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**Fairer Decisions, Better Health
for All: Health Equity and Cost-
Effectiveness Analysis**

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CHE Research Paper 135

Fairer decisions, better health for all: Health equity and cost-effectiveness analysis

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Abstract

This report provides a non-technical introduction to practical methods for using cost-effectiveness analysis to address health equity concerns, with applications to low-, middle- and high-income countries. These methods can provide information about the likely impacts of alternative health policy decisions on inequalities in health, financial risk protection and other health-related outcomes that may be considered unfair, allowing for the distribution of costs as well as benefits. They can also provide information about the trade-offs that sometimes arise between improving total health and reducing health inequalities of different kinds. We distinguish three general ways of using cost-effectiveness analysis to address health equity concerns: (1) equity impact analysis, which quantifies the distribution of costs and effects across a population by equity-relevant variables such as socioeconomic status, ethnicity, location, gender, age and severity of illness; (2) equity constraint analysis, which counts the cost of choosing fairer but less cost-effective options; and (3) equity weighting analysis, which uses equity weights or parameters to explore how much concern for equity is required to choose fairer but less cost-effective options. We hope this report will raise awareness of the practical tools of cost-effectiveness analysis that are now available to help give health care and public health policy makers a better understanding of who gains and who loses from their priority setting decisions.

Further resources are available at this website:

http://www.york.ac.uk/cbe/research/equity/economic_evaluation/

Executive summary

Introduction

Health equity has risen to prominence on policy agendas across the world, in the wake of the universal health coverage movement and landmark international reports on social inequalities in health and health care. Conventional cost-effectiveness analysis (CEA) can help decision makers identify smarter investments that deliver larger health gains from limited resources. Currently, however, most CEA studies do not provide information about who gains and who loses from policy decisions. Both producers and users of cost-effectiveness analysis need to start paying more attention to health equity concerns – and this report shows how.

Cost-effectiveness analysis

In the health sector, CEA usually focuses on getting the largest total health benefit for a given cost. Standard CEA of this kind can help to inform decision making in at least four different health policy contexts, each of which involves different though overlapping communities of decision makers, analysts and stakeholders:

1. Purchasing costly new health care technologies – e.g. whether to fund imatinib for stomach cancer, at what price, and for which patients?
2. Designing health care benefit packages – e.g. whether to cover diabetes in a public health insurance plan, and if so which diabetes treatments to include?
3. Investing in health care infrastructure – e.g. whether to invest in a community health worker programme, and if so how to prioritise investments in different geographical areas?
4. Public health – e.g. whether to implement a sugar tax, and if so how much should it be?

CEA provides decision makers with a standard way of assessing value for money. It compares the value of the outcomes generated by a policy intervention against those that could have been achieved with alternative uses of the same resources, i.e. the ‘opportunity costs’. In (1), for example, the funding could be used for other hospital-based cancer treatments – or, with more difficulty, shifted towards primary care. In (2), there may only be enough income from premiums or taxes to cover diabetes or dementia – but not both. In (3), the investment could instead be used to buy hospital equipment. Lastly, in (4), a sugar tax will increase the price of sugar-sweetened products, potentially requiring households to cut back on consumption. In each case, equity may play an important but typically unanalysed role: standard CEA does not tell us who gains the most, nor who bears the heaviest burden of opportunity costs.

Trade-offs between maximising total health and reducing health inequities

In ‘win-win’ cases standard CEA may be all that is needed, because the cost-effective policy that maximises total health also reduces a particular health inequity. However, more careful analysis of equity impacts may be needed in ‘win-lose’ cases, when a policy improves total health but harms health equity, and in ‘lose-win’ cases, when improvement in equity comes at the expense of lower total health.

Improving total health and health equity are often aligned, and ‘win-win’ cases are common. When delivered equally to all social groups, for example, programmes of vaccination and primary care for infectious diseases may be not only highly cost-effective but also more beneficial to disadvantaged groups at higher risk of infection. But delivery is not always equal. For example, delivery costs may be relatively high and effective healthcare coverage relatively low in poor urban areas and remote rural areas which lack well-resourced clinics and struggle to recruit qualified medical staff. In such

cases, delivery may be unequal unless additional resources are invested to facilitate delivery to disadvantaged groups – resulting in trade-offs between cost-effectiveness and health equity, and hard choices between more equal delivery versus larger total health gains.

Three ways of using cost-effectiveness analysis to address health equity concerns

- (1) **Equity impact analysis.** The effects of alternative policy options can be broken down by one or more social variables. The distribution of opportunity costs may also be presented, based on evidence and assumptions about where the funding comes from and who would otherwise have gained the most from alternative use of scarce resources.
- (2) **Equity constraint analysis.** Equity can be analysed as an ethical constraint on the pursuit of cost-effectiveness, rather than as an outcome. The opportunity cost of imposing this ethical constraint can be calculated as the difference in total health benefit between the policy that offers the most total health and a more equitable policy option.
- (3) **Equity weighting analysis.** When there are trade-offs between improving total health and reducing health inequity, the implications of different value judgements about those trade-offs can be analysed by conducting sensitivity analysis around how much decision makers care about reducing health inequity. This can be done using ‘equity weights’ for health benefits to people with different characteristics, or ‘equity parameters’ quantifying the degree of concern for reducing health inequity versus improving total health.

Alongside these analyses, one can also conduct an **equity evidence review** to provide useful information for decision makers by identifying previous studies on the relevant health inequities and the distributional impacts of similar policies that have been studied in other contexts.

Two specific methods of equity-informative cost-effectiveness analysis

We describe two specific methods of equity-informative CEA. Extended Cost-Effectiveness Analysis (ECEA), developed by the Disease Control Priorities, 3rd edition (DCP3) project (www.dcp-3.org), examines the social distribution of costs, health effects and financial risk protection effects. Distributional Cost-Effectiveness Analysis (DCEA), developed by the University of York, examines the distribution of health benefits and opportunity costs and then, if health equity trade-offs are identified, conducts equity constraint and weighting analyses to provide further information about the nature of those trade-offs. ECEA is particularly useful when health policy decisions have substantial impacts on household financial risk protection, as is often the case in low- and middle-income countries. DCEA, by contrast, is better suited to cases where impacts on household income and financial risk protection are less important, as is the case in high-income countries like the UK with well-developed social protection safety nets and universal publicly funded health care systems.

Key messages for decision makers who use cost-effectiveness studies

- Some decisions involve trade-offs between improving health and reducing health inequity.
- Such trade-offs can occur, for example, when delivering services to disadvantaged communities requires additional cost, due to poor infrastructure or utilisation barriers.
- In such cases, equity-informative CEA can help make fairer decisions.

Key messages for analysts who produce cost-effectiveness studies

- Who gains most depends on social variation in several factors including health risks, access to care, adherence to care, quality of care, clinical effects, and capacity to benefit.
- Providing a full picture of health equity impacts requires analysing not only who gains but also who bears the opportunity costs of diverting scarce resources from other uses.
- Understanding health equity impacts can benefit from analysis of social inequality in service delivery and the implementation costs of attempting to reduce this inequality.
- Health equity findings should include sensitivity analysis that helps decision makers understand the implications of alternative value judgements about equity.

Introduction

Health equity has risen to prominence on policy agendas, in the wake of the universal health coverage movement (Gwatkin and Ergo 2011, Norheim, Ottersen et al. 2014, Cotlear, Nagpal et al. 2015, Wagstaff, Cotlear et al. 2016) and landmark international reports on inequality in health (Marmot, Friel et al. 2008, Marmot, Allen et al. 2012) and health care (WHO 2014, World Health Organization 2015). However, the cost-effectiveness studies that are routinely used across the globe to inform decision making in health care and public health rarely provide information about who gains and who loses from alternative decisions (Sassi, Archard et al. 2001, Cookson, Drummond et al. 2009, Culyer 2012, Johri and Norheim 2012, Daniels, Portenry et al. 2016).

Equally, most studies of health equity lack a cost-effectiveness perspective. A cost-effectiveness perspective can enhance health equity research in two important ways. First, as well as understanding the nature and causes of health inequalities, decision makers need to know how the policy options open to them are likely to impact upon health inequalities. This requires not only epidemiological analysis of the determinants of health inequalities, but also economic analysis of costs and how policies are likely to change individual and organisational behaviour. Second, when evaluating the health equity impacts of policies the distribution of opportunity costs matters as well as the distribution of benefits. If costs fall on government budgets for health, education or other public services, for example, this is likely to have a disproportionate impact on disadvantaged populations who rely most heavily on those public services.

This report brings together two different strands of literature – on cost-effectiveness analysis and on health equity – and shows how they can be integrated in a practical way to provide decision makers with useful information about health equity concerns. It describes methods for using cost-effectiveness analysis to provide new information about inequalities in health-related outcomes that may be considered unfair, or as ‘health inequities’.

In recent years there have been a number of methodological advances in this area which have been developed into practical tools (Verguet, Murphy et al. 2013, Asaria, Griffin et al. 2015, Verguet, Laxminarayan et al. 2015, Verguet, Kim et al. 2016). The technical details of these new methods have been published in scientific journals in a form suitable for health economists, but may require further description to be communicated in a more user-friendly manner suitable for the policy makers and managers who commission and use cost-effectiveness evidence and for students and scholars in disciplines outside health economics.

This report focuses on methods of analysis, rather than processes of decision making. Evidence about health inequities generated using the methods described in this report is only one input into decision making, and there are further important issues – not addressed in this report – about how to design processes of decision making that appropriately reflect concerns about health inequities (Culyer and Lomas 2006). Re-aligning the methods of CEA to address equity concerns is only one facet of the much larger question of how to design fair processes of decision making that appropriately address equity concerns (Culyer 2012, Culyer 2016). Equity-informative CEA can only address an important subset of the diverse stakeholder concerns about fairness that may arise in relation to a specific decision, and decision makers will always need to consider wider issues and wider sources of information. One useful approach to ensuring that decision makers give due attention to wider equity concerns, for example, is the use of ‘equity checklists’ (Culyer and Bombard 2012, Norheim, Baltussen et al. 2014). More fundamentally, robust institutional structures, processes and incentives are needed to ensure that decision makers take appropriate steps to reduce inequities in health, as well as new methods of analysis. Analysis of the health equity implications of decisions cannot help to improve decision making, for example, if it is poorly

conducted or communicated, if it is based upon the idiosyncratic value judgements of a narrow group of experts rather than a broader community of stakeholders, if policy advisers lack sufficient training to understand the findings, or if the conclusions are disregarded by decision makers who merely pay lip-service to health equity concerns.

Implicitly or explicitly, all CEA studies already embody social value judgements about equity in scoping and methodological decisions about the relevant policy options and comparators, about which costs and effects to measure, about how to compare costs and effects of different kinds, about how to aggregate costs and effects for different people and organisations, about how to value future costs and effects, and so on (Shah, Cookson et al. 2013). To take just one example, a methodological decision to include 'productivity costs' in the cost denominator will increase the implicit priority given to life-extending treatments for 'productive' citizens, such as high-earning parents of young children, compared with 'unproductive' citizens, such as frail older people. Indeed, the basic ethical underpinning of standard cost-effectiveness analysis adheres to an equity principle – the principle that health policy makers should seek to increase sum total population health as much as possible given scarce resources, and hence that each unit of health gain should be valued equally, regardless of who obtains it (Cookson 2015). These value judgements are rarely mentioned in applied CEA studies or health technology assessment (HTA) reports, but are extensively discussed in textbooks, methods guidance documents and other underpinning literature (Culyer 2016). This article shows how to go beyond embodying pre-specified value judgements about equity within applied CEA studies, and towards using the techniques of CEA to provide new information about the health equity implications of alternative policy options that facilitate deliberation among decision makers and stakeholders (Culyer 2012, Culyer 2016).

This report has two main sections. In the first section, we introduce key concepts of cost-effectiveness analysis and health equity. In the second section we then describe three general approaches and two specific methods for using cost-effectiveness analysis to address health equity concerns. These approaches are illustrated with applications to low-, middle- and high-income country settings.

Part I: Concepts

Cost-effectiveness analysis

Cost-effectiveness analysis compares the costs and effects of one policy option with another policy option – which might be ‘do nothing’ (Drummond, Sculpher et al. 2015). Health effects are often measured using a composite summary index of health, such as the quality-adjusted life year (QALY) or the disability-adjusted life year (DALY), to facilitate comparison between policies in different disease areas with diverse and distinct mortality and morbidity impacts. This allows the calculation of a cost per QALY gained, or cost per DALY averted. A cost-increasing policy option can then be considered ‘cost-effective’ if its cost per unit of health gain compares favourably with alternative ways of using scarce resources.

In a public health system with a fixed budget, the displaced activities will comprise alternative health programs that would have produced alternative health benefits. Cost-effectiveness can then be defined as a test of whether a program will improve total health. A cost-effective policy will have a positive net health impact, because its health gains will outweigh the health losses from shifting expenditure away from other health programs. By contrast, a cost-ineffective policy will have a negative net health impact, because the health losses from shifting expenditure away from other health programs will outweigh the health gains. The policy objective underpinning conventional CEA can then be interpreted as the quasi-utilitarian health equity objective of maximising sum total health in the general population (Culyer 2006, Cookson 2015). CEA can thus help decision makers to choose investments that increase total health, and avoid investments that reduce total health. This interpretation of opportunity costs in terms of forgone health benefits is more problematic if there is no fixed health budget, in which case opportunity costs may instead fall on household consumption (via increased taxes or insurance premiums) or on reductions in public expenditure on programs not primarily designed to improve health. Whatever the setting in which CEA is used, however, the recognition of opportunity costs – i.e. that resources used in the provision of a program would have generated value if used elsewhere – is fundamental to CEA. Every benefit attributed to a program must be weighed against those displaced when resources are diverted from alternative activities.

To provide useful information for priority setting decisions, it is important to give a clear description of the options being compared and the policy context. Decision makers can then assess how far these options are relevant to their own decision making context. Comparisons of hypothetical policy options may have limited use in helping with the task of setting priorities between specific health sector investment decisions. However, they can help with the task of ‘agenda setting’ or ‘making the case’ in favour of investment in a broad policy area (e.g. mental health) or a broad objective or direction of travel for policy making. For example, a 2013 report by the Lancet Commission on Investing in Health made the case that low- and middle- income countries should all set a long-term policy ambition of achieving universal health coverage by the year 2035 (Jamison, Summers et al. 2013). This case was supported by an economic evaluation comparing two hypothetical policy options – no growth in health spending versus sustained long-term growth so as to achieve universal health coverage by 2035.

Cost-effectiveness studies of specific policy alternatives can help to inform priority setting in at least four decision contexts, each of which involves different though overlapping communities of decision makers, analysts and stakeholders. Decisions that are considered investments should also consider disinvestments as these are likely to have distributional consequences as well:

1. Pricing and reimbursement of new pharmaceuticals and other health technologies – e.g. whether to fund imatinib for stomach cancer, at what price, and for which patients?

2. Health care benefit package design – e.g. whether to cover diabetes in the national health insurance plan, and if so which diabetes interventions to include in the package?
3. Investments in healthcare organisation and delivery infrastructure – e.g. whether to invest in a community health worker programme, and if so how many and what kinds of new staff to recruit, located where, and with what pay and conditions?
4. Public health investments and regulations – e.g. whether to implement a sugar tax, and if so how much should it be?

In each case, cost-effectiveness analysis can provide decision makers with a standard way of assessing the value for money of specific policy options compared with alternative uses of scarce resources. In (1), for example, the funding for imatinib could be used for other hospital-based cancer treatments – or, with more difficulty, shifted towards primary care. In (2), there may only be enough money to cover diabetes or dementia – but not both. In (3), the investment could instead be used to buy hospital equipment. And in (4), the opportunity costs of a sugar tax will be felt by consumers paying higher food prices – potentially pushing some further into poverty. In each case, equity plays an important but typically unanalysed role: standard cost-effectiveness analysis does not tell us who gains most, nor who bears the heaviest opportunity costs.

Health equity

In this report, we use the term ‘health inequities’ in a broad sense to refer to differences in health-related outcomes that may be considered unfair, inequitable or unjust (Whitehead 1992, Norheim, Baltussen et al. 2014). Health equity then refers to the policy goal of seeking to reduce or eliminate health inequities. Under our broad definition, health inequities may include not only inequalities in health per se but also inequalities in outcomes related to ill-health and lack of access to affordable health care, such as catastrophic health care expenditure, impoverishment, inability to work, and inability to perform domestic tasks such as child care. These outcomes may be unequally distributed – for example, decisions about public funding for a particular medical technology could have differential impacts by social group on healthcare costs, or on ability to work or perform domestic tasks, and the resulting financial risks to households.

Figure 1 shows differences in people's lifetime experience of health in England and Ethiopia in the year 2011 (Dawkins 2015, Asaria et al. 2015, Love-Koh. 2015); see Annex.

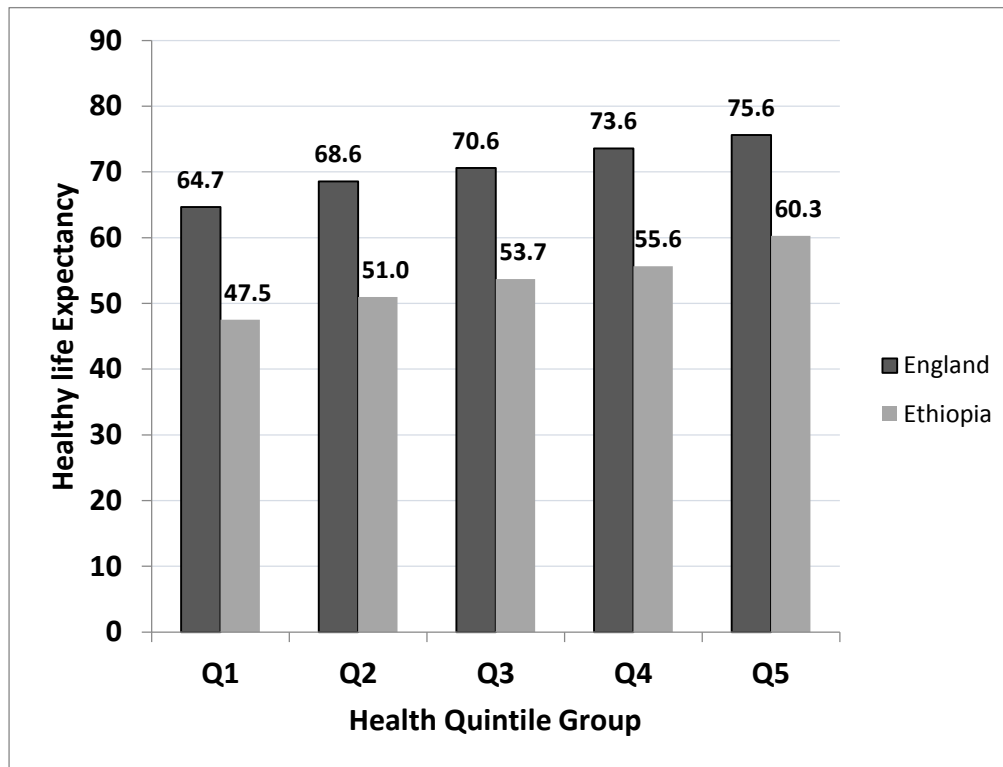


Figure 1: Distribution of Healthy Life Expectancy in England and Ethiopia in 2011

Note: This figure compares quintile groups of healthy life expectancy at birth as predicted by socioeconomic status and sex only.

The figure shows healthy life expectancy at birth by health quintile groups. The health quintile groups are based on healthy life expectancy at birth as predicted by just two equity-relevant variables: socioeconomic status and sex. We use health quintile groups, rather than socioeconomic groups, to emphasise that policy makers may be concerned with many different sources of inequality in health. In principle, we could also include variation due to further equity-relevant variables such as ethnicity, region, working conditions and so on. The figure shows that there is a gradient in health within each country, but also that there is an inequality between countries since the most advantaged health group in Ethiopia does not achieve as much health as the least advantaged in England. If considered unfair, the differences in **Figure 1** represent health inequities.

Differences in health-related outcomes are sometimes considered fair, and equality in health-related outcomes are sometimes considered unfair. For example, providing different health services to people with different needs may be fair, and providing the same services to people with different needs may be unfair. More controversially, if someone's life is cut short by a random accident – a matter of 'residual' or 'unexplained' bad luck, not avoidable or remediable by any social action – this might by some be considered unfortunate or tragic, but not a matter of social injustice (Hausman 2013). This can make a big difference to inequality analysis. For example, if we consider 'unexplained' variation to be unfair, we would need to include it in Figure 1 and predict the 'ex post' distribution of healthy length of life, allowing for unexplained variation in mortality and morbidity, which would include much more variation than the 'ex ante' distribution of healthy life expectancy (Asada, Hurley et al. 2015).

In assessing how far a particular difference is ‘unfair’, there are always thorny issues of both scientific and social value judgement to consider. For example, inequality in life expectancy may be considered more ‘unfair’ when it is caused by unequal childhood circumstances than by lifestyle choices in adulthood. Judgements of this kind turn on contestable scientific judgements about complex causal pathways in the face of imperfect evidence, as well as contestable ethical issues of social value judgement. That is why we use the cautious phrase ‘differences that may be considered unfair’ in our definition of inequity, rather than the bolder phrase ‘unfair differences’ – to emphasise that value judgements about equity are properly a matter for decision makers and stakeholders rather than analysts.

We also use the less well-known term, ‘health equity impacts’, to mean changes in health inequities brought about by policy interventions. In practice, due to data limitations, modelling of health equity impacts is typically restricted to differences associated with categorical social group variables such as income or wealth groups, education groups, ethnic groups, by gender or region. For example, a social variable commonly used in low- and middle-income country applications is wealth quintile based on a survey of household assets, and a social variable commonly used in high income country applications is socioeconomic quintile group based on small area deprivation. These were the socioeconomic variables used to estimate the figures in **Figure 1** for Ethiopia and England, respectively. When suitable data are available, health equity impacts can also include impacts on within-group differences associated with continuous social variables, such as income, or even impacts on the whole-population univariate distribution of health unrelated to any particular social variable.

There are many reasons for policy concern about health inequalities, one of which is that all forms of social inequality – including health inequality – may act as a kind of ‘social pollution’ that is bad for everyone’s health in society (Wilkinson and Pickett 2010). In principle, if a particular decision had large impacts on the distribution of wealth and power within society, it might be worth incorporating the resulting change in the level of ‘social pollution’ into cost-effectiveness analysis. When evaluating most health policies, however, it is reasonable to assume that impacts on social inequality as a whole will be relatively small and hence that any indirect impacts on health via changes in the level of ‘social pollution’ will be too small to be worth including in the analysis.

The tools described in this report can be used to provide information about health equity impacts for decision makers and stakeholders; it is then up to them to process the information, draw conclusions and take decisions based on their own value judgements.

Accounting for the social distribution of opportunity costs

The distribution of policy costs matters, as well as the distribution of policy benefits. Understanding health equity impacts requires analysing not only who gains health benefits but also who bears the opportunity costs – the forgone health benefits that could have been generated through alternative ways of using the same scarce resources may also be unequally distributed. The distribution of opportunity costs will depend crucially on where the funding for the policy or programme comes from. For example, if the money comes from an increase in progressive general taxation, the absolute opportunity costs are likely to be borne disproportionately by the rich and the opportunity costs in terms of losses in health and wellbeing may be equally distributed. By contrast, if it is funded by reducing public expenditure on other health, education or welfare services, the opportunity costs in terms of losses in health and wellbeing may be borne disproportionately by poorer individuals who rely more heavily upon public services. The same applies to foreign aid funding that would otherwise be used to fund alternative programs that disproportionately benefit more socially disadvantaged people.

In order to estimate net health equity impact accurately one needs to compare the health benefits and health opportunity costs using the same metric. To do this, it is usually necessary to measure health outcomes using a generic health measure that can be compared across different diseases, such as QALYs or DALYs, rather than in disease specific units such as cases of malaria prevented. This is because we typically do not know which patient groups will bear the health opportunity costs, and without a generic measure of health it is hard to compare the value of a case of malaria prevented versus a case of cancer or tuberculosis or heart disease. The only case in which it might make sense to compute health benefits and opportunity costs in the same disease specific unit is if there is a fixed budget for a 'vertical programme' in a particular disease area, which cannot be used for treating any other disease. In that case, the opportunity costs of alternative uses of the budget will all fall on patients with that specific disease, and so it may make sense to measure both health benefits and opportunity costs in disease specific units. Where reliable data on morbidity impacts are not available for computing QALYs or DALYs, an alternative is to measure health benefits in terms of life years or mortality risk reduction. However, this is less comparable with health opportunity costs because some interventions focus primarily on reducing morbidity rather than mortality, and the balance between the two can vary substantially between different disease areas.

Insofar as public and donor expenditure tends disproportionately to benefit socially disadvantaged groups, this provides a tough benchmark for assessing the health equity impacts of specific public or donor-funded programmes compared with other uses of public or donor funding. As **Figure 2** shows, interventions that may initially seem to have a 'pro-poor' health equity impact may in fact be equity-neutral or even 'anti-poor', when one considers where the money is coming from and what the alternative uses of that money would be. This is shown with the downward arrows that convert the 'gross' health impacts – considering programme benefits only – to 'net' health impact, after allowing for the health opportunity costs of alternative uses of the money.

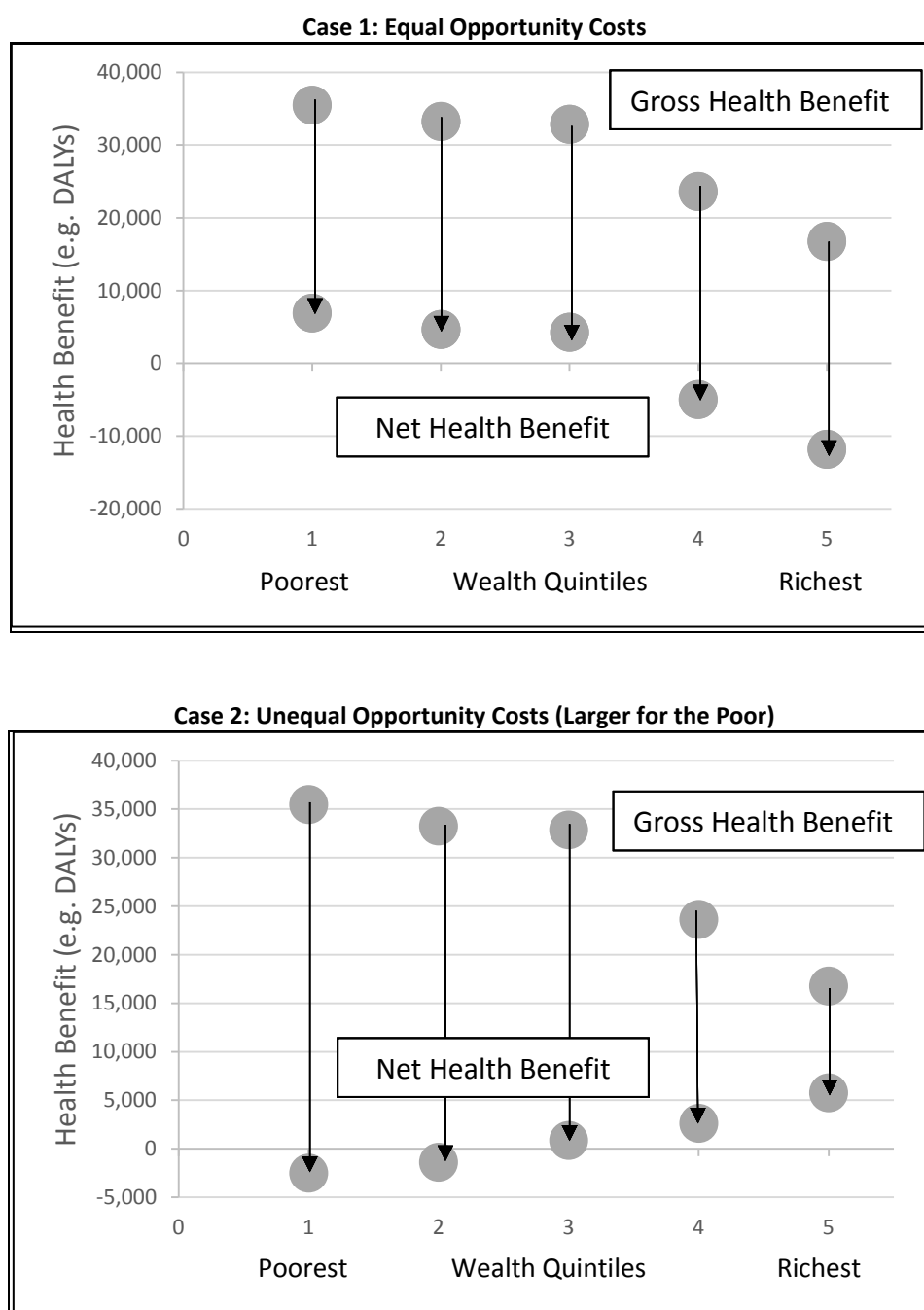


Figure 2. Distribution of Net Health Benefits from a Hypothetical Programme

The top panel of **Figure 2** illustrates the assumption that health opportunity costs (forgone health benefits) are constant across all groups. For an investment in a hypothetical programme the gross health benefits as seen in the top lines of each case in **Figure 2**, show the same distribution of benefit. In case 1, as the opportunity costs are accounted for by taking the forgone benefits to be constant across wealth quintiles leads one to conclude there is a 'pro-poor' distribution of net health benefits. That is, the poor appear to benefit more in the net benefits of case 1 with negative net health benefits for the richest. The bottom panel illustrates the assumption that the opportunity costs are unequally distributed and disproportionately borne by more socially disadvantaged groups. The result is now a 'pro-rich' distribution of net health benefits, with negative net health benefits for the poorest. This public programme is less pro-poor than alternative public programmes. So if the

goal is to reduce health inequality, the money would be better spent on other public programmes rather than this one.

Empirically estimating the distribution of opportunity costs is difficult. However, work is under way by researchers at the University of York to estimate the social distribution of the opportunity costs of public healthcare expenditure in England, and similar studies in the future could provide other relevant estimates to be incorporated in future work.

Trade-offs between total health and health equity

Health maximisation and health equity are often aligned, but not always. The ‘health equity impact plane’ in **Figure 3** helps one to think about the potential trade-offs (McAuley, Denny et al. 2016). The vertical axis shows the cost-effectiveness of a health intervention. As explained above, this can under certain assumptions be interpreted as its ‘net total health impact’ – i.e. the total health benefits of the programme minus the forgone health benefits that would have been obtained by spending the money on other health programmes. The horizontal axis shows the ‘net health equity impact’, which refers to the net impact upon fairness in the distribution of health after allowing for opportunity costs as well as benefits. Health equity impact can be defined and measured in various ways, as discussed below.

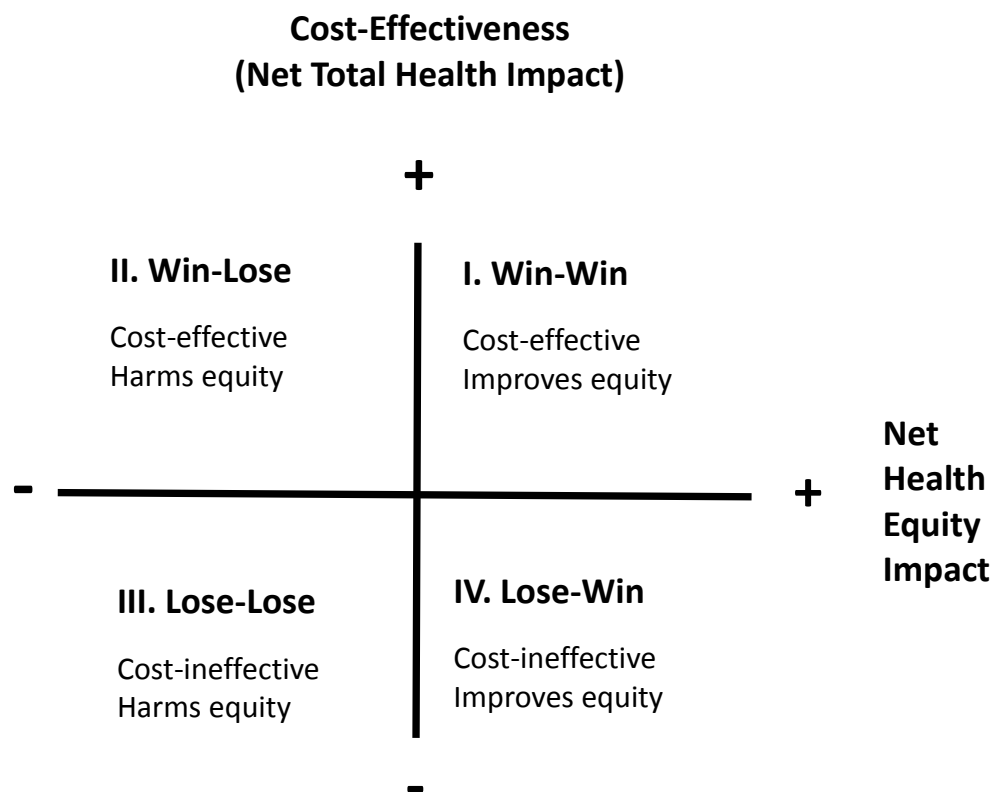


Figure 3: Health Equity Impact Plane

The plane defines four quadrants. In quadrant I (‘win-win’), the policy improves both total health and equity, and in quadrant III (‘lose-lose’), the policy harms both. In these two cases, health maximisation and equity are aligned. In the other two quadrants, by contrast, health maximisation and equity are opposed and there may be trade-offs. In quadrant II (‘win-lose’), the policy is good for total health but bad for equity, and in quadrant IV (‘lose-win’), the policy is bad for total health but good for equity.

If all policies fell in the two aligned quadrants (win-win and lose-lose) then there would be no need to analyse health equity impacts. We would then have a guarantee that a policy identified as cost-effective using standard CEA approaches would always improve health equity, and a cost-ineffective policy would always harm health equity.

Many policies do indeed fall into these two quadrants. In low-income countries, for example, investments in high-cost hospital treatments often fall into the 'lose-lose' quadrant of being neither cost-effective nor likely to reduce health inequality, insofar as they deliver relatively small health gains per unit of cost and disproportionately benefit wealthy urban elites. By contrast, programmes of vaccination and primary care for infectious diseases often fall into the 'win-win' quadrant of delivering large health gains per unit cost and reducing health inequality, insofar as they disproportionately benefit socially disadvantaged groups at high risk of infection.

However, socially disadvantaged groups may sometimes gain less than more advantaged groups from a decision to fund a particular medical technology, due to unequal access, utilisation, adherence, quality and outcomes of healthcare (Tugwell, de Savigny et al. 2006). For example, access costs may be relatively high, and effective healthcare coverage relatively low, in urban slums and remote rural areas which lack well-resourced clinics and struggle to recruit qualified medical staff. In such cases, there may be trade-offs between health maximisation and health equity – and hard choices between more equal delivery versus larger total health gains.

Measuring health equity impacts

Health inequities can be measured in different ways depending on the decision problem in hand and the equity concerns of the relevant decision makers and stakeholders. There are many useful training resources describing how to do so, in general (O'Donnell, van Doorslaer et al. 2008, Fleurbaey and Schokkaert 2011, Asada, Hurley et al. 2014), in the context of health system performance monitoring (World Health Organization 2013) and in the context of cost-effectiveness analysis (Asaria, Griffin et al. 2013). In each case, at least four basic questions must be addressed:

1. Equality of what?
2. Equality between whom?
3. Equality indexed how?
4. Equality adjusted how?

In relation to 'equality of what?', for example, the central equity concern might be inequality in health, or inequality in capacity to benefit, or inequality in financial risk protection; and there are many different metrics for measuring each of these concepts. In relation to 'equality between whom?', for example, the unit of analysis might be individuals or households or geographical areas or social groups, and the inequality breakdowns of interest may relate to socioeconomic status, ethnicity, gender or other social variables. In relation to 'equality indexed how?', different indices of inequality may contain different normative judgments and can yield quite different patterns of change depending for example whether they are defined in terms of relative or absolute differences and in terms of achievement or shortfall (e.g. survival or mortality) (Harper, King et al. 2010) (Arcaya, Arcaya et al. 2015, Kjellsson, Gerdtham et al. 2015, Wagstaff 2015). In relation to 'equality adjusted how', it is rarely enough to measure crude, unadjusted differences in health-related outcomes: one should also consider adjusting for factors that influence the assessment of how far differences are unfair (Asada, Hurley et al. 2014, Asada, Hurley et al. 2015). For example, differences in health care utilisation may be fair if they are due to difference in needs or preferences; and differences in health outcomes may be fair if they are due to differences in exogenous factors beyond the control of health services, such as a patient's age. This adjustment process can yield different answers depending on the selection of standardising variables, the choice of reference values for those

variables, and different model specifications and methods of adjustment (e.g. direct versus indirect standardisation). To measure health inequality that is considered unfair, for example, differences in mortality risk between socioeconomic groups may be partly driven by (or masked by) differences in the age structure of the different groups. Insofar as age is not considered to be an 'unfair' determinant of mortality, an adjustment is needed to control for the influence of age on mortality. There are various more or less sophisticated ways of adjusting for 'fair' differences in outcomes, but whatever approach is taken it is important to be as clear and explicit as possible about the contestable value judgements about fairness that underlie such adjustments.

Health equity concerns can be placed on a spectrum from general to specific. At the broad end of this spectrum is concern to reduce unfair inequality in lifetime health between all individuals (Norheim 2010, Robberstad and Norheim 2011). At the specific end of the spectrum might be concern for equalising the benefits of a particular policy between urban and rural groups over a particular time period. There are at least four aspects of health equity concern that can vary depending on whether a more general or specific perspective is adopted:

1. Levels vs. gains – concern for equality in health levels (more general) rather than concern for the health gains arising from a specific policy (more specific)
2. Outcome specificity – concern for equality in health (more general) rather than concern for equality in the ill-health burden of cancer (more specific)
3. Time horizon – concern for equality over the life course (more general) rather than equality in a particular age group or over a specific time period (more specific)
4. Single vs. multiple social variables – concern for inequality by multiple social variables (more general) rather than by one social variable (e.g. urban vs. rural)

Figure 4 illustrates a specific equity impact, using a modified version of a hypothetical example used in a 2004 article in the Lancet (Gwatkin, Bhuiya et al. 2004). It shows two policies for increasing coverage of skilled birth attendance in a low-income country – a ‘universal’ policy and a ‘targeted’ policy that focuses on developing maternity service infrastructure in socially disadvantaged areas. It shows that the ‘targeted’ policy is less equal in terms of the distribution of gains: it delivers larger benefits to socially disadvantaged groups, in terms of increases in the proportion of birth deliveries attended by a skilled midwife. From this highly specific perspective, the ‘targeted’ policy may seem unfair to people in the middle and upper wealth groups who gain less.

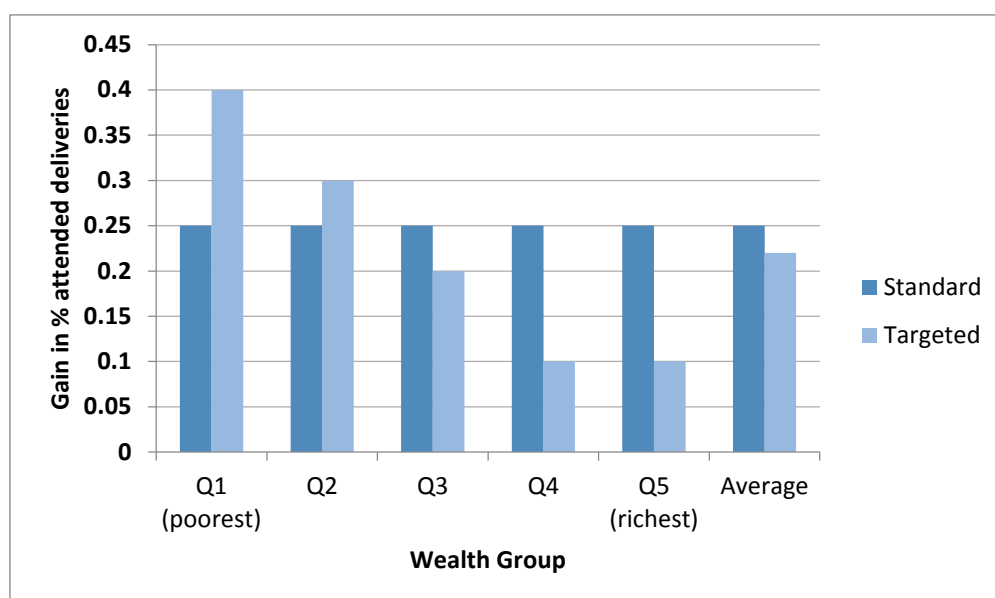


Figure 4: Coverage gains by wealth group, comparing standard and targeted options for improving maternity services in a low income country – hypothetical example based on (Gwatkin, Bhuiya et al. 2004)

However, **Figure 5** shows that the ‘targeted’ policy is more equal in terms of the resulting levels of attended deliveries. If one takes this broader perspective, the ‘targeted’ policy may seem fairer.

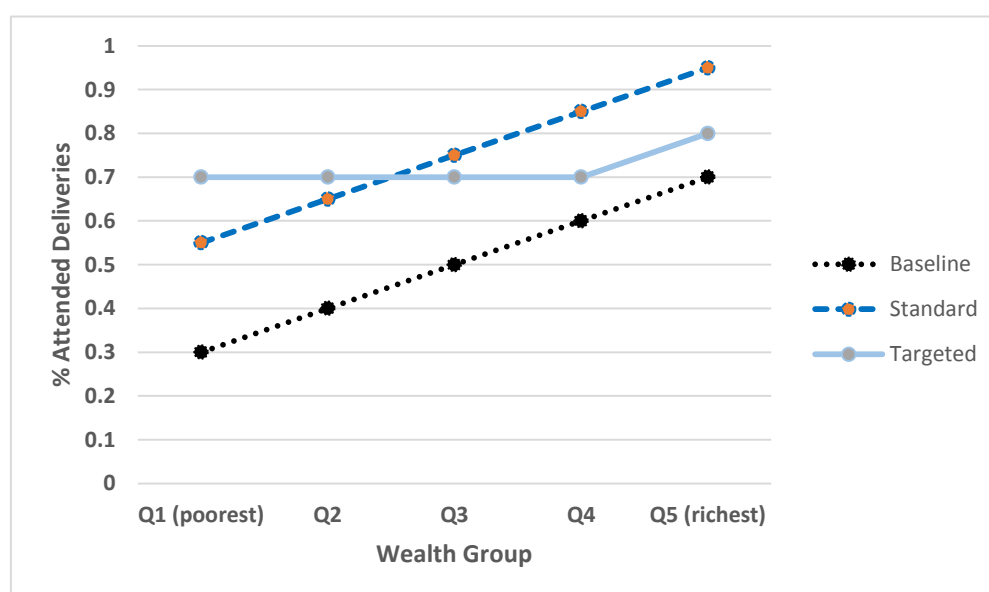


Figure 5: Coverage levels by wealth group, comparing standard and targeted options for improving maternity services in a low-income country – hypothetical example

One might also wish to take an even broader perspective, by looking at impacts on inequalities in lifetime health of the kind illustrated by **Figure 1** earlier in this report. From this perspective, the ‘targeted’ policy will seem even fairer, since it will help to reduce the large pre-existing inequality in lifetime health between socioeconomic groups. This is easy to show using mathematical indices of inequality. However, an important challenge for communicating lifetime health impacts to decision makers is that individual policy decisions typically have small impacts on expected lifetime outcomes for the average citizen. Health equity impacts still matter, however, even though they seem small from the ‘ex ante’ perspective of expected changes in risk of future mortality and morbidity – since we are still talking about large and important changes in many people’s lives from an ‘ex post’ perspective looking back at how far they experienced a long and healthy life (Eyal, Hurst et al. 2013). From an ‘ex ante’ population perspective, the cost-effectiveness impacts of most policy decisions also seem small – costing little to the average citizen and adding only a small proportion to average healthy life expectancy. Furthermore, a sustained sequence of small impacts can over time accumulate into a large impact.

Quantifying health equity trade-offs

When there are trade-offs between health equity and total health – i.e. we know that the policy lies in either the ‘win-lose’ or ‘lose-win’ quadrants of **Figure 3** – it can be helpful to provide a more refined quantitative analysis of those trade-offs. One general approach, which we call ‘equity constraint analysis’, is to count the cost of choosing a fairer but less cost-effective policy, in terms of a reduced total health (QALY equality) benefit. Another general approach, which we call ‘equity weighting analysis’, is to quantify how much concern for health inequity is required to recommend a fairer but less cost-effective policy option, using sensitivity analysis. This sensitivity analysis can be done by specifying alternative ‘equity weights’ for health benefits to different people, or alternative values of an ‘inequality aversion parameter’ quantifying your degree of concern for reducing health inequality versus improving total health (Norheim 2013) (Asaria, Griffin et al. 2013, Wagstaff, Cottle et al. 2016). Sensitivity analysis can help decision makers understand the implications of alternative value judgements. The aim of health equity trade-off analysis is thus to help inform a decision making process, rather than to impose a particular set of value judgements upon decision makers.

Part II: Methods

This part of the report describes three general ways of using cost-effectiveness analysis to evaluate policy concerns about health equity, each of which addresses different equity questions (Cookson, Drummond et al. 2009, Johri and Norheim 2012). These are: equity impact analysis, equity constraint analysis and equity trade-off analysis. Table 1 provides a definition of each approach and the questions they help to answer.

Table 1. Three General Approaches to Evaluating Health Equity Concerns

Approach	Description	Questions Answered
Equity impact analysis	Disaggregation of the relevant costs and benefits by equity-relevant sub-groups, providing a dashboard of results.	How much do different social groups gain or lose? This may be in terms of money, health services, health outcomes or other outcomes related to ill-health and access to affordable health services, such as financial risk protection.
Equity constraint analysis	Calculation of the health opportunity cost of choosing a fairer option rather than a more cost-effective option.	How much total health benefit is forgone if a more cost-effective option is ruled out on equity grounds?
Equity weighting analysis	Sensitivity analysis around the value of health equity impacts, based on different concepts of inequality, and the strength of concern for reducing health inequality.	How large is the health equity impact in terms of standard summary metrics of inequality? How much concern for health equity is required to choose a more equitable option compared with a more cost-effective option?

We use the umbrella term ‘equity-informative cost-effectiveness analysis’ to describe any study that uses the methods of cost-effectiveness analysis to provides information about health equity objectives other than improving total health. We illustrate two specific methods of equity-informative cost-effectiveness analysis. Extended Cost-Effectiveness Analysis (ECEA), developed by the Disease Control Priorities, 3rd edition project (www.dcp-3.org), examines the social distribution of costs, health effects and financial risk protection effects. Distributional Cost-Effectiveness Analysis (DCEA), developed by the University of York, examines the distribution of health benefits and opportunity costs and then, if health equity trade-offs are identified, conducts equity constraint and equity trade-off analyses to provide further information about the nature of those trade-offs. The key difference between these two methods is that ECEA presents estimation of financial risk protection (e.g. poverty reduction benefits) and disaggregated information on a range of different costs and effects, while DCEA aggregates and compares all costs and effects using the common currency of QALYs or DALYs, thus allowing the construction of summary indices of inequity and equity weighting analysis.

We first describe methods of equity evidence review that can be performed alongside or prior to cost-effectiveness analysis in order to provide information about health equity concerns.

Equity evidence review

Equity evidence review can address a range of health equity questions of interest to decision makers, for example ‘What are the relevant health equity issues?’, ‘What do stakeholders think?’, ‘What is already known about the size of pre-existing health inequities?’ and ‘What do studies of past policies suggest may be the potential health equity impacts of the policy options currently under consideration?’.

There are published guidelines for using the methods of systematic review of randomised controlled trials to gather information about equity impacts, such as the PROGRESS framework adopted by both the Campbell and Cochrane Collaborations (O'Neill, Tabish et al. 2014). **Box 1** describes a Cochrane systematic review regarding food supplementation for disadvantaged young children; another example is the review by Brown and colleagues of the equity impact of interventions and policies to reduce smoking in youth (Brown, Platt et al. 2014) and another is the review by Noor and colleagues about reducing inequity in use of insecticide-treated bed nets in Kenya (Noor, Amin et al. 2007). Systematic review methods have an important role in helping to avoid the all-too-common trap of falling unknowingly into a selective reading of the evidence, and to avoid 're-inventing the wheel'. However, systematic reviews can be resource intensive, and often require several months of work by large multi-disciplinary teams. Furthermore, there are ongoing debates about appropriate review methods for complex interventions where theoretical and observational evidence may play a more central role than randomised controlled trials. So if the requisite capacity is not available to conduct a systematic review, it may be useful to undertake a rapid review.

It is also possible to conduct a review of philosophical arguments about equity in relation to a particular case, such as the 'ethical case review' approach that Miljeteig and colleagues used to examine end-of-life decisions in a neonatal unit in India (Miljeteig, Johansson et al. 2010). However, in conducting a review of this kind analysts must be wary of going too far down the road of adjudicating between alternative views of justice in an attempt to answer the question 'what is fair?', rather than clarifying alternative points of view so that decision makers can make up their own minds.

Box 1 – Example of an equity evidence review

Food supplementation for disadvantaged young children – a systematic review

Kristjansson and colleagues use the Cochrane systematic review method to examine interventions to address malnutrition in young children. They primarily review the effectiveness of supplementary feeding interventions, but they secondarily look at how such interventions interact with inequalities, implementation and adverse outcomes. We focus in this synopsis on what they find for inequality.

The authors develop a conceptual framework to guide thinking about how inequalities may factor into childhood nutrition and health. Equity was then evaluated by looking at outcomes for given subgroups such as age, sex, level of malnourishment (baseline health) and socioeconomic status.

Meta-analysis of the studies and differences between sub-groups were then conducted. The results of this review and analysis find that supplementary feeding programmes have unequal impacts on certain subgroups, being more effective for children who were poorer and more malnourished, but no difference of impact in other subgroups such as by sex of the child.

Reference: Kristjansson E, Francis DK, Liberato S, Benkhalti Jandu M, Welch V, Batal M, Greenhalgh T, Rader T, Noonan E, Shea B, Janzen L, Wells GA, Petticrew M. Food supplementation for improving the physical and psychosocial health of socio-economically disadvantaged children aged three months to five years. *Cochrane Database of Systematic Reviews* 2015, Issue. DOI: 10.1002/14651858.CD009924.pub2.

Equity impact analysis

Equity impact analysis examines who gains and who loses from one policy option compared with another, and by how much. Typically, this approach yields a ‘dashboard’ of outcomes, showing gains and losses by social group for various different kinds of costs and effects. This provides the decision-maker with relevant disaggregated information on the equity impacts.

An example of equity impact analysis alongside cost-effectiveness analysis in a high income context is the study by Holmes and colleagues of the impacts of minimum alcohol pricing in the UK (Holmes, Meng et al. 2014). This study estimated the social class distribution of effects on alcohol consumption, spending and alcohol-related health harm, and found that benefits are substantially concentrated on heavy drinkers in routine and manual worker households.

The DCP3 project has developed a specific method of cost-effectiveness analysis that incorporates equity impact analysis and analysis of financial risk protection effects as well as health effects, called ‘extended cost-effectiveness analysis’ (ECEA) (Verguet, Laxminarayan et al. 2015). This method has now been applied to about 20 studies of policy interventions in several different low- and middle-income country settings, producing breakdowns of costs, health benefits and financial risk protection benefits by socioeconomic quintile group (Verguet and Jamison forthcoming). **Box 2** gives an example of ECEA relating to tobacco taxes in China.

Sometimes equity impact analysis only examines the benefits of a policy, not the costs. As explained above, this provides an incomplete picture of health equity impact, since it only looks at one side of the distributional coin: the costs may also be unequally distributed.

Equity impact analyses can also be performed outside the context of cost-effectiveness analysis, to look at the impacts of changes in risk factors, health behaviours or the utilisation of effective health technologies, rather than the impacts of specific policy options. For example, Bajekal and colleagues examined the impacts on coronary heart mortality in England from 2000 to 2007 of changes in risk factors and treatment utilisation in different social groups (Bajekal, Scholes et al. 2012). This kind of study does not directly inform the priority setting task of selecting between specific future policies, as it does not provide information about either the costs of those policies or their effects on risk factors, health behaviours or the utilisation of effective health technologies. However, it can provide decision makers with useful contextual information for policy making purposes, in raising awareness of the importance of particular factors and their contributions to health inequality.

Box 2 – Example of an equity impact analysis**Tobacco tax in China – an “extended cost-effectiveness analysis” (ECEA)**

This modelling exercise examines a 50% excise tax on cigarettes over a 50-year period. In aggregate, this is estimated to save 231 million life years, add \$703 billion in tax revenue to government budgets, reduce expenditure on tobacco-related illness and improve financial risk protection.

The ECEA further breaks down model inputs by equity-relevant groups, in this case by five income quintiles. The descriptive tables of the paper show how input variables such as smoking prevalence, cigarette consumption, price elasticity and health utilization are all parametrized according to income quintile.

The results are presented in a dashboard-like format, where the aggregate results are broken down into results for each quintile group. For example, the years of life gained are more concentrated on the poor (79 million in the poorest quintile) than the rich (11 million in the richest quintile), as seen in the figure below. Expenditures on tobacco, which one may worry would be regressive with a new excise tax, also show a progressive distribution in absolute terms, or an inverted U distribution in relative terms. In either case, the tax is shown not to overly harm the poor.

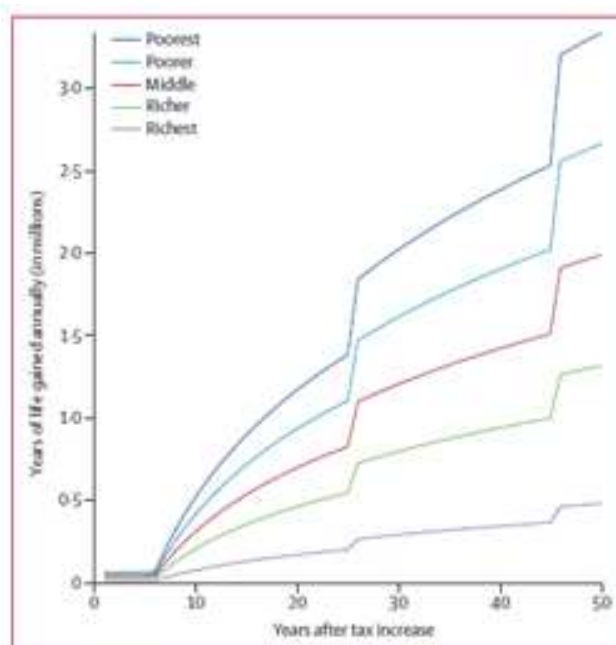


Figure 1: Annual years of life gained for the tobacco excise tax increase (50% retail price increase) in China, over 50 years, by income quintile

Lastly, the ECEA also incorporates financial risk protection benefits. In the case of the Chinese tobacco tax, this is measured as a money-metric value of insurance. This is similarly disaggregated by income quintile, showing that there is more financial risk protection for the poorer quintiles.

Reference: Verguet S, Gauvreau CL, Mishra S, MacLennan M, Murphy SM, Brouwer ED, Nugent RA, Zhao K, Jha P, Jamison DT. The consequences of tobacco tax on household health and finances in rich and poor smokers in China: an extended cost-effectiveness analysis. *The Lancet Global Health*. 2015 Apr 30;3(4):e206-16.

Finally, a form of equity impact analysis known as ‘benefit incidence analysis’ looks at the benefits of public healthcare spending as a whole for different social groups. Traditionally, this kind of analysis has typically assumed that health benefits are proportional to health care consumption, and has only looked at the average benefits of the current overall level of spending rather than the marginal benefits of changes in spending. So traditional forms of benefit incidence analysis have not been useful for predicting the health benefits of a policy decision to change expenditure from the current baseline level. However, some benefit incidence analyses are now starting to look at marginal benefits, by exploiting data on sub-national variation and change in expenditure and outcomes, and so can be more useful for priority setting purposes (Kruse, Pradhan et al. 2012).

Equity constraint analysis

Equity can be analysed as a constraint on the pursuit of cost-effectiveness, rather than as a goal or outcome to be pursued in its own right. The health opportunity cost of imposing this ethical constraint can be calculated as the difference in total health benefit between the most cost-effective policy option and a more equitable policy option. The health loss associated with choosing a more equitable option thus gives an indication of the value the decision maker places on equity (Williams and Cookson 2006). This approach can be implemented either using a simple cost-effectiveness framework comparing two or more options given a fixed budget, or using more specialised ‘mathematical programming’ techniques to handle complex choices involving different amounts of expenditure on different programmes (Earnshaw, Richter et al. 2002, Epstein, Chalabi et al. 2007).

Box 3 – Example of an equity constraint analysis

HIV Treatment in South Africa – a mathematical programming study

Cleary and colleague analyse the equity concern to provide only the most effective treatment as a constraint on improving total health in relation to anti-retroviral (ART) HIV treatment in South Africa. They measure cost-effectiveness in terms of QALYs gained per unit of cost, and equity in terms of the percentage of met need for ART.

The study uses mathematical programming to examine different treatment delivery scenarios under different health budgets. As budgets increase, more total health can be provided. However, at given budget levels there are trade-offs and more cost-effective solutions exist that deliver larger total health gains by offering some people cheaper but less effective treatments rather than fully meeting their needs by providing the most effective treatment. Hence particular target levels of met need (the equity constraint) are only achievable by sacrificing total health.

This approach highlights that the opportunity cost of equity can be understood in terms of the amount of health that is forgone by implementing a more equitable solution, as opposed to implementing the most cost-effective solution under a given budget constraint.

Reference: Cleary, S., Mooney, G., & McIntyre, D. (2010). Equity and efficiency in HIV-treatment in South Africa: the contribution of mathematical programming to priority setting. *Health Economics*, 19(10), 1166-1180. doi:10.1002/hec.1542

Equity weighting analysis

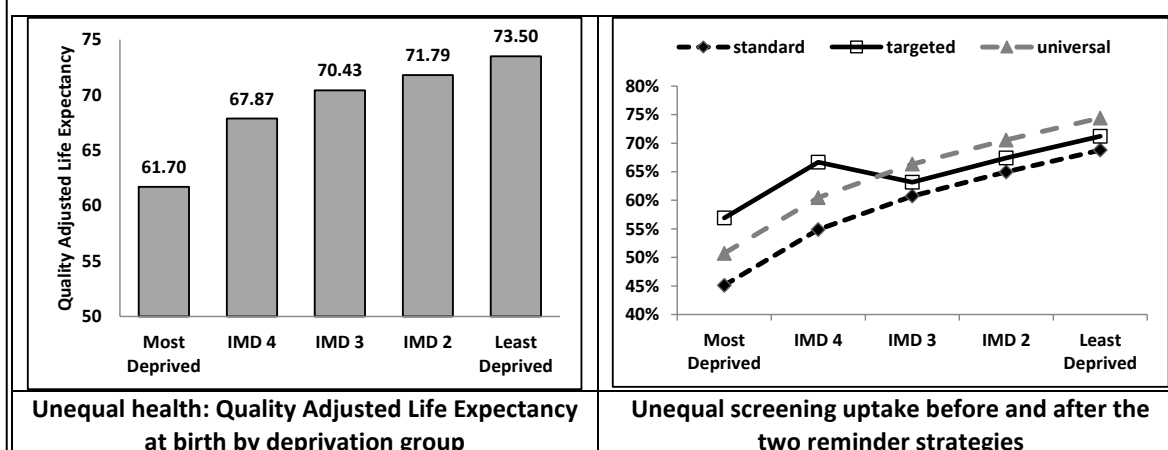
The final approach is health equity weighting analysis. In contrast to the previous approaches, this approach attempts to quantify the overall health equity impact, using summary indices of inequality, and to analyse trade-offs between the health equity impact and the net health impact (Johansson and Norheim 2011, Norheim 2013, Asaria, Griffin et al. 2015). The basic idea is to conduct sensitivity analysis in order to find out how much you need to care about reducing inequality to recommend a fairer option rather than a health maximising option. This sensitivity analysis can be done by specifying alternative 'equity weights' for health benefits to different people, or alternative values of an 'equity parameter' quantifying your degree of concern for health equity versus improving total health. **Box 4** illustrates, using an example comparing more equitable and more cost-effective ways of increasing uptake of colorectal cancer screening in England.

Many different characteristics of health policies and the people affected by them could be used as the basis for setting 'equity weights', and several different equity weighting systems have been proposed (Wailoo, Tsuchiya et al. 2009, Cookson, Griffin et al. 2014). Many of these systems do not pay special attention to the social characteristics of people, but rather focus on their health characteristics – for example, their current severity of illness, or their overall lifetime experience of health including past, present and future health (Nord 1993, Williams 1997, Lindemark, Norheim et al. 2014, Ottersen, Mæstad et al. 2014, Ottersen, Forde et al. 2016, Rowen, Brazier et al. 2016). These systems tend to be based upon one or more 'equity parameters', such as an inequality aversion parameter within a social welfare function, which specifies how much you care about reducing unfair health inequality rather than how much you care about individuals with certain social characteristics (Asaria, Griffin et al. 2013). An 'equity parameter' then indirectly implies a set of equity weights for people with different characteristics, in conjunction with information about the existing distribution of health between individuals with different characteristics. These implied weights will then change in response to changes in the distribution of health and social variables.

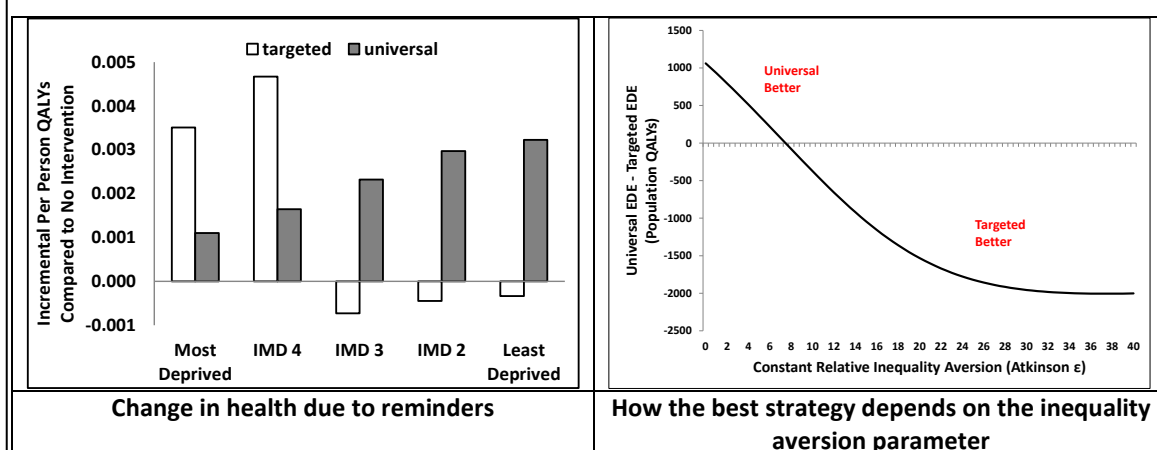
If decision makers are interested in impacts on relative inequality (e.g. life expectancy ratios), as well as absolute inequality (e.g. life expectancy gaps) then they will require an estimate of the baseline distribution of health – since the impact on relative inequality depends upon the baseline. Furthermore, since equity trade-off analysis requires the estimation of net health impacts, benefits have to be quantified using the same metric as opportunity costs, for example using annual mortality risk, life years, QALYs or DALYs.

Box 4 – Example of an equity weighting analysis**Bowel Cancer Screening in England – a “distributional cost-effectiveness analysis” (DCEA)**

This study compares two strategies for increasing uptake of a universal bowel cancer screening programme. The “targeted” strategy focuses on social groups with low uptake, by sending a personalised reminder from their family doctor; the “universal” strategy sends a generic reminder to everyone. Inequality impacts are analysed by deprivation, ethnicity and gender, and then combined to assess the overall impact. The illustrations below focus on inequality by deprivation. The left hand panel below shows unequal health by deprivation group before the screening programme. The right hand panel shows unequal uptake of screening from the “standard” programme and after the “targeted” and “universal” reminder strategies.



The left hand panel below shows the resulting changes in health. The targeted strategy is inequality reducing but produces less total health than the universal strategy, which is inequality increasing. Which strategy you consider best depends on how much you care about reducing health inequality versus improving total health. The right hand panel shows how this trade off can be quantified using the inequality aversion parameter from an Atkinson social welfare function. Which strategy you consider better depends on how much you care about reducing health inequality – in this case, the “targeted” strategy is better if your inequality aversion parameter is greater than 8. Recent survey data suggest the average member of the English general public has an inequality aversion parameter of around 11 (Robson, Asaria et al. 2016).



Reference Asaria, Miqdad, Susan Griffin, and Richard Cookson. "Distributional Cost-Effectiveness Analysis: A Tutorial." *Medical Decision Making* 36.1 (2016): 8-19.

In the past, some authors have taken a sceptical view about the value of equity weighting analysis (Sassi, Archard et al. 2001). However, we take a more pragmatic approach. Equity weighting analysis will not be useful when there are no trade-offs between improving total health and health equity. However, equity trade-off analysis may be useful when decision makers do face difficult trade-offs. Often there will not be trade-offs, as seen in many examples where there are 'win-win' scenarios. However, previous studies have often not paid close attention to the question of whether additional delivery costs are required in disadvantaged communities due to poor infrastructure, weak governance and access barriers; nor have they analysed the distribution of opportunity costs from public or donor budgets. Due to issues of this kind, there will sometimes be difficult trade-offs due to social variation in access, adherence and effectiveness, and social variation in opportunity costs, and in such cases there may be a need for equity trade-off analysis (Eyal, Hurst et al. 2013). Analysis of these trade-offs can help decision makers understand the implications of alternative value judgements; and the use of equity parameters and weights can help form useful 'benchmarks' for decision makers to compare across different decisions. As with the cost-effectiveness threshold, this kind of benchmark can be useful to decision makers as a way of justifying their decisions in the face of competing political demands from rival stakeholders, and of facilitating both transparency and consistency between decisions.

Conclusion

In response to growing policy concern about health equity, the tools of economic evaluation are being re-fashioned to provide useful evidence about health equity impacts and trade-offs. Our report has described the key concepts and methods now available for using cost-effectiveness analysis to analyse health equity concerns. We have distinguished three general approaches: (1) equity impact analysis, (2) equity constraint analysis and (3) equity weighting analysis. We have also described two specific methods of 'distributional economic evaluation' that incorporate equity impact analysis within economic evaluation: 'extended cost-effectiveness analysis' (ECEA) and 'distributional cost-effectiveness analysis' (DCEA). ECEA examines the distribution of costs, health outcomes and financial risk protection outcomes; and DCEA combines equity impact analysis with equity constraint and trade-off analyses.

Our report has the following conclusions for decision makers who use cost-effectiveness studies:

- Some decisions involve equity trade-offs between total health and health equity.
- Equity trade-offs can occur when delivering services to more disadvantaged communities if it requires additional investment of resources, due to poor infrastructure, weak governance, and utilisation barriers.
- In the face of equity trade-offs, equity-informative economic evaluation can be used to provide useful quantitative information to help make fairer decisions and improve health for all.

Our report also has the following conclusions for analysts who produce cost-effectiveness studies:

- Who gains most depends on social variation in several factors including health risks, access to care, adherence to care, quality of care, clinical effects, and capacity to benefit.
- Providing a full picture of health equity impacts requires analysing not only who gains but also who bears the opportunity costs of diverting scarce resources from other uses.
- Accurate estimates of health equity impacts requires analysis of social inequality in service delivery and the implementation costs of attempting to reduce this inequality, rather than merely assuming that services will be delivered and used in the same way and at the same cost in advantaged and disadvantaged communities
- Health equity findings should include sensitivity analysis that helps decision makers understand the implications of alternative value judgements about equity.

Using CEA to analyse distributional equity impacts and trade-offs requires the same basic analytical skills as standard cost-effectiveness analysis. However, it is more demanding in terms of data requirements because it requires social distributions of key parameters rather than merely population average values. Data limitations can be particularly severe in low-income countries which lack basic health information systems such as vital statistics on births and deaths, and hospital and primary care administrative data. However, as the DCP3 project has amply demonstrated, distributional economic evaluation studies can successfully be performed in low-income countries using existing datasets and existing, large survey-based datasets in low-income countries such as UNICEF's Multiple Indicator Cluster Survey (MICS) and ICF International's Demographic and Health Surveys (DHS), among others, which include information disaggregated by socioeconomic status (ICF-International-USAID 2016, UNICEF 2016). Datasets are improving all the time, and in the future it will become increasingly feasible to estimate social distributions of key parameters in economic evaluation studies.

Three important frontiers of research in this field are (1) research on the distribution of opportunity costs of funding health programmes from different sources (e.g. public health care, donor budgets, taxation), (2) research on the implementation costs of achieving more equal delivery and utilisation of services in disadvantaged communities, and (3) research on public and stakeholder views about health equity trade-offs to provide benchmark values to help guide decision makers faced with difficult policy trade-offs. Work on the distribution of opportunity costs issue is ongoing in England, drawing on existing research on variation in health care expenditure and outcomes at sub-national level (Claxton, Martin et al. 2013). This issue is particularly challenging in low- and middle-income countries where the existence of informal health systems, donor aid, and a variety of health financing models creates challenges for identifying where the opportunity costs lie, and is a critical area for further research.

We hope this report will help those who produce, commission and use evidence to support priority setting in health care and public health to navigate the practical options for using the techniques of cost-effectiveness analysis to provide policy makers with more useful information about the health equity implications of their decisions.

Further reading

Asada, Y., J. Hurley, O. F. Norheim and M. Johri (2014). A three-stage approach to measuring health inequalities and inequities. *International Journal for Equity in Health* 13(1): 98.

Asaria, Miqdad, Susan Griffin, and Richard Cookson. 'Distributional Cost-Effectiveness Analysis: A Tutorial.' *Medical Decision Making* 36.1 (2016): 8-19.

Cookson, R., M. Drummond and H. Weatherly (2009). 'Explicit incorporation of equity considerations into economic evaluation of public health interventions.' *Health Econ Policy Law* 4(Pt 2): 231-245.

Cleary, S., Mooney, G., & McIntyre, D. (2010). Equity and efficiency in HIV-treatment in South Africa: the contribution of mathematical programming to priority setting. *Health Economics*, 19(10), 1166-1180. doi:10.1002/hec.1542

Culyer, A. J. (2012). 'Hic Sunt Dracones: The Future of Health Technology Assessment—One Economist's Perspective.' *Medical Decision Making* 32(1): E25-E32.

Culyer, A. J. (2016). 'HTA – Algorithm or Process?; Comment on 'Expanded HTA: Enhancing Fairness and Legitimacy'.' *International Journal of Health Policy and Management* 5(8): 501-505.

Culyer AJ, Bombard Y. An equity framework for health technology assessments. *Med Dec Making*. 2012; 32: 428 – 441.

Daniels, N., T. Porteny and J. Urritia (2016). 'Expanded HTA: enhancing fairness and legitimacy.' *International journal of health policy and management* 5(1): 1-3.

Johri, M. and O. Norheim (2012). 'Can cost-effectiveness analysis integrate concerns for equity? Systematic review.' *Int J Technol Assess Health Care* 28(2): 125 - 132.

Kjellsson, G., U.-G. Gerdtham and D. Petrie (2015). 'Lies, damned lies, and health inequality measurements: understanding the value judgments.' *Epidemiology* 26(5): 673-680.

Love-Koh, J., M. Asaria, R. Cookson and S. Griffin (2015). 'The Social Distribution of Health: Estimating Quality-Adjusted Life Expectancy in England.' *Value Health* 18(5): 655-662

Norheim, O., R. Baltussen, M. Johri, D. Chisholm, E. Nord, D. Brock, P. Carlsson, R. Cookson, N. Daniels, M. Danis, M. Fleurbaey, K. Johansson, L. Kipiriri, P. Littlejohns, T. Mbeeli, K. Rao, T. T.-T. Edejer and D. Wikler (2014). 'Guidance on priority setting in health care (GPS-Health): the inclusion of equity criteria not captured by cost-effectiveness analysis.' *Cost Effectiveness and Resource Allocation* 12(1): 18.

Thokaka P, Devlin, N, Marsh K, et al. Multiple Criteria Decision Analysis for Health Care Decision Making—An Introduction: Report 1 of the ISPOR MCDA Emerging Good Practices Task Force. *Value Health* 2016;19:1-13.

Verguet, S., J. J. Kim and D. T. Jamison (2016). 'Extended cost-effectiveness analysis for health policy assessment: a tutorial.' *PharmacoEconomics* 34(9): 913-923.

Williams, A. H. and R. A. Cookson (2006). 'Equity-efficiency trade-offs in health technology assessment.' *International Journal of Technology Assessment in Health Care* 22(1): 1-9.

Annex: Computation of the distribution of healthy life expectancy in Ethiopia

In England, the baseline socioeconomic distribution of healthy life expectancy can be estimated by linking whole-population administrative data on mortality, population and small area deprivation, and making adjustments for self-reported health-related quality of life based on survey data from a nationally representative random sample (Asaria et al., 2015, Love-Koh et al., 2015). However, estimating the distribution of healthy life expectancy is more challenging in low income countries such as Ethiopia, which lack reliable census and vital registration systems that can provide whole-population data on all-age population and mortality. We developed an approach which draws on WHO data on healthy life expectancy, a previous analysis of Demographic Health Surveillance (DHS) survey data on child mortality by household wealth asset group, and further adjustments for the distribution of morbidity based on additional DHS data on child and adult disease prevalence.

Our approach involved a three stage process. First, we took the average HALE values for men and women from the WHO database (WHO, 2015). Second, relative mortality weights by socioeconomic group were applied, based on a previous analysis of modelled life expectancy drawing on DHS data on child mortality by household asset group. Third, relative morbidity weights by socioeconomic group were applied based on available prevalence data. This is explained more fully below and in **Annex Table 1**. Like many methods used in practice in the global health field, our approach involves making a number of assumptions in order to extract useful information from imperfect data. It nevertheless provides a starting point for analysis until better data becomes available.

Stage 1: Healthy Life Expectancy

Healthy life expectancy (HALE) is a summary measure of population health measured in healthy life years (HALYs) that has begun to be included in WHO datasets of life expectancy. It is developed using Sullivan's method applied to country life tables and age-sex-specific estimates of severity-adjusted equivalent years of healthy life lost as a fraction of total years lived by each age-sex group. The latter is calculated by summing years of healthy life lost due to disability (YLD) across a comprehensive set of disease and injury causes drawing on analyses from the Global Burden of Disease study (WHO, 2014). HALE was chosen as the starting point for the analysis as it uses more detailed data on morbidity than rival approaches such as disability-free life expectancy, which only use binary morbidity data on whether or not a person has disability. By contrast, HALE uses cardinal data on health-related quality of life based on disease prevalence and public views about health loss associated with different disease states (Salomon, Wang et al. 2012). It also has the added benefit of being available for a wide range of countries, which is of particular importance when data limitations are so prominent. Again, no disaggregated HALE data is available but the HALE values give average measures of population health that take account of both quality and length of life, and therefore provide a reasonable starting point.

Stage 2: Adjust HALE according to distribution of life expectancy

As no life expectancy data that is disaggregated by social characteristics is available, modelled life expectancies by wealth quintile (taken from Tranvag, Ali et al. 2013) were used to calculate relative weights which were applied to the average HALE values for males (54 HALYs) and females (56 HALYs) (WHO, 2015). The modelled life expectancy values were calculated using a modified logit life table system which requires stratified under-5 and adult mortality data. Under-five mortality data by gender, urban-rural residence and wealth quintiles from the 2011 EDHS was used. In 2011 the EDHS surveyed 17,817 households 31% in urban areas and 69% in rural areas, interviewing 16,515 women and 14,110 men. Adult mortality rates by the same groups were not available and were, therefore, calculated using adult mortality and life expectancy from the Global Burden of Disease study 2010 and weighted ratios of under-5 mortality rates for the respective groups (see Tranvag, Ali et al. 2013 for full explanation). The relative weights were calculated by assuming the modelled life expectancy

of the middle wealth quintile, Q3, was equal to the mean life expectancy, and relative weights for the other quintile groups were calculated accordingly. By assuming that the distribution of life expectancy applies equally to the morbidity and mortality components of the HALE, these weights were applied as relative adjustment factors to the average HALE values to produce a distribution of HALE that reflects the distribution of life expectancy among the population according to their wealth.

Stage 3: Adjust HALE according to distribution of mortality

The distribution of HALE obtained in Stage 2 reflects the distribution of life expectancy. However, a second adjustment is required so that it also reflects the distribution of morbidity. This adjustment was based on data on the prevalence of disease disaggregated by wealth quintile group taken from the Ethiopia Demographic and Health Survey (Central Statistical Agency and ICF International, 2012). Of the available diseases for which prevalence data was available, those selected to form the basis of the adjustment were anaemia, diarrhoea and acute respiratory infection (ARI) in children. This selection was based on the diseases that accounted for the largest burden of disease according to the Global Burden of Disease study and was restricted to three diseases because of the limited number of diseases and health issues for which data is available (GBD, 2010, IHME, 2015). Only the prevalence in children was used because of the limited data on adult morbidity that was available. Consequently, for the morbidity adjustment it was assumed that there is equal morbidity in adults as in children. The average morbidity prevalence was calculated from the 3 diseases selected and was then subtracted from 100 to equate to the prevalence of good health. This was then used to calculate the relative adjustment factors for quality of life in the same way as for the adjustment for the distribution of life expectancy – assuming that the prevalence of good health for Q3 was equal to the average. By applying these relative adjustment factors to the HALE values obtained in Stage 1, a HALE distribution reflecting both the distribution of morbidity and the distribution of life expectancy was obtained. As before, this assumed that the morbidity adjustment applies equally to the morbidity and mortality components of HALE.

The Baseline Health Distribution

Following the adjustments for quality and length of life outlined above, the groups were ordered from least to most healthy and adjusted for the size of the group to produce a population distribution of HALE at birth (see **Figure 1** of main text).

Annex Table 1: Modelling the Baseline Health Distribution

Stage 1			Stage 2				Stage 3			
*Average HALE		Wealth Quintile	*Modelled Life expectancy	Adjustment Factor (LE)	Adjusted HALE		100-Average Morbidity Prevalence	Adjustment Factor (QoL)	Adjusted HALE	
Female	Male				Female	Male			Female	Male
56	54	Q1	53.4	0.88	49.35	47.58	76.5	0.97	48.19	46.47
		Q2	56.2	0.93	51.93	50.08	78	0.99	51.71	49.87
		Q3	60.6	1	56	54	78.33	1	56	54
		Q4	59.9	0.99	55.35	53.38	77.97	0.99	55.09	53.13
		Q5	62.5	1.03	57.76	55.69	82.97	1.06	61.17	58.99

*Source: WHO, 2015

**Source: Tranvag, Ali & Norheim, 2013

References

- Arcaya, M. C., A. L. Arcaya and S. V. Subramanian (2015). Inequalities in health: definitions, concepts, and theories. *Glob Health Action* 8: 27106.
- Asada, Y., J. Hurley, O. Norheim and M. Johri (2015). Unexplained health inequality - is it unfair? *International Journal for Equity in Health* 14(1): 11.
- Asada, Y., J. Hurley, O. F. Norheim and M. Johri (2014). A three-stage approach to measuring health inequalities and inequities. *International Journal for Equity in Health* 13(1): 98.
- Asada, Y., J. Hurley, O. F. Norheim and M. Johri (2015). Unexplained health inequality—is it unfair? *International Journal for Equity in Health* 14(1): 11.
- Asaria, M., S. Griffin and R. Cookson (2013). *Measuring health inequality in the context of cost-effectiveness analysis*. Health and Inequality (Research on Economic Inequality, Volume 21) Emerald Group Publishing Limited 21: 491-507.
- Asaria, M., S. Griffin, R. Cookson, S. Whyte and P. Tappenden (2015). Distributional cost-effectiveness analysis of health care programmes—a methodological case study of the UK Bowel Cancer Screening Programme. *Health Econ* 24(6): 742-754.
- Bajekal, M., S. Scholes, H. Love, N. Hawkins, M. O'Flaherty, R. Raine and S. Capewell (2012). Analysing recent socioeconomic trends in coronary heart disease mortality in England, 2000-2007: A population modelling study. *PLoS Medicine* 9: 12.
- Brown, T., S. Platt and A. Amos (2014). Equity impact of interventions and policies to reduce smoking in youth: systematic review. *Tob Control* 23(e2): e98-105.
- Central Statistical Agency [Ethiopia] and ICF International (2012). Ethiopia Demographic and Health Survey 2011. Addis Ababa, Ethiopia and Calverton, Maryland, USA, Central Statistical Agency and ICF International.
- Claxton, K., S. Martin, M. Soares, N. Rice, E. Spackman, S. Hinde, N. Devlin, P. C. Smith and M. Sculpher (2013). *Methods for the estimation of the NICE cost effectiveness threshold*. York: University of York.
- Cookson, R. (2015). Justice and the NICE approach. *Journal of medical ethics* 41(1): 99-102.
- Cookson, R., M. Drummond and H. Weatherly (2009). Explicit incorporation of equity considerations into economic evaluation of public health interventions. *Health Econ Policy Law* 4(Pt 2): 231-245.
- Cookson, R., S. Griffin and E. Nord (2014). *Incorporation of concerns for fairness in economic evaluation of health programs: overview*. Encyclopedia of Health Economics. A. J. Culyer. San Diego, Elsevier. 2: 27-34.
- Cotlear, D., S. Nagpal, O. Smith, A. Tandon and R. Cortez (2015). Going Universal: How 24 Developing Countries are Implementing Universal Health Coverage from the Bottom Up, World Bank Publications.

- Culyer, A. J. (2006). The bogus conflict between efficiency and vertical equity. *Health Economics* 15(11): 1155-1158.
- Culyer, A. J. (2012). Hic Sunt Dracones The Future of Health Technology Assessment—One Economists Perspective. *Medical Decision Making* 32(1): E25-E32.
- Culyer, A. J. (2016). HTA – Algorithm or Process?; Comment on Expanded HTA: Enhancing Fairness and Legitimacy. *International Journal of Health Policy and Management* 5(8): 501-505.
- Culyer, A. J. and Y. Bombard (2012). An equity framework for health technology assessments. *Medical Decision Making* 32(3): 428-441.
- Culyer, A. J. and J. Lomas (2006). Deliberative processes and evidence-informed decision making in healthcare: do they work and how might we know? *Evidence & Policy: A Journal of Research, Debate and Practice* 2(3): 357-371.
- Daniels, N., T. Porteny and J. Urritia (2016). Expanded HTA: enhancing fairness and legitimacy. *International Journal of Health Policy and Management* 5(1): 1-3.
- Dawkins, B. (2015). *Distributional Cost-Effectiveness Analysis in Global Health*. Masters of Science in Health Economics, University of York.
- Drummond, M. F., M. Sculpher, K. Claxton, G. L. Stoddart and G. W. Torrance (2015). *Methods for the Economic Evaluation of Health Care Programmes*, Oxford University Press.
- Earnshaw, S. R., A. Richter, S. W. Sorensen, T. J. Hoerger, K. A. Hicks, M. Engelgau, T. Thompson, K. M. Narayan, D. F. Williamson, E. Gregg and P. Zhang (2002). Optimal allocation of resources across four interventions for type 2 diabetes. *Med Decis Making* 22(5 Suppl): S80-91.
- Epstein, D. M., Z. Chalabi, K. Claxton and M. Sculpher (2007). Efficiency, Equity, and Budgetary Policies Informing Decisions Using Mathematical Programming. *Medical Decision Making* 27(2): 128-137.
- Eyal, N., S. A. Hurst, O. F. Norheim and D. Wikler (2013). *Inequalities in Health: Concepts, Measures, and Ethics*, Oxford University Press.
- Fleurbaey, M. and E. Schokkaert (2011). Chapter Sixteen - *Equity in Health and Health Care*. *Handbook of Health Economics*. T. G. M. Mark V. Pauly and P. B. Pedro, Elsevier. Volume 2: 1003-1092.
- Global Burden of Disease (GBD). (2010). GBD Profile: Ethiopia. Retrieved 22 July, 2015, from http://www.healthdata.org/sites/default/files/files/country_profiles/GBD/ihme_gbd_country_report_ethiopia.pdf.
- Gwatkin, D. R., A. Bhuiya and C. G. Victora (2004). Making health systems more equitable. *Lancet* 364(9441): 1273-1280.
- Gwatkin, D. R. and A. Ergo (2011). Universal health coverage: friend or foe of health equity? *The Lancet* 377(9784): 2160-2161.

Harper, S., N. B. King, S. C. Meersman, M. E. Reichman, N. Breen and J. Lynch (2010). Implicit value judgments in the measurement of health inequalities. *Milbank Q* 88(1): 4-29.

Hausman, D. (2013). *Egalitarian Critiques of Health Inequalities*. Inequalities in Health: Concepts, Measures, and Ethics. N. Eyal, S. A. Hurst, O. F. Norheim and D. Wikler. Oxford, Oxford Press 27.

Holmes, J., Y. Meng, P. S. Meier, A. Brennan, C. Angus, A. Campbell-Burton, Y. Guo, D. Hill-McManus and R. C. Purshouse (2014). Effects of minimum unit pricing for alcohol on different income and socioeconomic groups: a modelling study. *Lancet* 383(9929): 1655-1664.

ICF-International-USAID. (2016). The DHS Program: Demographic and Health Surveys. Retrieved 14 July 2016, 2016, from <http://www.dhsprogram.com/>.

Institute for Health Metrics and Evaluation (IHME). (2015). Ethiopia. Retrieved 22 July, 2015, from <http://www.healthdata.org/ethiopia>.

Jamison, D. T., L. H. Summers, G. Alleyne, K. J. Arrow, S. Berkley, A. Binagwaho, F. Bustreo, D. Evans, R. G. Feachem and J. Frenk (2013). Global health 2035: a world converging within a generation. *The Lancet* 382(9908): 1898-1955.

Johansson, K. A. and O. F. Norheim (2011). Problems with prioritization: exploring ethical solutions to inequalities in HIV care. *Am J Bioeth* 11(12): 32-40.

Johri, M. and O. Norheim (2012). Can cost-effectiveness analysis integrate concerns for equity? Systematic review. *Int J Technol Assess Health Care* 28(2): 125 - 132.

Johri, M. and O. F. Norheim (2012). Can cost-effectiveness analysis integrate concerns for equity? Systematic review. *Int J Technol Assess Health Care* 28(2): 125-132.

Kjellsson, G., U.-G. Gerdtham and D. Petrie (2015). Lies, damned lies, and health inequality measurements: understanding the value judgments. *Epidemiology* 26(5): 673-680.

Kruse, I., M. Pradhan and R. Sparrow (2012). Marginal benefit incidence of public health spending: Evidence from Indonesian sub-national data. *Journal of Health Economics* 31(1): 147-157.

Lindemark, F., O. F. Norheim and K. A. Johansson (2014). Making use of equity sensitive QALYs: a case study on identifying the worse off across diseases. *Cost Effectiveness and Resource Allocation* 12(1): 1.

Love-Koh, J., M. Asaria, R. Cookson and S. Griffin (2015). The Social Distribution of Health: Estimating Quality-Adjusted Life Expectancy in England. *Value Health* 18(5): 655-662.

Marmot, M., J. Allen, R. Bell, E. Bloomer and P. Goldblatt (2012). WHO European review of social determinants of health and the health divide. *The Lancet* 380(9846): 1011-1029.

Marmot, M., S. Friel, R. Bell, T. Houweling and S. Taylor (2008). Closing the gap in a generation: health equity through action on the social determinants of health. *Lancet* 372(9650): 1661 - 1669.

McAuley, A., C. Denny, M. Taulbut, R. Mitchell, C. Fischbacher, B. Graham, I. Grant, P. OHagan, D. McAllister and G. McCartney (2016). Informing Investment to Reduce Inequalities: A Modelling Approach. *PLoS One* 11(8): e0159256.

Miljeteig, I., K. A. Johansson, S. A. Sayeed and O. F. Norheim (2010). End-of-life decisions as bedside rationing. An ethical analysis of life support restrictions in an Indian neonatal unit. *J Med Ethics* 36(8): 473-478.

Noor, A. M., A. A. Amin, W. S. Akhwale and R. W. Snow (2007). Increasing coverage and decreasing inequity in insecticide-treated bed net use among rural Kenyan children. *PLoS Med* 4(8): e255.

Nord, E. (1993). The trade-off between severity of illness and treatment effect in cost-value analysis of health care. *Health Policy* 24(3): 227-238.

Norheim, O., R. Baltussen, M. Johri, D. Chisholm, E. Nord, D. Brock, P. Carlsson, R. Cookson, N. Daniels, M. Danis, M. Fleurbaey, K. Johansson, L. Kipiriri, P. Littlejohns, T. Mbeeli, K. Rao, T. T.-T. Edejer and D. Wikler (2014). Guidance on priority setting in health care (GPS-Health): the inclusion of equity criteria not captured by cost-effectiveness analysis. *Cost Effectiveness and Resource Allocation* 12(1): 18.

Norheim, O., T. Ottersen, F. Berhane, B. Chitah, R. Cookson, N. Daniels, N. Eyal, W. Flores, A. Gosseries and D. Hausman (2014). Making fair choices on the path to universal health coverage: Final report of the WHO consultative group on equity and universal health coverage, World Health Organization.

Norheim, O. F. (2010). Priority to the young or to those with least lifetime health? *Am J Bioeth* 10(4): 60-61.

Norheim, O. F. (2013). Atkinsons Index Applied to Health. Inequalities in Health: Concepts, Measures, and Ethics. N. Eyal, S. A. Hurst, O. F. Norheim and D. Wikler. Oxford, Oxford Scholarship Online: 30.

Norheim, O. F., R. Baltussen, M. Johri, D. Chisholm, E. Nord, D. Brock, P. Carlsson, R. Cookson, N. Daniels, M. Danis, M. Fleurbaey, K. A. Johansson, L. Kipiriri, P. Littlejohns, T. Mbeeli, K. D. Rao, T. T. Edejer and D. Wikler (2014). Guidance on priority setting in health care (GPS-Health): the inclusion of equity criteria not captured by cost-effectiveness analysis. *Cost Eff Resour Alloc* 12: 18.

ODonnell, O., E. v. van Doorslaer, A. Wagstaff and M. Lindelow (2008). Analyzing health equity using household survey data : a guide to techniques and their implementation. Washington, D.C., World Bank.

ONEILL, J., H. Tabish, V. Welch, M. Petticrew, K. Pottie, M. Clarke, T. Evans, J. Pardo Pardo, E. Waters, H. White and P. Tugwell (2014). Applying an equity lens to interventions: using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. *J Clin Epidemiol* 67(1): 56-64.

Ottersen, T., R. Forde, M. Kakad, A. Kjellefold, H. O. Melberg, A. Moen, A. Ringard and O. F. Norheim (2016). A new proposal for priority setting in Norway: Open and fair. *Health Policy*.

Ottersen, T., O. Mæstad and O. F. Norheim (2014). Lifetime QALY prioritarianism in priority setting: quantification of the inherent trade-off. *Cost Effectiveness and Resource Allocation* 12(1): 1.

Robberstad, B. and O. F. Norheim (2011). Incorporating concerns for equal lifetime health in evaluations of public health programs. *Soc Sci Med* 72(10): 1711-1716.

Robson, M., M. Asaria, A. Tsuchiya, S. Ali and R. A. Cookson (2016). *Eliciting the Level of Health Inequality Aversion in England*, Centre for Health Economics, University of York: 1-19.

Rowen, D., J. Brazier, C. Mukuria, A. Keetharuth, A. R. Hole, A. Tsuchiya, S. Whyte and P. Shackley (2016). Eliciting societal preferences for weighting QALYs for burden of illness and end of life. *Medical Decision Making* 36(2): 210-222.

Salomon, J. A., H. Wang, M. K. Freeman, T. Vos, A. D. Flaxman, A. D. Lopez and C. J. Murray (2012). Healthy life expectancy for 187 countries, 1990-2010: a systematic analysis for the Global Burden Disease Study 2010. *Lancet* 380(9859): 2144-2162.

Sassi, F., L. Archard and J. Le Grand (2001). Equity and the economic evaluation of healthcare. *Health Technol Assess* 5(3): 1-138.

Shah, K. K., R. Cookson, A. J. Culyer and P. Littlejohns (2013). NICEs social value judgements about equity in health and health care. *Health Econ Policy Law* 8(2): 145-165.

Tranvag, E. J., M. Ali and O. F. Norheim (2013). Health inequalities in Ethiopia: modeling inequalities in length of life within and between population groups. *Int J Equity Health* 12: 52.

Tugwell, P., D. de Savigny, G. Hawker and V. Robinson (2006). Applying clinical epidemiological methods to health equity: the equity effectiveness loop. *BMJ* 332(7537): 358-361.

UNICEF. (2016). Multiple Indicator Cluster Surveys (MICS). Retrieved 14 July 2016, 2016, from <http://mics.unicef.org/>.

Verguet, S. and D. T. Jamison (forthcoming). Applications of extended cost-effectiveness analysis (ECEA) methodology in DCP3. Disease Control Priorities. D. T. Jamison, R. A. Nugent, H. Gelband et al. Washington, DC, World Bank. 9.

Verguet, S., J. J. Kim and D. T. Jamison (2016). Extended cost-effectiveness analysis for health policy assessment: a tutorial. *PharmacoEconomics* 34(9): 913-923.

Verguet, S., R. Laxminarayan and D. T. Jamison (2015). Universal public finance of tuberculosis treatment in India: an extended cost-effectiveness analysis. *Health Econ* 24(3): 318-332.

Verguet, S., S. Murphy, B. Anderson, K. A. Johansson, R. Glass and R. Rheingans (2013). Public finance of rotavirus vaccination in India and Ethiopia: an extended cost-effectiveness analysis. *Vaccine* 31(42): 4902-4910.

Wagstaff, A. (2015). Commentary: Value Judgments in Health Inequality Measurement. *Epidemiology* (Cambridge, Mass.) 26(5): 670.

Wagstaff, A., D. Cotlear, P. H.-V. Eozenou and L. R. Buisman (2016). Measuring progress towards universal health coverage: with an application to 24 developing countries. *Oxford Review of Economic Policy* 32(1): 147-189.

Wailoo, A., A. Tsuchiya and C. McCabe (2009). Weighting must wait. *Pharmacoeconomics* 27(12): 983-989.

Whitehead, M. (1992). The concepts and principles of equity and health. *International journal of health services* 22: 429-445.

WHO (2014). Making Fair Choices on the Path to Universal Health Coverage: Final Report of the WHO Consultative Group on Equity and Universal Health Coverage, World Health Organization: 84.

Wilkinson, R. and K. Pickett (2010). The spirit level. *Why equality is better for*.

Williams, A. (1997). Intergenerational equity: an exploration of the fair innings argument. *Health Econ* 6(2): 117-132.

Williams, A. H. and R. A. Cookson (2006). Equity-efficiency trade-offs in health technology assessment. *International Journal of Technology Assessment in Health Care* 22(1): 1-9.

World Health Organisation (2014). WHO methods for life expectancy and healthy life expectancy. *Global Health Estimates Technical Paper WHO/HIS/HSI/GHE/2014.5*. Geneva, Department of Health Statistics and Information Systems, WHO.

World Health Organisation (2015). Life Expectancy Data by Country.

World Health Organization (2013). Handbook on health inequality monitoring with a special focus on low-and middle-income countries, World Health Organization.

World Health Organization (2015). Tracking universal health coverage: first global monitoring report, World Health Organization.