend analyses. In particular, I aimed to assess how socio-economic inequalities in under-5 mortality change (a) in a period of economic growth and strong mortality decline, and (b) in a context of economic stagnation and rising mortality levels.

First, I studied time-trends in inequality in under-5 mortality in Indonesia during a period of rapid economic growth and mortality decline. Under-5 mortality declined substantially during the 1980s and 1990s in this country. Inequalities in under-5 mortality by maternal education decreased, though not statistically significantly, from a hazard ratio of 2.00 (95% CI 1.60, 2.50) to 1.52 (95% CI 1.27, 1.82). Inequalities between urban and not-electrified rural areas increased, from 1.84 (95% CI 1.48, 2.28) to 2.18 (95% CI 1.70, 2.80). Mortality inequalities between not-electrified and electrified rural areas increased statistically significantly. Inequalities in under-5 mortality between the Outer Islands and the central islands of Java and Bali increased from 1.16 (95% CI 0.92, 1.46) to 1.43 (95% CI 1.17, 1.74). Irregular time-trends were observed for mortality inequalities by household wealth. Trends in health care use were fairly similar for the low and high educated.

These results show that widening socio-economic mortality inequalities in times of rapid economic growth and mortality decline are not inevitable; declining inequalities can occur as well, certainly in absolute sense. The results also show that stable or declining inequalities

according to one dimension can go together with increasing inequalities in another. This underlines the importance of monitoring mortality inequalities across a broad spectrum of socio-economic and regional dimensions. Widening or narrowing of mortality inequalities in times of economic growth might depend on how equally this growth is distributed. The results suggest that an equitable distribution of economic growth in general, and rural development in particular, might be important factors for preventing widening inequalities in under-5 mortality.

Secondly, I examined inequality in time-trends in under-5 mortality in a period of mortality increase and economic stagnation. My analysis of five African countries (Burkina Faso, Cameroon, Côte d'Ivoire, Kenya and Zimbabwe) shows that lower socio-economic groups are not necessarily the ones who are most vulnerable to a mortality increase. Under-5 mortality increased substantially (25% to 71% in 10 years) in the above countries during the 1990s. The increase in under-5 mortality was highly concentrated in specific socio-economic and geographical subgroups. Exactly which groups were most affected was highly variable. In Kenya, the increase was largest among children born to lower educated mothers (test for difference between educational groups: $p=0.074$) and in rural areas ($p=0.090$). In Cameroon, the increase was largest among the higher educated ($p=0.013$), and in Zimbabwe among the higher educated ($p=0.098$) and in urban areas ($p=0.093$). For Burkina Faso and Côte d'Ivoire, no statistically significant differences between educational and rural/urban subgroups were observed. Despite these variable mortality trends, in all countries, under-5 mortality levels remained highest among the less educated and those in rural areas.

In Kenya, the deteriorating economic conditions, the decline in health care use, and the increase in drug-resistant malaria might have had a stronger impact on lower socio-economic groups and rural areas. Even though similar patterns might have been expected for other countries, the mortality increase appeared largest among the higher educated in Zimbabwe and Cameroon, and in urban areas in Zimbabwe. Further research is needed to assess to what extent HIV/AIDS has contributed to this opposite pattern. These results show that it cannot be assumed that lower socio-economic groups are most vulnerable to a mortality increase. Strategies to halt the mortality increase should be based on disaggregate information for individual countries.

10.2 REFLECTIONS ON METHODOLOGY

In this section, I will critically discuss the approach taken in the research underlying this thesis along four key methodological issues in the field of health inequalities research. The first two issues concern the unit of analysis and the socio-economic indicators used for these units. The last two issues concern the uses and limitations of descriptive and explanatory comparative research in the study of socio-economic health inequalities. While I will focus on research on inequalities in childhood mortality in low and middle income countries, some of the general lessons learned might be equally applicable to high income countries.

Unit of analysis - people or place?

In this thesis, attributes of individuals (maternal education) and households (household wealth) are the key dimensions along which inequalities in under-5 mortality were described. Substantial socio-economic mortality inequalities along these dimensions have been reported in previous chapters. Regional stratification, in particular rural/urban residence, received some attention. Detailed study of regional inequalities in mortality within countries was, however, beyond the scope of this thesis. Below, I will assess to what extent the observed higher mortality levels among poorer and lower educated groups can be explained by the fact that these groups tend to live in places with characteristics that instigate high mortality. I will also asses to what extent the mortality effects of socio-economic characteristics are place-dependent.

Individualistic vs. environmental approaches

The focus on individual and household level characteristics in this thesis is consonant with common practice in research on determinants of child survival and socio-economic mortality inequalities in low and middle income countries. Maternal education and household wealth are given particular importance in this field, with auxiliary attention to rural/urban residence. The "household production of health" framework provides a conceptual underpinning of this focus. This framework underscores the importance of health related behaviours at the household level as determinants of health outcomes (Berman *et al.* 1994; Gardiner 1997; Harkness *et al.* 1994; Schumann *et al.* 1994; Weaver *et al.* 1996). This study field has produced abundant evidence on the importance of socio-economic conditions

at this level for child health and survival and on the mechanisms through which these conditions exert their influence (*cf.* Caldwell *et al.* 1982; Cleland *et al.* 1988).

The focus on individual and household level determinants has its roots in five decades of epidemiological and social epidemiological research, during which attention was given primarily to determinants at these levels (Macintyre *et al.* 2002). This contrasts with 19th and early 20th century public health research and public health movement, which focussed primarily on environmental and community level determinants of mortality (*cf.* Engels 1987 [1845]). In recent years, this methodological individualism, in which research and policy making focus on individual rather than on contextual or higher level health determinants, has been criticized, particularly in literature on high income countries (*cf.* Berkman 2004; Diez Roux 2004; Diez-Roux 1998; Macintyre *et al.* 2002). Indeed, a narrow focus on individual and household factors inhibits a thorough understanding of the determinants of disease and mortality, and will miss important entry points for intervention. Moreover, a sole focus on individual or household level determinants may lead to victim blaming (Kanji *et al.* 1991; Krieger 2001; Millard 1994; Nations *et al.* 1988; Scheper-Hughes 1984). This is illustrated by quotes like "the criminal ignorance and neglect of mothers" as explanation for observed socio-economic mortality inequalities in early 20th century England (*The Evening Citizen*, 5 Jan 1944, quoted in Roberts 1997). The critique on methodological individualism spurred research on contextual mortality determinants, among others at the neighbourhood level, in studies on high income countries (*cf.* Kaplan 1996, 1999; Kawachi 1999; Van Lenthe *et al.* 2005). This is still less so in research on low and middle income countries.

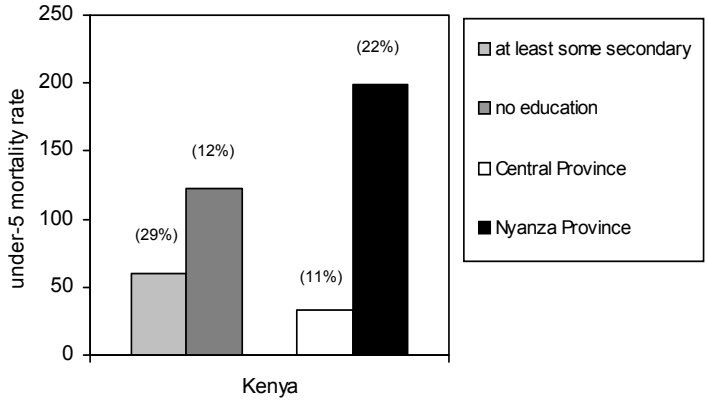
Do 'place' effects partly explain socio-economic mortality inequalities?

Despite abundant evidence on the effects of individual and household level attributes on the risks of under-5 mortality, the observed socio-economic mortality inequalities might be partly explained by characteristics of the place where people live.

Indeed, regional mortality inequalities within countries can be substantial. In rural areas, for example, under-5 mortality tends to be higher than in urban areas, though with some exceptions (Cleland *et al.* 1992; Knobel *et al.* 1994; Kuate Defo 1996; Wang 2003). Regional mortality inequalities are sometimes much larger than socio-economic mortality inequalities. This is illustrated in Figure 10.1 for Kenya. Regional mortality inequalities can be found at various levels, including the neighbourhood, community and provincial level.

Place characteristics can have effects on under-5 mortality that are independent of individual or household level socio-economic characteristics (Sastry 1997) (Chapter 8). The rural-poor, for example, exhibit higher mortality levels and lower levels of health care use than the urban-poor (Gwatkin *et al.* 2000) (Chapters 7).

Figure 10.1 Under-5 mortality in Kenya among children of high and low educated mothers and among children living in regions with the lowest and the highest under-5 mortality levels; the distribution of women is given in brackets.



Source: this figure is based on data from Kenya DHS 1998 (National Council for Population and Development (NCPD) *et al.*, 1999).

Socio-economic inequalities in under-5 mortality tend to be partly explained by regional mortality inequalities. The observed socio-economic inequalities in under-5 mortality in Indonesia, for example, were partly explained by community type (Chapter 8).

Nonetheless, maternal education and household wealth also tend to have effects on under-5 mortality partly independent of place characteristics (Chapter 8). Large intra-urban and intra-rural poor-rich inequalities in childhood mortality and health care use have been reported for many countries (Chapter 7) (Gwatkin *et al.* 2000; Timæus *et al.* 1995). Also within small areas, substantial poor-rich inequalities in childhood mortality have been observed (Gwatkin 2005). Even within seemingly uniformly poor rural areas, inequalities in treatment seeking behaviour between wealth groups have been demonstrated (Schellenberg *et al.* 2003).

Concluding, the socio-economic inequalities reported in this thesis and elsewhere are probably partly explained by place characteristics. Yet, socio-economic characteristics at the individual and household level also tend to have effects on mortality independent of

place characteristics, and vice versa. Monitoring of both socio-economic and regional inequalities is important. This is underlined by my finding that time-trends in these inequalities do not necessarily change in the same direction (Chapter 8).

The relative importance of attributes of people and place can vary between countries. Regional mortality inequalities within African countries, for example, have been suggested to be particularly large, possibly indicating the importance of the macro disease environment (Farah *et al.* 1982). The mortality effects of place characteristics are also time-dependent. There is evidence, for example, that regional stratification has become increasingly important in Indonesia (Chapter 8). Finally, the relative importance of characteristics of 'people' and 'place' also varies with the outcome studied. Immunisation coverage, for example, is strongly clustered at the community level in many low and middle income countries (Fenn *et al.* 2004). Conversely, factors at the household or individual level, rather than the community level, seem to be of key importance for childhood malnutrition (Fenn *et al.* 2004).

Attributes of people and place can also interact. A contribution of this thesis is the finding that country-level variables can act as effect modifier in the relationship between household wealth and under-5 mortality. The association between national per capita income and under-5 mortality was found, for example, to be significantly stronger among the rich compared with the poor. Conversely, the association between public spending on health and under-5 mortality was significantly stronger among the poor (Chapter 6). Also lower levels of geographical aggregation, such as the community level, can act as effect modifier. The effect of maternal education, for example, has been reported to vary with the accessibility of health care services (see section 10.3). Similarly, the effect of household wealth may vary between rural and urban areas (Sastry 2004b). Problems with comparability of measures of household wealth between rural and urban areas may, however, impede such analyses (Millard 1994). So, households are not autonomous units. The effects of socio-economic conditions at the household level on under-5 mortality are influenced by factors at higher levels of aggregation, including the community and country level.

So, the determinants of under-5 mortality cannot be fully unravelled by zooming-in on household level factors alone. Zooming-out to community, provincial, country, and even global-level determinants of under-5 mortality, and especially studying their interaction with socio-economic characteristics of individuals and households, is of fundamental importance. In such research, 'place' and 'people' can't be expected to have similar effects over

time and in all countries. Rather, the size of their effects and their relative importance is context dependent.

Towards future research on the effects of 'people' and 'place'

Perhaps surprising is the relatively little attention given to 'place' in the study of inequalities in childhood mortality in low and middle income countries, including, to a certain extent, my own study. It seems plausible that the effects of 'place' are more important in these countries, where state structures tend to be weaker. In such countries, governments have less capacity to mitigate the effects of regional variations in health risks. Citizens of such countries also are less likely to hold equal entitlements to basic services and securities (Sen 1981, 1999).

Future research should seek to contribute to the development of measures of regional stratification and place characteristics. Rural/urban is an important and often-used distinction, usually implying a form of stratification. Beyond that, there is little conceptualisation of within-country regional stratification. In want for such measures, inequalities between provinces are often measured. Provinces are administrative units, and it is important to unpack what "province" stands for. First steps towards measuring regional stratification were set in Chapter 8. I distinguished, in this chapter, between politically and economically more central islands versus more peripheral islands in Indonesia, and between rural areas with and without electricity, and urban areas.

Future research should also give more attention to the analysis of micro-meso-macro interlinkages or cross-level interactions (Howard 1994). Educational attainment and household wealth, for example, depend on local and regional opportunities for education and capital accumulation, such as the availability and quality of schools, roads and other infrastructure (Macintyre *et al.* 2003; Macintyre *et al.* 2002). Conversely, household wealth and literacy levels in a region may influence regional characteristics at the aggregate level, such as social cohesion or quality of local governance, which, in their turn, may impact on mortality inequalities.

Socio-economic indicators

In this section, I will critically assess the asset index used in this thesis as measure of household economic status. The emphasis in research and policy making on socio-economic

mortality inequalities has shifted from education to household economic status. Yet, the evidence base on measurement of household economic status remains limited. I will reflect on the usefulness of the asset index for research on and monitoring of socio-economic inequalities in childhood mortality in low and middle income countries, and will give some recommendations for further research.

The asset index as a measure of relative position in the national wealth hierarchy

The asset index used in this thesis is a measure of the relative position of households in the national wealth hierarchy. The relative size of the wealth groups is the same in each country. The use of a measure of relative economic status is in line with my conceptual framework, in which household economic status is conceived to be a dimension of social stratification (section 2.3). The index does not measure the magnitude of wealth inequality between groups (section 2.5). Additional data are needed to assess whether variations between populations in the magnitude of mortality inequality are due to variations in the magnitude of wealth inequality (see for example Chapter 8).

The positive side of using an even population distribution across wealth groups is that there are no differences in relative group size across populations that need to be considered. Mortality inequalities can be expected to be larger when more extreme groups are compared. In the interpretation of comparative data on mortality inequalities, such selectiveness should be taken into account. The measure of educational attainment that I used, for example, is absolute (with absolute categories such as 'no education', 'primary' and 'secondary'). Consequently, differences in relative group size were taken into account when interpreting the time-trend data in Chapters 8 and 9.

If an absolute measure of wealth were used, group sizes would be extremely skewed in many countries and hamper comparative analyses. In some countries, the majority of the population would be categorised as poor. In other countries a substantial part would be categorised as rich. The richest 20% group in Niger, for example, is almost as poor as the poorest 20% group in Brazil (own calculations using GDP per capita (PPP, constant 2000 international$) and income share held by richest 20% and poorest 20% (World Bank accessed 22-10-2006)).

Concluding, a relative wealth measure is meaningful and useful for describing health inequalities by household economic status. When seeking to explain population variations

in health inequality, this measure should ideally be combined with information on the absolute wealth distance between groups.

Validity of the asset index as a measure of relative economic status

One way to assess the validity of an indicator is to compare it with a golden standard. This is called criterion validity (Russell Bernard 1994). There is a large diversity of indicators of household economic status used in health research on low and middle income countries (Bollen *et al.* 2002). Unfortunately, there is no consensus on which measure is best and could function as golden standard. Household income and consumption-expenditures, which are often-used indicators in high income countries, have their limitations as indicators of long-run household wealth or permanent income (Friedman 1957) in these countries (Bollen *et al.* 2002; Filmer *et al.* 2001). It therefore remains difficult to assess the criterion validity of the asset index.

A comparison between the asset index and household expenditures may, nevertheless, give some idea of what the asset index does or does not measure. Household ownership of assets has been shown to be associated, though not strongly, with household expenditures (Filmer *et al.* 2001; Montgomery *et al.* 2000). A study on childhood malnutrition in 19 countries found that "for the most part" it makes little difference, in terms of observed poor-rich inequalities, whether an asset index or household consumption is used (Wagstaff *et al.* 2003). Others, however, warn for substantial sensitivity in observed poor-rich inequalities in health related variables in some contexts (Lindelöw 2004).

A second way to asses the measure of economic status is to evaluate its content validity, i.e. the extent to which the measure adequately represents the content domain of the theoretical construct. Following the permanent income hypothesis, one may argue that household ownership of assets is a valid indicator of long-run household wealth (see section 2.3). There are, however, some problems with the content validity of the asset index. The index partly captures rural/urban residence, rather than household wealth only, as the included items are those that urban people are more likely to own. This might partly explain the observed wealth-related mortality inequalities. This urban bias of the wealth index also hampers comparisons of the magnitude of intra-urban and intra-rural mortality inequalities (Millard 1994). Nevertheless, even within urban and within rural areas substantial wealth-related inequalities in under-5 mortality have been demonstrated (Gwatkin *et al.* 2000). The asset index also does not cap-

ture economic resources that are common among mobile pastoralist populations (Randall 2006). This is a problem for countries with a sizable mobile pastoralist population.

Fitness for purpose

Not only the validity of the asset index, but also whether it is fit for the purpose of describing and understanding health inequalities matters. This depends, among others, on the ability to develop a refined stratification of households in the national wealth hierarchy. At present, such a refined stratification depends on the inclusion of items on housing, water and sanitation. Ownership of the durable consumer goods included in DHS can be very low in rural areas. It should be noted that proximate determinants of under-5 mortality, such as water and sanitation facilities and housing conditions, are ideally not included in a measure of economic status in health inequalities research (Chapter 5). I would therefore recommend including in future wealth measures, items that poor and rural people are more likely to own (Chapter 5). Upcoming DHS surveys may already do this (Rutstein *et al.* 2004). Inclusion of land ownership might, however, prove to be difficult due to measurement problems (Morris *et al.* 2000).

Concluding, the asset index is currently the only measure of economic status that is readily available in health surveys for a large number of low and middle income countries. The index is now widely used in research and for advocacy purposes, and reaches a broad audience. Despite its limitations, the measure is useful for showing the existence of wealth-related health inequalities and for indicating the order of magnitude of these inequalities. Also for describing and explaining general patterns in large cross-national studies, the index is useful. It seems unlikely that systematic patterns observed across a large number of very diverse countries would be grossly biased by the above problems. I expect the general patterns presented in Chapters 4, 6, 7, and the Annex to be fairly robust to the specific measure of relative economic status used. Conversely, a more precise description of the magnitude of poor-rich inequalities in a country, and the detection of smaller variations in such inequality between populations, can be problematic. This is due to problems with content validity and comparability and due to the sensitivity of the magnitude of mortality inequality to the specific asset items included (Chapter 5). The very irregular time-trends in under-5 mortality by household wealth observed for Indonesia are illustrative of such problems. Such strong fluctuations within a short period were unlikely in this case (Chapter 8). The asset index has therefore been given less emphasis in the time-trend analyses in Chapters 8 and 9.

Implications for monitoring socio-economic inequalities in health

The problems discussed above limit the current usefulness of the asset index for monitoring of socio-economic mortality inequalities. More work on the validity and comparability of the asset index is needed before it is suitable for application in national and international monitoring systems. Currently, maternal education seems, in my view, more suitable for monitoring of socio-economic inequalities in childhood mortality. Information on maternal education is included in most large-scale health surveys. Inequalities in childhood mortality by maternal education have never been monitored systematically for a broad set of countries and time-periods. This has become feasible due to wider data availability. In monitoring systems, maternal education should be combined with at least one indicator of regional stratification, such as rural/urban residence.

This does not negate the importance of monitoring wealth-related inequalities in childhood mortality. The mechanisms through which household wealth influences childhood mortality can differ from those of maternal education. The importance of monitoring such wealth related inequalities is underlined by the increase in income inequalities during the 1980s and 1990s (Cornia *et al.* 2001). It is important to monitor the effects of these trends on mortality inequalities. Furthermore, childhood illness can have substantial impacts on household wealth (Xu *et al.* 2003), and can push households (further) into poverty. The differential consequences of illness on poorer and richer households are important to measure and monitor. This underlines the importance investing in further research to improve the validity and comparability of measures of household economic status.

Recommendations for further research on measures of household economic status

The importance of further research on the comparability across countries and between rural and urban areas of wealth measures has already been raised above. Also the content validity of the weighting scheme used in the asset index deserves further research. These weights were assigned through an entirely empirical procedure, i.e. principal component analysis, rather than on a theoretical basis. Whereas these weights generally lead to a distribution of assets across wealth groups as expected (Filmer *et al.* 2001), results are sometimes contra-intuitive (Chapter 5). Comparisons with alternative weighting procedures, such as a linear combination of items (Gage 1997), or a weighting equal to the reciprocal of the proportion of the households owning that item (Morris *et al.* 2000), might be useful. Alternatively, it

might be feasible to link asset ownership with data on their monetary value, for example from the Living Standard Measurement Study, as suggested by Filmer et al. (2001).

An interesting issue for further research on the content validity of the asset index is the following. The asset index and its theoretical foundation, the permanent income hypothesis, are based on the premise of the rational consumer, the *homo economicus*, which is assumed to be constant over time and place. Scarce material resources can be allocated in various ways, for example to satisfy basic needs such as food and health care, but also to buy durable consumer goods, or to invest or save. The theoretical construct of the rational consumer assumes that people make rational choices in their allocation of scarce material resources, and, based on Maslow's 'hierarchy-of-needs' (Maslow 1970 [1954]), will satisfy their basic needs first. The asset index only captures those resources that are allocated to durable consumer goods and amenities such as housing, water and sanitation. If the rational consumer assumption is correct, the asset index indeed measures household economic status, as people tend to satisfy basic needs first, and then will buy progressively more expensive consumer items.

The assumption of the rational consumer, however, is not always correct (Van Kempen 2005). Expenses on durable consumer goods are not only determined by household economic status, but can also be driven by a desire for social status (Van Kempen 2005). Even people below the poverty line sometimes use scarce resources to buy status goods like a television, in some cases in parallel with, or causing unfulfilled basic needs (Gell 1986; Van Kempen 2005; Wells 1977). Higher levels of status consumption tend to be associated with a lower educational attainment, as predicted by the hypothesis of compensatory consumption (Van Kempen 2005). Also female decision making power in the allocation of household resources is important. Evidence suggests that women tend to invest more in basic needs than men (Csete 1993; Lemke *et al.* 2003).

The validity of the asset index as a measure of economic status thus depends on the extent to which the assumption of the rational consumer holds. The general pattern of lower mortality levels among the rich suggests that the assumption of the rational consumer tends to hold on the whole, with richer people having the capacity to invest both in health as well as durable consumer goods. Yet, the magnitude of the observed poor-rich inequalities in under-5 mortality would be under-estimated if the poor consume more durable consumer goods relative to their economic position. Poor people who invest in status rather than

health would not be categorised at the bottom of the wealth index, while their mortality risks would tend to be high.

Constructing an asset index without status goods seems challenging. It would therefore be important to conduct more fundamental research that seeks to improve our understanding of processes of intra-household resource allocation. Policy oriented research could assess how the mechanism of status consumption can be used for the benefit of health and the reduction of health inequalities. Some health related goods may lend themselves to marketing as status goods. A study in rural Benin, for example, showed that prestige was an important driver for installing a pit latrine, with health considerations only playing a minor role (Jenkins *et al.* 2005). The possibilities of social marketing research (Ling *et al.* 1992) to reduce socio-economic inequalities in health should be further explored.

Uses and limitations of comparative research on mortality inequalities: descriptive research

Comparative analyses of socio-economic mortality inequalities in low and middle income countries will arguably become increasingly important in research and for policy making. The increasing data availability for these countries is spurring new research. The salience of mortality inequalities for policy makers is stimulating monitoring and policy evaluation. There are a number of comparative studies on high income countries, using cross-country (*cf.* Avendano *et al.* 2004; Huisman *et al.* 2005a; Huisman *et al.* 2005b; Kunst *et al.* 1998b; Mackenbach *et al.* 2000; Mackenbach *et al.* 2004; Mackenbach *et al.* 2005) and/or time-trend designs (Avendano *et al.* 2005; Giskes *et al.* 2005; Mackenbach *et al.* 2003). In relation to low and middle income countries, comparative analyses remain more scarce (Wagstaff 2000). The lack of time-trend studies has been especially noted (*cf.* Braveman *et al.* 2002; Sastry 2004a). Below, I will evaluate the value and limitations of a comparative approach in health inequalities research in view of my experience with such research using DHS data. This section focuses on descriptive comparative research and the next section on explanatory comparative research.

Descriptive-comparative research on health inequalities serves a number of purposes. First, it can be used for benchmarking: cross-country comparisons may provide a yardstick against which to judge whether inequalities in a particular country are small or large from an international perspective (Kunst 1997). Monitoring of time-trends in mortality inequalities serves a similar purpose, and allows for evaluation of progress towards targets

(Davey-Smith *et al.* 2002). Secondly, comparative research can be used to assess the generalizability of inferences concerning one population to other populations. Inequality in time-trends in under-5 mortality in Kenya, for example, showed the expected pattern, with stronger mortality increases among lower socio-economic groups (Chapter 9). This pattern, however, was not generalizable to other, seemingly rather similar, African countries; in Zimbabwe, the under-5 mortality increase was stronger among the higher educated. Similarly, the analysis of a heterogeneous group of 10 countries and 2 health indicators allowed me to conclude that the magnitude of inequalities in health-related outcomes is generally sensitive to the precise measure of economic status used (Chapter 5). Indeed, a comparative approach can be used to identify general patterns and outlier values that can not be found when one country or time period is studied (Kohn 1987). The description of general patterns and irregularities across countries or time periods is an essential first step towards explaining these time or place variations.

A comparative design places additional requirements on the data and methods used to ensure the internal validity of the comparisons and sufficient statistical power. First, the internal validity of descriptive comparisons is influenced by the comparability of the study design, concepts, indicators, data and methods across the study populations (Kunst *et al.* 1994). European comparative studies have shown that estimates of health inequalities can be sensitive to specifications of data, methods and indicators, and that data problems can substantially bias estimates (Kunst *et al.* 2004; Kunst *et al.* 1998a). I experienced, for example, that the magnitude of mortality inequalities can be sensitive to the precise method used to estimate under-5 mortality (*e.g.* a simple ratio of deaths and live births or a more sophisticated Cox proportional hazards model). When aiming to demonstrate small variations in the magnitude of mortality inequalities between populations, it is therefore important to use refined methods to precisely describe mortality (*cf.* Chapters 8 and 9).

The Demographic and Health Surveys are the best data source currently available for comparative research on socio-economic inequalities in under-5 mortality in low and middle income countries. The standardized questionnaires and survey methodology, and the national representativeness of the samples bolster the internal validity of comparative analyses. Nevertheless, data from surveys such as DHS are based on self-reports, are therefore susceptible to reporting bias. Data on maternal education and under-5 mortality are relatively reliable and internationally comparable. The reliability of proximate determinants varies, with some (*e.g.* immunisation coverage) being more reliable than others (*e.g.*

prevalence and treatment of childhood illness) (Boerma 1996; Boerma *et al.* 1991; Macro International Inc. 1994; Tsui *et al.* 1988).

Secondly, demonstrating statistically significant differences in mortality inequality between populations requires more statistical power than demonstrating inequalities within one population. I found that statistical power is usually sufficient to establish mortality inequalities within one country. Also, establishing statistically significant differences in mortality inequality between sharply contrasting populations is possible using DHS data. Statistical power is, however, often insufficient to demonstrate (at conventional levels) small variations in mortality inequality (Korenromp *et al.* 2004; Wagstaff 2000b). This is particularly a problem for time-trend analyses. Even with relatively large surveys for four periods, as for Indonesia, substantial changes in mortality inequality could not be demonstrated with statistical significance. This is partly related to the necessary adjustment for the cluster sampling design used in DHS, something which many studies omit.

Large survey programs, in particular DHS, are an important step forward. Yet, larger sample sizes are needed for more precise monitoring of mortality inequalities. Identity registration at birth is a human right (United Nations 1989) and population-wide vital registration systems should be strived for. However, as long as complete and reliable vital registration systems are not available, investments should be made in larger, internationally comparable datasets. Investments are also needed in internationally comparable methods and indicators, among others to measure household wealth, as discussed above, and methods for quantifying the level of under-5 mortality.

Recommendations for future descriptive comparative research

Comparing the magnitude of inequality in under-5 mortality across populations is important and is feasible using DHS data. Broad international comparisons and contrasting case studies are research designs that are least constrained by the issues discussed above. Future descriptive comparative research can fruitfully use cross-national analyses to study general patterns or similarities across a broad set of populations (see Annex). It seems unlikely that systematic patterns observed across a large number of very diverse countries are seriously biased by the above problems (*cf.* Landman 2003). Descriptive comparisons can provide a basis for explanatory analysis and can stimulate advocacy and policy making. The systematic pattern of huge inequalities in maternity care, for example, hopefully generates such a response. The description of general patterns also allows for the identification of positive

and negative outliers. Indeed, DHS data allow for comparisons of strongly contrasting (groups of) countries or populations.

More detailed comparisons of rather similar populations can be hampered by a lack of statistical power. Also problems with the asset index and the validity of some proximate determinants discussed above, hamper detailed comparisons that use these variables. However, sometimes it is better to have a best estimate than have no estimate at all. Below, I will give recommendations for such analyses, based on my experience with time-trend analyses of mortality inequalities.

1. When selecting the countries or data sources, I would recommend, where feasible, to select those for which sample sizes are large and for which data for many periods are available.
2. Concerning the methods used, I would recommend to define mortality levels for relatively broad age groups, for example using under-5 mortality rather than neonatal mortality. An open cohort design/period based measure of mortality allows for left-hand censoring and gives a better estimate of the mortality experience for that period than a closed cohort design. Also, the time-frames for calculating mortality levels should be long enough to capture sufficient cases, but should not be too long as that would compromise data quality. I used time-frames of around 5 years. Furthermore, it is important to adjust for sampling design in DHS and other cluster sample surveys, for example through bootstrapping (Efron *et al.* 1993). This, however reduces statistical power. Sometimes it might be useful and feasible to do sensitivity analyses.
3. As a matter of course, one should give due importance to the precision of the estimates and type 1 error (saying there is an association whereas actually there is none) when interpreting the results. However, type 2 error (saying there is no association whereas there is actually one) should also be given due consideration. The systematicity of the observed trends over time could play a role in assessing whether the observed time-trends in mortality inequality are real or due to chance fluctuations.
4. When reporting the findings, it is important to be very precise, in order to allow other researchers to judge the methods used. This is particularly important given the sensitivity of results to the specific methods used, as discussed above.
5. Finally, given the current data availability, the expectations of researchers and policy makers should be realistic. Sometimes it may be unavoidable to accept that the best estimates available are not as precise as we would like them to be.

Uses and limitations of comparative research in the field of health inequalities research: explanatory research

Part of the work in this thesis concerns the question of why inequalities in under-5 mortality are larger in some populations than in others. Below, I will discuss the possibilities for and limitations of explanatory comparative research on low and middle income countries in view of my experience with such research. I will focus on research on country level determinants of health inequalities and on disentangling causal mechanisms.

Country characteristics

There is fairly little empirical research on the relationships between country characteristics and the magnitude of mortality inequalities. This is surprising given the importance of assessing the impact of public policies on health inequalities. The lack of contrast across high income countries (Mackenbach *et al.* in preparation) and the limited number of countries are a challenge to drawing causal inferences. Conversely, the strong contrast across the large number of low and middle income countries for which data are available provides exciting opportunities to contribute to this research field.

In my study, contrast in exposure (i.e. country characteristics) was attained through comparisons of countries and of time-periods. First, I used time-trend analysis for purposefully selected contexts that provide 'natural experiments'. Rapid economic growth or social change, for example, allow for the analysis of the effects of such changes. Secondly, I used a quantitative cross-national design to study country characteristics (Chapter 6). This design is commonly used in sociology, political sciences and development studies (*cf.* Przeworski *et al.* 1970). Variations in health outcomes, such as average under-5 mortality, are regressed against a battery of, *ex ante* selected, predictors. I used a more elaborate methodology, in which mortality levels among separate wealth groups within countries were used as dependent variable.

Below, I will discuss three problems that arise when seeking to draw inferences on the effect of country characteristics on the magnitude of mortality inequalities, i.e. confounding, temporality, and effect modification.

Confounding The first issue concerns the problem of confounding variables, or third variables that are associated with the country characteristic under study and independently

affect the magnitude of mortality inequality. The quantitative cross-national design allows for statistical adjustment for confounding. By adjusting for 'region', I tried to capture a whole set of, among others, historical, geographical and cultural confounders (Chapter 6). Conversely, time-trend analyses are based on the logic of the "most similar systems" design (Przeworski *et al.* 1970). By analysing changes over time for the same country, one "controls" for all determinants that have not changed (see section 2.7).

However, in quantitative cross-country analyses, the number of potential confounders is often very large (countries differ in many ways) relative to sample size (i.e. the number of countries under study) (*cf.* Sen 2006). Only a limited number of confounders can be adjusted for. Therefore, the possibility of residual confounding remains difficult to exclude, also in Chapter 6. Also over time, many explanatory variables can change. This may prove it difficult to disentangle the causes of widening or narrowing mortality inequalities. In the African countries studied in Chapter 9, for example, several factors may have contributed to the observed time-trends, including economic stagnation/decline, changes in disease ecology and deterioration of the health care system.

In research on country level determinants of health inequalities there is no single design that can adequately solve the problem of confounding on its own. Experimental designs at the country level are impossible. A program of research that combines several research methodologies is, in my view, the most promising way forward.

Temporality A specific issue when dealing with potential confounding is temporality. I used a cross-national design to study associations between concurrent exposures and outcomes (Chapter 6). Time-lags in effect or an accumulation of effect over time of the exposure and potential confounders were not considered. The same is true in my time-trend analyses for determinants outside the study period. This may have influenced the results presented in Chapters 6, 8, and 9. Very little is known about the effect of country characteristics on mortality inequalities, let alone about time-lags in or accumulation of such effects. The explanatory analyses in this thesis should be seen as one step forward. Future research may want to refine the quantitative cross-national design that I used, by studying associations between past exposures and current outcomes, perhaps assuming various time-lags in effect. Such analyses would require improvements in the availability and quality of time-trend data on country characteristics such as public spending on health.

Also, if associations are found between country characteristics and concurrent health outcomes, it may be difficult to distinguish between the short-term impact of these country characteristics, and the effects of long-term historical processes with which these characteristics are associated (Pierson 2001). Current health outcomes are the consequence of both short and long-term processes. The current under-5 mortality level in Zimbabwe, for example, is the outcome of long-term processes that include state formation, medium-term processes (including outside medical interventions since the mid-20th century), and more short-term processes (from the point of view of current mortality levels) such as the HIV/AIDS epidemic since the 1980s (the consequences of which can be long-term in nature). Such long-term processes are often not considered in health inequalities research. The study of these processes was also beyond the scope of this thesis. Future research could, in my view, usefully explore possibilities to combine historical analyses with social epidemiological research. The lack of long-term trend data on mortality inequalities may however, hamper such an effort.

Effect modification Countries are very diverse units, historically, politically, socially, culturally, and geographically. These features may act as strong effect modifiers in the relationship between specific country characteristics such as national per capita income and health outcomes. This is why some have argued that quantitative cross-national analyses are not appropriate for studying the effects of country characteristics (Kittel 2004). Rather, unravelling of underlying causal mechanisms is seen as a more fruitful approach (Sen 1999).

I concur with the above authors on the importance of unravelling causal mechanisms, an issue that I will discuss further below. However, I consider effect modification not an *a priori* reason for refraining from using a quantitative cross-national research design. Rather, *a posteriori*, if no associations are found, one may conclude that this may be due to strong effect modification. In my view, cross-country comparative analyses can play a role within a broader program of research that also seeks to disentangle the causal mechanisms. For example, research on the association between national per capita income and life expectancy has generated important insights, both about general patterns and outliers, and has triggered further research on mechanisms explaining positive outliers (Halstead *et al.* 1985). The strong, systematic variations across wealth groups in the mortality effect of variables like national per capita income and public spending on health (Chapter 6) can be seen as a first step towards further explanatory research.

Disentangling causal mechanisms

As discussed above, research on *what* variables are causally related to the magnitude of mortality inequalities does not necessarily give insight into *how* these variables influence the magnitude of mortality inequalities.

The analysis of proximate mortality determinants and cause-specific mortality plays an important role in disentangling causal mechanisms in research on high income countries (Avendano *et al.* 2004; Avendano *et al.* 2005; Giskes *et al.* 2005; Huisman *et al.* 2005a; Huisman *et al.* 2005b; Mackenbach *et al.* 2003; Mackenbach *et al.* 2000; Mackenbach *et al.* 2004). Such downstream explanatory analyses are more problematic, or sometimes downright impossible, in research on low and middle income countries. Cause of death data are generally not available in surveys such as DHS. The explanatory inferences in, for example, the analyses of time-trends in five African countries (Chapter 9) would have been much more certain if such data would have been available. Moreover, data on many proximate mortality determinants are not available for deceased children in DHS. Such proximate determinants can, therefore, not be included in regression analyses at the individual level. At the subgroup level, however, the prevalence of proximate determinants can be calculated. This allows for the identification of factors that may have contributed to time and place variations in the magnitude of mortality inequality.

Unfortunately, only infrequently such downstream explanatory analyses are linked to more upstream analysis of country characteristics and an understanding of why inequalities in proximate determinants change in a certain way. Chapter 6 provides an example of how such causal pathways can be explored using a quantitative cross-national analysis.

Recommendations for future research

The increasing data availability for a large set of countries and multiple time periods provide exciting opportunities for the emerging field of explanatory comparative social epidemiological research on low and middle income countries. At the same time, difficulties with doing downstream explanatory analysis in relation to low and middle income countries, and the relatively long and complex causal pathways between country characteristics, social stratification and proximate mortality determinants (*cf.* Victora *et al.* 2004), are a challenge to drawing causal inferences.

In my view, these challenges are best met using a multi-pronged approach, in which results obtained using a variety of methods are checked against each other. Associations observed across countries, for example, can be checked against those observed over time. Research on general patterns can generate hypotheses concerning the mechanisms through which health inequalities are produced. These hypotheses can be studied more in-depth using one or a few countries. Cross-national analyses can also be used to identify outlier countries, which, again, can be studied more in-depth. As a matter of course, such analyses should be embedded in the existing evidence base and theoretical frameworks concerning the social and biological plausibility of the relations and mechanisms studied. Finally, combining evidence from analyses at the country level with evidence from studies at lower levels, such as the community, may be fruitful. Community intervention trials (*cf.* Manandhar *et al.* 2004; Pronyk *et al.* 2006), for example, may provide insight into mechanisms through which the magnitude of inequality in health or health determinants changes. Of course, due considerations should be given to the generalizability of the results of such trials to the country level.

10.3 THE DEVELOPMENT OF MORTALITY INEQUALITIES

How do socio-economic mortality inequalities change over time, and what explains time and place variations in the magnitude of these inequalities? These are fundamental questions in health inequalities research. Improving our knowledge base on these issues is important for evidence based policy making. This section highlights the contribution this thesis purports to make to answering the above questions against the backdrop of the available literature. I will review the evidence on patterns of change in mortality inequalities along the epidemiological transition. Thereafter, I will explore the role of three factors (*viz.* economic growth and income inequality, differential diffusion of innovation, and the role of the state) in explaining the observed patterns. To review in detail factors that may contribute to the observed patterns of change, would require a PhD thesis in itself. Only a preliminary investigation can be made here.

Mortality inequalities and the epidemiological transition

Child survival has improved substantially during the last century and a half in contemporary high income countries and during the last five decades in most low and middle income countries (Ahmad *et al.* 2000; Cleland *et al.* 1992; Delaunay *et al.* 2001; Hill *et al.* 1998; Hill

et al. 1989; Mackenbach 1992). Evidence is fragmentary on how socio-economic mortality inequalities develop along the epidemiological transition (Omran 1971) and whether there are regularities in how these inequalities change. I will explore this issue below, combining evidence from my cross-sectional cross-national and time-trend analyses with evidence from the literature. I will argue that there appears to be a regular pattern in which mortality inequalities change along the epidemiological transition.

At high mortality levels, absolute socio-economic inequalities in childhood mortality tend to be very large. Contemporary low income countries with high under-5 mortality levels, such as Mali, Niger and Malawi, often exhibit very high absolute socio-economic and rural-urban inequalities in such mortality (*cf.* Chapter 4 and the Annex). Niger provides an extreme example, with an under-5 mortality gap of 184 per 1,000 live births between children of mothers with no education and those of mothers with at least some secondary education. The rural-urban gap is 150 per 1,000 live births. Whereas the more educated are a highly selective group in this country, consisting of about 5% of the women, this is less so for urban residents (20% of the women). Conversely, relative inequalities tend to be small at high mortality levels. The distinction between absolute and relative inequalities is, therefore, pivotal. The apparently weak association between maternal education and childhood mortality in Sub-Saharan Africa that some reported with astonishment (Hobcraft 1993) concerns relative inequalities only. The often huge absolute inequalities were failed to be acknowledged.

When mortality levels decline, relative inequalities between socio-economic groups within countries tend to widen, while absolute mortality inequalities tend to narrow. The cross-national analyses presented in Chapter 4 show that lower levels of under-5 mortality are associated with larger relative inequalities and smaller absolute inequalities in under-5 mortality. Longitudinal studies of low and middle income countries suggest a similar pattern. Analyses of large sets of low and middle income countries suggest that declining absolute socio-economic mortality inequalities and stable or widening relative inequalities accompanied the decline in childhood mortality between the 1970s and 1990s (Cleland *et al.* 1992; Minujin *et al.* 2003). A case study on earlier (1946-1975) substantial declines in infant mortality in Malaysia showed a widening of relative inequalities in infant mortality by maternal education (DaVanzo *et al.* 1986). More evidence from longitudinal studies, is, however, needed to confirm these initial finding.

Whereas trends in mortality inequalities in earlier centuries remain uncertain due to data problems (*cf.* Antonovsky 1967; Woods *et al.* 1995), studies of the 19th and 20th century mortality declines in Europe suggest a similar pattern of change as described above. Declines in absolute socio-economic inequalities in infant and perinatal mortality in Amsterdam, The Netherlands, have been demonstrated (with data available for 1854-1990 for infant and 1946-1980 for perinatal mortality) (Mheen 1998). Also in Stockholm, Sweden, absolute inequalities in under-5 mortality, and especially in mortality due to diarrhoea, declined between 1878-1925 (Burstrom *et al.* 2005). Relative inequalities strongly increased. These inequalities declined again during the first decades of the 20th century, possibly due to the universal implementation of water and sanitation facilities and hygiene interventions (Burstrom *et al.* 2005). In England and Wales, absolute inequalities in infant mortality declined, whereas relative inequalities increased during the first half of the 20th century (Haines 1995). Even in contemporary The Netherlands, which exhibits among the lowest levels of infant mortality globally, relative socio-economic inequalities in such mortality still persist undiminished (Mheen 1998). Declines in total mortality among adults during the 1980s and 1990s in Western Europe were also accompanied by increasing relative mortality inequalities between socio-economic groups (Mackenbach *et al.* 2003; Marang-van de Mheen *et al.* 1998; Martikainen *et al.* 2001).

The general pattern described above became apparent when drawing on evidence from a large set of countries and periods. At the same time, exceptions to the general pattern can be identified. Some countries exhibit lower inequalities in under-5 mortality then others at the same stage in the epidemiological transition. There are high mortality countries with seemingly low absolute mortality inequalities, and low mortality countries that exhibit low relative inequalities (Chapter 4). Also, relative mortality inequalities can remain stable or even decline during a period of rapid mortality decline, as illustrated by the time-trend analyses for Indonesia (Chapter 8). Furthermore, different dimensions of stratification may show different time-trends. In Indonesia, for example, trends in educational inequalities in under-5 mortality were favourable, whereas regional mortality inequalities increased (Chapter 8). Another study, using census data from Sao Paulo state, Brazil, showed that in a period of rapid decline in under-5 mortality (1970-1991), relative inequalities in under-5 mortality by maternal education increased and by household wealth declined in urban areas. In rural areas, relative inequalities by household wealth increased dramatically (Sastry 2004a). This underlines the importance of monitoring inequalities across a broad set of dimensions. Also, different age groups can exhibit different trends over time. Relative

inequalities in infant mortality, for example, increased in The Netherlands, whereas relative inequalities in perinatal mortality declined (Mheen 1998).

Reversals in the secular mortality decline have been rare during the last two centuries (McMichael *et al.* 2004) and earlier studies emphasized the resilience of secular mortality trends to "countervailing powers" (Caldwell 1996; Murray *et al.* 1993). Yet, the epidemiological transition is, perhaps, not the smooth process some authors once thought it was. Since the 1990s, a worldwide slowing-down or stagnation of mortality declines has occurred, even in countries with relatively high mortality levels (Ahmad *et al.* 2000; Claeson *et al.* 2000). Some countries even experienced reversals (McMichael *et al.* 2004; UNICEF 2004; WHO 2003). There is virtually no evidence on which groups are most vulnerable to such mortality increases. My study of five African countries shows that there is not one general pattern of increase in under-5 mortality (Chapter 9). In some countries, lower socio-economic groups and those in rural areas were more vulnerable to the mortality increase. In other countries higher socio-economic groups and those in urban areas showed stronger mortality increases.

Summarizing, there appears to be a regular pattern of change in absolute and relative mortality inequalities along the epidemiological transition, with widening relative inequalities and narrowing absolute inequalities along with declining mortality levels. Although reliable data on long-term time-trends in mortality inequalities are scarce in both high and low income countries, existing evidence points to broadly similar patterns of change. If there is indeed such a similar pattern, this is all the more remarkable given the different sources of mortality decline in low and high income countries. These sources include more long-term mortality declines in parallel with industrialisation and increases in medical and public health knowledge in high income countries and declines partly stemming from external medical technologies in low income countries. At the same time, irregularities are observed. By examining such irregularities, through contrasting case studies, future research might provide clues on the mechanisms through which inequalities increase or decrease.

The above described patterns of change are purely descriptive. It is important to understand the mechanisms through which the regular patterns and the observed irregularities are produced. Relative inequalities, for example, do not increase *because* mortality declines, but because of the *way in which* mortality declines. Evidence on the mechanisms through which mortality inequalities in low and middle income countries change is scarce. This

is partly due to a lack of individual level data on cause-of-death and proximate mortality determinants for deceased children. In the following sections I will explore the role of three factors or processes that may have contributed to the observed time and place variations in mortality inequality, i.e. economic growth and income distribution, differential diffusion of innovation, and the role of the state. These should not be considered as mutually exclusive explanatory factors, but rather as three, interrelated, ingredients of a possible explanation.

Mortality inequalities, economic growth and income inequality

Economic growth and mortality declines tend to go together at the country level (Pritchett *et al.* 1996). If income inequalities tend to rise in times of economic growth, the rising relative mortality inequalities that are associated with mortality declines might be partly explained by rising income inequalities. In this section, I review the relationships between economic growth, income inequality and mortality inequality, and will discuss lines for further research.

Economic growth and mortality inequalities

There is some evidence that relative socio-economic mortality inequalities tend to rise in low and middle income countries in periods of economic growth. Evidence comes from my cross-national analyses, showing a significantly stronger association between national per capita income and under-5 mortality levels for the relatively well-off compared to the poor within countries (Chapter 6). This suggests that economic growth has a stronger impact on under-5 mortality declines among the relatively rich, leading to larger poor-rich inequalities in under-5 mortality. Wagstaff comes to a similar conclusion (Wagstaff 2002). The limited evidence from time-trend studies on childhood mortality and morbidity and adult mortality support this cross-sectional evidence (DaVanzo *et al.* 1986; Vega *et al.* 2001; Wagstaff 2002). China's rapid economic growth during the last two decades of the 20th century, for example, has seemingly been accompanied by increasing rural-urban inequalities in childhood stunting (Shen *et al.* 1996) and infant mortality (Liu *et al.* 1999), though these conclusions appear to be sensitive to the data source used (Gao *et al.* 2002). Likewise, regional mortality inequalities in Indonesia increased in a period of economic growth (Chapter 8). Cross-sectional and time-trend analyses thus tend to converge in their findings. The findings on educational inequalities in under-5 mortality in Indonesia are remarkable in this respect, and show that increasing socio-economic mortality inequalities in times of economic growth are not inevitable (Chapter 8).

Economic growth and income inequality

Do mortality inequalities tend to rise in times of economic growth because economic growth is associated with rising income inequalities, and the latter is instigating a rise in mortality inequalities? First of all, this assumes that income inequalities rise in times of economic growth. The relationship between economic growth and income inequality is, however, contested (Galbraith *et al.* 2001). This is partly due to the fact that the availability of reliable time-trend data on income inequality is problematic (Deininger *et al.* 1997).

Kuznets hypothesized that the relationship between income inequality and economic growth takes the form of an inverted-U. In the early stages of economic growth, income inequality would increase, and would subsequently decline as industrialization of the economy becomes more comprehensive (Kuznets 1955). This hypothesis is "based on a model where individuals migrate from a low-wage rural sector with little inequality to an urban sector characterized by high income inequality and high average income" (Deininger *et al.* 1997 p.38). According to Kuznets' inverted–U hypothesis, the causal relationship runs from economic growth to income inequality. Kaldor argued the other way around, hypothesizing that income inequality stimulates economic growth, as rich people have the propensity to save, and thus provide funds for investment (Kaldor 1956; UNDP 1996).

More recent evidence suggests that, across countries, there is little or no relationship between economic growth and (subsequent) income inequality (Deininger *et al.* 1997; Ravallion nd), apparently disproving Kuznets hypothesis. Yet, there is important variation between countries in the association between economic growth and income inequality over time, with strong distributional effects of growth in some countries (Ravallion nd). The East Asian Tiger economies demonstrate that economic growth and a (more) equitable income distribution can go together (BPS *et al.* 2001; Siddiqi *et al.* 2001; UNDP 1996). Furthermore, the initial distribution of income and land appears to influence the level of economic growth in the opposite direction hypothesized by Kaldor; countries with a more equal distribution of income or land show higher rates of subsequent growth (Deininger *et al.* 1997). At the same time, the initial income distribution appears to influence the income distribution following economic growth. "Countries that enter into a period of rapid growth with rather equal distribution of income tend to distribute the gains from growth in a rather fair way. Countries that enter into a period of rapid growth with grossly unequal income distribution, see inequality increase." (Morawetz 1977 p.41).

The upshot of this summary of the literature is that we do not have a shorthand economic formula [economic growth→ income inequality→ health inequality] available for generating hypotheses explaining health inequalities. Matters are more complex than that.

Income inequality and mortality inequalities

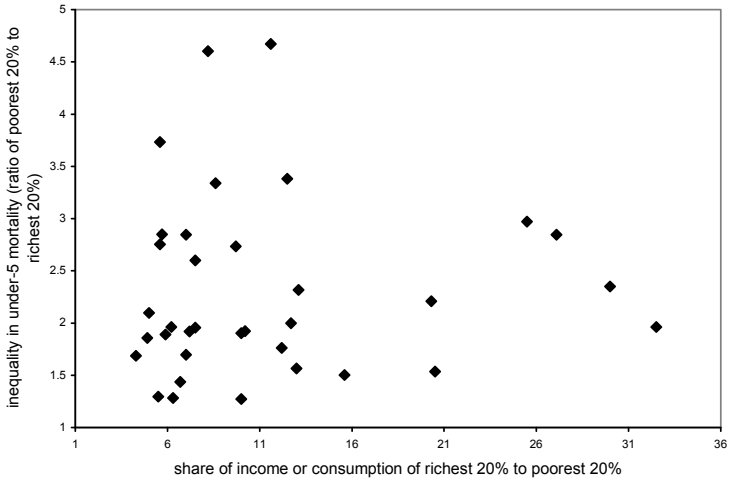
Is it plausible to posit a causal relationship between the magnitude of income inequalities and mortality inequalities? There are at least two mechanisms through which income inequality may impact on mortality inequalities. The first mechanism acts directly. As lower individual incomes are associated with higher mortality risks, larger income inequalities can, *ceteris paribus*, be expected to be associated with larger mortality inequalities. The second mechanism acts indirectly. Large income inequalities may hamper agreement on public policy choices and the provision of public goods such as infrastructure and waste disposal (Deaton 2001). Polarized societies may also foster rent-seeking behaviour (Alesina *et al.* 1999; Easterly *et al.* 1997). This may have stronger detrimental impacts on the most vulnerable in society.

Are mortality inequalities larger in countries with large income inequalities? Cross-nationally there is little evidence of an association between income inequality and mortality inequality. Figure 10.2 shows, for 35 low and middle income countries, that inequalities in under-5 mortality are not larger in countries with larger income inequalities. Similar findings have been reported by others (Wagstaff 2002). Evidence from high income countries suggests that relative inequalities in adult mortality are also not smaller in egalitarian societies (Kunst *et al.* 1998b; Mackenbach *et al.* in preparation; Mackenbach *et al.* 1997a). If associations are found, they are due to an outlier (Van Doorslaer *et al.* 2004; Van Doorslaer *et al.* 1997). Equally, income inequality did not explain the stronger effect of national per capita incomes on under-5 mortality levels among the rich reported in Chapter 6. Similar results were found by Wagstaff (2002).

However, time-trend analyses provide some evidence of changes in mortality inequality concurrent with changes in income inequality. For example, the relatively favourable distribution of the fruits of economic growth across socio-economic groups in Indonesia was associated with stable or declining relative inequalities in under-5 mortality by maternal education. At the same time, the stronger concentration of the benefits of economic growth, and in particular a faster rural development on the two central Indonesian islands was accompanied by an increasing regional inequality in under-5 mortality (Chapter 8). Similarly, the increasing

rural-urban mortality inequalities during China's rapid economic growth, seem to be partly explained by the increasing rural-urban income inequalities (Liu *et al.* 1999). In Chile, rising incomes and income inequalities were accompanied by rising inequalities in adult mortality (Vega *et al.* 2001). Also in the UK, the increases in income inequality have coincided with increases in (adult) mortality inequality (Davey-Smith *et al.* 2002).

Figure 10.2 The relationship between income inequality (measured by the share of income or consumption of the richest to the poorest 20% population group) and relative inequality in under-5 mortality (mortality rate ratio of poorest 20% to richest 20%) for 35 low and middle income countries



Source: Data on inequality in under-5 mortality are derived from Country Reports on Health, Nutrition and Population (Gwatkin *et al.* 2000), which are based on DHS data. The mortality data are obtained from surveys conducted during the 1990s. Data on income inequality are obtained from the Human Development Report 2000 (UNDP 2000) and refer to the most recent year available during the period 1987-1998.

Conclusions and recommendations for further research on economic growth, income inequality and mortality inequality

In summary, existing evidence suggests that relative mortality inequalities tend to rise in times of economic growth. However, positive outliers to this general pattern suggest that increasing mortality inequalities are not inevitable. Time-trend analyses for a broader set of countries is needed to assess the generalizability of this general pattern.

To what extent economic growth explains the observed association between mortality declines and rising relative mortality inequalities, remains uncertain. Further research can contribute to answering this question by comparing time-trends in mortality inequalities between countries with economic growth mediated mortality declines (Sen 1999) and

countries with support-led mortality declines (i.e. declines induced by public policies, especially socially important investments, rather than economic growth) (Sen 1999).

There is inconclusive evidence on income inequality as a mechanism through which economic growth may lead to rising mortality inequalities. Clearly, without income inequality there would be no mortality differences by income level. Yet, the relationship between economic growth, income inequality and mortality inequalities is complex, and certainly not linear. Complex interactions between economic growth and income inequality may influence mortality inequalities (for example with both preceding and subsequent levels of income inequality and levels of economic growth mutually influencing each other and the level of mortality inequalities). These non-linear relationships are usually not observed in cross-sectional correlational analysis. Moreover, it seems unlikely that trends in inequality in adult mortality –which is the result of an accumulation of risk factors over the life course– are strongly influenced by concurrent changes in income inequality (Leon 2001; Lynch *et al.* 2003). Concurrent effects of income inequality on inequalities in childhood mortality, however, seem plausible. The above mentioned time-trend studies suggest such an effect indeed. Yet, temporal coexistence, however, does not necessarily imply causality. More systematic evidence is needed, including tracing of the mechanisms through which income inequality may influence inequalities in childhood mortality, and the study of the interrelationship between income inequality and other dimensions of social stratification such as the distribution of land and education (see Figure 2.1 and Figure 2.2).

Conversely, perhaps not (only) economic growth or changes in social stratification, but rather (also) differential changes in health related behaviour or other proximate determinants explain the rising mortality inequalities when overall mortality levels fall. An unequal diffusion of health-related interventions across societal layers, with earlier and faster adoption among higher socio-economic groups might explain the rising relative mortality inequalities. This hypothesis is discussed below.

Differential diffusion of innovation

Rising relative mortality inequalities in times of mortality decline are perhaps explained by a differential change in proximate determinants across socio-economic strata. If health-related innovations or programs reach lower socio-economic groups systematically later, or if these groups are systematically later in the adoption of these innovations (Rogers 2003 [1962]), health inequalities between socio-economic groups will increase (Victora *et al.*

2000). Below, I will review the empirical evidence for such a differential pattern of change. I will argue that changes in proximate health determinants across socio-economic groups indeed tend to follow a systematic pattern. Such changes occur first in higher socio-economic groups before trickling-down to lower strata; and this contributes to the observed rising relative mortality inequalities.

In low and middle income countries, improvements in proximate determinants of childhood mortality appear to follow a systematic pattern of change. Improvements tend to occur first and faster among higher socio-economic groups and in urban areas. Evidence comes from cross-sectional studies, showing systematically more beneficial levels of proximate health determinants, such as health care use, among richer and more educated groups, and in urban areas (Chapters 4, 7 and the Annex) (Gwatkin *et al.* 2004; Gwatkin *et al.* 2000). Exclusive breastfeeding is an exception (own calculations using DHS data, results not shown), with higher levels among lower educated women and in rural areas. Corroborating evidence comes from time-trend and intervention studies, which show that improvements in proximate health determinants occur first and faster among higher socio-economic groups (Mushi *et al.* 2003; Victora *et al.* 2000).

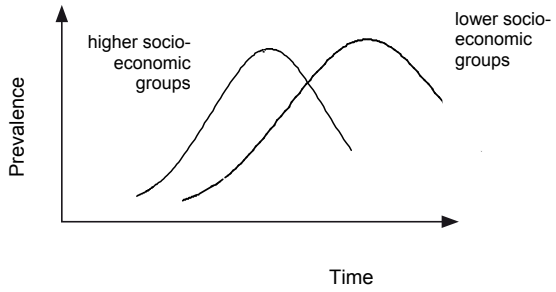
Also historical evidence from high income countries supports the hypothesis that a differential change in proximate determinants across socio-economic groups contributes to rising relative mortality inequalities concurrent with falling overall mortality levels. The stronger relative decline in infant mortality in wealthier neighbourhoods in Amsterdam, The Netherlands, at the end of the 19th century, for example, has been explained by the fact that public health interventions reached higher socio-economic groups first (Mheen 1998). Also, it has been argued that the stronger decline in infectious diseases in secularised areas of The Netherlands in the late 19th century was associated with a faster "acceptance [in these secularised areas, TAJH] of new ideas on hygiene and disease processes" (Wolleswinkel-van den Bosch *et al.* 2001). Similarly, the increase in relative inequalities in infant mortality after the Second World War has been explained by an earlier adoption of healthier lifestyles (*e.g.* decline in smoking prevalence) by higher socio-economic groups (Mheen 1998).

The recent increase in relative inequalities in ischemic heart disease mortality in several European countries has also been attributed to a differential change in health-related behaviour across socio-economic groups (including a decline in smoking prevalence among higher socio-economic groups and an increase in prevalence among lower socio-economic groups) (Avendano *et al.* 2005). The proportional faster decline in cardiovascular disease

mortality among higher socio-economic groups, again, was an important factor in the rising relative inequalities in total mortality in these countries (Mackenbach *et al.* 2003). Similarly, the earlier onset of the decline in ischemic heart disease mortality in the urbanized western part of The Netherlands compared to more peripheral regions, has been attributed to a differential onset in lifestyle changes across these regions (Mackenbach *et al.* 1989).

Not only beneficial, but also detrimental health-related behaviours (such as smoking, or the use of infant formula (-the latter can be particularly harmful in low income settings-) seem to reach higher socio-economic groups first. The pattern of change in these behaviours can perhaps be described in the form of two overlapping waves. In the first wave, behaviours rise among higher socio-economic groups. In the second wave, lower socio-economic groups follow. At the same time, higher strata are the first to give up these detrimental health behaviours. Figure 10.3 provides a hypothetical example.

Figure 10.3 Hypothetical example of the form in which the prevalence of a detrimental health behaviour changes over time among lower and higher socio-economic groups



The phenomenon of time-overlapping waves in the adoption of innovations between different socio-economic groups has, for instance, been described for the smoking epidemic. Initially, smoking prevalence was higher among higher societal strata. It took time for the smoking habit to reach lower socio-economic groups. Higher strata were also the first to give up smoking once it became clear that it had adverse health effects. This led to a reversal of the smoking gradient, with a higher prevalence among lower socio-economic groups (Graham *et al.* 1999; Huisman *et al.* 2005b; Lopez *et al.* 1994). A similar pattern has been observed for the obesity epidemic. The obesity prevalence in countries rises with rising national per capita incomes. In low income countries, the prevalence of obesity is higher among higher socio-economic groups. Once national incomes increase, the obesity-gradient reverses; in high income countries, lower socio-economic groups have a higher prevalence of obesity (Monteiro *et al.* 2004). Perhaps something similar might happen with

HIV prevalence in Africa. Currently, HIV prevalence rates are (substantially) higher in urban areas and among the higher educated, at least according to the DHS surveys for the six African countries where seroprevalence data were included (own calculations using STATcompiler at www.measuredhs.com, results not shown). This might have contributed to the observed stronger increase in under-5 mortality among the higher educated and those in urban areas in Zimbabwe (Chapter 9).

A reversal of the socio-economic gradient is typical for detrimental health behaviours. My results suggest that factors beneficial for health, such as professional attendance during deliveries, will continue to spread over time until prevalence is very high among all. The non-users of care, however, will tend to remain concentrated among pockets of lower socio-economic groups. This has been observed, for example, in a county in the UK, where a strong increase in overall immunisation coverage was accompanied by a stronger concentration of under-coverage among deprived groups (Reading *et al.* 1994). This underscores the importance of continued monitoring of inequalities, even at high overall levels.

The magnitude of inequality in a proximate determinant at a given time depends, among other things, on the stage in the process of its diffusion across the socio-economic groups, as described above. The magnitude of socio-economic mortality inequalities is dependent, among others, on epidemiological time, or the stage of a country in the long-term process of change from a situation of high mortality, predominantly caused by infectious diseases, to a situation of low mortality, predominantly caused by non-communicable diseases. Such long-term mortality declines are the result of a continuous process of improvements in multiple proximate determinants, which tend to spread, as discussed above, unequally across a population. As each new intervention tends to reach higher socio-economic groups first and faster, relative inequalities in mortality will tend rise with falling mortality levels. Mortality inequalities observed at one point in time, are the interim product of such a continuous process of differential diffusion of innovations. The historical process of differential change of health improving and damaging behaviours within societies, is in my view, a powerful determinant of time-trends in socio-economic mortality inequalities. Understanding the magnitude of socio-economic inequalities in health-related behaviour and, ultimately, in mortality, and the variations in such inequalities between countries and time-periods, is only possible when the historical processes of differential change across socio-economic groups are taken into account. The effect of interventions to reduce inequalities in proximate determinants or mortality, should also be evaluated in the light of the above two processes of change.

The longstanding debate on the interaction effects between availability of health care facilities and maternal education can perhaps be understood in this light. Some have argued that the advantages of maternal education are substituted by the availability of health care, leading to smaller inequalities in childhood mortality between educational groups (Rozenzweig *et al.* 1982). Others have argued that the effect of health care adds to the effect of education, leading to larger mortality inequalities (*cf.* Cleland *et al.* 1988). Based on the discussion above, I would expect the effect of maternal education on health care use and childhood mortality to be strong in relative terms (i.e. large relative inequalities) when health care facilities are newly introduced or scarcely available, and to diminish (i.e. smaller relative inequalities) once they become more widely available.

The process of differential change seems to be systematically more unequal for certain proximate determinants than for others. Socio-economic inequalities in professional delivery care in low and middle income countries, for example, tend to be much larger than inequalities in many other types of care (Chapter 7). Positive deviations can be observed as well. Perinatal mortality in The Netherlands during the 19th and 20th century, for example, declined equally across socio-economic groups. This has been attributed to the importance of medical care for survival in this age group and the fact that medical care had become broadly accessible to due a public health insurance system (Mheen 1998). Also in contemporary low and middle income countries, some programs are successful in preferentially reaching lower socio-economic groups (Manandhar *et al.* 2004; Rivera *et al.* 2004). In Mexico, for example, Oportunidades, a program of cash transfers conditional on participation in health, nutrition and education programs, appears successful in reaching the poor (Braine 2006; Rivera *et al.* 2004).

What explains the process of differential change across socio-economic groups? And why is the diffusion of certain interventions or programs more unequal than that of others? Two influential (theoretical) frameworks might provide a starting point for an explanation. The first is Roger's diffusion of innovations theory (Rogers 2003 [1962]). According to this theory, the rate of adoption of innovations, or new ideas, is faster among higher socio-economic groups than lower socio-economic groups. Indeed, maternal education has been shown to be an important factor in adopting 'modern' health behaviour and taking advantage of new health technologies (Caldwell 1990; Cleland *et al.* 1988). This focus on individual level factors, with much less attention for more systemic factors that may explain differential diffusion of innovation, has been criticised (Haider *et al.* 2004).

Conversely, the second explanatory 'framework' on which I would like to draw, Hart's Inverse Care Law, focuses more on systemic factors (Hart 1971). According to this 'Law', "[T]he availability of good medical care tends to vary inversely with the need for it in the population served" (p. 405). Health care facilities, for example, tend to be concentrated in urban areas. Hart focuses on the health care sector. Yet, his argument can be used more broadly for structural inequalities in the supply of services, information, and other resources. The huge inequalities in professional delivery care that I described, are probably largely explained by such systemic factors (Chapter 7). Hart posited that "[T]his inverse care law operates more completely where medical care is most exposed to market forces, and less so where such exposure is reduced" (p. 405). The next section focuses on the role of the state. Further unravelling of the individual and structural determinants of differential change in proximate determinants across socio-economic groups remains an important challenge for future research.

In summary, I hypothesize that a systematic pattern of differential change in proximate determinants across socio-economic groups plays an important role in explaining the rise in relative inequalities in under-5 mortality when overall mortality levels decline. Mortality levels decline because of a continuous flow of improvements in proximate determinants. As such changes occur earlier and in a faster rate among higher societal strata, relative inequalities in mortality will tend to increase when overall mortality levels decline. I expect relative inequalities in the uptake of an intervention to be large at early stages and to decline at later stages, but relative inequalities in mortality to increase continuously.

Role of the state

Do relative mortality inequalities rise concurrent with mortality declines because states are an insufficient buffer against processes that cause these inequalities to increase? Or do public policies even instigate these rising mortality inequalities because of a pro-rich or urban bias in public policy making? And can the positive outliers, *viz.* countries with low mortality levels and low relative mortality inequalities, be explained by pro-poor/rural state intervention? Rationales for government action include social justice and human rights arguments; states have the obligation to guarantee human rights, including those to education and health care (Levy *et al.* 2006; World Bank 2003). Also the correction of market failures ("the amount of services produced and consumed would be less than optimal from society's standpoint without government intervention" (World Bank 2003

p.33) is used as argument for state intervention. In practice, public polices may not be as equity-oriented as one would expect on basis of the above rationales.

There are a number of entry points through which states can influence the magnitude of mortality inequalities (see Figure 2.1). These include social stratification (relationship E in Figure 2.1), the effect of social stratification on inequality in proximate determinants (relationship F), the effect of inequality in proximate determinants on inequality in mortality (relationship G), and the effects of health inequality on social stratification (relationship H). So, the role of the state should be seen in interlinkage –rather than in juxtaposition– with the discussions above on economic growth and rising income inequalities (i.e. stratification) and differential change of proximate determinants across socio-economic groups.

Systematic research on the role of the state in relation to mortality inequalities is scant. Below, I will discuss how public spending on health and public policies on health sector financing may influence the magnitude of childhood mortality inequalities in low and middle income countries. Thereafter, I will discuss a number of institutional characteristics that may influence the willingness or capacity of states to implement equity oriented public policies.

Public spending on health

Governments may seek to influence the uptake of preventive and curative health care services among lower socio-economic groups and to reduce health inequalities through public spending on health and policies on health sector financing.

There is strong evidence that public spending on health tends to be pro-rich, a phenomenon which has been phrased as "socialism for the rich and *laisser-faire* for the poor" (Mitchell 1971). Evidence comes from benefit-incidence analyses, which combine information about the costs of the provision of public services with the use of these services (Castro-Leal *et al.* 2000). Public money tends to go to more expensive services that the rich tend to use more, despite the higher health care needs among lower socio-economic groups. I have shown, with others (Gwatkin *et al.* 2004), that absolute poor-rich inequalities in the use of public facilities for maternity care are much larger than inequalities in private facilities (Chapter 7). Government policies and public spending also tend to be biased towards urban areas, where higher socio-economic groups tend to live (Lipton 1977). This urban bias in development probably reinforces rural-urban income inequalities and the differential change in proximate determinants across socio-economic and regional groups discussed above. Health services,

for instance, are concentrated in urban areas (Wilkinson *et al.* 1993). This might probably partly explains the much lower rate of use of maternal health services in rural areas (Chapter 7). This urban bias in development probably partly accounts for the large rural-urban differences in childhood mortality in many low and middle income countries. I expect this urban bias in development to be particularly strong, and rural-urban mortality inequalities to be particularly large, in weak states where the power projection of the state is focussed on the capital city (Migdal 1988), and where citizens do not have equal entitlements to basic services and social security (Sen 1981, 1999). I hypothesize that weak state structures in combination with a regional bias in development might also partly explain the large provincial level inequalities in childhood mortality observed in many low and middle income countries.

Whereas in monetary terms public spending favours the rich, I have shown that the effects in mortality terms may be stronger for the poor (Chapter 6). Similar results have been reported by others (Bidani *et al.* 1997; Gupta *et al.* 2003). When discussing the effects of public spending, it is therefore important to separate benefit-incidence from the analysis of mortality effects. The stronger mortality effect of public spending on health on the poor is possibly explained by the significantly stronger responsiveness of health care use among these households to increases in such spending (Chapter 6) (relationships A and F in Figure 2.1) combined with stronger mortality effects of health care use in this group (relationship B in Figure 2.1). In other words, I would expect increases in public spending on health to be accompanied by declining relative inequalities in health care use and in under-5 mortality. This effect of public spending on health can be expected to be even stronger if the benefit-incidence of public spending were more biased towards lower socio-economic groups and rural areas. This suggests that increased public spending on health might partly remedy the tendency of widening relative mortality inequalities when overall under-5 mortality levels fall, and perhaps partly accounts for the positive outliers discussed above.

Also public policies on health sector financing, through user fees or social insurance, taxation or development aid, may influence poor-rich inequalities in health care use. Since the 1980s, the Washington consensus policies of structural adjustment focussed on economic growth and reducing state intervention (including in the health care sector) (Williamson 2000, 2002). This fuelled the implementation of cost-recovery strategies, including user-fees, in the health care sector. This has raised a lot of debate on its effects on health care use among lower socio-economic groups. A literature review suggests that user fees tend to deter people from using health care services, but also that more evidence is needed (Palmer *et al.* 2004). Other unfavourable consequences of user fees reported include

untreated morbidity, irrational drug use and further impoverishment of the poor (Pryer 1989; Whitehead *et al.* 2001). Health expenditures can take up a substantial part of the household budget (David 1993). User fees, hidden costs, and especially the unpredictability of costs of professional delivery care probably contribute to the huge poor-rich inequalities in professional delivery care (Chapter 7). The proportion of households facing catastrophic health expenditures is strongly related to the share of out-of-pocket expenditures in total health expenditures (Xu *et al.* 2003). The proportion of out-of-pocket expenditures in total expenditures varies strongly between countries. I would expect, *ceteris paribus,* inequalities in health care use to be smaller in countries with lower out-of-pocket expenditures. Future research should examine whether this is indeed the case. The experience with the abolishment of user fees in public primary care facilities in Uganda shows that adequate financial mechanisms for the facilities should be sought before user fees are abolished. Otherwise, informal payments, or purchasing of drugs through private facilities may sustain catastrophic expenditures among the poor (Xu *et al.* 2006). Interventions in Honduras (Morris *et al.* 2004) and Mexico (Braine 2006) show that cash transfers to households conditional on the use of (preventive) health services, appears to have strong positive impacts on the use of such services.

Institutional characteristics

Institutional characteristics may influence the willingness and capacity of governments to adopt and implement policies that reduce mortality inequalities. First, some have suggested that democracy plays an important role in adopting pro-poor policies (Caldwell 1993; Sen 1999). As democracy, through competition for political power, is thought to make "politicians more likely to respond to people's needs" (Sen 1999; UNDP 2002 p.56), public policies may be expected to be more pro-poor, especially in those countries where a large part of the electorate is poor. I showed that more democratic states have, on average, substantially lower under-5 mortality levels (Chapter 6). However, this effect virtually disappeared after adjustment for national per capita income, female literacy rate and region. (It may be argued that per capita income and female literacy are on the causal pathway between democracy and mortality, and that a lack of effect after adjustment for these factors does not provide evidence for an actual lack of effect.) I found no statistical evidence for the hypothesis that relative inequalities in under-5 mortality are smaller in democracies. More evidence, from research using, for example, process-tracing and other types of in-depth analysis, would be needed to confirm this finding.

Secondly, there is evidence that ethnic fragmentation "may increase polarization and thereby impede the agreement about the provision of public goods" (Easterly *et al.* 1997). It may restrain the efficiency of public spending (Kuijs 2000). The potentially unfavourable effects of ethnic fragmentation are not confined to low and middle income countries (Alesina *et al.* 1999). My cross-national analysis showed that high ethnic fragmentation was slightly, though significantly more strongly, associated with higher under-5 mortality among the poor compared to the rich. Democracy may function as a buffer against the negative effects of ethnic diversity on economic growth and public sector performance (Collier 1998), though this needs further research (Bluedorn 2001). Some have criticized the use of ethnicity (its definition, the measures used, and a lack of theoretical foundation) in the political economic literature (Green 2004). More in-depth research on the causal mechanisms through which ethnic fragmentation might impact on mortality inequality is needed.

The premise in much of the above discussion is that there *is* a functioning state. This is not necessarily the case. A substantial number of African countries has failing, *de facto* non-existing, or predatory states (Bayart 1993). Strong state structures are, arguably, a necessary condition for the universal implementation of, for example, water and sanitation facilities. This has been suggested in a historical study on Sweden (Burstrom *et al.* 2005). In Stockholm, this intervention ultimately resulted in a decline in relative inequalities in diarrhoea mortality in the early 20th century (Burstrom *et al.* 2005). State strength –measured as the percentage of national income that comes from taxing– was in my cross-national analysis slightly, though significantly, associated with lower under-5 mortality levels, also after adjustment for national per capita income, female literacy and region (Chapter 6). However, the strength of this association did not vary across wealth groups. This suggests that a strong, functioning, state may be a necessary, but not a sufficient condition for pro-poor state intervention.

Towards future research on the role of the state

What causes some governments to adopt equity oriented public policies and others not, is a matter for future investigation. Whereas a well-functioning state is a necessary condition for effective equity oriented state intervention, it is not a sufficient condition. Probably both the (un)willingness of governments, as well as (gaps in) the evidence base on effective public policies plays a role. More systematic research is needed on the effect of public policies and institutional characteristics on mortality inequalities. A rudimentary

typology of states, based on elements discussed in this and previous sections (*viz.* economic growth, public spending on health, state strength, democracy), may stimulate future comparative research on mortality inequalities in low and middle income countries. The first two types of states in my typology have the willingness and capacity to invest in human capital, including the universal provision of basic services, including health care. I would expect average mortality levels in these states to be low, and relative mortality inequalities to be comparatively small. The first type of state is the developmental state, which fosters economic growth by investing in human development for the whole population (Woo-Cumings 1999). In these states, economic growth has been relatively equitably distributed. East Asian countries and some Southeast Asian countries like Indonesia and Thailand are examples. The second type is the health care state, which invests in universal education and health care, but shows little or no economic growth. Examples include Kerela, Sri Lanka, Costa Rica, Cuba. These countries show favourable health outcomes relative to their national incomes, and have therefore been presented as examples of "good health at low cost" (Halstead *et al.* 1985). Transitional states, including former Soviet Republics, comprise a third category. The health effects of the former Soviet system became dramatically apparent after its collapse. Kazakhstan, for example, had low poor-rich and rural-urban inequalities in under-5 mortality during the first half of the 1990s. Preliminary analysis (using DHS data, results not shown) shows that the collapsing state system in the country (Parvizi Amineh *et al.* 2005) appears to have coincided with rising absolute and relative rural-urban inequalities in under-5 mortality during the 1990s. This increase seems to be due to a sharp increase in neonatal mortality in rural areas (results not shown, (ORC Macro 2005)). The fourth type consists of neo-liberal states, which focus on economic growth and which limit state intervention in, among others, health care. An example is perhaps Chile since 1973 (Taylor 2003). If economic growth indeed leads to increasing mortality inequalities, as correlational analyses suggest, I would expect comparatively large relative mortality inequalities in this type of countries. Failing or predatory states are the last type in my typology. These can be found in a number of African countries. This type of states neither shows economic growth, nor much investment in human development. In predatory states, the elite monopolizes the production of raw materials without distributing the profits to the population (Bayart 1993). I would expect high overall mortality levels and high absolute mortality inequalities across socio-economic groups, rural-urban areas and provinces in these countries.

ANNEX

International overviews of socio-economic inequalities in under-5 mortality and mortality determinants

This Annex is based on the following document: Kunst, A.E. and Houweling, T.A.J. (2001) International overview of poor-rich disparities in child mortality and the use of maternal and child health services. Report on a short-term consultancy to the World Bank. Rotterdam: Department of Public Health.

ABSTRACT

The World Bank has published a series of country-specific reports documenting poor-rich inequalities in selected health, nutrition and population indicators. In these reports, detailed tabulations are given for 44 low and middle income countries covered by the Demographic and Health Survey (DHS) program during the 1990s. The main objective of this Annex is to use these tabulations to make international overviews and comparisons of poor-rich inequalities in under-5 mortality and proximate determinants of under-5 mortality. The proximate determinants studied include indicators of health care use, childhood malnutrition and fertility.

For each indicator, the results can be summarised in 5 or 6 key messages. It was observed that

- in virtually all countries, there are large inequalities between the poor and the rich in under-5 mortality and the proximate determinants;
- under-5 mortality and the proximate determinants on the one hand and household wealth on the other are systematically associated across the entire wealth hierarchy;
- poor-rich disparities in under-5 mortality and proximate determinants are much large in some countries than in others;
- the overall level of the selected indicators would be improved considerably if all wealth groups would attain the levels enjoyed by the rich within countries;
- some indicators (*e.g.* professional delivery attendance) exhibit much larger poor-rich inequalities than others (*e.g.* immunisation coverage).

INTRODUCTION

Until recently, the development of policies aimed at improving population health and health care use among the poor in low and middle income countries was hampered by a lack of information on the health status of the poorest groups within these countries. Some years ago, a major step forward was made by the World Bank in co-operation with MacroInternational by producing a series of reports in which data from the Demographic and Health Survey (DHS) program was used to document health, nutrition and population indicators according to wealth groups within countries (Gwatkin *et al.* 2000). For 44 countries, these reports provide a rich source of information on health and health care use among the poor, as well as poor-rich disparities in these outcomes. Publication of these reports have greatly helped in raising awareness among policy makers, both of national, regional and international organisations, of the special needs of the poor, and the need to adjust health and other interventions towards their specific situation.

Unique in the DHS program as well as the 44 country reports published on the basis of this program, is the possibility that they offer to portray poor-rich disparities in health, nutrition and population indicators in a comparable way for a large number of countries throughout the world. They thus do not only provide a first opportunity to make world-wide overviews of poor-rich inequalities in these indicators, but also to comparative analyses across these countries. These comparisons can shed new light on important policy issues. If, for example, poor-rich inequalities in health are found to be much smaller in some countries than in others, this would suggest that these inequalities are amenable to modification, and that a closer look into the countries with smaller inequalities may yield suggestions on how to achieve such a reduction.

The main objective of this Annex is to utilise the series of 44 country reports to prepare cross-national overviews of poor-rich inequalities in selected indicators. These overviews are intended to be descriptive, with the special aim to identify general patterns across and variations between countries in the magnitude or pattern of inequalities in the selected indicators.

The following indicators were selected for our international overviews and comparisons. First of all, under-5 mortality was selected as the main health outcome. Secondly, a set of proximate determinants of childhood, including indicators of health care use as well childhood malnutrition and fertility were included. These indicators were chosen, among others, because of their direct relevance to policies and programs in the field of child and maternal health. The data come from DHS surveys that were conducted during the 1990s.

DATA AND METHODS

A detailed description of the data and methods applied in the series of 44 country reports is given elsewhere (Gwatkin *et al.* 2000). In short, data from the DHS surveys are used to estimate indicators for both the entire survey population as well as for sub-populations grouped into quintiles according to their score on an index of household wealth. Each household was assigned into one of five wealth quintiles according to its ownership of a number of household assets. These assets include a number of consumer items (*e.g.* television, car), dwelling characteristics (*e.g.* flooring material), and source of drinking water and type of toilet facilities used. To combine information on households ownership of individual assets into an overall index, the individual assets were given weights on the basis of factor scores generated through principal component analysis.

The results in the 44 country reports that are produced on the basis of this procedure exhibit the poor-rich inequalities that may be expected. Also in our analysis of these data, overall no gross anomalies were observed. It is beyond doubt that the poor-rich disparities demonstrated in these country-specific reports reflect the true existence of poor-rich inequalities within the 44 countries covered.

When these reports are used for cross-national overviews, however, the results may need to be looked at a bit more critically. When the magnitude of poor-rich inequalities is found to vary between countries, the question should be addressed whether these variations reflect true differences. The alternative explanation, that these variations are artificially caused by the data and methods used, cannot be discarded easily. Even though methodological problems cannot fully account for all poor-rich inequalities observed, they can have influenced the observed magnitude, as well differences between countries in this magnitude.

An example is the problem of low precision due to large random error. Overall, chance fluctuations cannot explain all of the poor-rich inequalities in an indicator, implying that the existence of these poor-rich inequalities can be demonstrated with statistically significance (*e.g.* with p-values smaller than 0.05). Despite this significance, the exact *magnitude* may be highly uncertain if chance fluctuations are large. The degree of uncertainty (i.e. the precision) should therefore be quantified. The most precise expression of this degree of uncertainty are 95 percent confidence intervals. Therefore, confidence intervals are added to some of our inequality estimates. The confidence intervals are probably somewhat underestimated, as the sample design was not taken into account in these calculations.

INTERNATIONAL OVERVIEW OF SOCIO-ECONOMIC INEQUALITIES IN UNDER-5 MORTALITY

This section presents international overviews of socio-economic inequalities in under-5 mortality. The main focus of this section is on inequalities in under-5 mortality, with some separate results for infant and child mortality presented at the end of this section. The results can be summarised in 5 key messages.

Key message 1. In virtually all countries, under-5 mortality rates are considerably higher among the poorest than among the richest population group.

Figure A.1 shows for each country the average under-5 mortality rate, as well as the rate for children in the poorest and the richest wealth quintile respectively. In virtually every country, the mortality rates among the poorest children exceeds by far the rates among the richest group. Fairly small inequalities in under-5 mortality are observed only in Kazakhstan and Uzbekistan. An anomalous pattern, with lower mortality rates among the poorest, is observed for Chad. However, Figure A.2 shows that the expected association between mortality and household wealth is observed in Chad between the next-lowest and higher quintiles.

Key message 2. Wealth and under-5 mortality are systematically associated across the entire wealth hierarchy.

Figure A.2 shows that, in general, an association between wealth and under-5 mortality is observed across the entire wealth hierarchy. Mortality rates are lower in each subsequent richer group. Poor-rich disparities in under-5 mortality pervade the entire society, and not only affect the poorest children as compared to all other children. In many countries, however, wealth-related disparities in under-5 mortality do not exhibit a linear gradient, but have a less regular pattern emphasising the situation among specific groups. In countries with the highest average under-5 mortality rates (mostly countries in sub-Sahara Africa) there is a gap between the elite with relatively low mortality rates, and the rest of the population, where the wealth-related inequalities in mortality are much weaker and less consistent. A reverse pattern is observed in some of the countries with low overall under-5 mortality rates. In Brazil, Peru, Indonesia and the Dominican Republic, for example, under-5 mortality rates are fairly low for most groups except the poorest, where rates are clearly higher. These different types of gradients imply that there are large variations

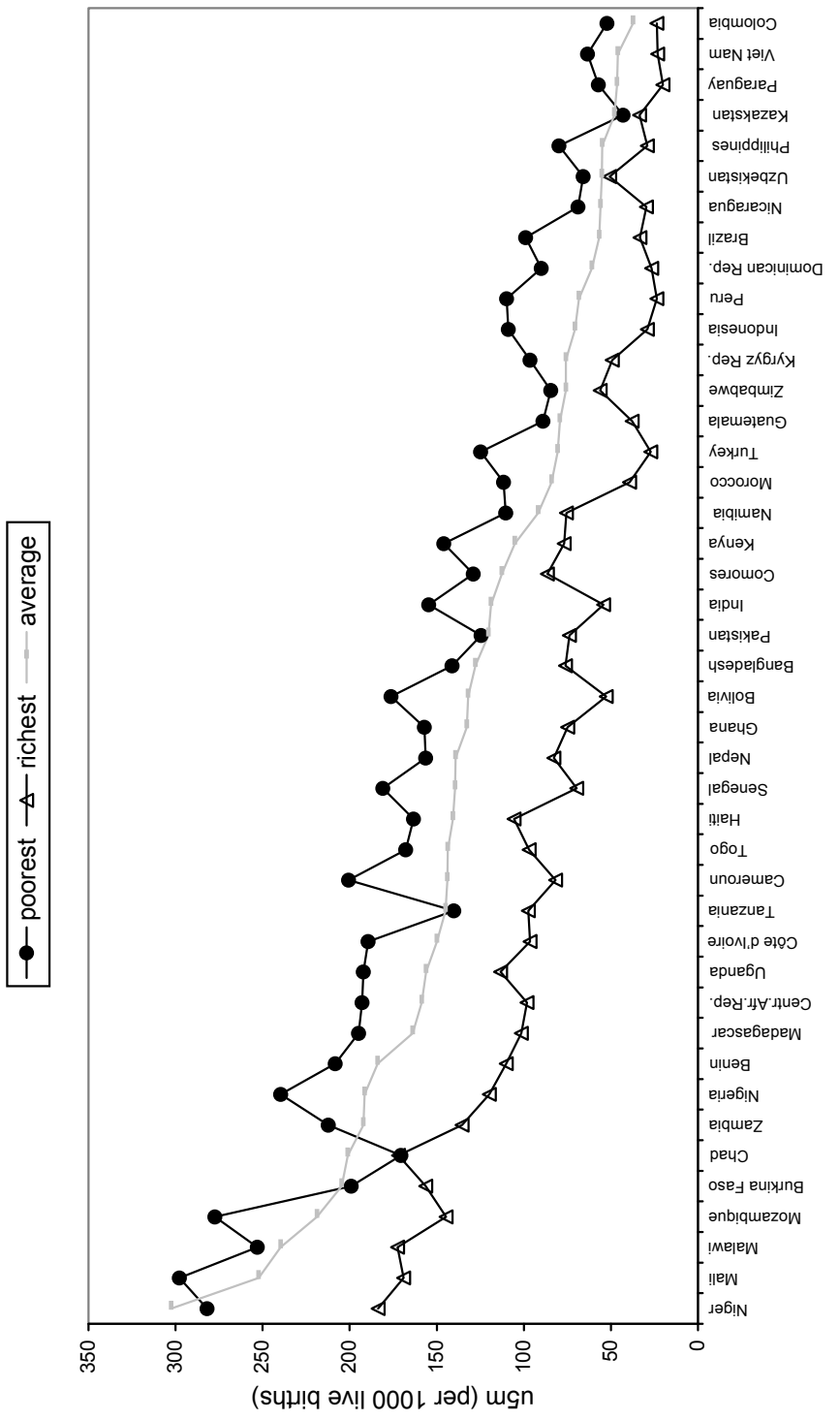


Figure A.1 Under-5 mortality rate (per 1,000 live births), among the poorest and richest quintile and the total population

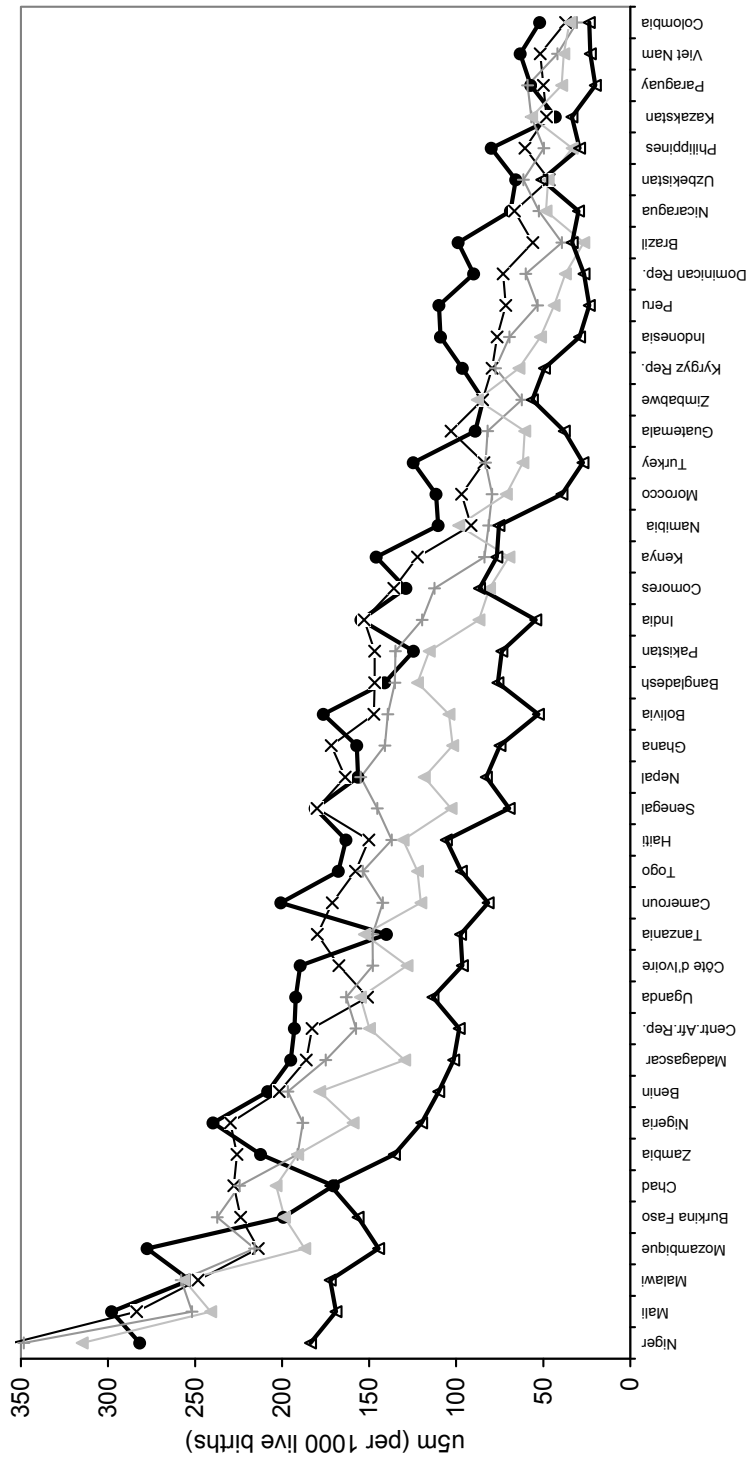
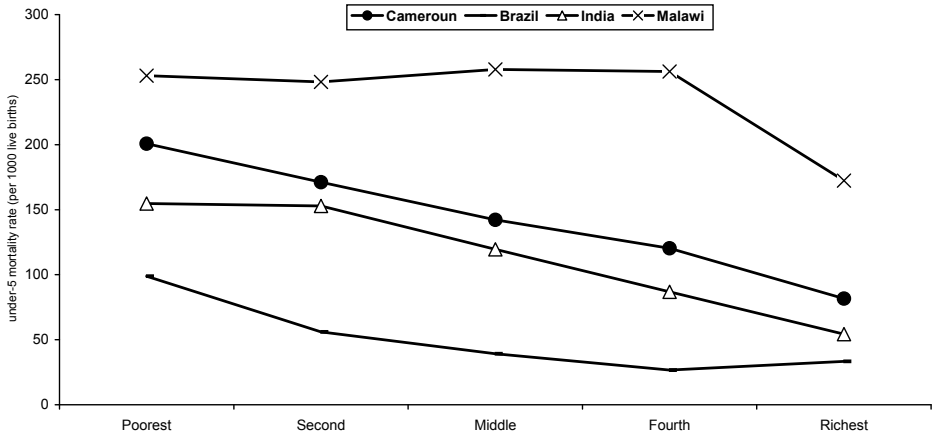


Figure A.2 Under-5 mortality rate (per 1,000 live births) by wealth quintile within countries

between countries in the specific groups of children that need to be targeted by child health and survival programs (Figure A.3).

Figure A.3 Under-5 mortality rate (per 1,000 live births) by wealth quintile; four countries illustrating different patterns of the relationship between household wealth and under-5 mortality



Key message 3. Poor-rich inequalities in under-5 mortality are much larger in some countries than in others.

Figure A.4 shows that the largest absolute inequalities in under-5 mortality are observed in countries in sub-Saharan Africa (*e.g.* Mozambique, Nigeria, Cameroon, Mali) and in Bolivia. The absolute difference between the richest and the poorest wealth quintile in these countries exceed more than 100 deaths per 1,000 live births. The smallest absolute inequalities are observed in the ex-Soviet Republics of Central Asia (especially Uzbekistan and Kazakhstan), a few countries in Sub-Saharan Africa (Namibia, Zimbabwe), and some Latin American countries (Colombia, Nicaragua, Paraguay). Absolute inequalities between the poorest and richest groups are still considerable in most countries (about 30 to 40 deaths per 1,000 births) except in Uzbekistan and Kazakhstan.

Figure A.5 ranks countries according to the magnitude of relative inequalities (rate ratios) in under-5 mortality. Also in relative terms, variations between countries are large. However, an entirely different rank order of countries is observed. By far the largest relative inequalities are observed for Indonesia, Turkey and Peru. On the other side, Uzbekistan and Kazakhstan again rank among the countries with the smallest inequalities, but are now joined by some sub-Saharan countries. The discrepancy between the patterns observed for absolute and relative measures is discussed in more detail in Chapter 4 of this thesis.

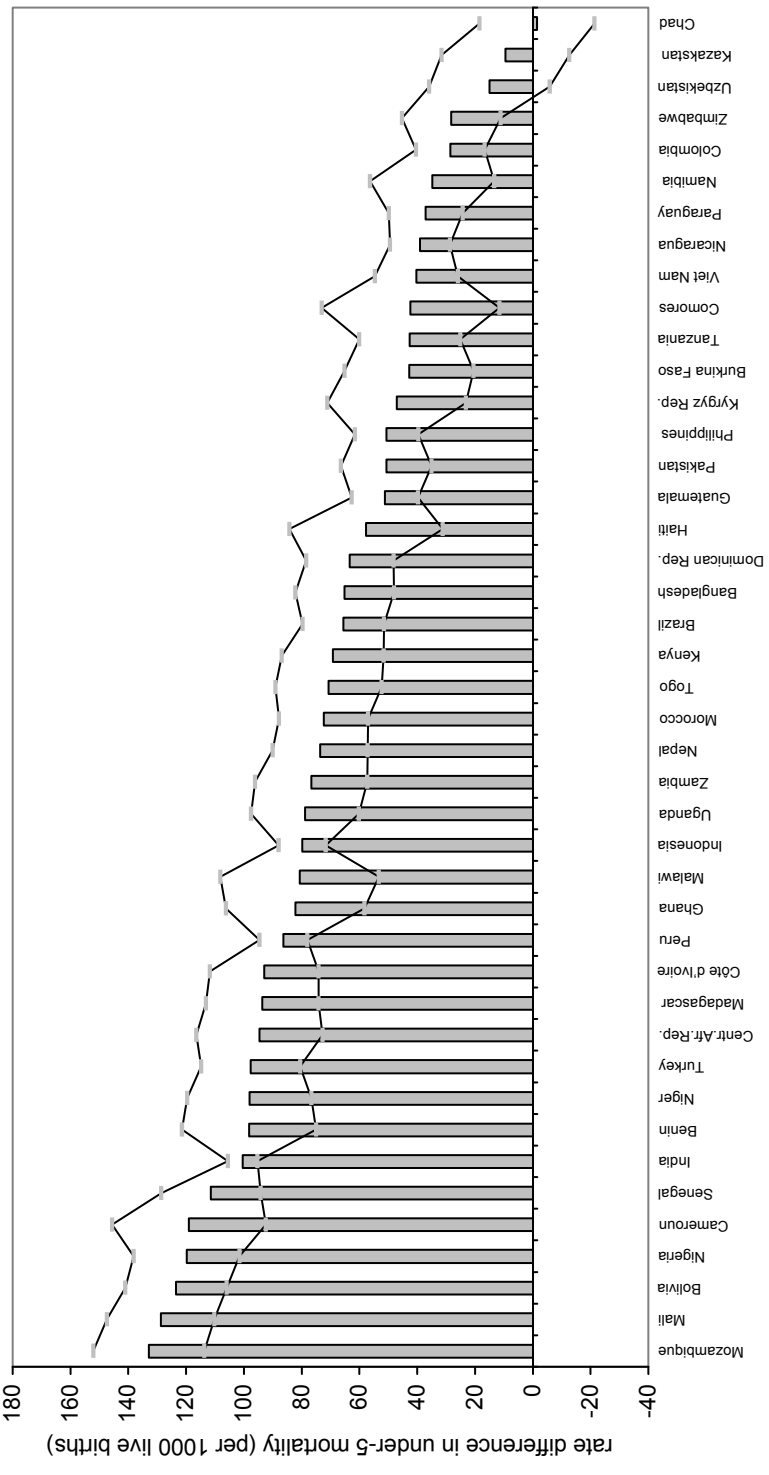


Figure A.4 Absolute inequalities (rate difference) in under-5 mortality between the poorest 20% and richest 20% population group, with 95% Confidence Interval

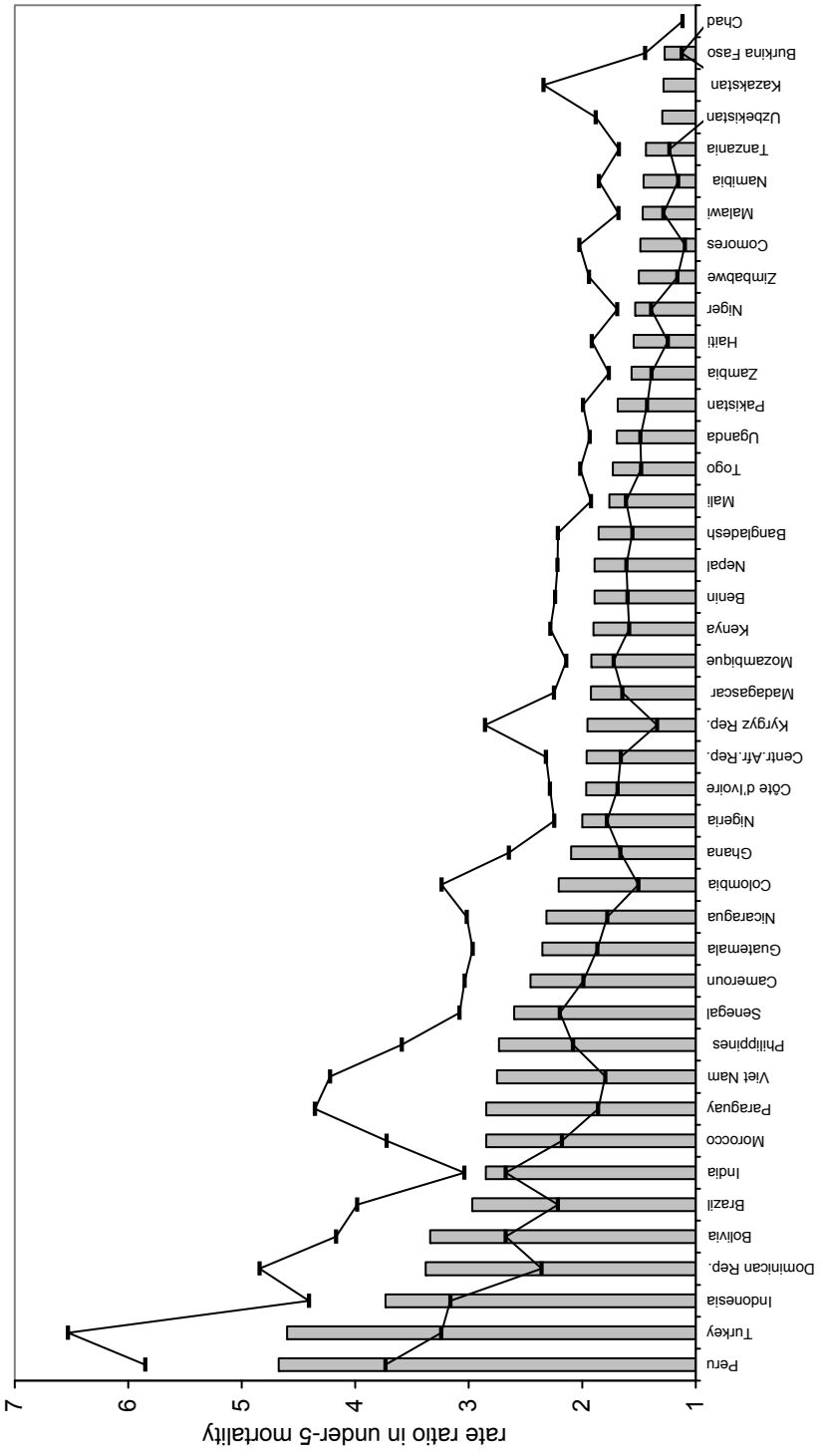


Figure A.5 Relative inequalities (rate ratio) in under-5 mortality between the poorest 20% and richest 20% population group, with 95% Confidence Interval

Key message 4. Eliminating poor-rich disparities in under-5 mortality by decreasing the mortality level of all groups to the level of the richest would substantially improve the average under-5 mortality level.

Figure A.6 presents the Population Attributable Risk (relative version), with the upper wealth quintile as the reference group. The potential relative decline in under-5 mortality is largest for some countries in Asia (Vietnam, India, Indonesia) and several Latin American countries. For these countries, the average under-5 mortality rate would fall by more than 50 percent if all groups would enjoy the under-5 mortality levels among the wealthiest quintile. Many other countries, but not all, would experience a reduction of at least about 30 percent.

Figure A.7 presents the absolute version of the Population Attributable Risk, again with the upper wealth quintile as reference group. It shows that the potential absolute decline in under-5 mortality (per 1,000 live births) would be large in many countries. This decline would be largest in many African countries. In over two thirds of the countries, average under-5 mortality would fall with over 40 deaths per 1,000 live births. In nearly all countries, the potential reduction would be over 15 deaths per 1,000 live births.

These estimates demonstrate the large potential impact of tackling poor-rich inequalities on the overall under-5 mortality level in most countries.

Key message 5. Absolute inequalities in infant mortality tend to be larger than those in child mortality.

Figure A.8 shows absolute inequalities (rate difference) in infant mortality and in child mortality for each of the countries. The sum of rate difference in infant mortality and the rate difference in child mortality is equal to the rate difference in under-5 mortality. For two-thirds of the countries, absolute inequalities in under-5 mortality consist for the major part (>50%) of inequalities in infant mortality. For a few countries, inequalities in child mortality are larger. In Namibia, for example, 82% of the rate difference in under-5 mortality consists of inequality in mortality among children aged 1-4 years. These results indicate the importance of tackling inequalities in mortality among infants in order to reduce absolute inequalities in deaths among children under the age of 5.

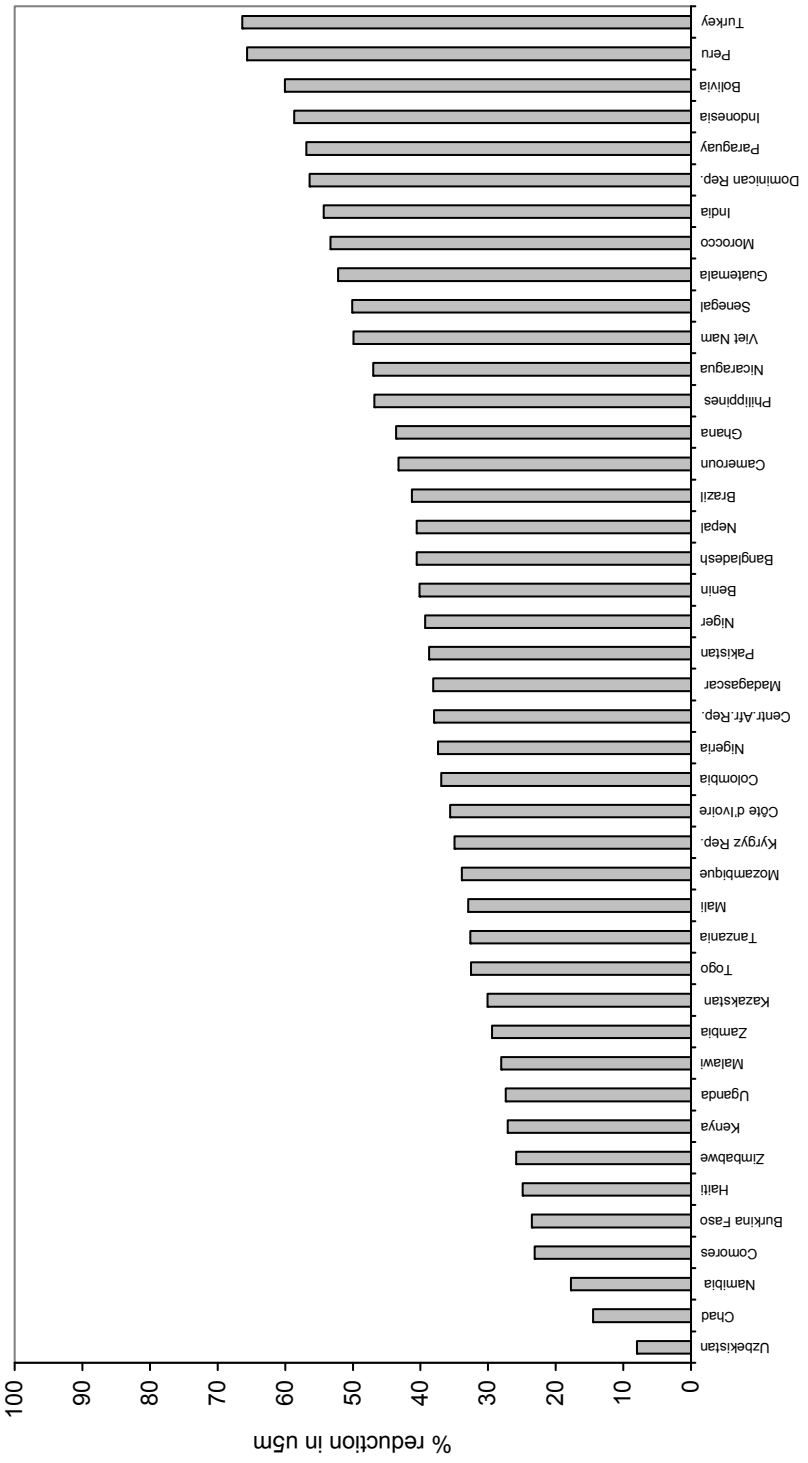


Figure A.6 Potential reduction (in %) of under-5 mortality rate by elimination of inequalities (if all had under-5 mortality level of the richest 20%)

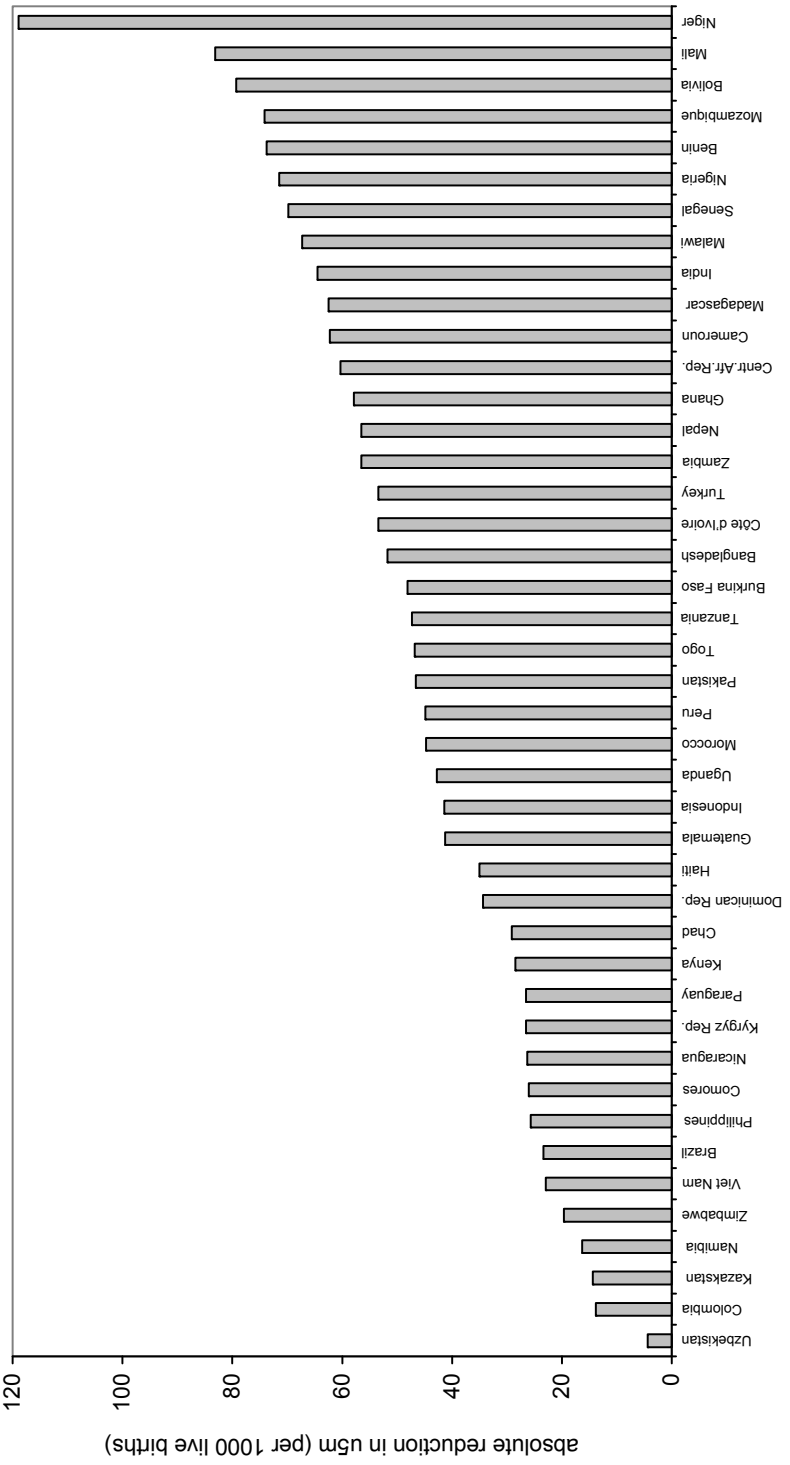


Figure A.7 Potential absolute reduction of under-5 mortality rate by elimination of inequalities (if all had under-5 mortality level of the richest 20%)

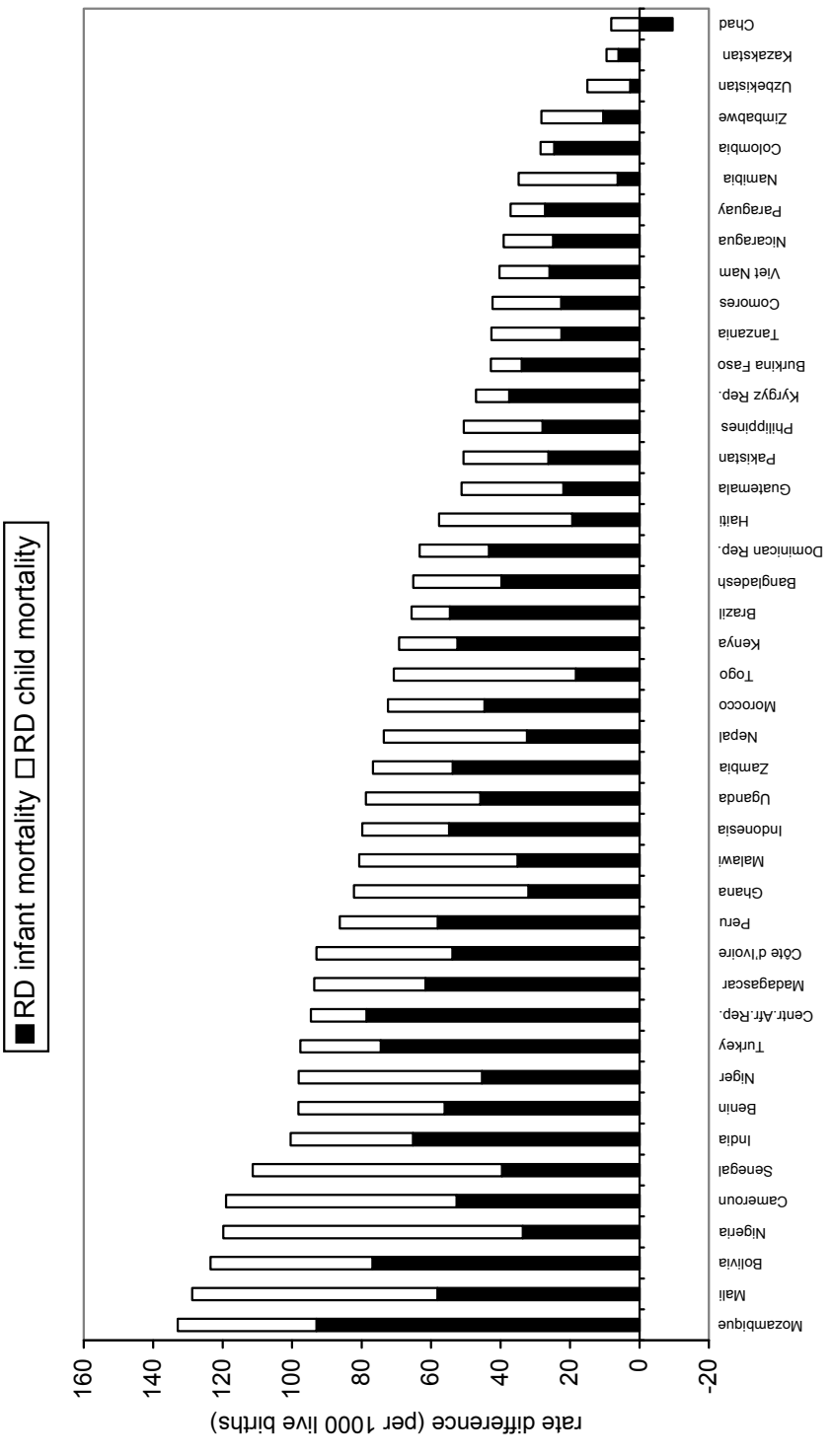


Figure A.8 Absolute inequalities (rate difference (RD) between the poorest 20% and richest 20% population group) in infant and child mortality compared. The sum of the RD in infant mortality and RD in child mortality is equal to the RD in under-5 mortality.

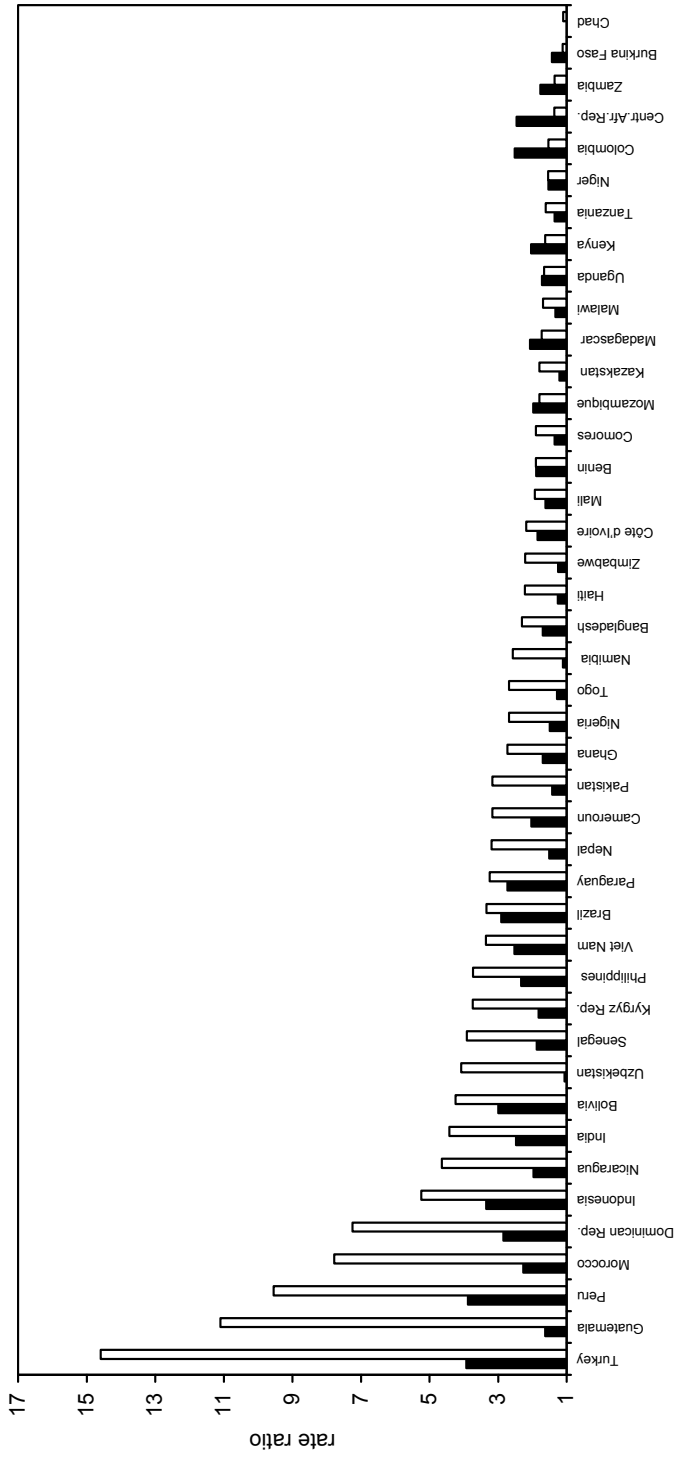


Figure A.9 Relative inequalities (rate ratio poorest 20% to richest 20% population group) in infant and child mortality compared

Key message 6. Relative inequalities in child mortality tend to be larger than those in infant mortality.

Figure A.9 compares relative inequalities in infant and in child mortality within countries. The graph shows that relative inequalities in child mortality tend to be larger than those in infant mortality. This is related to the tendency of relative inequalities to be larger when overall mortality levels are lower (see Chapter 4).

INTERNATIONAL OVERVIEW OF SOCIO-ECONOMIC INEQUALITIES IN HEALTH CARE USE

This section presents international overviews of socio-economic inequalities in health care use, assessing inequalities in childhood immunisation coverage, professional antenatal care and professional delivery care.

Immunisation coverage

The focus in this section is on full childhood immunisation coverage. This is defined as the percentage of living children aged 12-23 months who received BCG, three doses of DPT and oral polio, and measles vaccination. The results can be summarised in 5 key messages.

Key message 1. In virtually all countries there are substantial inequalities between the rich and the poor in full coverage of childhood immunisation.

Figure A.10 shows that in all countries, the rich have a consistently higher coverage than the poor. In Paraguay, Burkina Faso and Pakistan, for example, the richest quintile has an immunisation coverage of approximately 55 percent while the coverage among the poorest is only around 20 percent. There are a few exceptions to this pattern: in Guatemala, the Kyrgyz Republic and Uzbekistan there are virtually no poor-rich disparities.

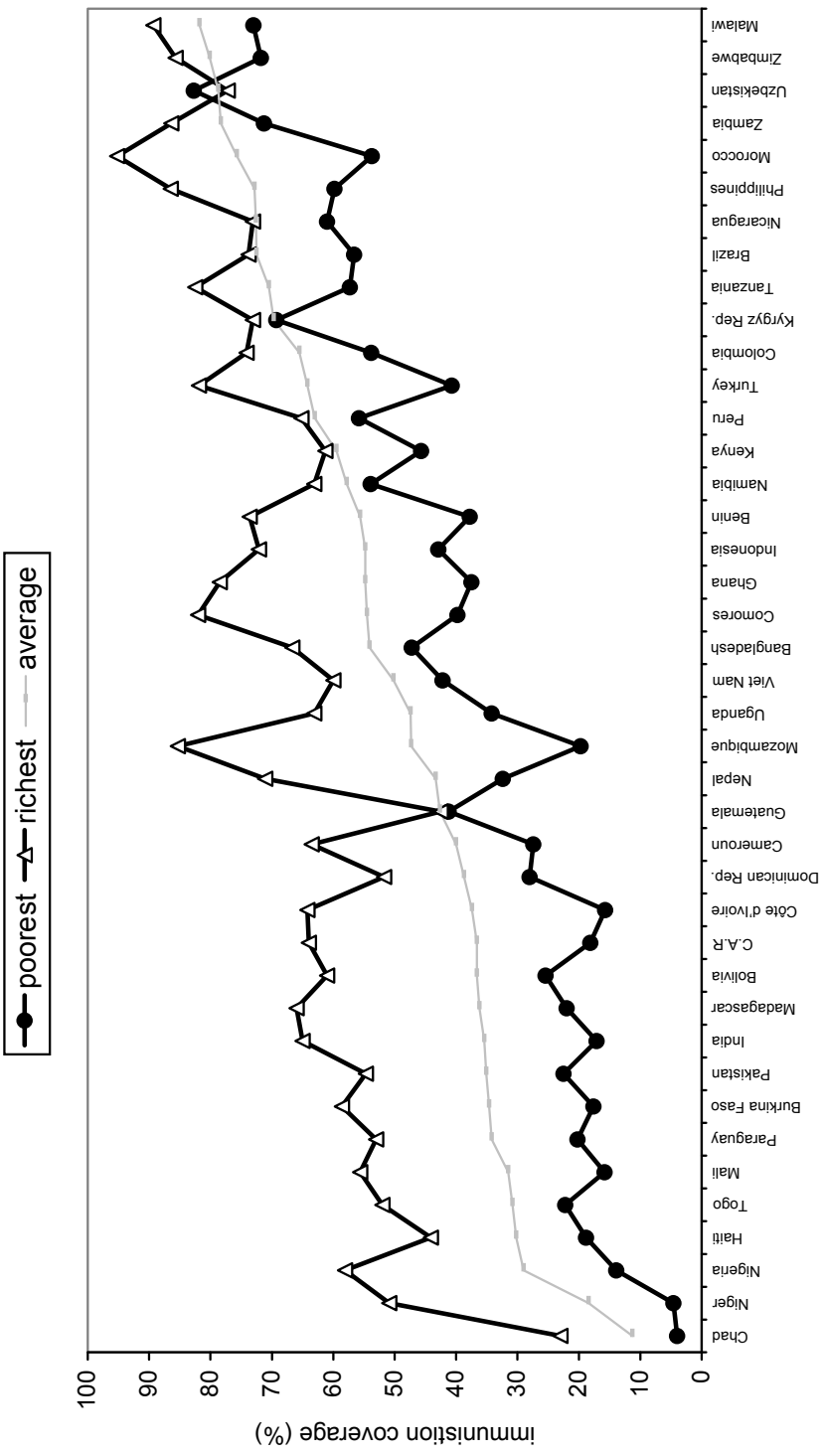


Figure A.10 Percentage of children aged 12-23 months with complete immunisation coverage, among the poorest 20% and the richest 20% population group and the total population

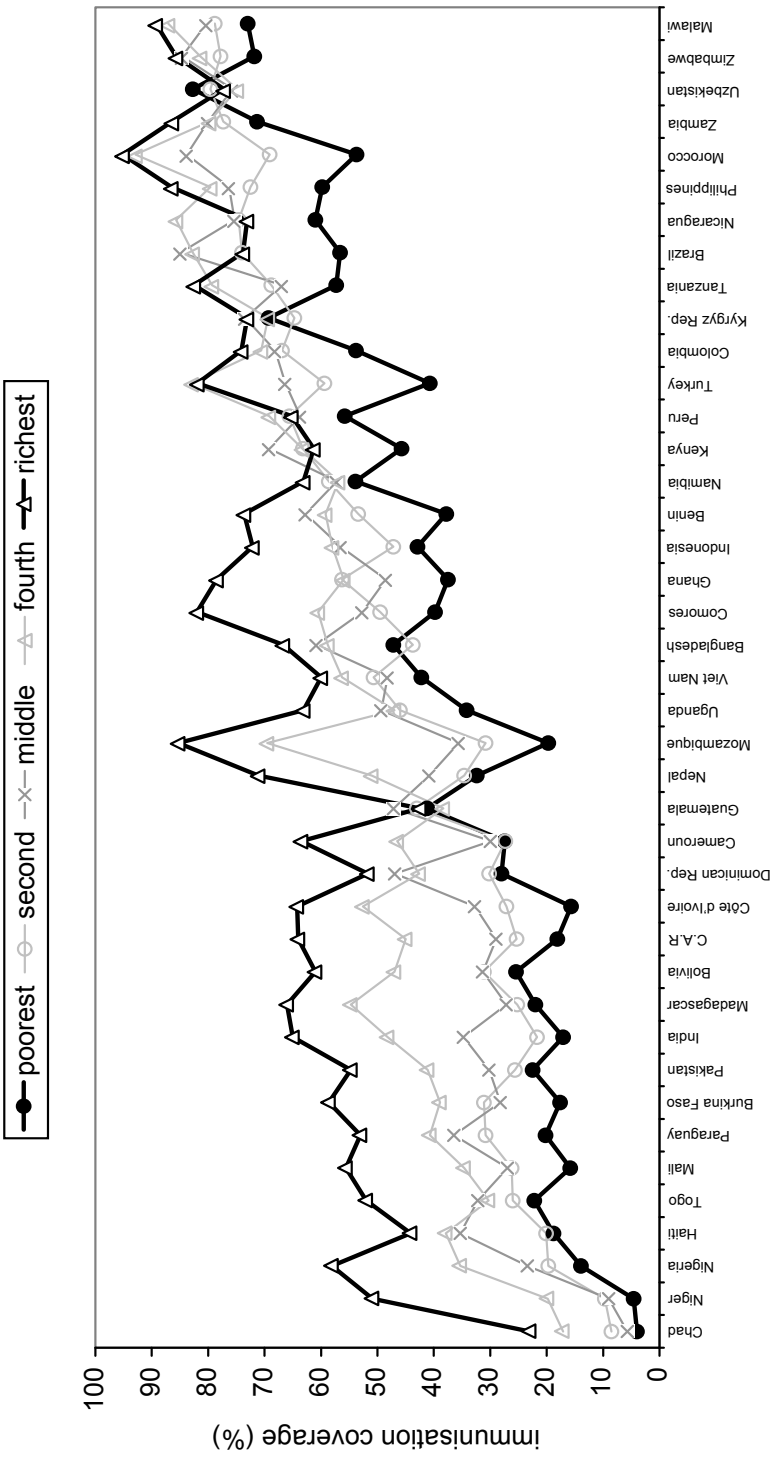
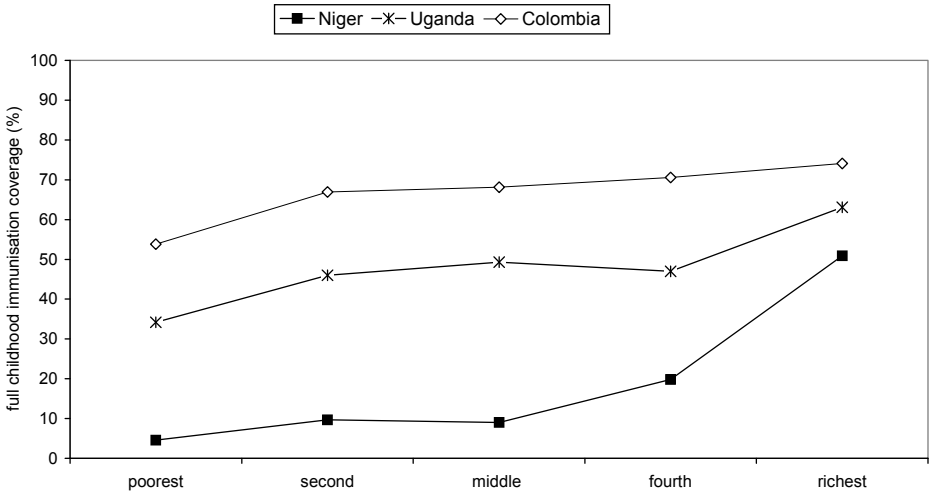


Figure A.11 Percentage of children aged 12-23 months with complete immunisation coverage, for five wealth quintiles, ranked by country average

Key message 2. Wealth and immunisation coverage are systematically associated across the entire wealth hierarchy.

Figure A.11 shows that for many countries, there is a systematic poor-rich gradient in immunisation coverage across the entire wealth hierarchy. Poor-rich disparities pervade the entire society, and not only affect the poorest children as compared to all other children. In many countries, however, disparities in immunisation coverage do not resemble a linear gradient, but have a less regular pattern emphasising the situation among specific groups. Some patterns are illustrated in Figure A.12. In countries with a low national coverage rate (*e.g.* Niger, Mali, Burkina Faso, India) there is a gap between the elite with relatively high immunisation rates and the rest of the population, where immunisation coverage is low. In a number of countries with intermediate national coverage rates (*e.g.* Uganda, Ghana, Benin, Comoros), the intermediate quintiles as a groups have shifted to a position halfway between the richest and the poorest. In many countries with a high national coverage rate (*e.g.* Brazil, Nicaragua, Philippines), the intermediate groups have joined the richest groups, leaving a gap between the poorest and the rest of the population. These different types of gradients imply that there are large variations between countries in the specific groups of that need to be targeted by immunisation policies and campaigns.

Figure A.12 Complete childhood immunisation coverage for five wealth quintiles for three exemplary countries



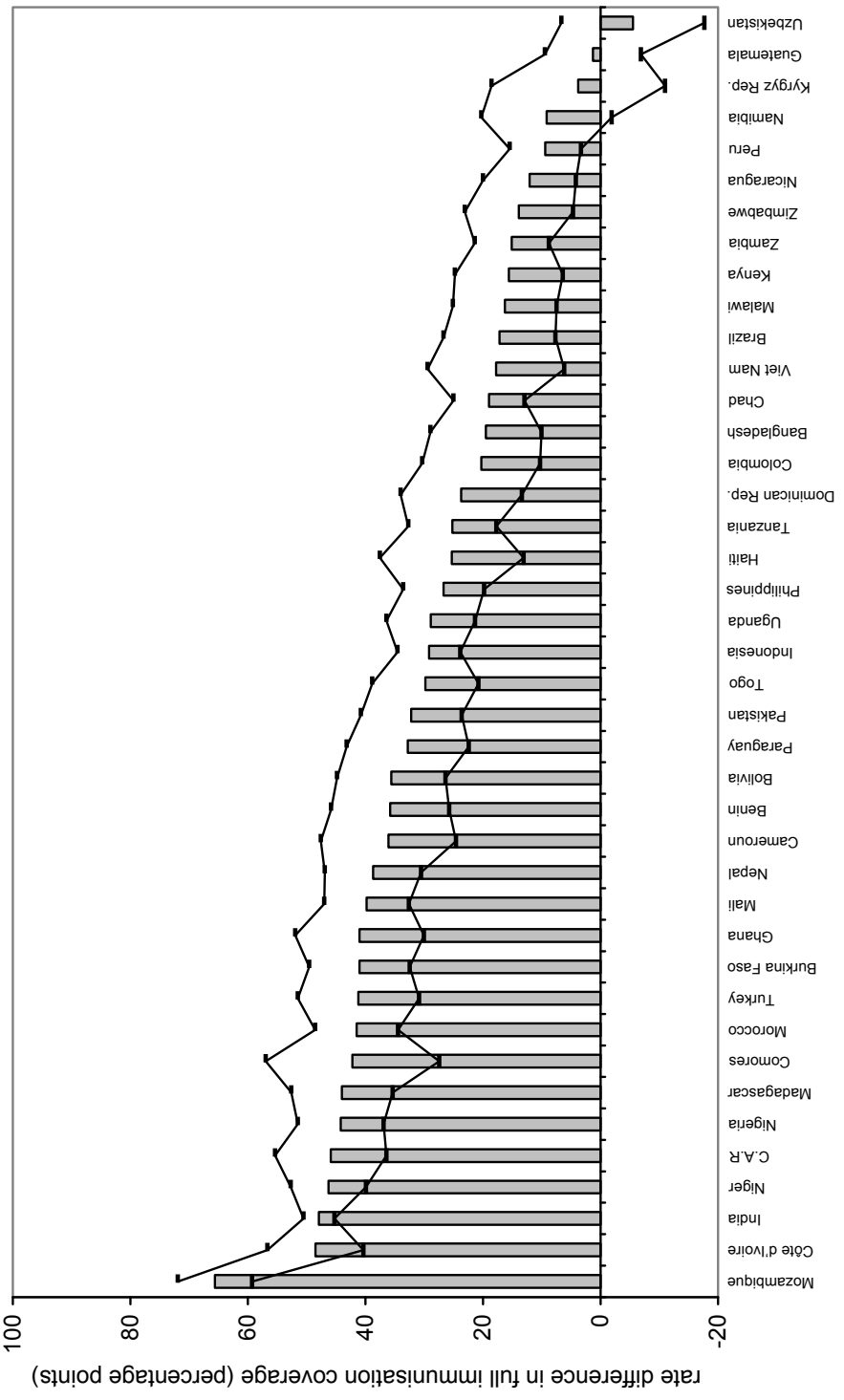


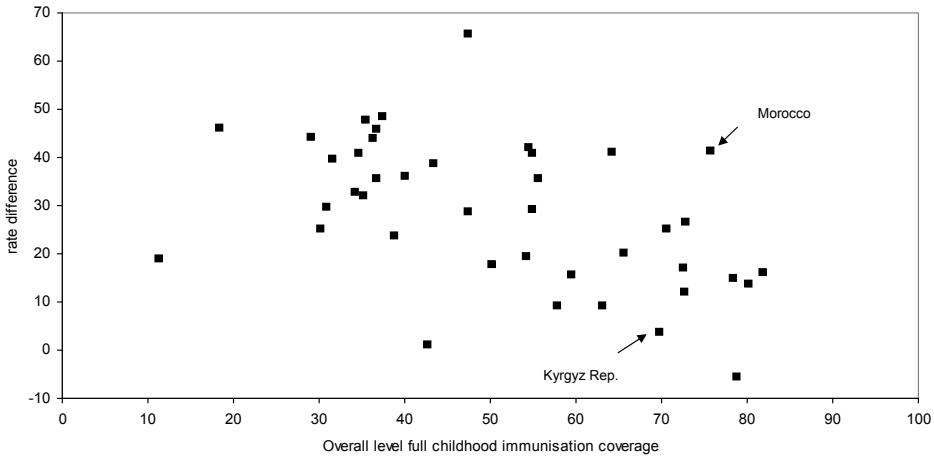
Figure A.13 Absolute inequalities (rate difference) in full childhood immunisation coverage between poorest 20% and richest 20% population group

Key message 3. Poor-rich inequalities in immunisation coverage are much larger in some countries than in others.

Figure A.13 shows that the largest absolute inequalities are observed in countries in Africa (*e.g.* Mozambique, Côte d'Ivoire, Niger) and in India. The absolute difference between the richest and the poorest wealth quintile in these countries is more than 40 percentage points. The smallest inequalities are observed in some of the Republics of Central Asia (Uzbekistan and Kyrgyz Republic), some countries in Sub-Saharan Africa (*e.g.* Namibia, Zimbabwe) and Latin America (Peru and Nicaragua). Absolute inequalities between the poorest and richest groups are less than 15 percentage points.

Figure A.14 shows that there are large variations even between countries with similar overall levels of immunisation coverage (see also Chapter 4 of this thesis). For example, Morocco and the Kyrgyz Republic have both high overall levels of immunisation (around 70 percent), but the absolute poor-rich inequalities are ten times as large in Morocco (40 percent) than in Kyrgyz Republic (4 percent).

Figure A.14 Absolute inequalities (rate difference) in full childhood immunisation coverage between poorest 20% and richest 20% population group by overall level in full childhood immunisation coverage



Key message 4. Eliminating poor-rich disparities in immunisation by raising the level of all groups up to the level of the richest would substantially improve the overall level.

Figure A.15 presents the Population Attributable Risk (absolute version), with the upper wealth quintile as the reference group. The potential gain in immunisation coverage would

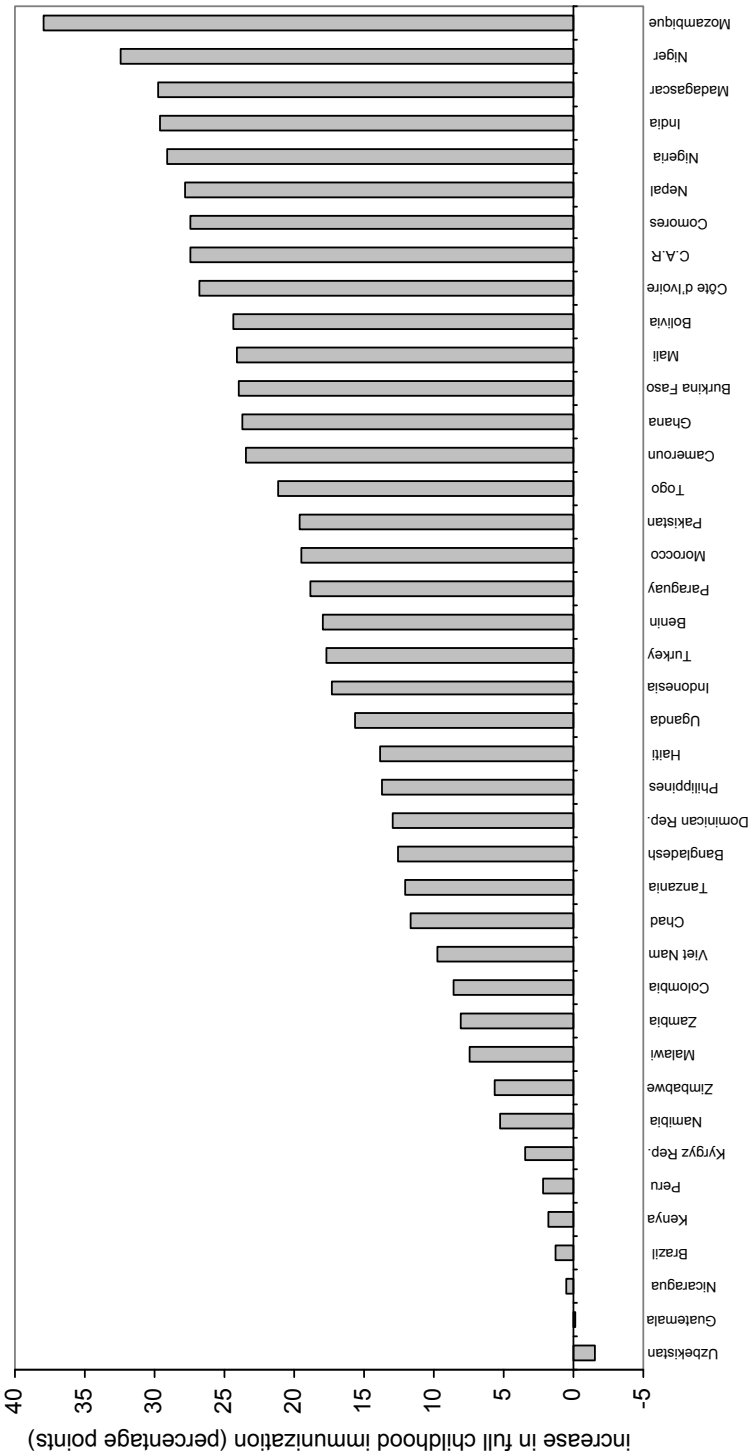


Figure A.15 Potential increase (in percentage points) in full childhood immunization by elimination of inequalities (if all had level of the richest 20%)

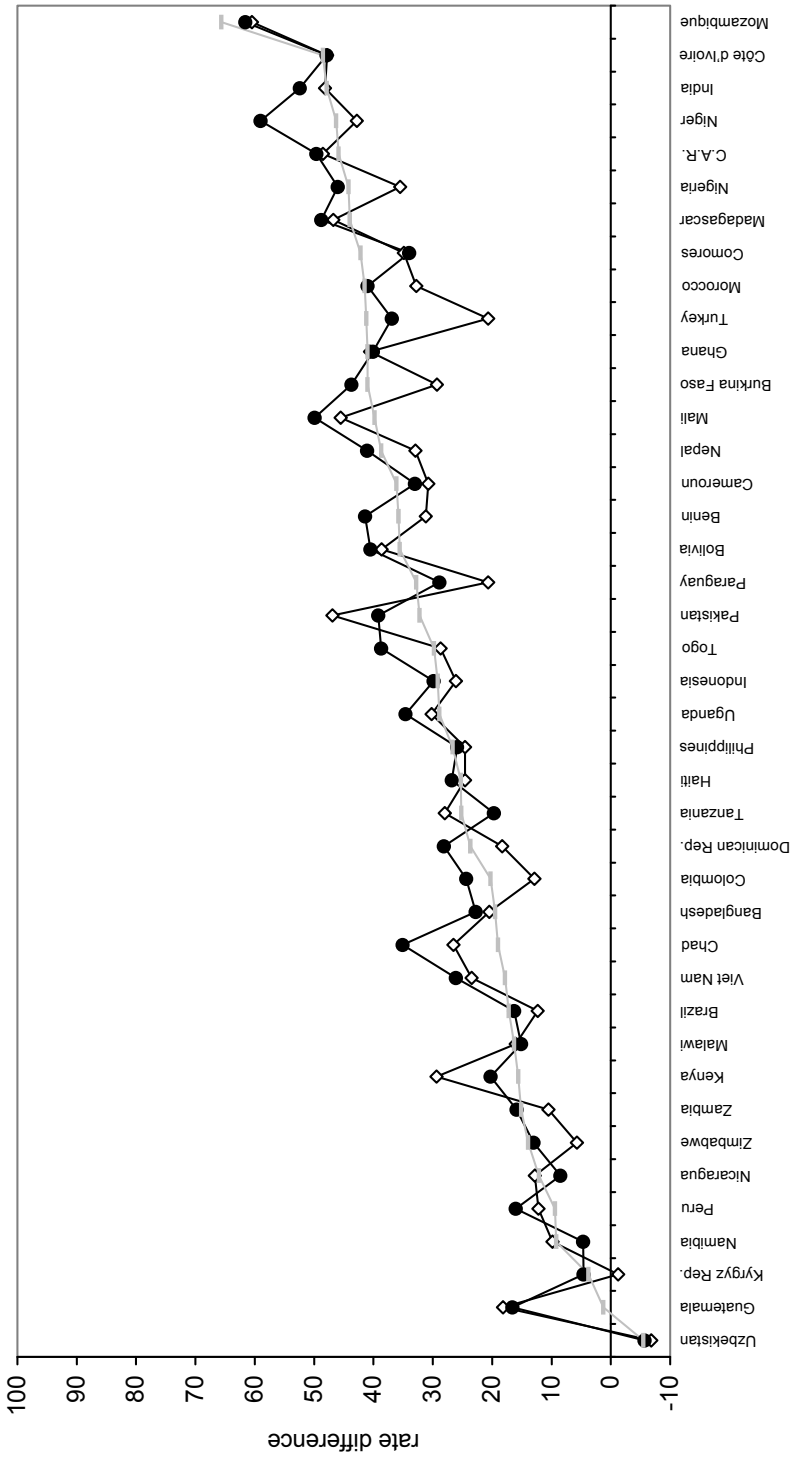


Figure A.16 Absolute inequalities (rate difference) between poorest 20% and richest 20% population group in coverage of immunisation against measles and against DTP and full childhood immunisation coverage respectively

be the greatest for some countries in Africa and Asia (Mozambique, Niger, Nigeria, Nepal). For these countries, the overall level of immunisation coverage would increase with around 20 percentage points. More than half of all countries would experience an improvement of at least 15 percentage points in the hypothetical situation that all inequalities would be eliminated. These estimates demonstrate the potentially large impact of tackling poor-rich inequalities.

Key message 5. Poor-rich disparities in immunisation against Measles and DTP are broadly the same as the disparities in overall coverage.

Figure A.16 shows that absolute inequalities between the poorest and the richest quintiles in coverage of immunisation against Measles and DTP are broadly comparable to those for complete immunisation. In general, inequalities in DPT3 are slightly larger than inequalities in Measles immunisation. The two major exceptions to this rule are Pakistan and Kenya, where poor-rich inequalities are especially large for Measles immunisation.

Antenatal care

This section describes inequalities in professional antenatal care, which is defined as the percentage of births in the three or five years (depending on the country) before the survey for which a woman received at least one antenatal care consultation from a medically trained person, defined as a doctor, nurse or nurse-midwife. In the last figure of this section, a further distinction is made between assistance by a doctor and by a nurse or nurse midwife. The results can be summarised in 5 key messages.

Key message 1. In virtually all countries there is a large gap between the rich and the poor in use of antenatal care

Figure A.17 shows that in all included countries, use of antenatal care as provided by a medically trained person is consistently higher among rich women compared to poor women. In Cameroon, for example, 99 percent of the women in the richest quintile made an antenatal care visit to a medically trained person, while only 53 percent of mothers in the poorest quintile did so. It is rare that in a country less than 85 percent of the richest women makes an antenatal care visit, as it is rare that more than 85 percent of the poorest women do so. In other words, rich women in nearly any country are better off than the

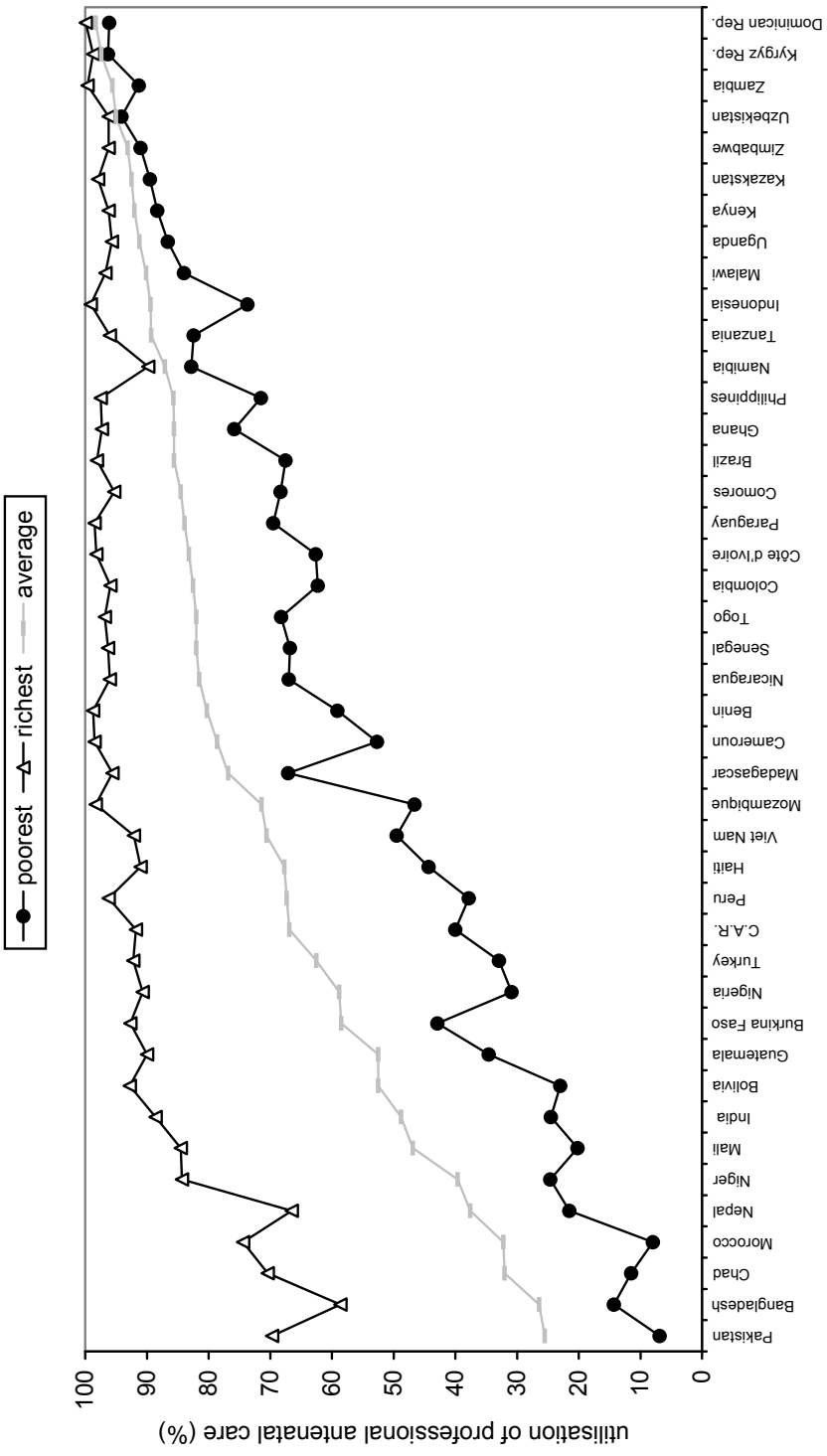


Figure A.17 Percentage of births for which a woman received at least one antenatal care consultation from a medically trained person, among the poorest 20% and richest 20% population gropu and the total population.

poorest women in whatever country. Poor-rich inequalities thus appear to be much larger than inter-country variations in overall levels of antenatal care.

Key message 2. Wealth and antenatal care use are systematically associated across the entire wealth hierarchy.

Figure A.18 shows that for virtually all countries, there is a systematic poor-rich gradient, across the entire wealth hierarchy, in the use of antenatal care. Poor-rich disparities pervade the entire society, and not only affect the poorest women as compared to all other women. In a few countries disparities in antenatal care do not exhibit a linear gradient but have a less regular pattern emphasising the situation among specific groups. In some of the countries with the lowest overall rates (*e.g.* Bangladesh, Pakistan, Chad, Niger) there is a gap between the elite with relatively high utilisation rates and the rest of the population among whom use of professional antenatal care is rare. A reverse pattern is observed in some of the countries with high overall rates. In Indonesia, Philippines and Brazil, utilisation rates are fairly high for all women except for the poorest. These different types of gradients imply that there are variations between countries in the specific groups of women that need to be targeted by maternal health programs.

Key message 3. Poor-rich inequalities in the utilisation of antenatal care are much larger in some countries than in others.

Figure A.19 shows that the largest absolute inequalities are observed in Bolivia, Morocco, Mali and India, where the difference between the richest and poorest quintile is more than about 65 percentage points. Virtually no inequalities are observed in Kyrgyz Republic, Uzbekistan, the Dominican Republic and Zimbabwe for the years under study. As shown in Chapter 4 of this thesis, these cross-national variations in the magnitude of poor-rich inequalities are strongly correlated with the overall rates of utilisation of antenatal care.

Key message 4. Eliminating poor-rich disparities in antenatal care utilisation by levelling-up would substantially improve the overall level

Figure A.20 presents the Population Attributable Risk (absolute version), with the upper wealth quintile as the reference group. The potential gain in antenatal care utilisation would be substantial in countries with low overall utilisation rates. For some of these countries (*e.g.* Niger, Pakistan, Morocco and Bolivia) the gain would be more than 35 percentage

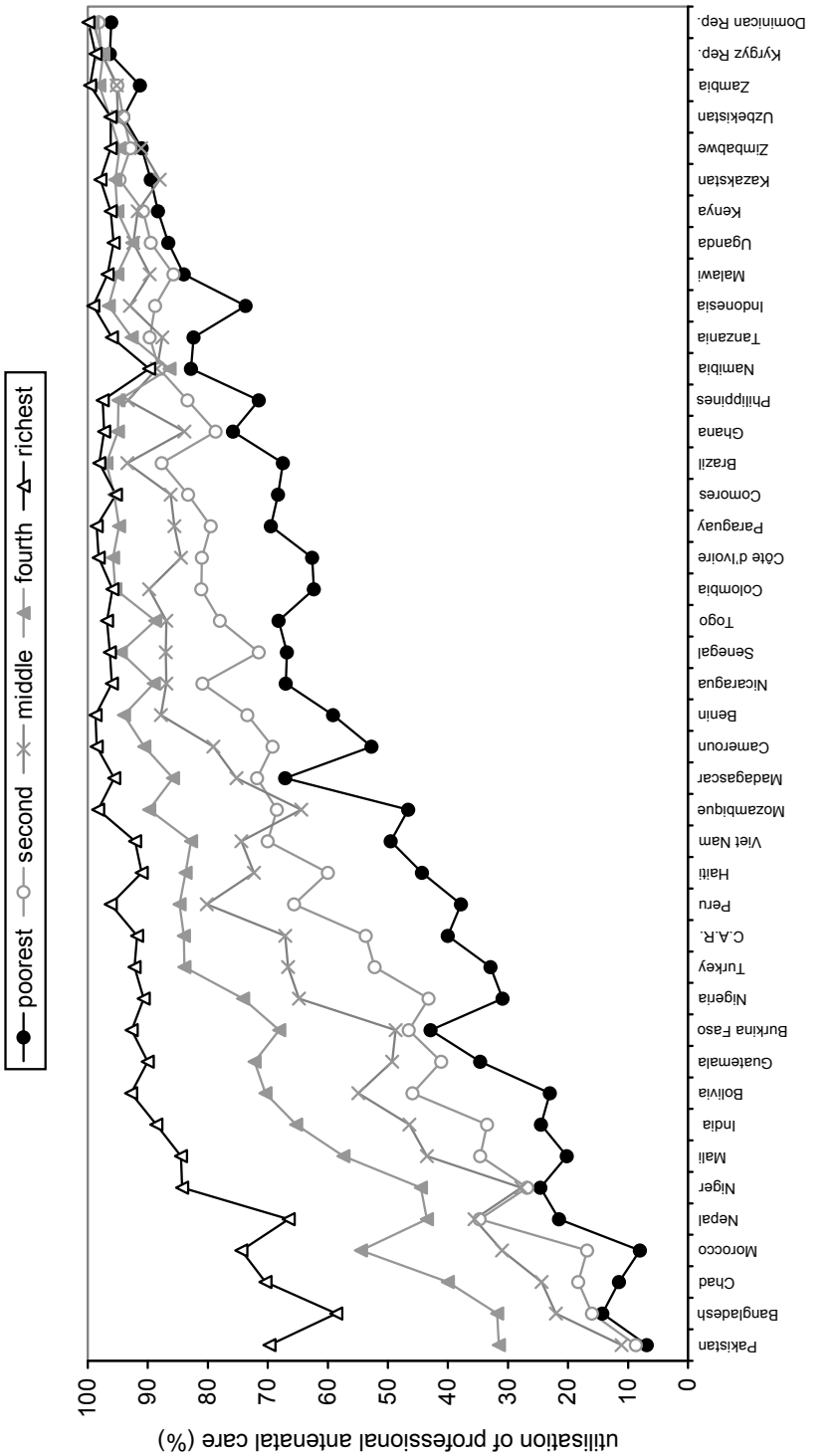


Figure A.18 Percentage of births for which a woman received at least one antenatal care consultation from a medically trained person, for five wealth quintiles

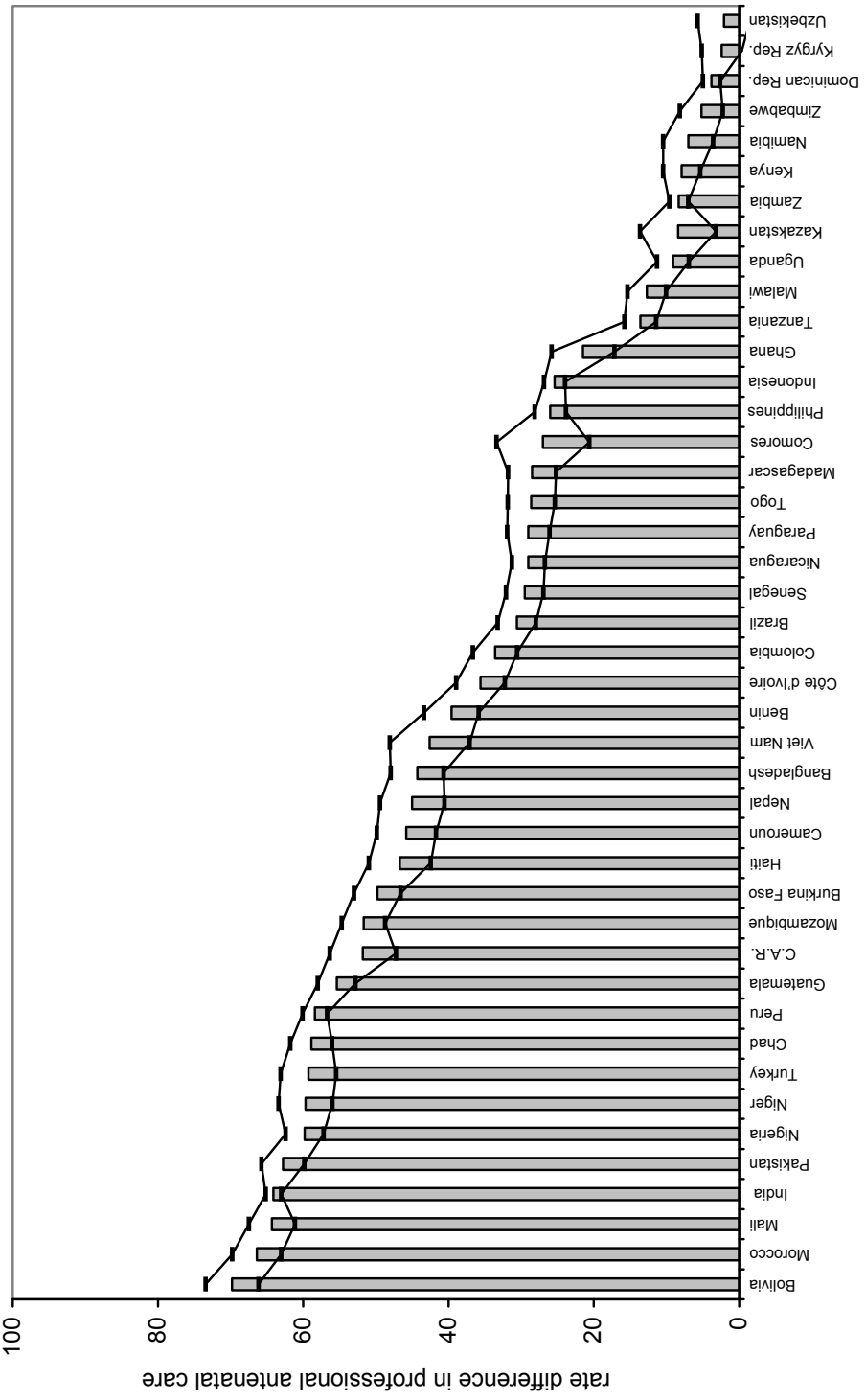


Figure A.19 Absolute inequalities (rate difference) in use of professional antenatal care between the richest 20% and poorest 20% population group

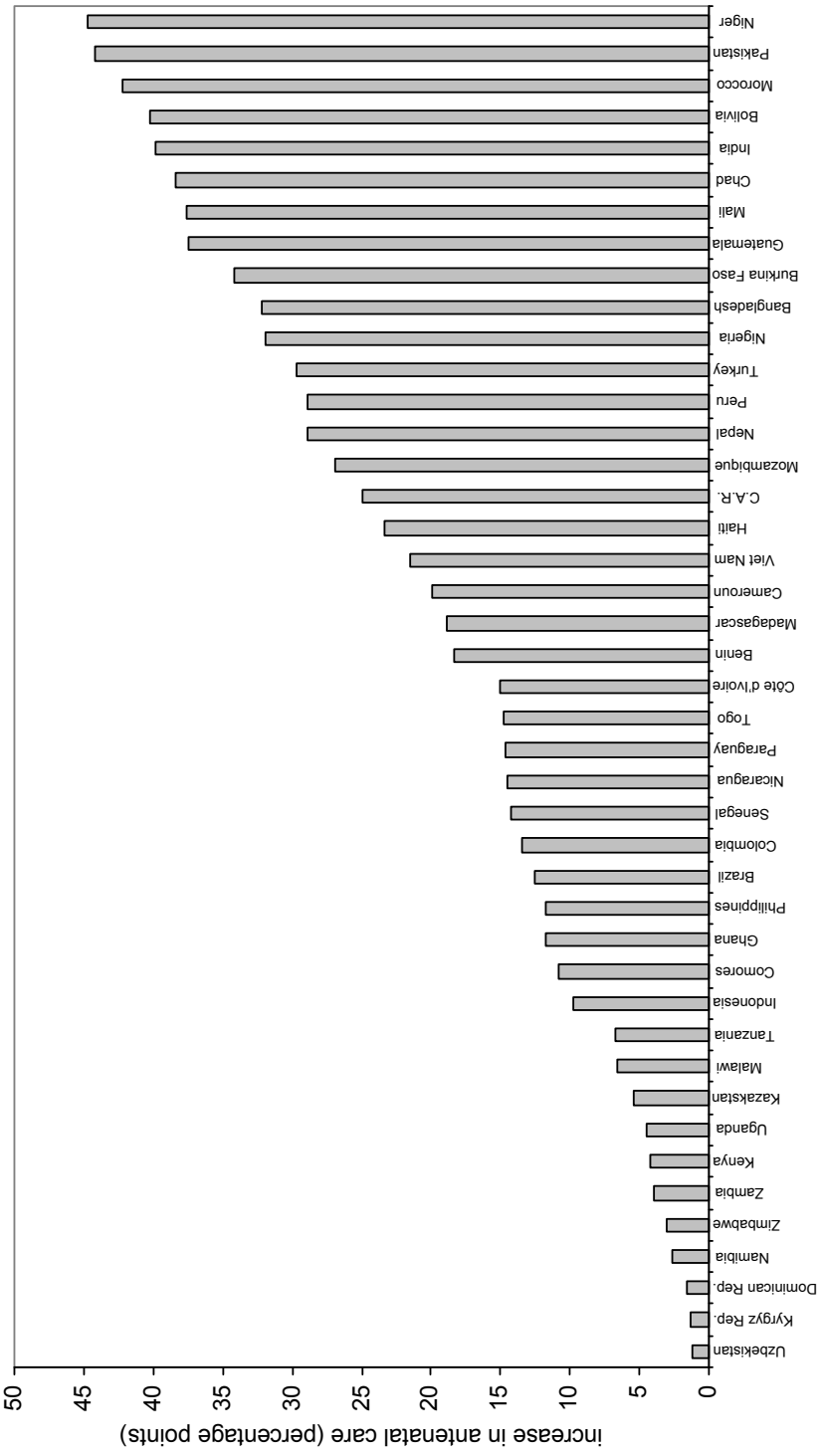


Figure A.20 Potential increase (in percentage points) in professional antenatal care by elimination of inequalities (if all had level of the richest 20%)

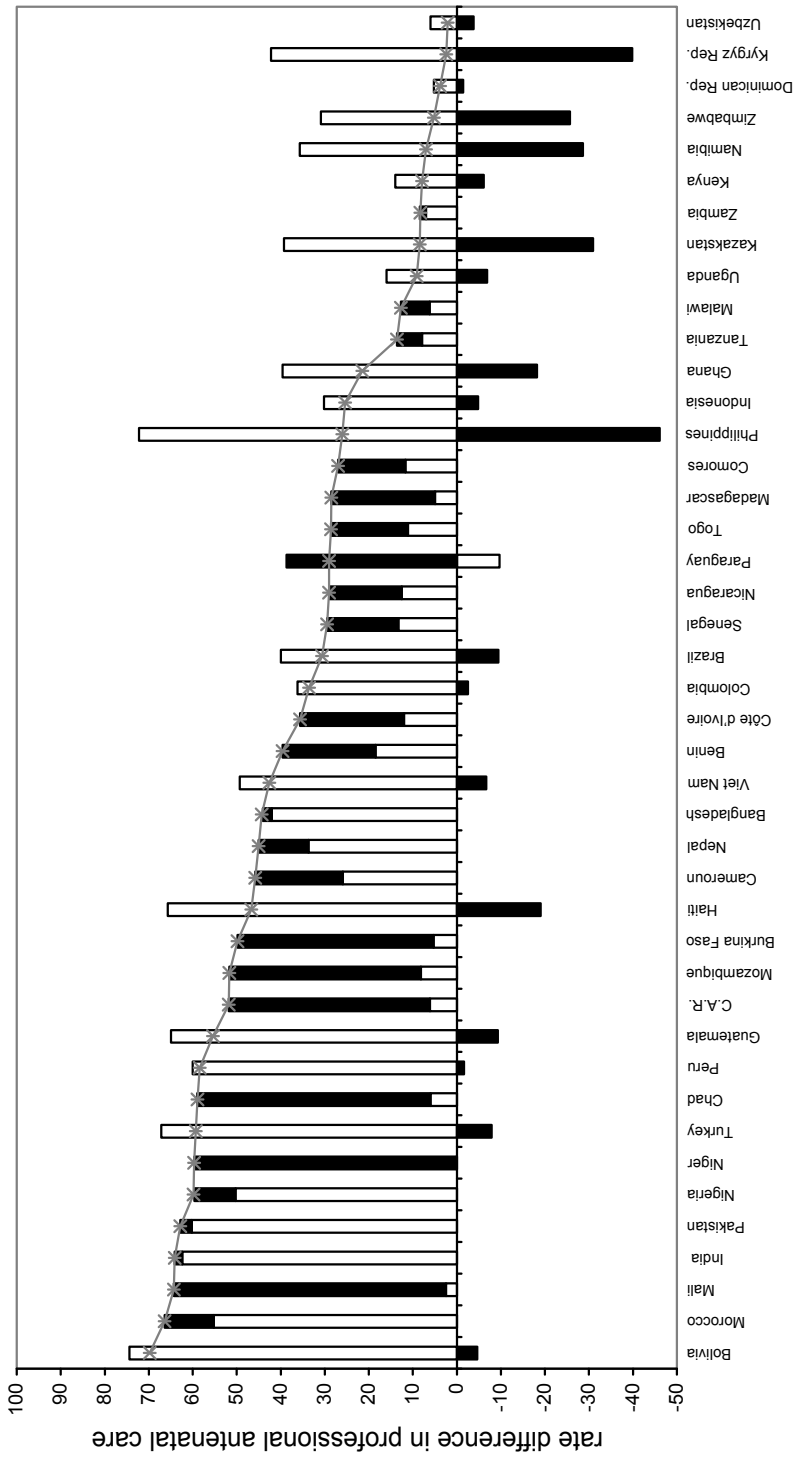


Figure A.21 Absolute inequalities (rate difference) in antenatal care provided by a doctor, nurse and medically trained person respectively between the poorest 20% and richest 20% population group

points. Half of the countries would experience an improvement in overall utilisation rates of at least 15 percentage points when the relative disadvantage of the poor would be eliminated. For those countries where overall levels of antenatal care utilisation is already high, the gain is modest. These hypothetical estimates show that for many countries, especially those with the lowest overall levels, the potential impact of tackling poor-rich inequalities in antenatal care utilisation is large.

Key message 5. Countries strongly differ in the extent to which inequalities in antenatal care visits to a medically trained person are due to inequalities in visits to a doctor.

Figure A.21 shows the extent to which poor-rich disparities in the utilisation of antenatal care services provided by a medically trained person (the level of which is indicated by the drawn line) are made up of inequalities in visits to either a doctor (the white bar) or a trained nurse (the black bar). For some countries, inequalities in the use of antenatal care are mostly due to inequalities in care provided by a nurse (*e.g.* Niger, Burkina Faso, Mali, Mozambique). In some other countries, inequalities in antenatal care provided by a doctor contribute most to poor-rich inequalities in antenatal care (*e.g.* India, Pakistan, Bangladesh, Nigeria). In a number of countries, inequalities in the use antenatal care is the sum of large inequalities in attendance by a doctor, which are compensated for by inverse poor-rich inequalities in delivery attendance by a nurse (*e.g.* Philippines, Kazakhstan, Kyrgyz Republic, Namibia). In these countries, rich women seek care by a doctor while poor women go to a nurse.

Professional delivery care

This section describes inequalities in professional delivery care, which is defined as the percentage of births in the three or five years (depending on the country) prior to the survey that were attended to by a medically trained person, defined as a doctor, nurse or nurse-midwife. In the last two figures of this section, a further distinction is made between assistance by a doctor and by a nurse. The results can be summarised in 6 key messages.

Key message 1. In virtually all countries there is a huge gap between the rich and the poor in rates of delivery care by a medically trained person

Figure A.22 shows that in all included countries, rates of delivery attendance by a medically trained person are consistently higher among the rich than among the poor. In Zambia and

Indonesia, for example, around 90 percent of the mothers in the richest group delivered with the attendance of a professional, while only around 20 percent of the mothers in the poorest group did so. It is rare that in a country less than 70 percent of the richest women uses professional delivery care, as it is rare that more than 70 percent of the poorest do so. In other words, rich women in nearly any country are better off than the poorest women in whatever country. Poor-rich inequalities are obviously much larger than inter-country variations in overall levels of delivery attendance.

Key message 2. Wealth and delivery attendance by a medically trained person are systematically associated across the entire wealth hierarchy.

Figure A.23 shows that there is a systematic poor-rich gradient in professional delivery attendance across the entire wealth hierarchy. Poor-rich disparities pervade the entire society, and not only affect the poorest women as compared to all other women. In some countries, however, disparities in delivery do not exhibit a linear gradient but have a less regular pattern emphasising the situation among specific groups. In countries with the lowest national rates (*e.g.* Bangladesh, Nepal, Chad, Niger) there is a gap between the elite with relatively high attendance rates and the rest of the population, where delivery attendance by professionals is rare. A reverse pattern is observed in some of the countries with high overall rates. In Turkey, Vietnam, Colombia and Brazil, attendance rates are fairly high for all women except for the poorest. These different types of gradients imply that there are large variations between countries in the specific groups of women that need to be targeted by maternal health programs.

Key message 3. Poor-rich inequalities in delivery attendance by a medically trained person are much larger in some countries than in others.

Figure A.24 shows that the largest absolute inequalities are observed in three Latin American countries (Bolivia, Peru, Guatemala), where the difference between the richest and poorest quintile is more than 80 percentage points. This means that deliveries among nearly all rich women but almost no poor women were attended by a professional. Virtually no inequalities are observed in the ex-Soviet Republics (Kazakhstan, Kyrgyz Republic, Uzbekistan) and the Dominican Republic for the years under study.

Figure A.25 shows that there are large variations even between countries with similar overall levels of delivery attendance (see also Chapter 4 of this thesis). For example, Guatemala

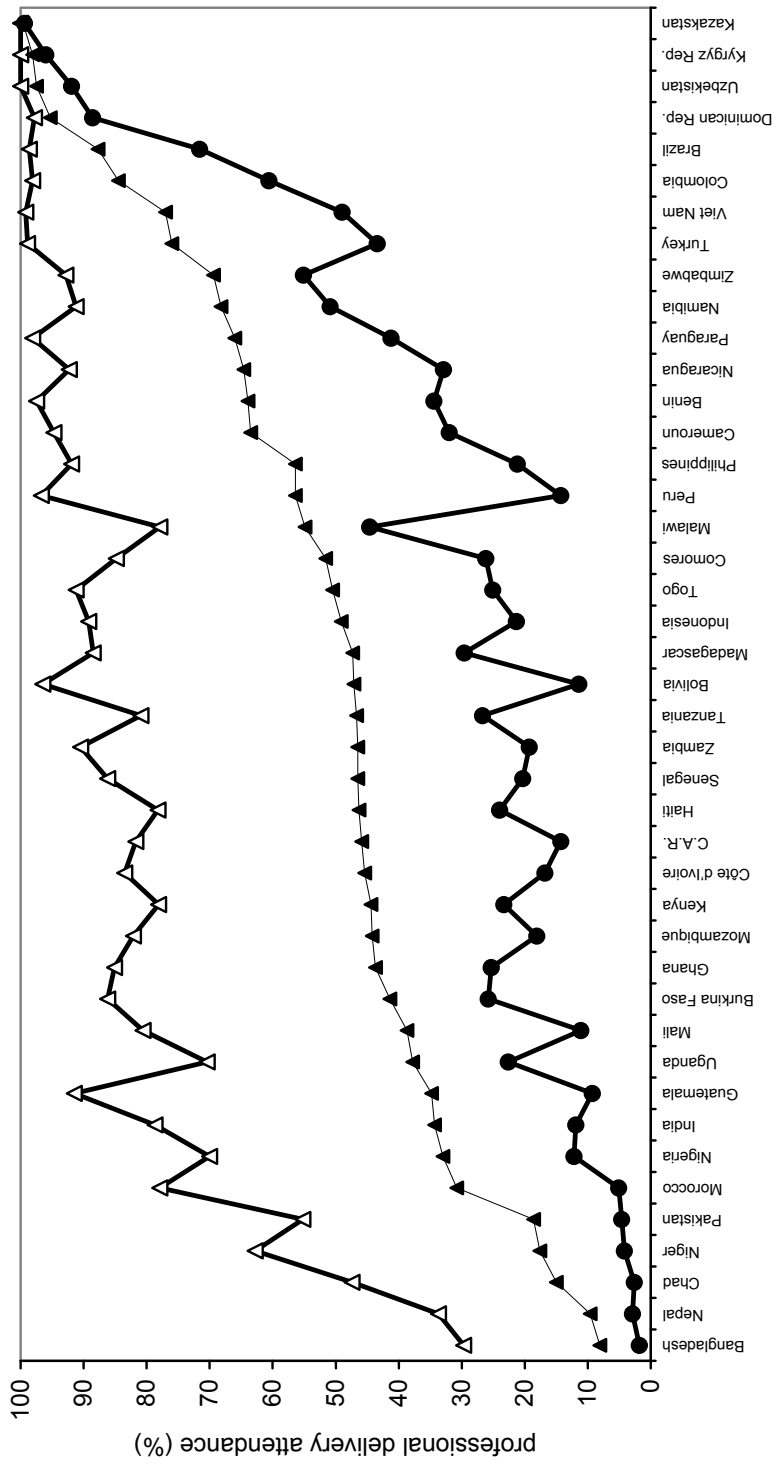


Figure A.22 Percentage of births that was attended by a medically trained person, among the poorest 20% and richest 20% population group and the total population

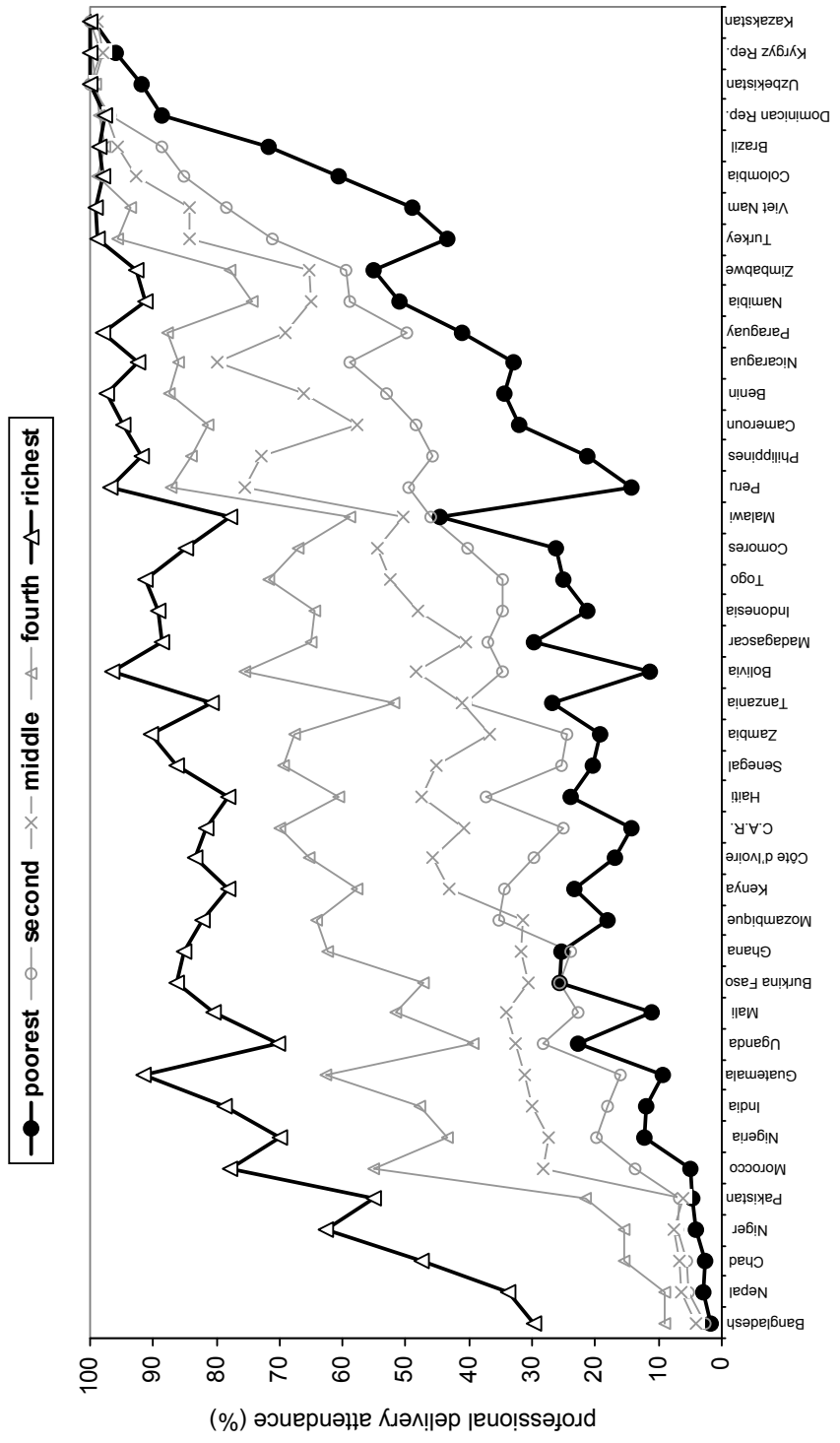


Figure A.23 Percentage of births that was attended by a medically trained person, for five wealth quintiles

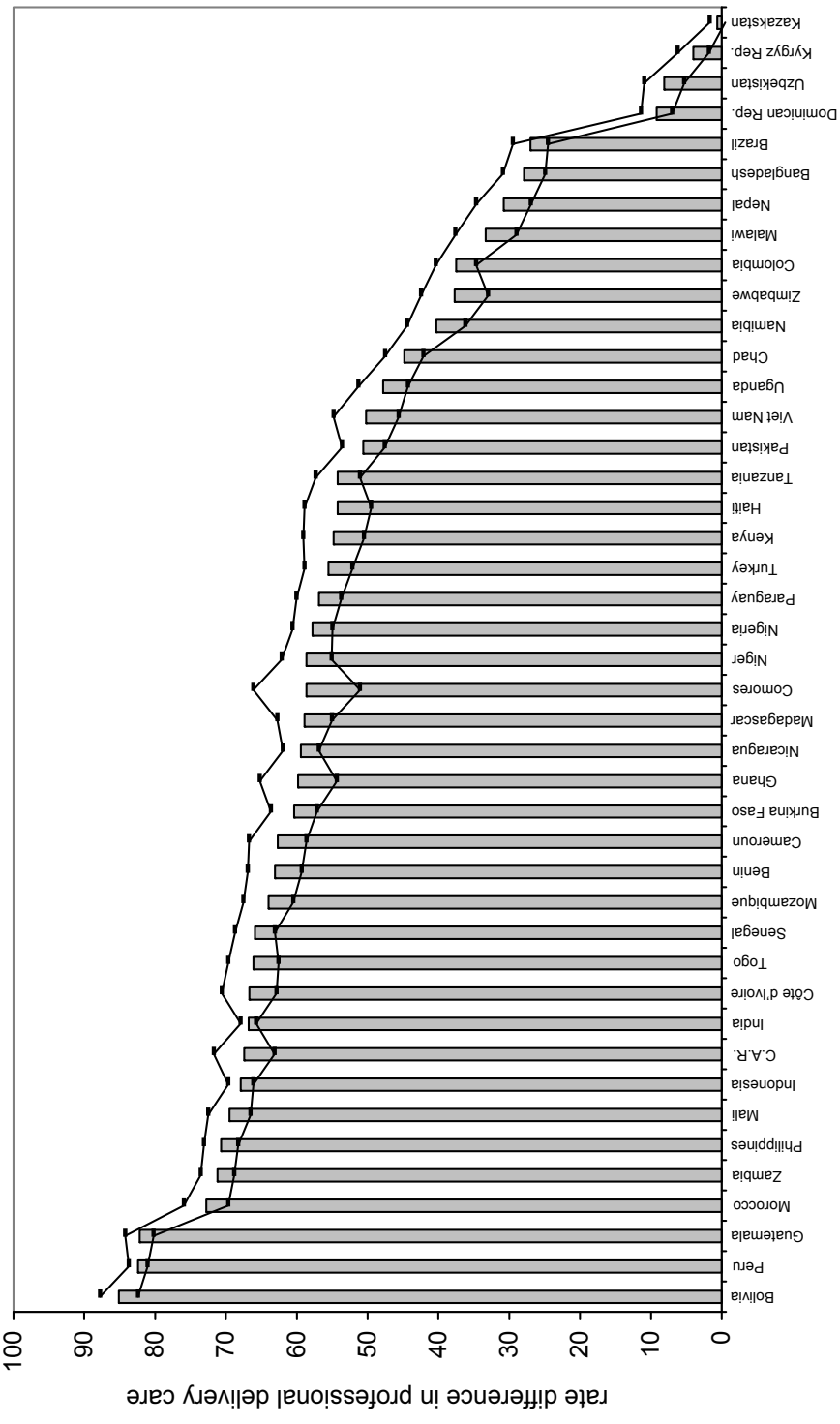
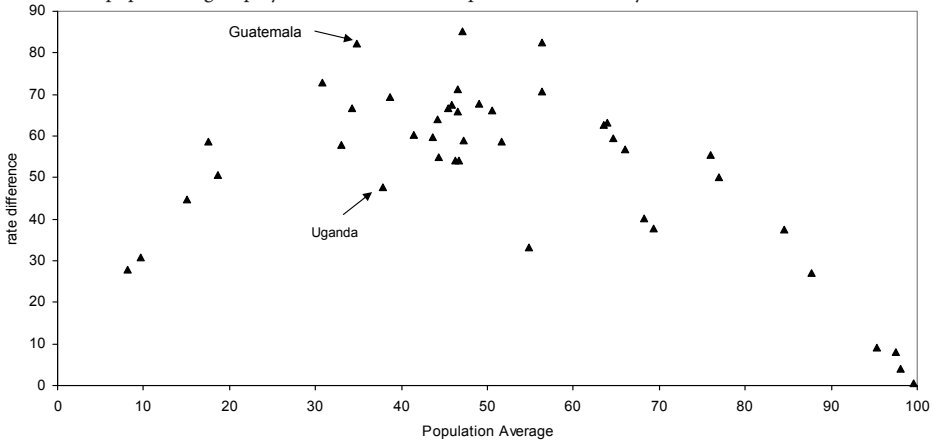


Figure A.24 Absolute inequalities (rate difference) in use of professional delivery care between the richest 20% and poorest 20% population group

and Uganda have similar overall attendance rates (around 35 percent), while poor-rich disparities in Guatemala are almost twice as large as in Uganda.

Figure A.25 Absolute inequalities (rate difference) in professional delivery care between poorest 20% and richest 20% population group by overall level in use of professional delivery care



Key message 4. Eliminating poor-rich disparities in delivery attendance by levelling-up would substantially improve the overall level

Figure A.26 presents the Population Attributable Risk, with the upper wealth quintile as reference group. The potential gain in overall delivery attendance would be substantial in nearly all countries, except for the four countries with almost 100 percent average attendance rates. For some countries (*e.g.* Guatemala, Bolivia, Morocco, Niger, Burkina Faso and India), the overall delivery attendance rates would increase with more than 40 percentage points. Half of the countries would experience an improvement in overall attendance rates of at least 35 percentage points when eliminating inequalities. These hypothetical estimates demonstrate the large impact that poor-rich inequalities do have on observed overall rates of delivery attendance, as well as the large potential of improvement to be gained by addressing the situation of the poor.

Key message 5. Wealth rather than need determines delivery attendance by a doctor

Figure A.27 shows rates of delivery attendance by a doctor. Assuming that at least 15 percent of all women need emergency obstetric care attended by a doctor, the data show that at least two thirds of the countries included fall short of this level. Even more importantly, for virtually all countries, rates of attendance for the poorest women are very low and much

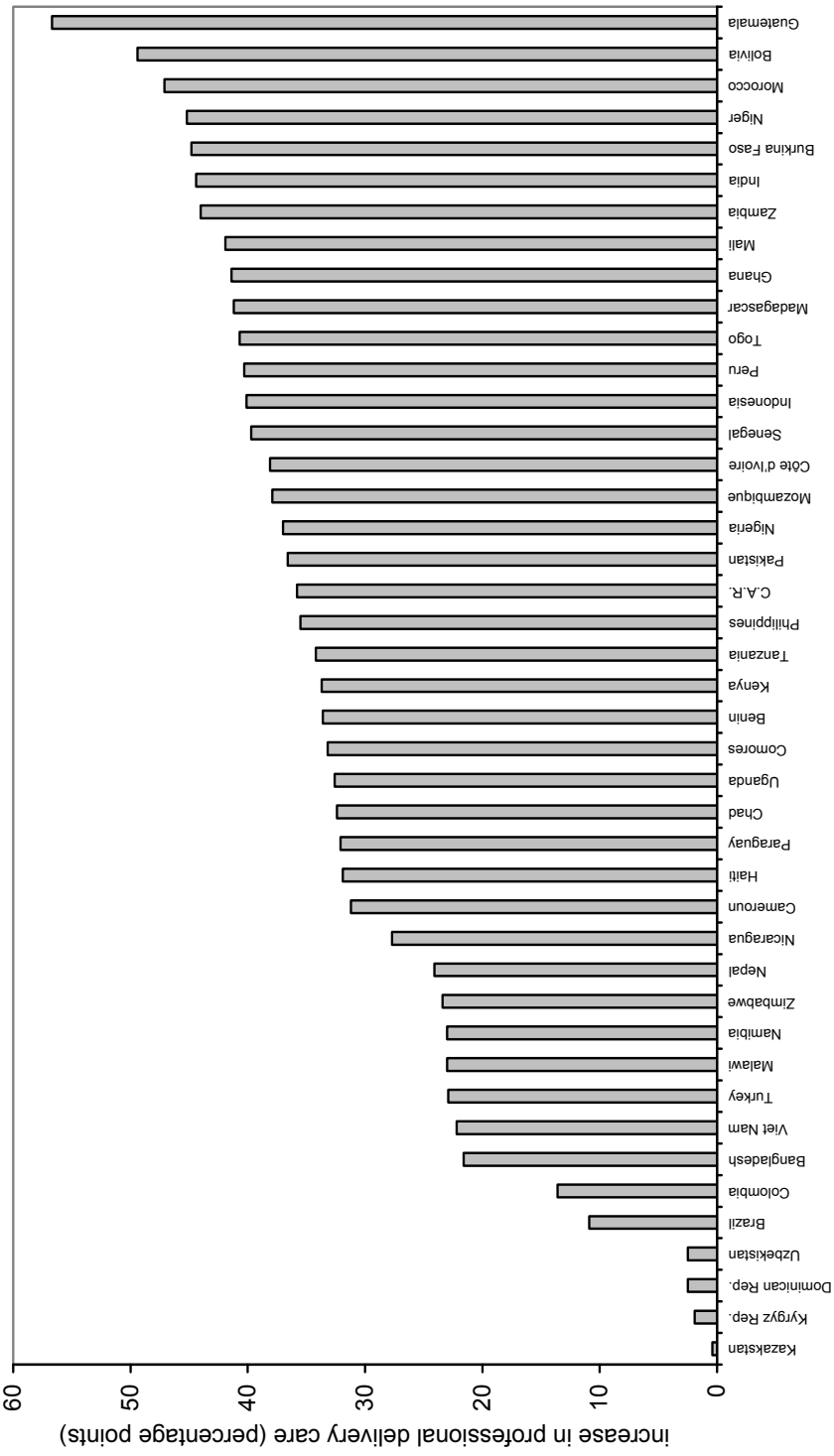


Figure A.26 Potential increase (in percentage points) in professional delivery care by elimination of inequalities (if all had level of the richest 20%)

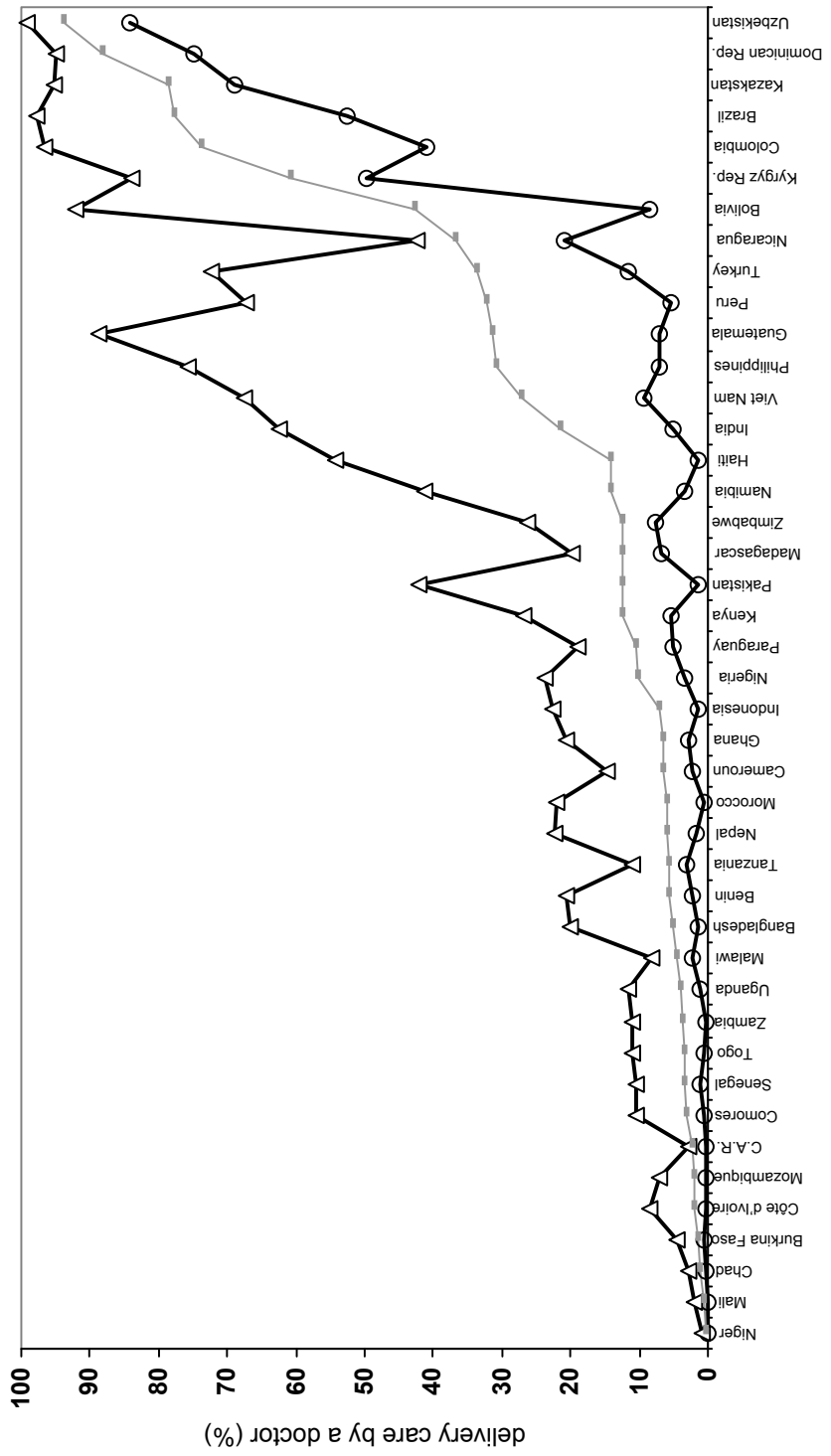


Figure A.27 Percentage of births that was attended by doctor, among the poorest 20% and richest 20% population group and the total population

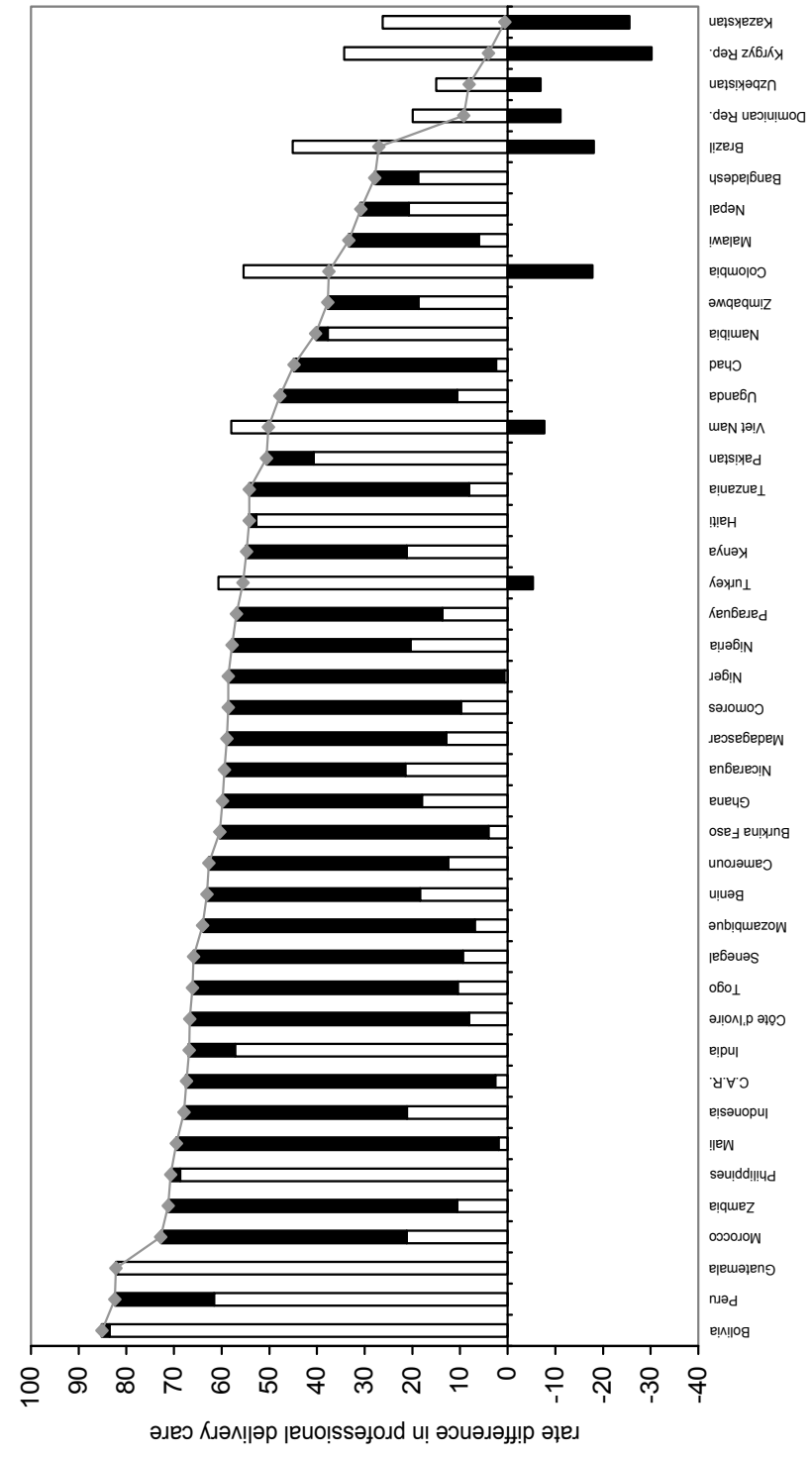


Figure A.28 Rate difference (RD) in delivery attendance by a doctor, and by a nurse respectively between the poorest 20% and richest 20% population group. The rate difference in attendance by a medically trained person (MTP) is the sum of the RD nurse and RD doctor.

below the attendance rates for the richest women. Even in countries where the overall level of attendance by a doctor is over 15 percent, the poorest women are attended much less, even though is it likely that precisely these women are most in need of emergency obstetric care.

Key message 6. Countries strongly differ in the extent to which inequalities in attendance by a MTP are due to inequalities in attendance by a doctor.

Figure A.28 shows the extent to which poor-rich disparities in attended deliveries (the level of which is indicated by the drawn line) are made up of inequalities attendance by doctors (the white bar) and by trained nurses (the black bar). For many countries, inequalities in attended deliveries are mostly due to inequalities in attendance by a nurse (*e.g.* Niger, Burkina Faso, CAR, Mali, Chad). In some other countries, inequalities in attendance by a doctor contribute most to poor-rich inequalities in attended deliveries (*e.g.* Bolivia, Morocco, Philippines, India, Haiti, Pakistan, Namibia). In a some other countries, inequalities in delivery attendance are the sum of large inequalities in attendance by a doctor, which are compensated by inverse poor-rich inequalities in delivery attendance by a nurse (*e.g.* Central Asian Republics, Vietnam, Dominican Republic, Brazil, Colombia, Turkey). In these countries, rich women more often deliver in attendance of a doctor while poor women more often are attended by a trained nurse.

INTERNATIONAL OVERVIEW OF SOCIO-ECONOMIC INEQUALITIES IN SOME OTHER PROXIMATE DETERMINANTS

Not only health care use, but also childhood malnutrition and total fertility rate are important determinants of under-5 mortality. This section presents international overviews of poor rich inequalities in these two latter proximate determinants.

Childhood malnutrition

This section describes inequalities in chronic childhood malnutrition, or stunting, which is defined as the percentage of children between three to five years old (depending on the country) whose height measurement is more than two standard deviations below the median reference standard for their age. The results can be summarised in three key messages.

Key message 1. In virtually all countries, chronic childhood malnutrition is considerably higher among the poorest than among the richest population group.

Figure A.29 shows that in virtually all the countries, chronic childhood malnutrition is higher among the poorest children compared to the richest children. In many countries, the malnutrition rates among the poor exceed by far the rates among the richest.

Key message 2. Wealth and chronic childhood malnutrition are systematically associated across the entire wealth hierarchy.

Figure A.30 shows that in general, an association between wealth and chronic childhood malnutrition is observed across the entire wealth hierarchy. Malnutrition rates are lower among each subsequent richer group. Poor-rich disparities in malnutrition pervade the entire society, and not only affect the poorest children as compared to all other children.

Key message 3. Poor-rich inequalities in chronic childhood malnutrition are larger in some countries than in others.

Figure A.31 shows that in many countries, inequalities in chronic childhood malnutrition vary between 20 and 30 percentage points. In a few countries, the absolute inequalities are lower than 10 percentage points (Madagascar, Uzbekistan, Niger), and in a few countries, these inequalities are over 40 percentage points (Guatemala, Peru). Variations between countries in the magnitude of absolute inequality in chronic childhood malnutrition seem smaller than international variations in the other indicators described in this Annex.

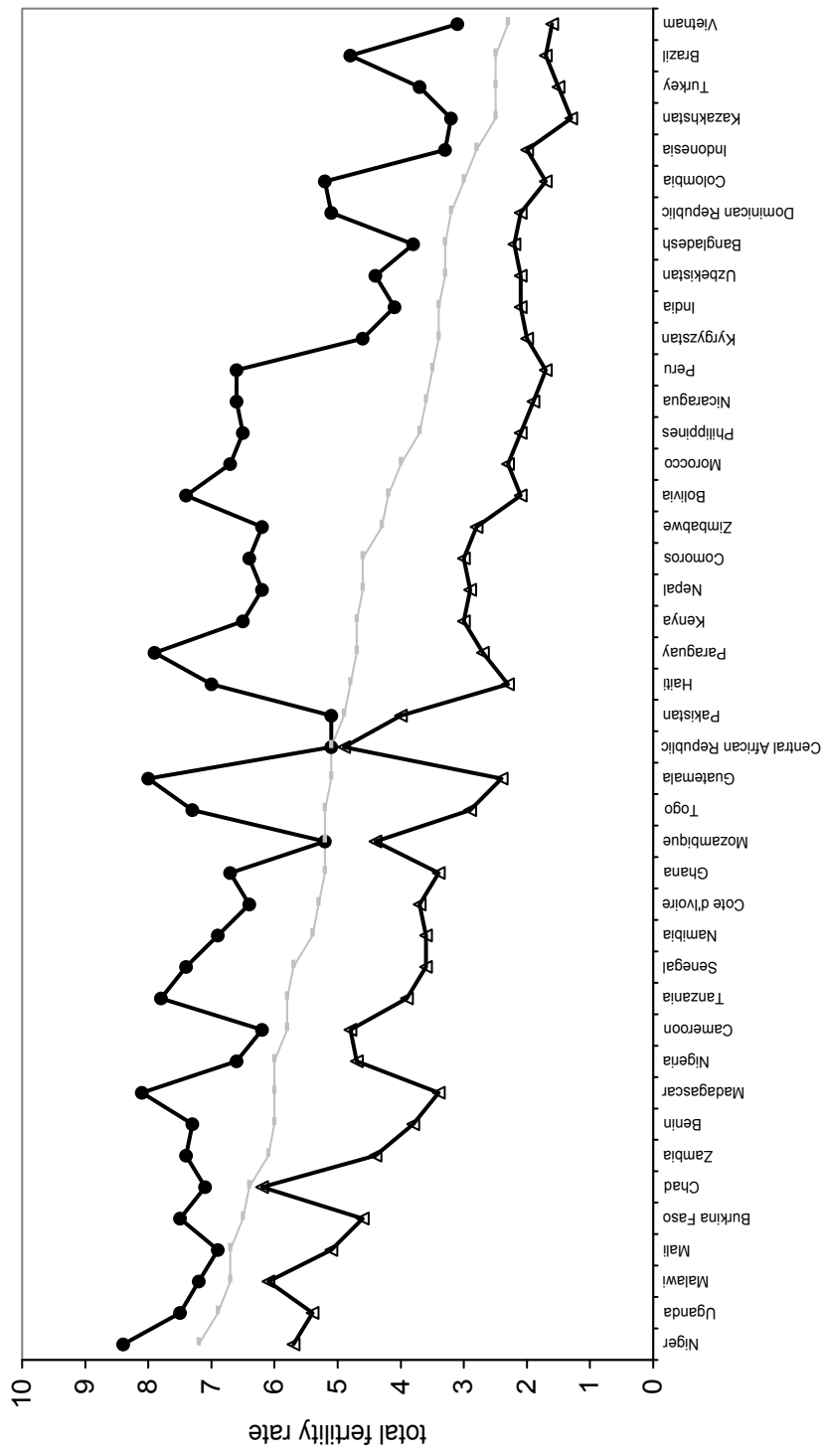


Figure A.29 Percentage of children that is chronically malnourished, among the poorest 20% and richest 20% population group, and among the total population

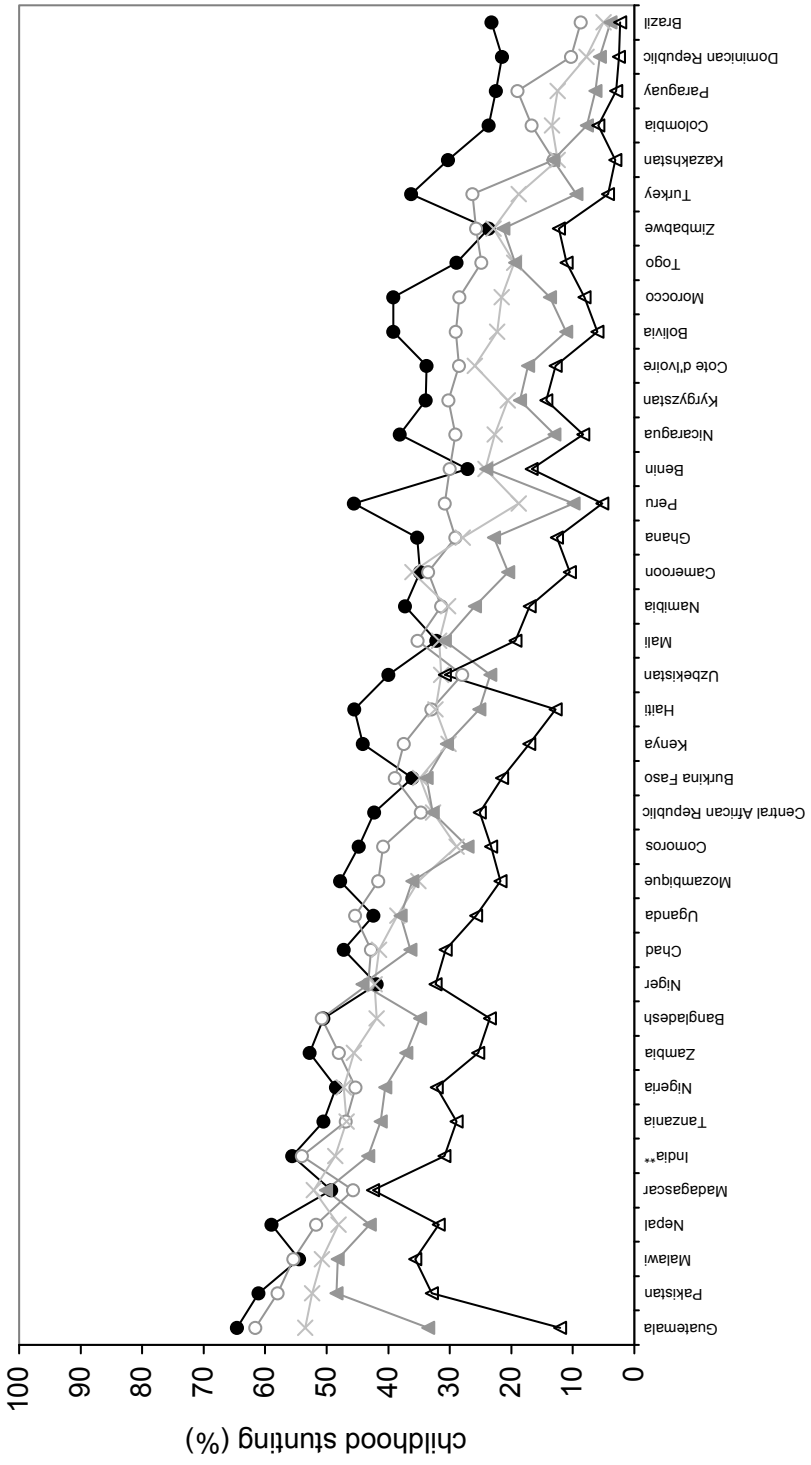


Figure A.30 Percentage of children that is chronically malnourished, among five wealth quintiles

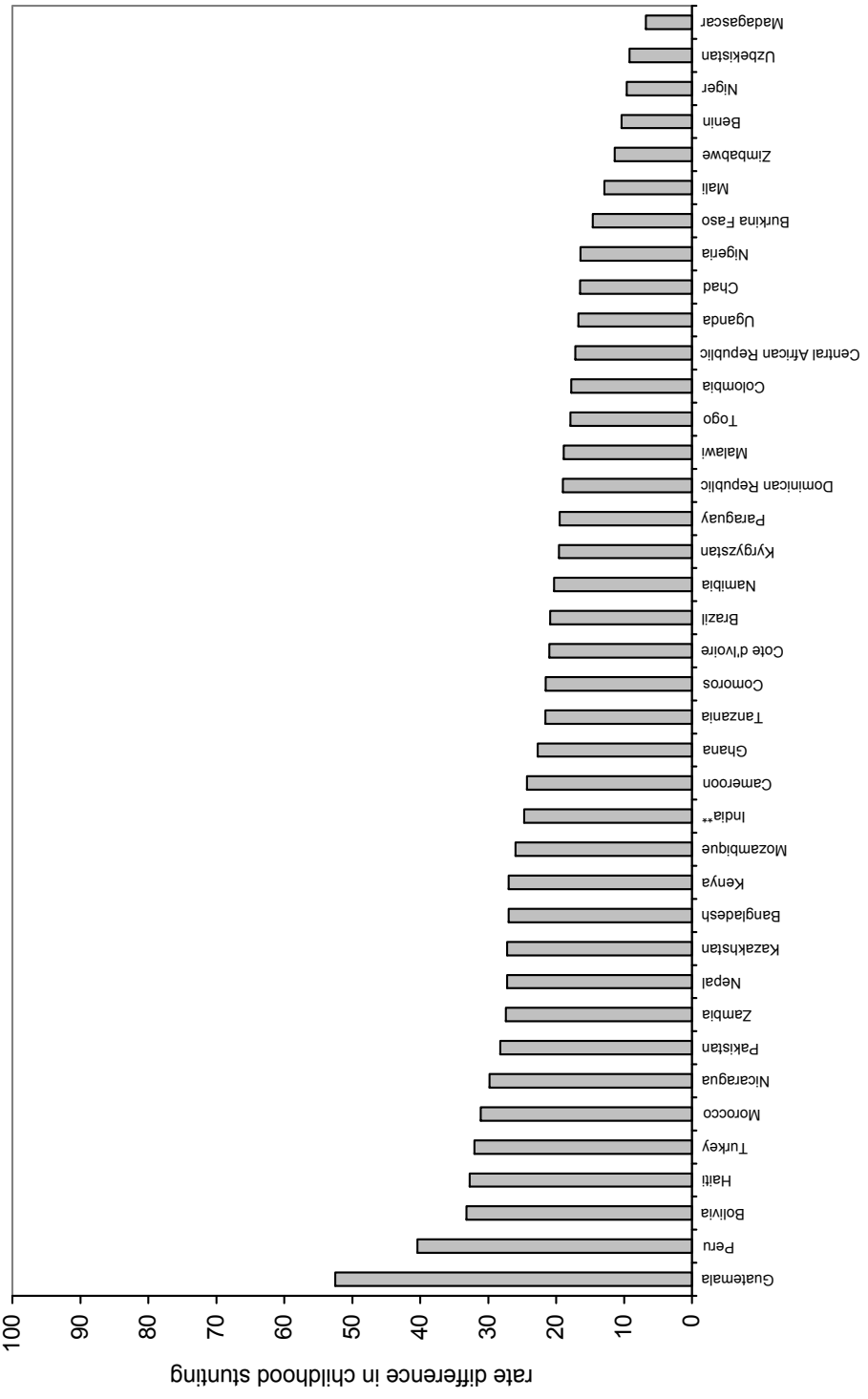


Figure A.31 Absolute inequalities (rate difference) in chronic childhood malnutrition between the poorest 20% and richest 20% population group

Total fertility rate

This section describes inequalities in total fertility rate, or the average number of births a woman could expect to have during her lifetime if she followed observed levels of fertility for her age group at every age. The results can be summarised in three key messages.

Key message 1. In virtually all countries, the total fertility rate is considerably higher among the poorest than among the richest population group.

Figure A.32 shows that in virtually all the countries, the total fertility rate is (much) higher among the poorest women compared to the richest women. Whereas in two third of the countries, poor women have a total fertility rate of 6 children, this is found among the rich in only two countries. Whereas in over two-third of the countries, rich women have a total fertility rate below 4 children, this is found among the poor in only five countries.

Key message 2. Wealth and total fertility rate are systematically associated across the entire wealth hierarchy.

Figure A.33 shows that in general, an association between wealth and total fertility rate is observed across the entire wealth hierarchy. The total fertility rate is systematically higher among each subsequent poorer wealth group. Poor-rich disparities in total fertility pervade the entire society.

Key message 3. Poor-rich inequalities in chronic childhood malnutrition are larger in some countries than in others.

Figure A.34 shows that the largest absolute inequalities are observed in three Latin American countries (Guatemala, Bolivia and Paraguay), where the difference between the poorest and the richest is more than five births. Smallest absolute inequalities are found in three African countries (Central African Republic, Mozambique and Chad), where the difference between he poorest and richest is less than one birth.

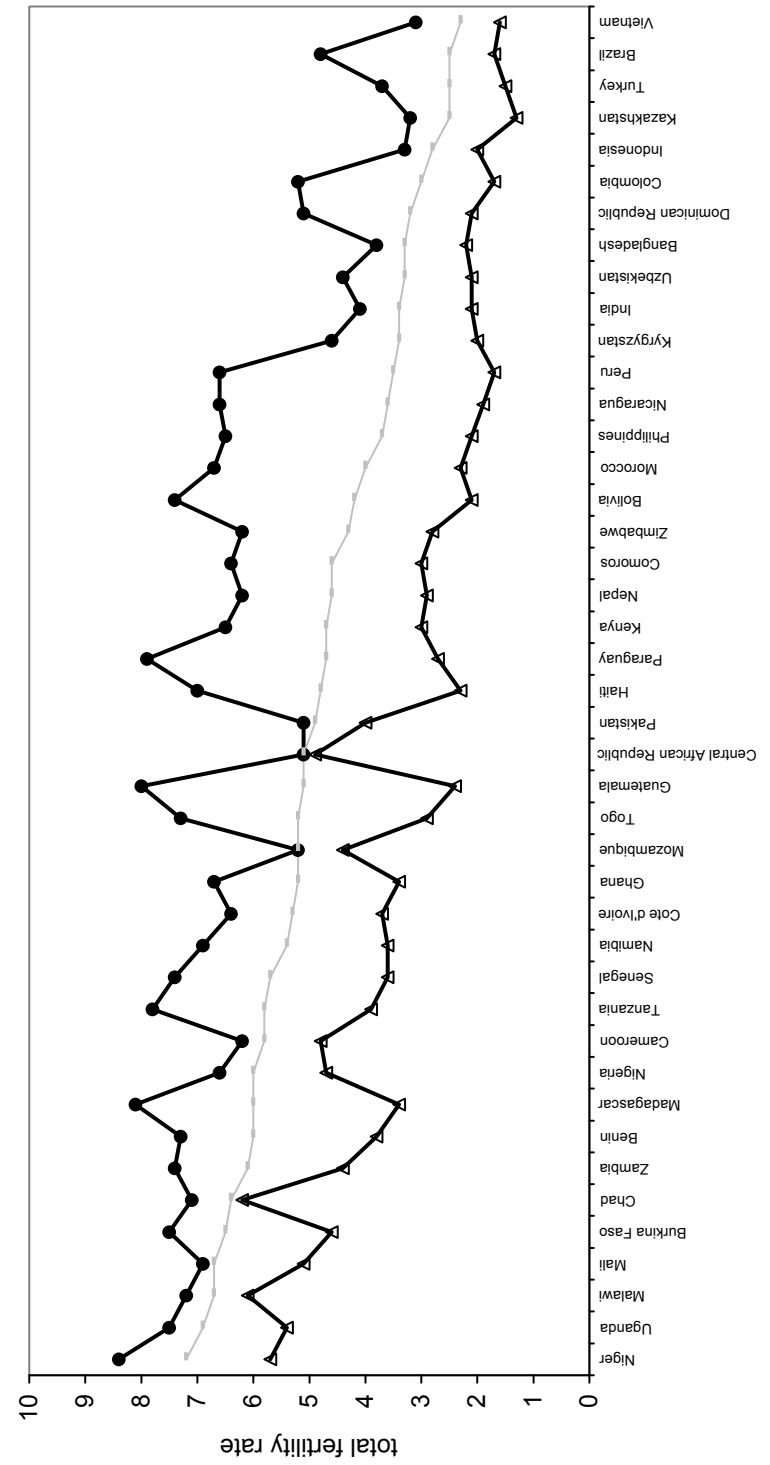


Figure A.32 Total fertility rate among the poorest 20% and richest 20% population group and the total population

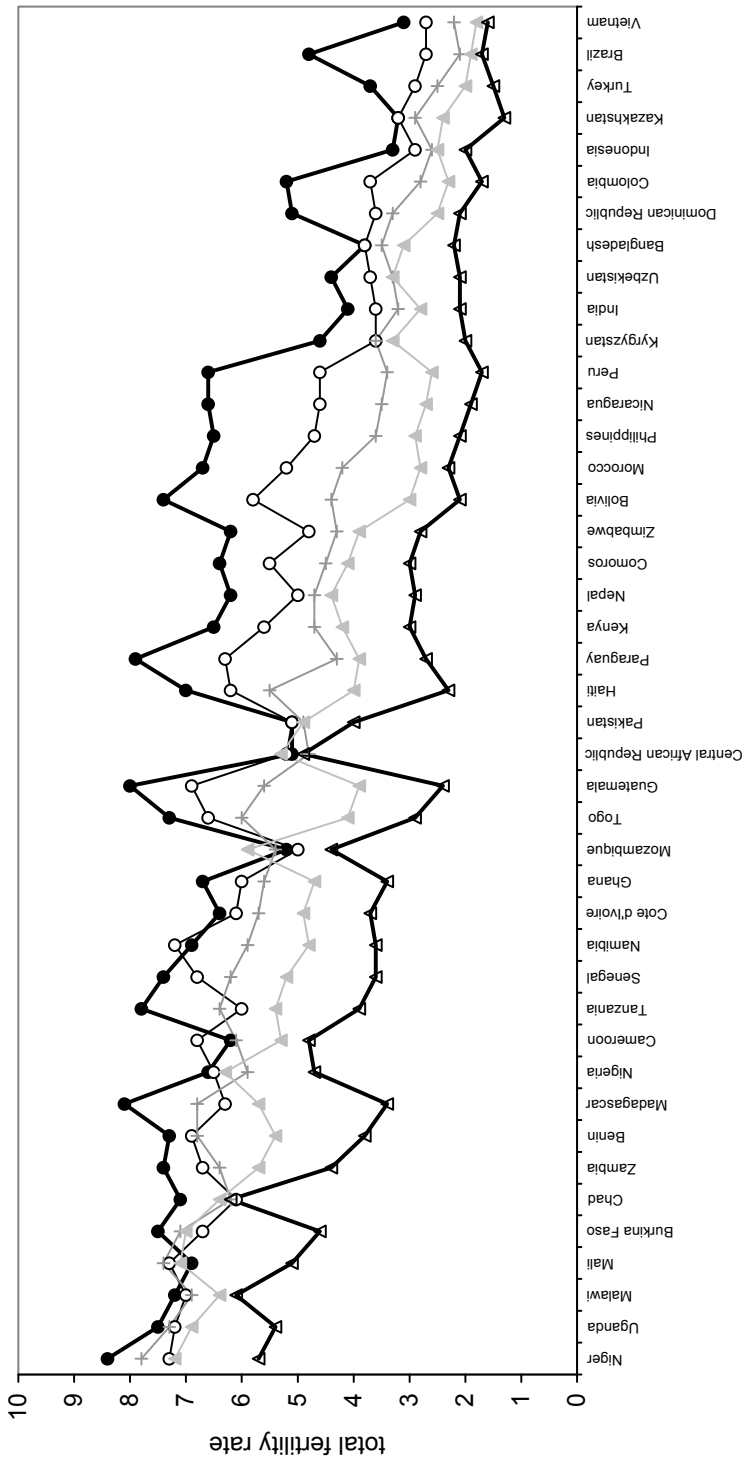


Figure A.33 Total fertility for five wealth quintiles

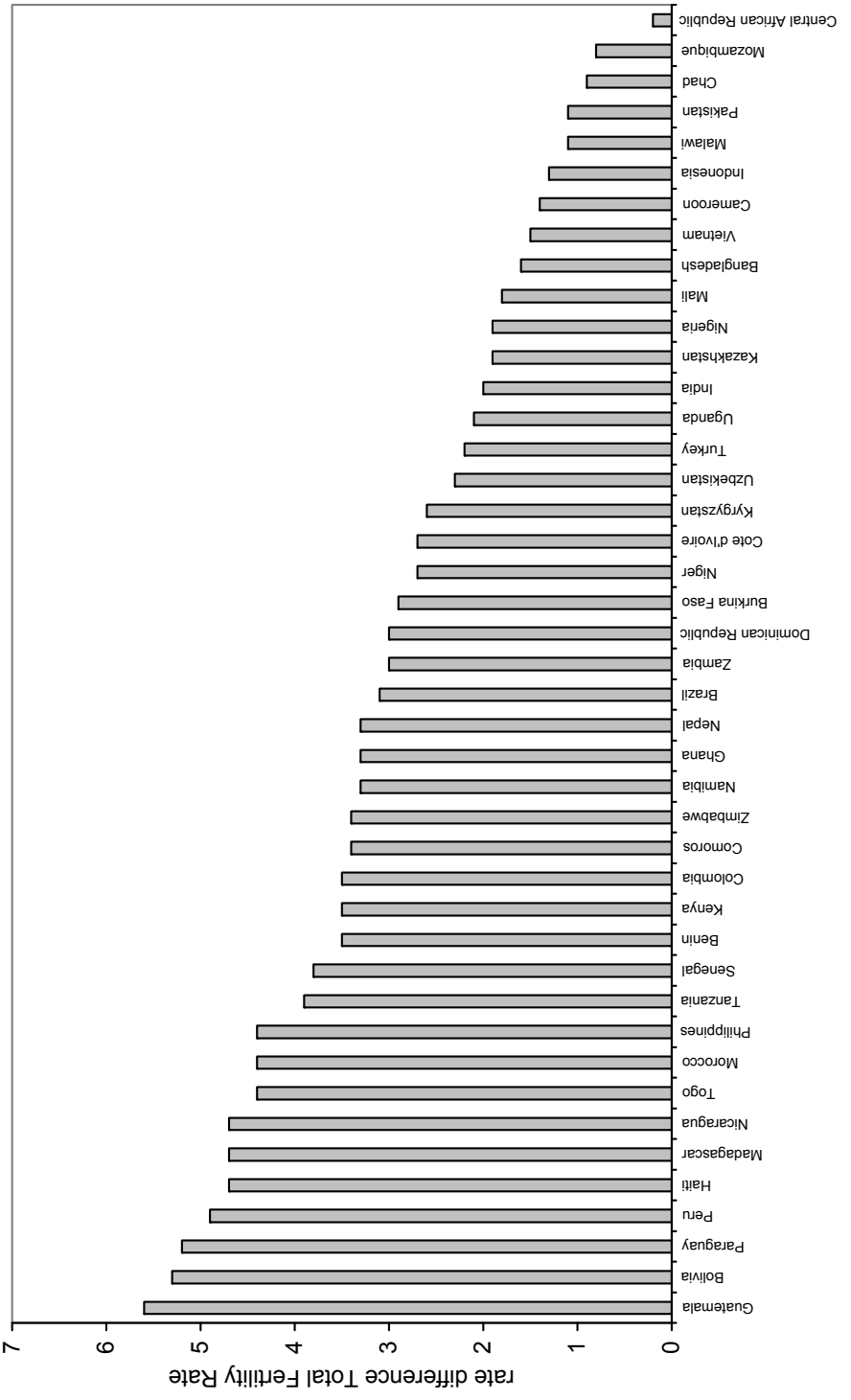


Figure A.34 Absolute inequalities (rate difference) in total fertility rate between the poorest 20% and richest 20% population group

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Summary

Worldwide more than 10 million children die each year before their fifth birthday (Black *et al.* 2003). Not only are these deaths concentrated in low and middle income countries; children of the poor and less educated within these countries too systematically exhibit substantially higher mortality levels. Reducing socio-economic inequalities in childhood mortality within countries, by reducing mortality levels among more disadvantaged groups, has become an increasingly important objective of national and international policy makers.

Valid and accurate measurement of socio-economic mortality inequalities is a prerequisite for evidence-based policy making in this area. Both the measurement of socio-economic characteristics and the summary measure of inequality are recurrent topics of debate and require further research. Understanding why inequalities are larger in some populations than in others is a next step towards evidence-based interventions. Unfortunately, not much is known about how socio-economic inequalities in childhood mortality vary across countries and over time, and what the determinants of these variations are.

The research underlying this PhD thesis aims to contribute to the measurement and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through comparative research. The specific aims are to contribute to (1) the development of valid, robust and meaningful ways of measuring socio-economic mortality inequalities, (2) the description and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through cross-national analyses, and (3) the description and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through time-trend analyses.

The Demographic and Health Surveys (DHS) are the main data source in the research underlying this thesis. These are nationally representative surveys among women aged 15-49 years. The surveys provide data on, among others, under-5 mortality, socio-economic characteristics of the household, health care use and other proximate (i.e. direct) determinants of under-5 mortality for over 70 low and middle income countries. For many countries, data for several time periods are available. These surveys are currently the best data source available for comparative research on socio-economic inequalities in under-5 mortality in low and middle income countries.

Part I (Chapters 3, 4, and 5) aims to contribute to the development of valid, robust and meaningful ways of measuring socio-economic mortality inequalities. Here, I show that the choice of the summary measure of inequality and the measure of household economic status should be well-considered, as the magnitude of mortality inequality and the interpretation of variations in such inequality across populations are sensitive to the precise measures used.

Chapter 3 evaluates the measure of mortality inequality as reported in the World Health Report 2000 (WHR) of the World Health Organisation (WHO 2000). The WHR index is a measure of inequality in mortality between individuals, and thus departs from established research that focuses on mortality differences between socio-economic groups. Nonetheless, many readers of the report might be inclined to interpret its index in terms of socio-economic inequalities in mortality. We therefore assessed to what extent there is an empirical association between the WHR index and established measures of socio-economic inequalities in mortality. Using available evidence on socio-economic mortality inequalities in 15 high income and 43 low and middle income countries, we show that the WHR index does not correspond with international variations in the size of socio-economic mortality inequalities. In this chapter, we conclude that the WHR index is not a valid measure of socio-economic inequalities in mortality. The WHR index should therefore not be used to replace the indices developed to monitor socio-economic inequalities in health. It is strongly recommend that the World Health Report returns to the use of indices that directly measure inequalities in health between socio-economic groups.

Chapter 4 seeks to contribute to the debate on whether relative or absolute summary measures of inequality are most meaningful for monitoring health inequalities. Some argue that increasing relative inequalities are nearly inevitable when overall mortality levels fall, and that therefore absolute measures are more meaningful. Others, however, argue that absolute inequalities almost inevitably fall when overall mortality levels decline, and that therefore relative measures are more meaningful. On the basis of a cross-national analysis of 43 low and middle income countries for one health outcome (under-5 mortality) and three indicators of health care use (full childhood immunization, skilled antenatal care, skilled delivery assistance), this chapter concludes the following. First, relative inequalities, using the rate ratio as measure, tend to be larger at lower overall levels (*e.g.* of mortality or health care use). Absolute inequalities, using the rate difference as measure, tend to be low at both very low and very high overall levels. Secondly, the magnitude of the rate ratio and the rate difference is bound by mathematical ceilings. These ceilings partly explain the

empirical patterns described above. Low rate ratios at very high overall levels, for instance, are a necessity, not an accomplishment. Yet, even where mathematically-defined ceilings do not play a role, the magnitude of absolute and relative inequalities is correlated with the overall level. However, the above tendencies are not necessities. There are countries with low mortality rates *and* low rate ratios. This is important, both for policy makers and researchers, especially those who assume that rising inequalities with declining mortality levels are inevitable. Moreover, the precise empirical patterns varied between the specific health-related outcomes, showing that the relationship between relative and absolute inequalities on the one hand, and overall levels on the other, is not as rigid as is sometimes suggested. This chapter concludes that measures of both absolute and relative inequality can be meaningful for monitoring socio-economic health inequalities, provided that differences or changes in the overall level of the outcome are carefully taken into account. It contains advice on how to take this overall level into account when monitoring these inequalities and presents data that can be used for benchmarking inequalities in the field of maternal and child health in low and middle income countries.

Household ownership of assets is the most frequently used indicator of economic status in health studies in low and middle income counties. However, different studies use different sets of asset items to measure economic status. **Chapter 5** examines the extent to which the magnitude of poor-rich inequalities in mortality and health care use is sensitive to the specific set of asset items used. This chapter shows that the magnitude of such inequalities is often sensitive to the specific items included in the asset index. In many cases, the extent of sensitivity found was not alarming. Yet, in a number of cases the specific measure of economic status used did make an important difference. Unfortunately, it appears difficult to predict in which cases this important sensitivity will occur. Researchers and policy makers should therefore be aware that the choice of the measure of economic status can influence the observed magnitude of health inequalities, and that differences in the magnitude of health inequality between countries or time periods, may be an artefact of different wealth measures used. Especially the interpretation of relatively small variations in wealth-related health inequality across populations should be done with particular caution.

Part II of this thesis (Chapters 6 and 7) aims to contribute to the description and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through cross-national analyses.

National level determinants of population health, such as national per capita income and female literacy rate, have been extensively studied. To what extent these determinants differentially influence mortality levels among children of poorer and richer households is, however, unknown. **Chapter 6** examines to what extent the association between under-5 mortality and well-known socio-economic, political, and health care factors varies in strength between richer and poorer children within countries. We found a significantly weaker association between national per capita income and under-5 mortality among the poor compared with the rich. This weaker association remained after adjusting for the income distribution within countries. Conversely, the association between public spending on health and under-5 mortality was significantly stronger for the poor. Also professional delivery attendance and immunisation coverage among the poor were significantly more strongly related to public spending on health than such health care use among the rich. Ethnic fragmentation was significantly more strongly associated with higher under-5 mortality among the poor. No differentials in the relative effect of female literacy, democracy and state strength were observed between wealth groups. The results suggest that economic growth is associated with widening poor-rich disparities in under-5 mortality. Increased public spending on health might partly remedy this effect. The stronger effect of public spending on health on mortality levels among the poor is possibly explained by a stronger responsiveness of health care use among poor households to increases in such spending combined with stronger mortality effects of health care use in this group.

Chapter 7 focuses on socio-economic inequalities in health care use as a proximate determinant of socio-economic inequalities in under-5 mortality. Specifically, it describes poor-rich inequalities in use of maternity care and seeks to understand these inequalities through comparisons with other types of health care. Our findings show that poor-rich inequalities in maternity care in general and professional delivery care in particular are huge, and are much greater than those in immunization coverage and treatment of childhood illnesses. Public sector inequalities make up a major part of the poor-rich inequalities in professional delivery attendance. Even delivery care provided by nurses is pro-rich in most of the countries. Poor-rich inequalities within both rural and urban areas are considerable. Yet, most births without professional delivery care occur among the rural-poor. The greatest improvements in professional delivery care can therefore be achieved by increasing coverage among the rural-poor. Problems with availability, accessibility, and affordability, as well as the nature of the services and demand factors appear to contribute to the larger poor-rich inequalities in delivery care. Reducing poor-rich inequalities in professional delivery care is essential for achieving the Millennium Development Goals for maternal

health. A concerted effort comprised of equity oriented policy and research is needed to address the huge poor-rich inequalities in maternity care.

Part III (Chapters 8 and 9) of this thesis aims to contribute to the description and explanation of socio-economic inequalities in under-5 mortality in low and middle income countries through time-trend analyses. In particular, it aims to assess how socio-economic inequalities in under-5 mortality change (a) in a period of economic growth and strong mortality declines, and (b) in a context of economic stagnation and rising mortality levels. Here it is shown that changes over time in the magnitude of socio-economic inequalities in under-5 mortality do not necessarily follow an expected pattern.

Chapter 8 describes and seeks to explain time-trends in socio-economic and regional inequalities in under-5 mortality in Indonesia during a period of rapid economic growth. The results show that mortality declines were possibly stronger among children of less educated mothers than children of highly educated mothers. Hence, the mortality gap between the low and high educated possibly narrowed. Peripheral areas lagged behind the mortality progress experienced by urban areas and the central islands of Java and Bali. This shows that stable or declining inequalities according to one dimension (*e.g.* education) can coincide with increasing inequalities in another (*e.g.* central *vs*. peripheral region). This underlines the importance of monitoring mortality inequalities across several socio-economic and regional dimensions. The observed stable or declining inequalities in under-5 mortality by maternal education show that widening socio-economic mortality inequalities in times of rapid economic growth and mortality decline are not inevitable. An equitable distribution of economic growth in general, and rural development in particular, might be important factors for preventing widening inequalities in under-5 mortality in such a context.

The positive changes in Indonesia stand in stark contrast to the increasing under-5 mortality levels in a number of African countries. **Chapter 9** aims to identify the socio-economic and geographical groups in which the under-5 mortality increase observed in Burkina Faso, Cameroon, Côte d'Ivoire, Kenya and Zimbabwe during the 1990s was most pronounced. It also aims to explore the contribution of a number of proximate mortality determinants to these trends. The results show that under-5 mortality has increased substantially in the countries under study. At the end of the 1990s, under-5 mortality in some countries was back to the level of two decades earlier. This increase in under-5 mortality was highly concentrated in specific population subgroups. Exactly which groups were most affected was highly variable. In Kenya, the increase in under-5 mortality was concentrated among

the less educated and the rural population, thereby increasing socio-economic mortality inequalities. In Zimbabwe and Cameroon, the mortality increase was largest among the higher educated, and, in Zimbabwe, in urban areas. In Burkina Faso and Côte d'Ivoire, the mortality trends did not differ statistically significantly between subgroups. Possibly, the deteriorating economic conditions, the decline in health care use, and the increase in drug-resistant malaria had a stronger impact on lower socio-economic groups and rural areas in Kenya. Further research is needed to assess to what extent HIV/AIDS has contributed to the opposite pattern in Zimbabwe. Despite these different trends, under-5 mortality levels remained highest among the less educated and the rural population in all countries. In summary, there is a highly variable pattern to how the mortality increase is distributed across socio-economic and geographical subgroups in these countries. It cannot be assumed that lower socio-economic groups are always most vulnerable. Strategies to halt the under-5 mortality increase should be based on disaggregate information for individual countries.

The **General Discussion (Chapter 10)** summarises the main findings of the research underlying this PhD thesis and critically assesses the approach taken. It also seeks to generate hypotheses for key findings against the backdrop of the available literature, and highlights the contribution this thesis purports to make to describing and explaining time and place variations in the magnitude of under-5 mortality inequalities. Below, a summary of the methodological issues and the hypotheses for key findings is provided.

I discussed four key methodological issues in the field of research on socio-economic health inequalities. First, I critically assessed the focus in this thesis on individual and household level characteristics as determinants of under-5 mortality. Socio-economic inequalities in under-5 mortality can often be partly explained by the fact that poorer and lower educated groups tend to live in places with characteristics that instigate high mortality. Furthermore, the magnitude of socio-economic inequalities in under-5 mortality is place-dependent, i.e. varies in size depending on community and country level characteristics. Nevertheless, socio-economic characteristics at the individual and household level often retain an effect on under-5 mortality also independent of important place characteristics. Socio-economic inequalities in under-5 mortality can, however, not be fully understood by zooming-in on household level factors alone. Future research should pay more attention to determinants at the community, provincial, country, and even global level. Also, monitoring of both socio-economic and regional inequalities is important, as time-trends in these inequalities do not necessarily change in the same direction.

Secondly, I discussed the usefulness of the asset index for research on socio-economic health inequalities in low and middle income countries. The emphasis in research and policy making on this issue has shifted from education to household economic status. Yet, fairly little is known about how to measure household economic status in health surveys. The asset index is currently the only measure of economic status that is readily available in health surveys for a large number of low and middle income countries. Despite its limitations, the measure is useful for demonstrating the existence of wealth-related health inequalities and for describing the order of magnitude of these inequalities. The index is also useful for describing and explaining general patterns in large cross-national studies. Conversely, a more precise description of the magnitude of poor-rich inequalities in a country, and the detection of smaller variations in inequality between populations (including the description of time-trends), can be problematic. This is due to problems with content validity (including an urban bias) and comparability, and due to the sensitivity of the magnitude of mortality inequality to the specific asset items included. More research on the asset index is needed before it is suitable for application in national and international monitoring systems. Currently, maternal education seems, in my view, more suitable for monitoring of socio-economic inequalities in childhood mortality.

Thirdly, I evaluated the uses and limitations of descriptive comparative research on mortality inequalities in view of my experience with such research using DHS data. Descriptive comparative research on health inequalities serves a number of purposes, including international benchmarking, monitoring of time-trends, and identifying general patterns and outlier values. Descriptive comparative research using DHS data can fruitfully use cross-national analyses to study general patterns or similarities across a broad set of populations. DHS data also allow for comparisons of strongly contrasting (groups of) countries or populations. More detailed comparisons of rather similar populations (including the description of time-trends) can be hampered by a lack of statistical power, problems with certain variables, and sensitivity to the specific methods and measures used. As more detailed descriptions can nevertheless be important, recommendations are given on how to do such analyses.

Finally, I evaluated the uses and limitations of explanatory comparative research on mortality inequalities in low and middle income countries. For evidence based policy making it is important to understand why mortality inequalities are larger in some populations than in others. Research on the effects of country characteristics, including public policies, is of particular importance. There is however, little empirical research in this area, including for

high income countries. The increasing data availability for a large set of low and middle income countries provides exciting opportunities to contribute to this important research field. I used, for this purpose, two types of study designs, i.e. (i) quantitative cross-national comparisons, and (ii) time-trend analyses for purposefully selected contexts that provide 'natural experiments'. My research shows that it remains, nevertheless, difficult to answer the question why mortality inequalities are larger in some populations than in others. Three important problems play a role, i.e. confounding, 'temporality', and effect modification. Also difficulties with doing downstream explanatory analysis in relation to low and middle income countries, and the relatively long and complex causal pathways between country characteristics, social stratification and proximate mortality determinants, are a challenge to drawing causal inferences. In my view, these challenges are best met using a multi-pronged approach, in which results obtained using a variety of methods are checked against each other.

Next, I highlighted the contribution this thesis purports to make to answering the question of how socio-economic mortality inequalities change over time, against the backdrop of the available literature. In particular, I reviewed the evidence on patterns of change in mortality inequalities along the epidemiological transition, and assessed the role of a number of factors in explaining the patterns observed.

There appears to be a regular pattern of change in absolute and relative under-5 mortality inequalities along the epidemiological transition, with widening relative inequalities and narrowing absolute inequalities concurrent with declining mortality levels. Although reliable data on long-term time-trends in mortality inequalities are scarce for both high and low income countries, existing evidence points to broadly similar patterns of change. At the same time, irregularities are observed. For example, relative inequalities can remain stable or even fall in times of mortality decline. By examining such irregularities, for example through contrasting case studies, future research might provide clues on the mechanisms through which inequalities increase or decrease.

Subsequently, I explored the role of three factors (*viz.* economic growth and income inequality, differential diffusion of innovation, and the role of the state) in explaining the pattern of rising relative mortality inequalities in times of overall mortality decline. These should not be considered to be mutually exclusive explanatory factors, but should instead be seen as three, interrelated, ingredients of a possible explanation.

First, I explored to what extent economic growth and income inequality could explain the pattern of rising mortality inequalities in times of overall mortality decline. Economic growth and mortality declines tend to go together at the country level. If income inequality tends to rise in times of economic growth, the rising relative mortality inequalities that are associated with mortality declines might be partly explained by rising income inequalities. The limited evidence suggests that relative mortality inequalities tend to rise in times of economic growth. However, positive outliers suggest that increasing mortality inequalities are not inevitable. The evidence on income inequality as a mechanism through which economic growth may lead to rising mortality inequalities is inconclusive. Clearly, without income inequality there would be no mortality differences by income level. Yet, the relationship between economic growth and income inequality is complex, and certainly not linear. Moreover, cross-nationally there is little evidence of an association between the magnitude of income inequality and mortality inequality. The few existing time-trend studies, however, suggest a relationship between changes in income inequality and changes in mortality inequality. Therefore, more systematic evidence is needed on this issue.

Secondly, I examined to what extent differential changes in proximate determinants across socio-economic strata explain the rising mortality inequalities when overall mortality levels decline. Based on the existing literature, I hypothesize that a systematic pattern of differential change in proximate determinants across socio-economic groups plays an important role in explaining the rising relative inequalities in under-5 mortality when overall mortality levels fall. Mortality levels decline because of a continuous flow of improvements in proximate determinants. As such changes occur earlier and in a faster rate among higher societal strata, relative mortality inequalities will tend to increase when overall mortality levels fall. I expect relative inequalities in the uptake of an intervention to be large at early stages of this diffusion process, and to decline at later stages, but relative inequalities in mortality to increase continuously.

Thirdly, I examined the hypothesis that states are an insufficient buffer to external processes that cause a rise in relative mortality inequalities concurrent with mortality declines, or that public policies even instigate these rising mortality inequalities.

One way in which governments can influence the magnitude of socio-economic mortality inequalities is through public spending on health. Such spending may influence the differential uptake of preventive and curative health care services across socio-economic groups. Public money tends to be urban biased and tends to go to more expensive services

that are mostly used by the rich. Whereas in monetary terms public spending tends to favour the rich, I have shown that the effects in mortality terms may be stronger for the poor. Therefore, I would expect increases in public spending on health to be accompanied by declining relative inequalities in health care use and under-5 mortality. Public spending on health perhaps partly accounts for the positive outliers mentioned above. This effect of public spending on health can be expected to be stronger if the benefit-incidence of public spending were biased towards lower socio-economic groups and rural areas. Conversely, a stronger dependence of the health care system on out of pocket expenditures, may lead to larger poor-rich inequalities in under-5 mortality. User fees, in combination with hidden costs, and especially the unpredictability of costs of professional delivery care, probably contribute to the huge poor-rich inequalities in professional delivery care described in Chapter 7. I would expect, *ceteris paribus,* inequalities in health care use to be smaller in countries with lower out-of-pocket expenditures. Future research should examine whether this is indeed the case.

Furthermore, institutional characteristics may influence the willingness or capacity of states to implement equity oriented public policies. Democracy may foster, for example, the adoption of pro-poor policies. However, poor-rich inequalities in under-5 mortality are not smaller in democracies (Chapter 6). More evidence is needed to confirm this finding. Furthermore, ethnic fragmentation may hamper the agreement on the provision of public goods (Easterly *et al.* 1997). My analyses showed that high ethnic fragmentation was slightly, though significantly more strongly, associated with higher under-5 mortality among the poor compared to the rich. More in-depth research on the causal mechanisms through which ethnic fragmentation may impact on mortality inequality is needed. Finally, strong state structures are arguably a necessary condition for the universal implementation of, for example, water and sanitation facilities. Under-5 mortality tends to be lower in countries with strong states (Chapter 6). However, the strength of this association did not vary across wealth groups. This suggests that a strong, functioning, state may be a necessary, but not a sufficient condition for pro-poor state intervention. I proposed a rudimentary typology of states, based on elements discussed above (*viz.* economic growth, public spending on health, state strength, democracy), to stimulate further comparative research on mortality inequalities in low and middle income countries. This typology distinguishes between 'developmental states' (Woo-Cumings 1999), 'health care states', 'transitional states', 'neoliberal states' and 'failing or predatory states'. Chapter 10 describes the way in which the level and socio-economic distribution of under-5 mortality might be associated with these different types of states.

The **Annex** presents international overviews and comparisons of poor-rich inequalities in under-5 mortality and proximate determinants of under-5 mortality for 43 low and middle income countries. The proximate determinants studied include indicators of health care use, childhood malnutrition and fertility. The results can be summarized in the following key messages: (1) In virtually all countries, there are large inequalities between the poor and the rich in under-5 mortality and the proximate determinants. (2) Under-5 mortality and the proximate determinants on the one hand and household wealth on the other are systematically associated across the entire wealth hierarchy. Poor-rich differences in mortality and mortality determinants are therefore not merely a phenomenon of the poorest compared to the richest within countries, but instead run across the entire wealth hierarchy. (3) In some countries, inequality in under-5 mortality and proximate determinants is much larger than in other countries. (4) Population health would substantially improve in low and middle income countries if poor-rich inequalities in under-5 mortality were reduced by improving survival among poorer groups. In many countries, under-5 mortality would fall by at least 30% if all wealth groups would attain the mortality levels enjoyed by the rich within these countries; in some countries, under-5 mortality would even fall by more than 50%. Health care use would also substantially increase, and childhood malnutrition and total fertility rates would fall, if poor-rich inequalities in these outcomes were reduced. (5) Some indicators (*e.g.* delivery attendance) exhibit much larger poor-rich inequalities than others (*e.g.* immunisation coverage).

Samenvatting

Wereldwijd sterven jaarlijks meer dan 10 miljoen kinderen voor hun vijfde verjaardag (Black *et al.* 2003). Niet alleen zijn deze sterftevallen geconcentreerd in lage- en middeninkomenslanden; ook binnen deze landen is het sterftenivo onder kinderen uit arme huishoudens en van laag opgeleide moeders systematisch en substantieel hoger dan dat onder beter gesitueerde kinderen. Het verkleinen van deze sociaal-economische ongelijkheid in kindersterfte binnen landen, door het reduceren van sterfte onder achtergestelde groepen, is een prioriteit van beleidsmakers op nationaal en internationaal nivo.

Een voorwaarde voor *evidence-based* beleid op dit onderwerp, is de beschikbaarheid van betrouwbare en nauwkeurige maten van sociaal-economische sterfteverschillen. Er bestaan echter een aantal problemen rondom het meten van sociaal-economische kenmerken van individuen en huishoudens. Vooral het meten van economische status is, in lage- en middeninkomenslanden, lastig. Ook de samenvattende maat van ongelijkheid is een steeds terugkerend onderwerp van debat. Beide onderwerpen behoeven verder onderzoek. Beter inzicht in waarom ongelijkheid in sommige populaties groter is dan in andere populaties is een volgende stap in de richting van *evidence-based* beleid ter reductie van deze sociaal-economische gezondheidsverschillen. Helaas is nog weinig bekend over variaties in de omvang van sociaal-economische ongelijkheid in kindersterfte tussen landen en over de tijd, en de determinanten van deze variaties.

Het onderzoek dat aan dit proefschrift ten grondslag ligt heeft als doel bij te dragen aan het meten en verklaren van sociaal-economische ongelijkheid in kindersterfte in lage- en middeninkomenslanden. De specifieke doelstellingen zijn het leveren van een bijdrage aan (1) de ontwikkeling van valide, robuste en betekenisvolle manieren om sociaal-economische ongelijkheid in sterfte te meten, (2) de beschrijving en verklaring van sociaal-economische ongelijkheid in kindersterfte in lage- en middeninkomenslanden middels landen-vergelijkend onderzoek, en (3) de beschrijving en verklaring van sociaal-economische ongelijkheid in kindersterfte in lage- en middeninkomenslanden middels tijd-trend analyses.

De '*Demographic and Health Surveys*' (DHS) zijn de belangrijkste databron in mijn onderzoek. Dit zijn nationaal-representatieve surveys onder vrouwen tussen de 15 en 49 jaar. Deze surveys verschaffen voor meer dan 70 lage- en middeninkomenslanden gegevens over ondermeer kindersterfte, sociaal-economische kenmerken van huishoudens, het gebruik

van gezondheidszorg en andere proximale (i.e. directe) determinanten van kindersterfte. Deze surveys zijn op dit moment de beste databron voor vergelijkend onderzoek naar sociaal-economische ongelijkheid in kindersterfte in lage- en middeninkomenslanden.

Deel I (Hoofdstukken 3, 4, en 5) heeft als doel bij te dragen aan de ontwikkeling van valide, robuste en betekenisvolle manieren om sociaal-economische ongelijkheid in sterfte te meten. De hoofdstukken in dit deel laten het belang zien van een weloverwogen keuze van de maat van ongelijkheid en de maat van economische status. De omvang van de gemeten ongelijkheid en de interpretatie van de variatie in ongelijkheid tussen landen en veranderingen over de tijd, blijken namelijk af te hangen van de gebruikte maten.

In **Hoofdstuk 3** wordt de maat van ongelijkheid in sterfte die is opgenomen in het '*World Health Report 2000*' (WHR) van de Wereldgezondheidsorganisatie (WHO 2000) geëvalueerd. Dit is een maat van ongelijkheid in sterfte tussen individuen, en wijkt dus af van gevestigd onderzoek dat zich richt op ongelijkheid in sterfte tussen sociale groepen. Lezers van dit rapport zijn mogelijk geneigd deze maat toch in termen van sociaal-economische sterfteverschillen te interpreteren. Wij hebben daarom onderzocht in hoeverre de WHR ongelijkheidsindex samenhangt met gevestigde maten van sociaal-economische ongelijkheid in sterfte. Vergelijking met informatie over sociaal-economische sterfteverschillen in 15 hoge en 43 lage- en middeninkomenslanden laat zien dat de WHR index niet correspondeert met internationale variaties in de omvang van sociaal-economische sterfteverschillen. In dit hoofdstuk wordt geconcludeerd dat de WHR index geen valide maat is van sociaal-economische ongelijkheid in sterfte. De WHR index kan reeds bestaande maten, die beogen deze ongelijkheid te monitoren, dus niet vervangen. Het is daarom sterk aan te bevelen dat het jaarlijkse '*World Health Report*' van de Wereldgezondheidsorganisatie terugkeert naar het gebruik van maten die ongelijkheid in gezondheid tussen sociaal-economische groepen rechtstreeks meten.

In **Hoofdstuk 4** wordt een bijdrage geleverd aan de discussie of maten van relatieve of van absolute ongelijkheid meer betekenisvol zijn voor het monitoren van sociaal-economische gezondheidsverschillen. Sommigen redeneren dat stijgende relatieve ongelijkheid tussen lagere en hogere sociaal-economische groepen schier onvermijdelijk is bij een daling van het algehele sterftenivo, en dat daarom absolute verschillen meer betekenisvol zijn. Anderen echter redeneren dat dalende absolute ongelijkheid schier onvermijdelijk is bij afnemende algehele sterftenivo's, en dat daarom relatieve maten meer betekenisvol zijn. Op basis van cross-nationale analyses van 43 landen laten we zien dat er inderdaad een

samenhang bestaat tussen het nivo van de uitkomst (*e.g.* sterfte, gezondheidszorggebruik) in de algehele bevolking, en de omvang van sociaal-economische ongelijkheid in deze uitkomst. Relatieve ongelijkheid is meestal hoger bij lagere algehele nivo's; absolute ongelijkheid is in het algemeen laag bij zowel erg hoge als erg lage algehele nivo's. Dit patroon wordt deels verklaard door mathematische plafonds die de omvang van ongelijkheid begrenzen. De hierboven beschreven empirische patronen zijn echter geen wetmatigheden. Er zijn bijvoorbeeld landen met zowel een laag sterftenivo als lage relatieve sterfteverschillen. Dit betekent dat een stijgende relatieve ongelijkheid bij dalende sterfte niet onvermijdelijk is. Ook de variatie in empirische patronen tussen de verschillende gezondheidsgerelateerde uitkomsten laat zien dat de relatie tussen relatieve en absolute ongelijkheid aan de ene kant, en algehele nivo's aan de andere kant, niet zo rigide is als soms wordt gesuggereerd. Dit hoofdstuk concludeert dat zowel absolute als relatieve maten van ongelijkheid betekenisvol kunnen zijn voor het monitoren van sociaal-economische gezondheidsverschillen. Veranderingen of verschillen in het algehele nivo van de uitkomst dienen echter wel in ogenschouw te worden genomen. In dit hoofdstuk geven we aanbevelingen hoe dit gedaan kan worden.

In **Hoofdstuk 5** wordt beschreven in hoeverre de omvang van gemeten arm-rijk verschillen in kindersterfte en gezondheidszorggebruik wordt beïnvloed door de specifieke maat van economische status die wordt gebruikt. Een vaak gebruikte maat van economische status in lage- en middeninkomenslanden is de '*asset index*'. Deze is samengesteld uit informatie over bezit van duurzame consumptiegoederen en de kwaliteit van huisvesting en water- en sanitatievoorzieningen. Verschillende onderzoekers gebruiken echter verschillende lijsten van bezittingen om een dergelijke index samen te stellen. Dit hoofdstuk laat zien dat de omvang van arm-rijk verschillen in sterfte en gezondheidszorggebruik vaak sensitief is naar de specifieke set van bezittingen die wordt gebruikt. De mate van sensitiviteit was in veel gevallen niet alarmerend. Echter, in een aantal gevallen was er wel een substantiëel verschil in de geobserveerde omvang van ongelijkheid. Het blijkt helaas lastig te voorspellen in welke gevallen deze grote mate van sensitiviteit zal optreden. Dit betekent dat onderzoekers en beleidsmakers zich ervan bewust dienen te zijn dat de keuze van de maat van economische status de omvang van de geobserveerde gezondheidsverschillen kan beïnvloeden. Ook kan gevonden variatie tussen populaties in arm-rijk verschillen in sterfte en gezondheidszorg, een artefact kan zijn van het gebruik van verschillende maten van economische status. Vooral de interpretatie van relatief kleine variaties in arm-rijk verschillen tussen populaties moet met bijzondere voorzichtigheid gebeuren.

Deel II (Hoofdstukken 6 en 7) heeft als doel bij te dragen aan de beschrijving en verklaring van sociaal-economische ongelijkheid in kindersterfte in lage- en middeninkomenslanden middels cross-nationale analyses.

Het is bekend dat gemiddelde kindersterfte in een land samenhangt met factoren als nationaal inkomen per hoofd van de bevolking en met geletterdheid onder vrouwen. In hoeverre dergelijke landkenmerken een verschillend effect hebben op sterfte onder kinderen van arme en rijke huishoudens binnen een land is echter onbekend. **Hoofdstuk 6** beschrijft in welke mate de associatie tussen sterfte en bekende sociaal-economische, politieke en gezondheidszorg-gerelateerde factoren variëert tussen armere en rijkere kinderen binnen landen. De associatie tussen nationaal inkomen en sterfte bleek significant zwakker te zijn voor armere kinderen dan voor rijkere kinderen, ook na controle voor inkomensverdeling. De samenhang tussen overheidsuitgaven aan gezondheidszorg en sterfte, daarentegen, bleek significant sterker te zijn voor armere kinderen. Ook de associatie tussen overheidsuitgaven aan gezondheidszorg en gezondheidszorggebruik was signficant sterker voor armere groepen. Voorts kwam aan het licht dat etnische fragmentatie significant sterker geassocieerd was met hogere sterfte nivo's onder armere kinderen. Wij vonden geen verschillen in het relatieve effect van geletterheid onder vrouwen, democratisch bestel, en kracht van het overheidsapparaat tussen armere en rijkere kinderen. Dit hoofdstuk laat zien dat landkenmerken een verschillend effect kunnen hebben op het sterftenivo onder armere en rijkere kinderen. Bij economische ontwikkeling neemt sterfte onder rijkere kinderen mogelijk sneller af dan onder armere kinderen, waardoor arm-rijk verschillen in kindersterfte toenemen. Overheidsuitgaven aan gezondheidszorg kunnen dit effect mogelijk deels compenseren. Het sterkere effect van overheidsuitgaven aan gezondheidszorg op sterfte onder armere kinderen wordt mogelijk verklaard door een combinatie van (i) een sterkere relatie tussen overheidsuitgaven aan gezondheidszorg en gezondheidszorggebruik onder armere groepen, en (ii) een sterker effect van gezondheidszorggebruik op sterfte onder armere kinderen.

Hoofdstuk 7 concentreert zich op sociaal-economische ongelijkheid in gebruik van gezondheidszorg als proximale determinant van ongelijkheid in kindersterfte. In het bijzonder worden arm-rijk verschillen in moederzorg beschreven. Door middel van vergelijkingen met ongelijkheid in het gebruik van andere typen zorg worden verklaringen gezocht voor de gevonden ongelijkheid in moederzorg. Arm-rijk verschillen in moederzorg in het algemeen, en professionele zorg bij de bevalling in het bijzonder, blijken enorm groot te zijn; veel groter dan ongelijkheid in het gebruik van andere typen zorg. Zowel binnen

urbane als binnen rurale gebieden, zijn arm-rijk verschillen in deze zorg aanzienlijk. De meeste bevallingen zonder professionele zorg vinden echter plaats onder armen in rurale gebieden. De grootste verbeteringen in zorg bij de bevalling kunnen daarom worden behaald door de dekkingsgraad van professionele zorg onder rurale armen te verhogen. Een groot deel van de arm-rijk verschillen in zorg bij de bevalling komt door ongelijkheid in het gebruik van zorg in de publieke sector. Deze functioneert dus niet als een vangnet voor arme bevolkingsgroepen. Zelfs professionele zorg bij de bevalling door een vroedvrouw of verpleegkundige is, in de meeste landen, hoger onder de rijkeren. Problemen met beschikbaarheid, toegankelijkheid en betaalbaarheid, alswel de aard van de zorg en factoren gerelateerd aan de zorg-vraag, lijken bij te dragen aan de veel grotere ongelijkheid in professionele zorg bij de bevalling in vergelijking met andere typen zorg. Het reduceren van arm-rijk verschillen in professionele zorg bij de bevalling is essentieel voor het halen van de Millennium Ontwikkelingsdoelen voor het reduceren van moedersterfte. Een gerichte inspanning is nodig om deze enorme arm-rijk verschillen in moederzorg te reduceren.

Deel III (Hoofdstukken 8 en 9) van mijn proefschrift heeft als doel bij te dragen aan de beschrijving en verklaring van sociaal-economische ongelijkheid in kindersterfte in lage- en middeninkomenslanden middels tijd-trend analyses. In het bijzonder wordt beschreven hoe sociaal-economische ongelijkheid in kindersterfte verandert in (a) een periode van economische groei en sterke sterfte daling, en (b) een context van economische stagnatie en stijgende sterftenivo's. De hoofdstukken in dit deel laten zien dat veranderingen in sociaal-economische sterfteverschillen niet altijd verlopen volgens te verwachte patronen.

Hoofdstuk 8 beschrijft tijd-trends in sociaal-economische en regionale ongelijkheid in kindersterfte in Indonesië tijdens een periode van snelle economische groei, en poogt verklaringen te geven voor deze trends. Kindersterfte is sterk gedaald in Indonesië in de jaren '80 en '90. Deze daling lijkt sterker te zijn geweest onder kinderen van laag opgeleide moeders. Relatieve ongelijkheid in kindersterfte tussen laag en hoog opgeleide groepen is dus vermoedelijk afgenomen. Perifere gebieden bleven achter bij de sterftedaling zoals geobserveerd voor urbane gebieden en de politiek-economisch centrale eilanden Java en Bali. Stabiele of zelfs dalende ongelijkheid in één dimensie (*e.g.* opleiding), kan dus samengaan met toenemende ongelijkheid in een andere dimensie (*e.g.* centraal *vs.* perifere regio). Dit onderstreept het belang van monitoren van ongelijkheid in sterfte voor verschillende sociale en regionale dimensies. De geobserveerde stabiele of dalende ongelijkheid in kindersterfte naar opleiding van de moeder laat zien dat sociaal-economische sterfteverschillen dus niet per definitie toenemen in tijden van snelle economische groei en sterftedaling.

Een gelijke verdeling van economische groei in het algemeen, en rurale ontwikkeling in het bijzonder, zijn mogelijk belangrijke factoren bij het voorkómen van toenemende ongelijkheid in kindersterfte.

In schril contrast met de positieve veranderingen in Indonesië, staat de toename in kindersterfte in een aantal Afrikaanse landen. In **Hoofdstuk 9** wordt beschreven in welke sociaal-economische en ruraal/urbane groepen in de jaren '90 deze toename was geconcentreerd in Burkina Faso, Kameroen, Ivoorkust, Kenya and Zimbabwe. Ook wordt de bijdrage van een aantal proximale determinanten van kindersterfte aan deze stijging verkend. De resultaten laten een sterke stijging in kindersterfte zien voor de hierboven genoemde landen. Eind jaren '90 was kindersterfte voor een aantal landen teruggevallen tot het nivo van twintig jaar daarvoor. Deze sterftetoename was sterk geconcentreerd in specifieke bevolkingsgroepen; *welke* groepen variëerde sterk per land. In Kenya was de toename in kindersterfte geconcentreerd in de lager opgeleide en rurale bevolking, hetgeen leidde tot een toename in sterfteverschillen tussen sociaal-economische groepen. In Zimbabwe en Kameroen steeg kindersterfte het sterkst onder de hoger opgeleiden, en in Zimbabwe ook in urbane gebieden. In Burkina Faso en de Ivoorkust was er geen significant verschil in sterftetrends tussen de sociaal-economische en ruraal/urbane bevolkingsgroepen. Mogelijk hebben de verslechterende economische omstandigheden, de afname in gezondheidszorggebruik en de toename in malaria resistentie een sterkere effect gehad op de lagere sociaal-economische en rurale bevolkingsgroepen in Kenya. Verder onderzoek is nodig om na te gaan in welke mate HIV/AIDS heeft bijgedragen aan het tegenovergestelde patroon in Zimbabwe. Ondanks dit sterk uiteenlopende patroon van sterftetoename, bleef in alle landen de kindersterfte het hoogst onder de lager opgeleide en rurale bevolking. Lagere sociaal-economische groepen lijken echter niet per definitie het meest te lijden te hebben van een toename in kindersterfte. Strategiëen om de stijgende kindersterfte een halt toe te roepen moet worden gebaseerd op gedeaggregeerde informatie voor individuele landen.

De **Algemene Discussie** (**Hoofdstuk 10**) vat de belangrijkste bevindingen van dit onderzoek samen en geeft een kritische beschouwing op de gekozen onderzoeksopzet. Ook worden in dit hoofdstuk hypotheses geformuleerd ter verklaring van de belangrijkste bevindingen tegen de achtergrond van de beschikbare literatuur. De besproken methodologische kwesties en hypotheses met betrekking tot de belangrijkste bevindingen worden hieronder samengevat.

Vier methodologische kwesties in onderzoek naar sociaal-economische gezondheidsverschillen worden besproken. Allereerst wordt de focus in dit proefschrift op kenmerken op individueel- en huishoud-nivo als determinanten van kindersterfte tegen een kritisch daglicht gehouden. Sociaal-economische ongelijkheid in kindersterfte wordt in het algemeen deels verklaard doordat armere en lager opgeleide bevolkingsgroepen in minder gunstige gebieden wonen. Ook blijkt de omvang van sociaal-economische ongelijkheid in kindersterfte afhankelijk te zijn van gebiedskenmerken, zoals rural-urbaan, en landkenmerken, zoals per capita inkomen en overheidsuitgaven aan gezondheidszorg. Toch behouden sociaal-economische kenmerken op individueel en huishoud-nivo deels hun effect onafhankelijk van dergelijke gebiedskenmerken. Sociaal-economische verschillen in kindersterfte kunnen echter niet volledig worden begrepen door slechts factoren op huishoud-nivo te bestuderen. Verder onderzoek zou meer aandacht moeten geven aan determinanten op gemeenschaps-, provinciaal-, land- en zelfs wereldwijd-nivo. Ook is het monitoren van zowel regionale als sociaal-economische ongelijkheid belangrijk, omdat deze niet noodzakelijkerwijs in dezelfde richting veranderen.

Ten tweede wordt de bruikbaarheid van de *asset index* voor onderzoek naar sociaal-economische sterfteverschillen in lage- en middeninkomenslanden geëvalueerd. De nadruk in onderzoek en beleid in deze landen is verschoven van opleiding van de moeder naar economische status van huishoudens. Er is echter nog weinig bekend over hoe economische status het beste gemeten kan worden. De asset index is op dit moment de enige maat van economische status die makkelijk beschikbaar is in gezondheidssurveys voor een groot aantal lage- en middeninkomenslanden. Ondanks beperkingen is deze maat bruikbaar om het bestaan van arm-rijk verschillen in sterfte aan te tonen en om de orde van grootte van deze ongelijkheid te beschrijven. Ook voor het beschrijven en verklaren van algemene patronen in grote cross-nationale studies is de *asset index* bruikbaar. Een meer precieze beschrijving van de omvang van arm-rijk verschillen in een land, en het opsporen van kleinere variaties in de omvang van deze ongelijkheid tussen populaties (inclusief het beschrijven van trends over de tijd), is echter vaak problematisch. Meer onderzoek naar de *asset index* is nodig voordat deze geschikt is voor toepassing in nationale en internationale monitoringsystemen. Op dit moment is opleiding van de moeder meer geschikt om sociaal-economische ongelijkheid in kindersterfte te monitoren.

Ten derde heb ik, in het licht van mijn eigen onderzoekservaring, het nut en de beperkingen van beschrijvend-vergelijkend onderzoek naar sociaal-economische sterfteverschillen geëvalueerd. Beschrijvend-vergelijkend onderzoek naar ongelijkheid in gezondheid dient

een aantal doelen, waaronder internationaal benchmarken, monitoren van trends over de tijd, en het identificeren van algemene patronen en uitbijters. Beschrijvend-vergelijkend onderzoek met DHS data kan vruchtbaar gebruik maken van cross-nationale analyses om algemene patronen tussen een groot aantal populaties op te sporen. DHS data laten ook vergelijking van sterk contrasterende (groepen) landen of populaties toe. Meer gedetaileerde vergelijkingen van weinig contrasterende populaties (inclusief het beschrijven van trends over de tijd) kunnen worden belemmerd door gebrek aan statistische power, problemen met specifieke variabelen, en sensitiveit naar de specifieke methoden en maten die worden gebruikt. Meer gedetaileerde beschrijvingen van sociaal-economische sterfteverschillen kunnen desalniettemin belangrijk zijn. In dit hoofdstuk worden daarom aanbevelingen gedaan voor dergelijk onderzoek.

Tenslotte heb ik het nut en de beperkingen van vergelijkend-verklarend onderzoek naar sociaal-economische sterfteverschillen in lage- en middeninkomenslanden geëvalueerd. Voor het opstellen van *evidence-based* beleid is het belangrijk te begrijpen waarom ongelijkheid in kindersterfte in sommige populaties groter is dan in andere populaties. Vooral onderzoek naar het effect van landkenmerken, waaronder overheidsbeleid, is van belang. Dergelijk onderzoek gebeurt echter nog nauwelijks, ook niet in hoge-inkomenslanden. De toegenomen beschikbaarheid van vergelijkbare data voor een groot aantal lage- en middeninkomenslanden opent nieuwe mogelijkheden voor dergelijk onderzoek. In mijn proefschrift gebruik ik hiervoor twee typen studiedesigns, i.e. (i) kwantitatief landenvergelijkend onderzoek, en (ii) tijd-trend analyses in contexten die fungeren als 'natuurlijke experimenten'. Mijn onderzoek laat zien dat het desalniettemin lastig blijft om een antwoord te vinden op de vraag waarom ongelijkheid in sterfte in sommige populaties groter is dan in andere. Drie belangrijke problemen spelen hierbij een rol, i.e. *confounding*, '*temporality*' en effect modificatie. Ook het gebrek aan informatie over doodsoorzaken en sommige proximale determinanten voor overleden kinderen belemmeren dergelijk onderzoek. Naar mijn mening is een onderzoeksprogramma waarin verschillende methodologiëen worden gecombineerd, en resultaten aan elkaar worden getoetst, de meest effectieve strategie voor vervolgonderzoek.

Vervolgens wordt de bijdrage die dit proefschrift levert aan het beantwoorden van de vraag hoe sociaal-economische gezondheidsverschillen veranderen over de tijd, en wat deze tijd en plaats variaties in sterfteverschillen verklaart, bezien in het licht van de beschikbare literatuur.

Allereerst wordt een beschrijving gegeven van veranderingen in sociaal-economische ongelijkheid in kindersterfte langs de epidemiologische transitie. In de afgelopen eeuw is kindersterfte in de hoge-inkomenslanden sterk gedaald. In de meeste lage- en middeninkomenslanden is dit het geval in de laatste decennia. Ondanks dat tijd-trend gegevens voor lange periodes schaars zijn, lijken beschikbare data te wijzen op een algemeen patroon van verandering in deze ongelijkheid langs de epidemiologische transitie. Dit patroon lijkt vergelijkbaar te zijn in hoge- en lage-inkomenslanden. Relatieve sterfteverschillen nemen in het algemeen toe, en absolute verschillen nemen vaak af bij dalende sterftenivo's. Tegelijkertijd kunnen onregelmatigheden worden geobserveerd. Relatieve sterfteverschillen kunnen, bijvoorbeeld, stabiel blijven of zelfs afnemen in tijden van snelle sterftedaling. Verder onderzoek naar dergelijke onregelmatigheden, bijvoorbeeld middels contrasterende *case studies*, kan een verder licht werpen op de mechanismen waardoor ongelijkheid toe of afneemt.

Vervolgens bespreek ik de rol van drie factoren (*viz.* economische groei en inkomensongelijkheid, differentiële diffusie van innovatie, en de rol van de staat) ter verklaring van het algemene patroon van toenemende relatieve ongelijkheid in sterfte tussen sociaal-economische groepen bij algehele sterftedaling. Deze factoren moeten worden beschouwd als drie, aan elkaar gerelateerde, ingrediënten van een mogelijke verklaring.

Ten eerste wordt nagegaan in hoeverre economische groei en inkomensongelijkheid de toenemende relatieve ongelijkheid in sterfte bij algehele sterftedaling kunnen verklaren. Economische groei en sterftedaling gaan over het algemeen samen. Als inkomensongelijkheid toeneemt ten tijde van economische groei, dan zou de toename in relatieve sterfteverschillen, die geassociëerd is met sterftedaling, mogelijk ten dele kunnen worden verklaard door toegenomen inkomensongelijkheid. Mijn resultaten en de literatuur wijzen erop dat relatieve sterfteverschillen neigen toe te nemen ten tijde van economische groei. Positieve uitbijters suggereren echter dat deze toename niet onvermijdelijk is. Het bewijs dat economische groei via inkomensongelijkheid leidt tot een toename in sociaal-economische sterfteverschillen is niet eenduidig. Uiteraard zou er zonder inkomensverschillen geen ongelijkheid in sterfte naar inkomensnivo zijn. Echter, de relatie tussen economische groei en inkomensongelijkheid is complex, en iedergeval niet lineair. Verder zijn sociaal-economische sterfteverschillen niet groter in landen met grotere inkomensongelijkheid. De paar beschikbare tijd-trend studies suggereren echter een relatie tussen veranderingen in het nivo inkomensongelijkheid en de omvang van sterfteverschillen. Dit onderwerp behoeft daarom meer systematisch onderzoek.

Ten tweede heb ik gekeken in hoeverre een proces van differentiële verandering in proximale determinanten van sterfte over sociaal-economische strata de toenemende relatieve sterfteverschillen bij algehele sterftedaling zou kunnen verklaren. Inderdaad lijkt dit een belangrijke rol te spelen. Sterfenivo's nemen af vanwege een continue stroom van verbeteringen in proximale determinanten. Omdat deze veranderingen eerder en sneller plaats vinden onder hogere sociale strata, zullen relatieve sterfteverschillen in het algemeen toenemen bij dalende sterftenivo's. Ik verwacht dat relatieve ongelijkheid in de adoptie van een interventie groot is in vroege stadia van dit diffusie-proces en zal dalen in latere stadia, maar dat relatieve ongelijkheid in sterfte continu blijft toenemen.

Vervolgens bespreek ik de hypothese dat overheden een onvoldoende buffer vormen voor externe processen die een toename in relatieve sterfteverschillen veroorzaken, of dat overheden zelfs direct bijdragen aan deze toenemende sterfteverschillen.

Eén van de manieren waarop overheden de omvang van sterfteverschillen mogelijk beïnvloeden, is via overheidsuitgaven aan gezondheidszorg. Deze uitgaven zouden een effect kunnen hebben op de differentiële adoptie van preventieve en curatieve gezondheidszorgmaatregelen tussen sociaal-economische groepen. Overheidsuitgaven zijn vaak geconcentreerd in urbane gebieden en gaan naar duurdere diensten die vooral door de hogere inkomensgroepen worden gebruikt. Hoofdstuk 6 laat echter zien dat de effecten in termen van sterfte mogelijk sterker zijn onder armere kinderen. Een toename in overheidsuitgaven voor gezondheidszorg gaat daarom mogelijk gepaard met dalende relatieve ongelijkheid in kindersterfte, en kan mogelijk de hierboven genoemde positieve uitbijters deels verklaren. Deze effecten zouden sterker zijn wanneer overheidsgelden worden gealloceerd in arme gebieden en aan diensten die lagere sociaal-economische groepen meer gebruiken. Aan de andere kant, leidt een sterkere afhankelijkheid van een gezondheidszorgsysteem van particuliere '*out of pocket*' bijdragen, mogelijk tot grotere arm-rijk verschillen in gezondheidszorggebruik. Deze *'user fees'* dragen, in combinatie met verborgen kosten en de onvoorspelbaarheid van de kosten voor professionele zorg bij de bevalling, bij aan de in Hoofdstuk 7 gerapporteerde enorme arm-rijk verschillen in deze zorg. Ik verwacht, *ceteris paribus,* dat ongelijkheid in gezondheidszorggebruik lager is in landen met lagere *out of pocket* bijdragen. Toekomstig onderzoek zou moeten uitwijzen of dit inderdaad het geval is.

Institutionele kenmerken beïnvloeden mogelijk de bereidheid en capaciteit van overheden om beleid ter reductie van gezondheidsverschillen te implementeren. Een democratisch bestel zou bijvoorbeeld een '*pro-poor*' beleid kunnen bevorderen. Arm-rijk verschillen in

kindersterfte zijn echter niet kleiner in democratiëen (Hoofdstuk 6). Meer bewijs is nodig om deze bevinding te ondersteunen. Verder zou etnische fragmentatie mogelijk een belemmering kunnen vormen bij het bereiken van overeenstemming over de verschafffing van publieke goederen (Easterly *et al.,* 1997). Mijn analyses laten zien dat etnische fragmentatie een sterker negatief effect lijkt te hebben op sterfte onder armere kinderen. Verder onderzoek is nodig naar de mogelijke belemmeringen die etnische fragmentatie opwerpt bij het terugdringen van arm-rijk verschillen in kindersterfte. Tenslotte is het aannemelijk dat sterke staatstructuren een noodzakelijke voorwaarde zijn voor de universele verschaffing van publieke voorzieningen als water en sanitatie. Kindersterfte is in het algemeen lager in landen met sterke overheden (Hoofdstuk 6). De sterkte van deze associatie variëert echter niet tussen arme en rijke kinderen binnen landen. Dit suggereert dat een sterke, functionerende staat wellicht en noodzakelijke, maar niet een voldoende voorwaarde is voor '*pro-poor*' overheidsbeleid. Op basis van de hierboven besproken elementen (*viz.* economsiche groei, overheidsuitgaven aan gezondheidszorg, kracht van de staatsorganisatie, en democratisch bestel) heb ik een rudimentaire typologie van staten opgesteld om toekomstig vergelijkend onderzoek naar sterfteverschillen in lage- en middeninkomenslanden te bevorderen. Deze typologie onderscheidt de '*developmental state*' (Woo-Comings, 1999), de *'health care state*', de '*transitional state*', '*neo-liberal state*' en de '*failing or predatory state*'. In Hoofdstuk 10 wordt beschreven hoe volgens mij het nivo van sterfte en de omvang van sociaal-economische sterfteverschillen variëert tussen deze typen staten.

De **Annex** presenteert internationale overzichten en vergelijkingen van arm-rijk verschillen in kindersterfte en een aantal proximale determinanten van kindersterfte (gezondheidszorggebruik, ondervoeding bij kinderen, en fertiliteit) voor 43 lage- en middeninkomenslanden. De resultaten kunnen worden samengevat in de volgende vijf hoofdboodschappen: (1) In vrijwel alle lage- en middeninkomenslanden bestaat er een grote ongelijkheid in kindersterfte en in directe determinanten van kindersterfte tussen armere en rijkere bevolkingsgroepen. (2) Er bestaat een systematische relatie tussen economische status en kindersterfte voor alle welvaartsgroepen. Ditzelfde geldt voor proximale determinanten van kindersterfte. Arm-rijk verschillen in gezondheidsuitkomsten zijn dus niet slechts een fenomeen van de armsten in vergelijking met de rijksten, maar treffen ook alle welvaarstlagen daartussen. (3) In sommige landen is ongelijkheid in kindersterfte en proximale determinanten veel groter dan in andere landen. (4) Reductie van arm-rijk verschillen in kindersterfte, door middel van het terugbrengen van sterfte onder lagere sociaal-economische groepen, zou een aanzienlijke verbetering van de volksgezondheid in lage- en middeninkomenslanden opleveren. Kindersterfte zou in de meeste landen met meer dan 30%

dalen indien sterfte onder alle groepen zou worden gereduceerd tot het nivo van de rijken binnen die landen; in sommige landen zou kindersterfte zelfs met meer dan 50% dalen. Ook zou gezondheidszorggebruik sterk toenemen, ondervoeding onder kinderen afnemen en fertiliteit dalen indien arm-rijk verschillen in deze uitkomsten zouden worden gereduceerd. (5) Ongelijkheid in sommige indicatoren (*e.g.* professionele zorg bij de bevalling) is veel groter dan ongelijkheid in andere indicatoren (*e.g.* immunisatie tegen kinderziekten).

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Curriculum vitae

Tanja AJ Houweling was born on the 10th of May 1975, in Amsterdam, The Netherlands. She grew up in the small town of Monnickendam, and obtained her secondary school degree at Scholengemeenschap Damstede in Amserdam. At 18 years old, she went for half a year to Indonesia, to explore what life was like as an anthropologist. She studied Indonesian language and culture at Satya Wacana Christian University in Salatiga, lived for some time in a tiny village on Bali with an elderly lady who made temple offerings for a living, and travelled across the country. Upon return in the Netherlands, she enrolled at university to study cultural anthropology and non-western sociology, as she had planned since she was eight years old. Tanja specialized in medical anthropology, urban sociology and Indonesian language and culture. She followed executive courses on child health, gender and health, and infectious diseases (University of Amsterdam), a master class on health, human rights and development (Leiden University) and public health and tropical health courses (Agricultural University Wageningen and Universitas Indonesia). She was 'Master-assistant' of Dr. Peter Nas, which resulted in several publications on urban settings, among others in an encyclopaedia. Tanja returned to Indonesia to do a field study and live in a poor neighbourhood in Jakarta, where she was hosted by the Indonesian NGO Yayasan Kusuma Buana. Tanja was awarded the "Prof.dr. Speckmann price" for her field study and MA thesis "Tapestry of Treatment: treatment-seeking behaviour among poor households in Jakarta in the context of the economic crisis". Tanja graduated *cum laude* for her propedeutics and *cum laude* for both her Masters degree in cultural anthropology and in non-western sociology at Leiden University, the Netherlands. Subsequently, she did PhD research at the Department of Public Health at Erasmus University in Rotterdam (promotor Prof.dr. J.P. Mackenbach, co-promotor Dr. A.E. Kunst). Concurrently, she obtained her MSc degree in Epidemiology (Netherlands Institute for Health Sciences), did a small study for the World Bank, went as consultant to Ethiopia to train Red Cross volunteers in the use of Participatory Rural Appraisal methods, and was involved in a technical consultation to WHO Geneva on measuring health inequalities. Tanja has also been involved in teaching on health inequalities. She has worked for two months as visiting researcher with Dr. Kath Moser and Prof.dr. Dave Leon at the London School of Hygiene and Tropical Medicine.

Tanja is currently employed as a research fellow at the Department of Epidemiology and Public Health at University College London, where she works as a member of the Secretariat of the Commission on Social Determinants of Health. This Commission has been set up by the World Health Organisation and is chaired by Professor Sir Michael Marmot.

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