

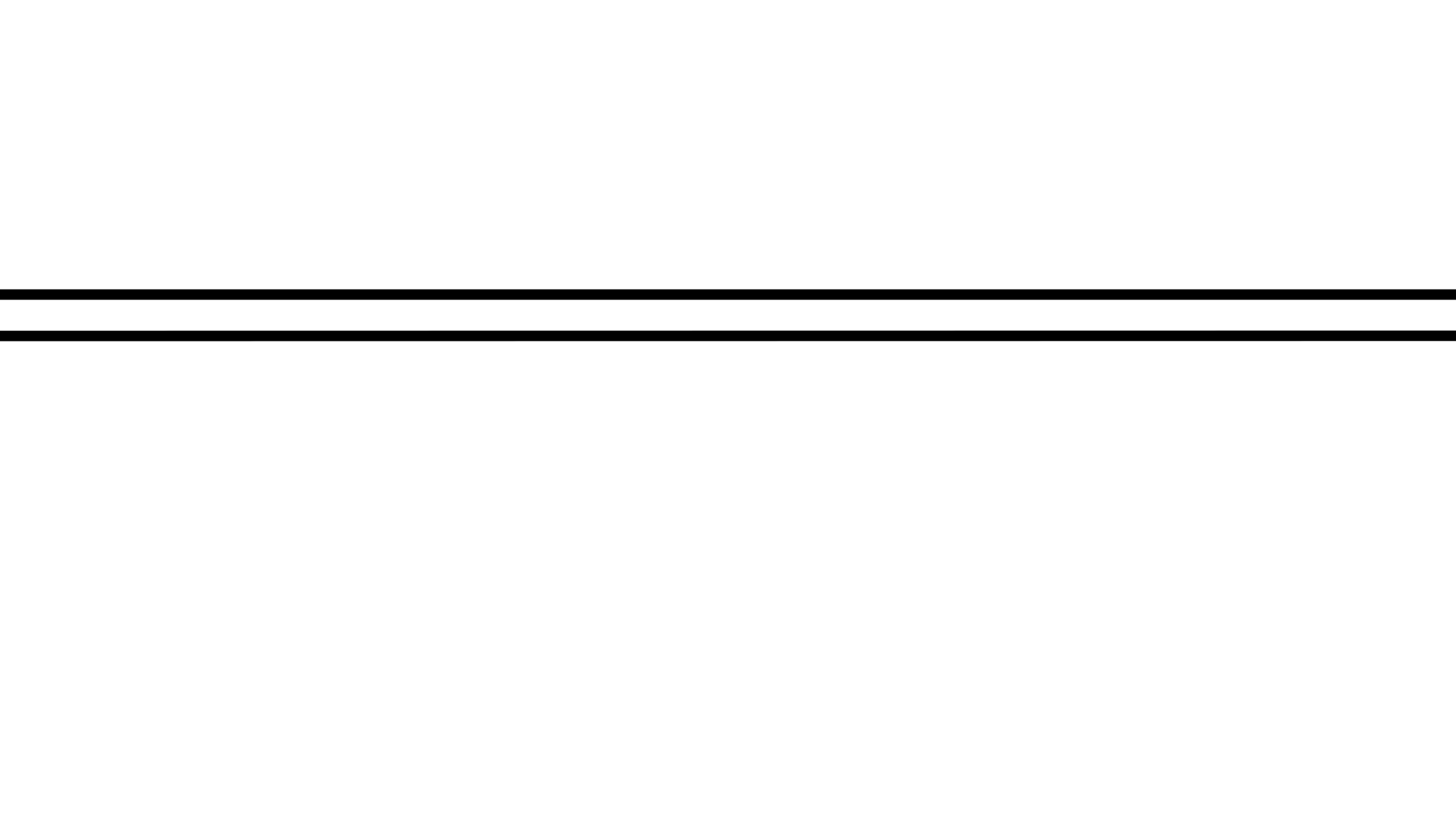
Distributional Cost-Effectiveness Analysis

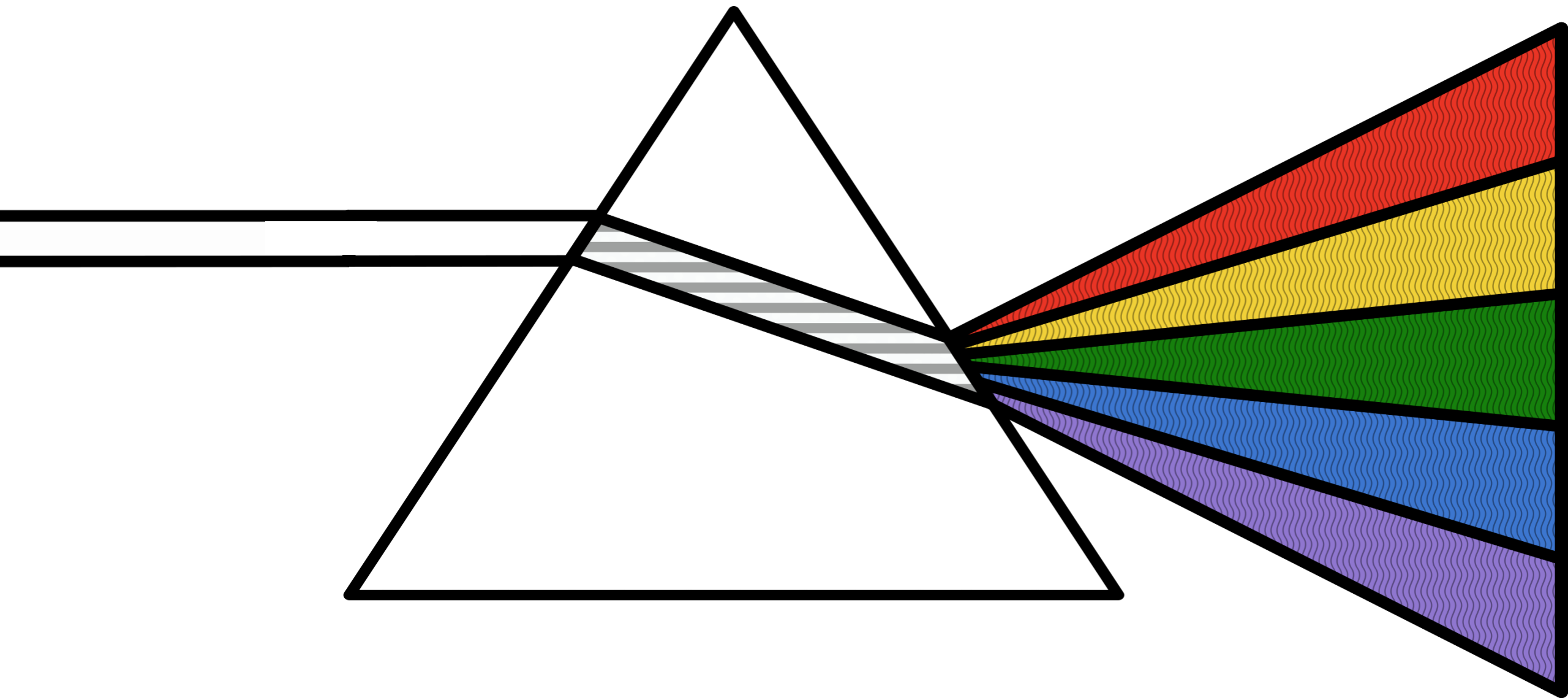
Dec 2024

**Professor Richard Cookson
Centre for Health Economics
University of York**

Caveats

My errors and opinions are my own, not those of NICE, the NHS or the UK government





Agenda



Terminology and background



What is DCEA?



Key concepts



Two examples: sickle cell and lung health checks



Trade-offs



Further reading

Terminology



Health variations: All differences in health, fair or not, ethically relevant or not - a purely factual matter.

- E.g., variation in mortality risk by age



Health inequalities: Unfair differences in health between more and less socially advantaged groups

- Also known as “**health inequities**” (WHO) and “**health disparities**” (USA)
- E.g., variation in mortality risk by income, education, occupation, neighbourhood deprivation, ethnicity, geographical region
- Potential confusion 1: the term “inequality” is sometimes used in a purely mathematical sense, with no necessary connotation of unfairness
- Potential confusion 2: the term “health inequality” is sometimes used to mean unfair differences in healthy lifespan among all individuals, which implies giving priority not only to more socially disadvantaged people but also to younger people, especially those who are also severely ill and/or have biological risks of premature illness and death



“**Equity**” as specific term for health inequality considerations that focus on social disadvantage

vs.

“**Equity**” as general umbrella term for any ethical consideration other than cost-effectiveness (including, e.g., severity, rarity, age, biological risk of premature illness and death)

ISPOR Value Flower

Green circles: core elements of value

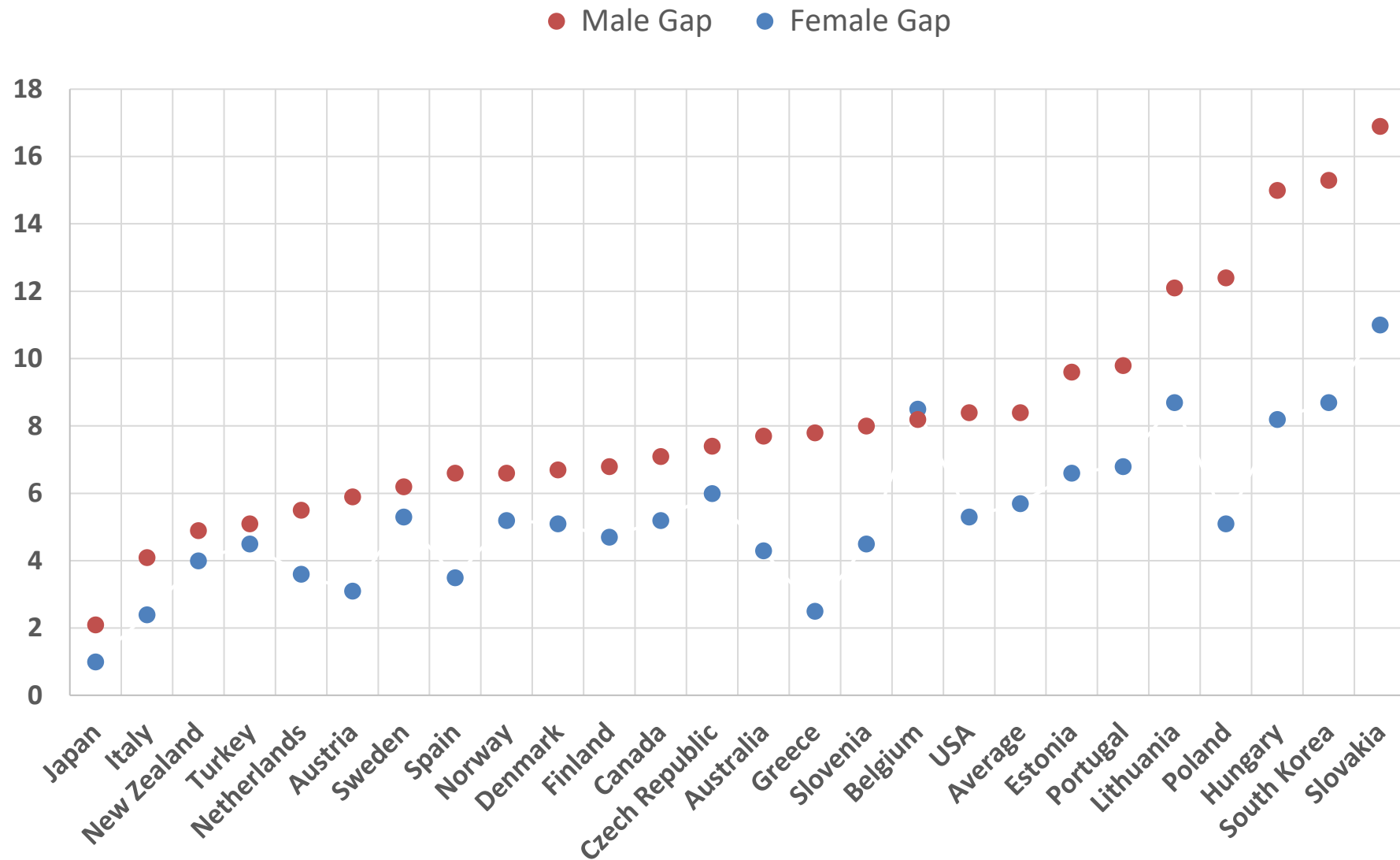


Light blue circles: common but inconsistently used elements of value

Dark blue circles: potential novel elements of value

Source: International Society for Pharmacoeconomics and Outcomes Research Special Task Force Report. *Value in Health*. 2018 Feb;21(2).

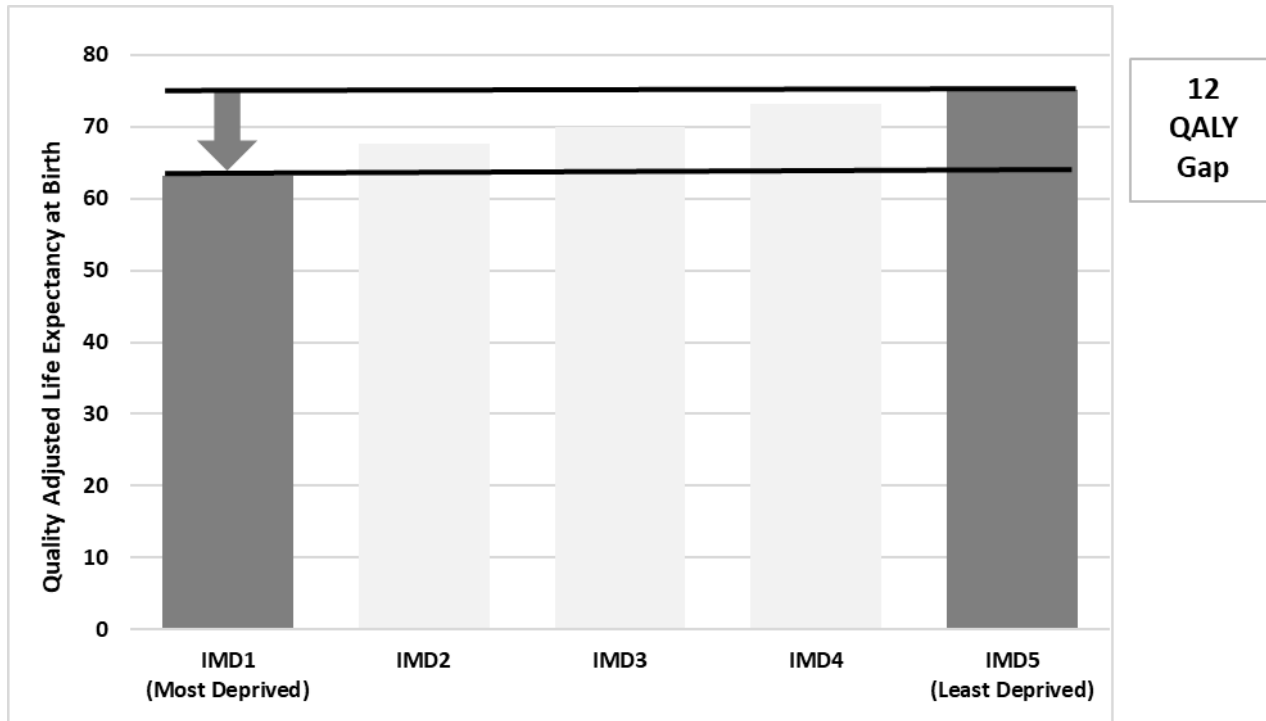
Inequality Gap in Life Expectancy at Age 25 Between High and Low Education Groups OECD Data, Around 2016



Source: Murtin, F. and C. Lübker (2022), "Educational inequalities in longevity among OECD countries around 2016", OECD Papers on Well-being and Inequalities, No. 8, OECD Publishing, Paris, <https://doi.org/10.1787/5faaa751-en>

National Health Inequality Gap, England

Individual Average Health Gap



Population Total Health Gap

**135m
QALY
gap**

12 QALY gap per person in the
most deprived quintile group

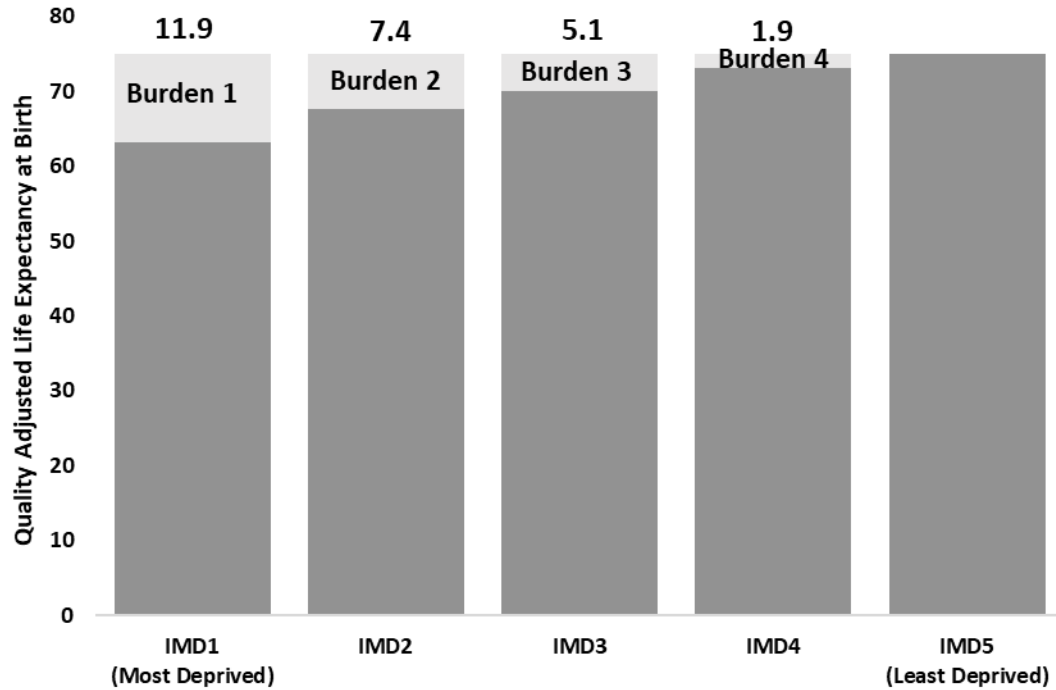
×

11.4m people in that group

National Health Inequality Burden, England

(All groups compared with the least deprived)

Individual Average Health Burden



Population Total Health Burden

**299m
QALY
burden**

26.2 total individual average QALY burden
across four groups

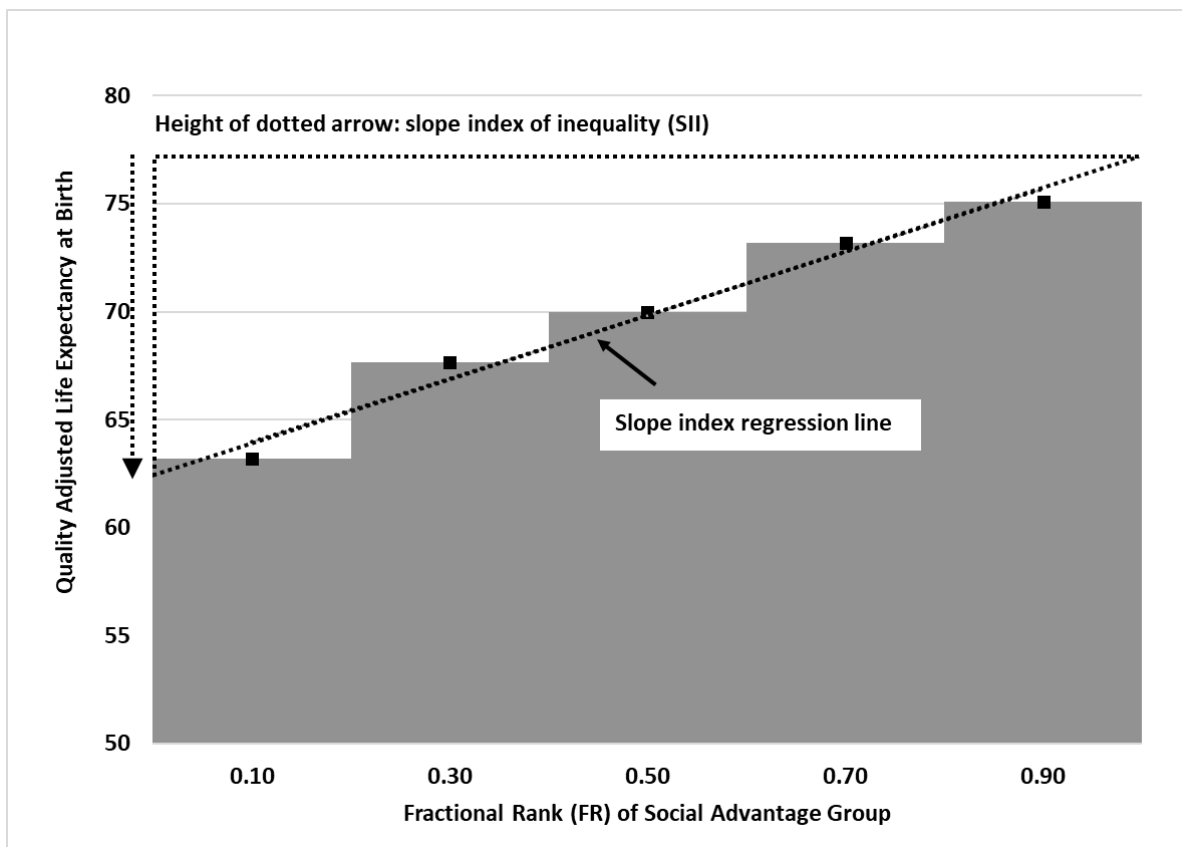
×

11.4m people in each group

Full National Health Inequality Burden, England

(All individuals compared with the least deprived, based on linear slope index)

Individual Average Health Burden



Population Total Health Burden

333m
QALY
gap

Slope index linear gap of 14.6 QALYs

×

57m individuals in England

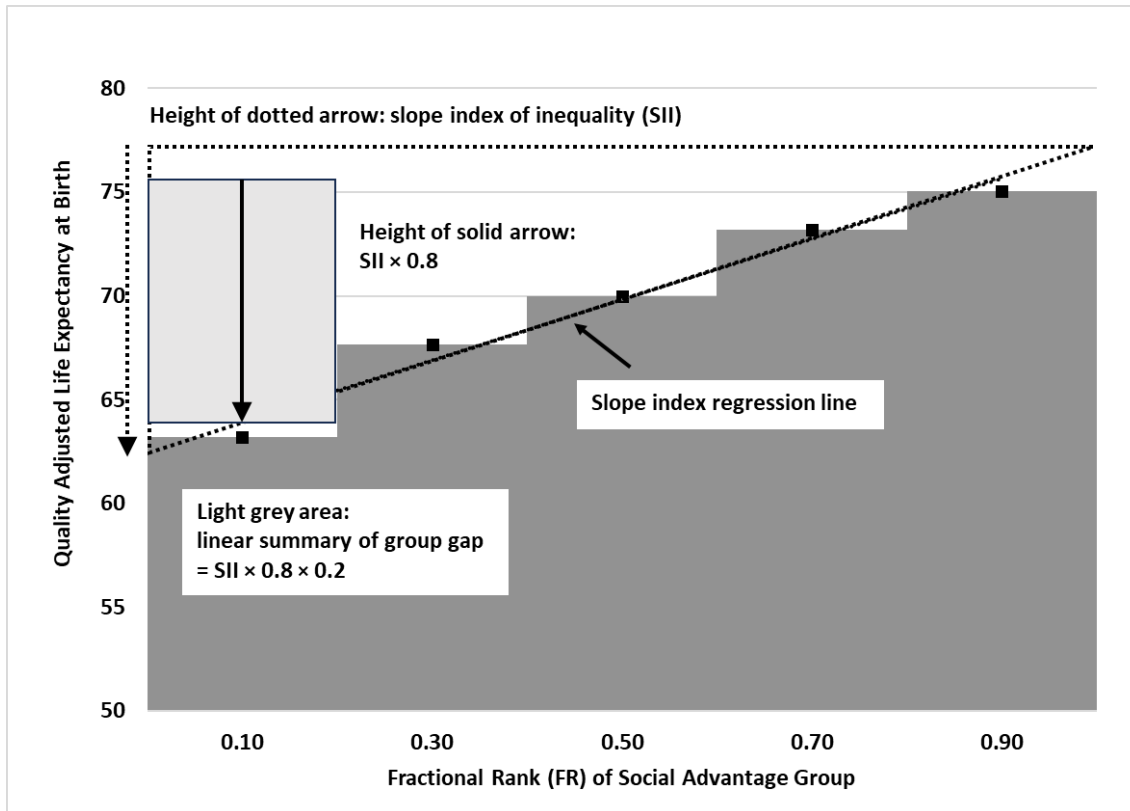
×

0.5 (area of triangle)

Adjusted National Health Inequality Gap, England

(Most deprived group compared with least deprived, based on linear slope index)

Individual Average Health Gap



Population Total Health Burden

**133m
QALY
gap**

Slope index linear gap of 14.6 QALYs

×

0.8 (range of group mid-points)

×

11.4m people in that group

Describing Problems vs. Evaluating Solutions

Cost of Illness

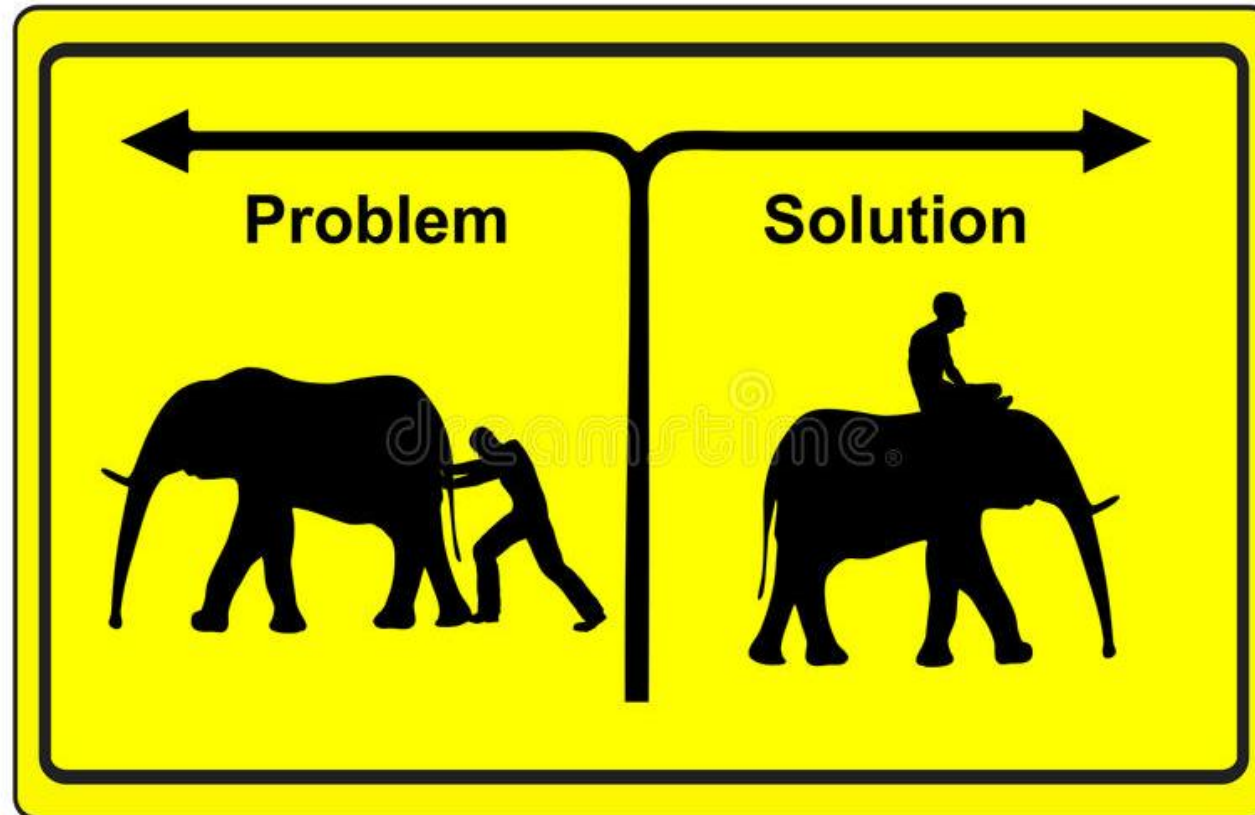
Intervention IMPACT on Cost of Illness

Burden of Illness

Intervention IMPACT on Burden of Illness

Health Inequality

Intervention IMPACT on Health Inequality



Why quantify impact on health inequality?

1. Faster access to equity-enhancing interventions that disproportionately benefit less socially advantaged populations (as measured e.g. by socioeconomic status or ethnicity)
 - Address bias against health conditions with higher prevalence in less socially advantaged populations, which are often also under-diagnosed and poorly managed
2. Rigorous, evidence-informed approach to reducing health inequalities

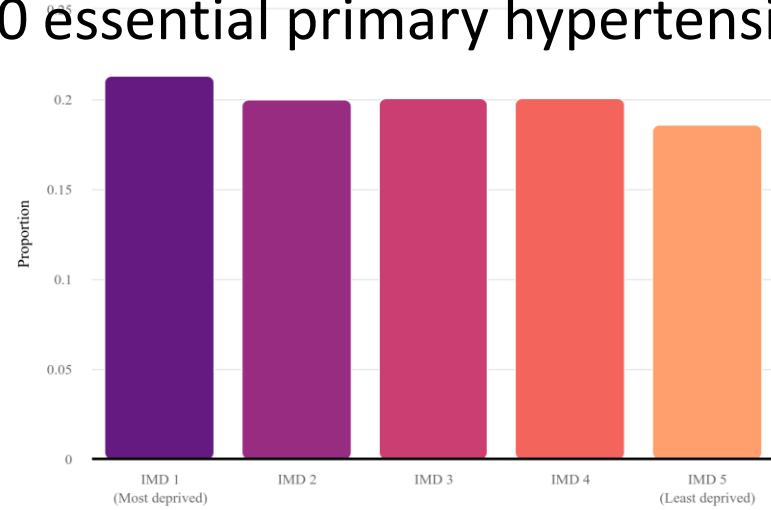
Prevalence inequality varies considerably between disease categories

Examples from England using whole-population data on hospital inpatient episodes; 3-digit ICD-10 diagnosis codes

Prevalence share by five social advantage groups
(neighbourhood deprivation fifths)

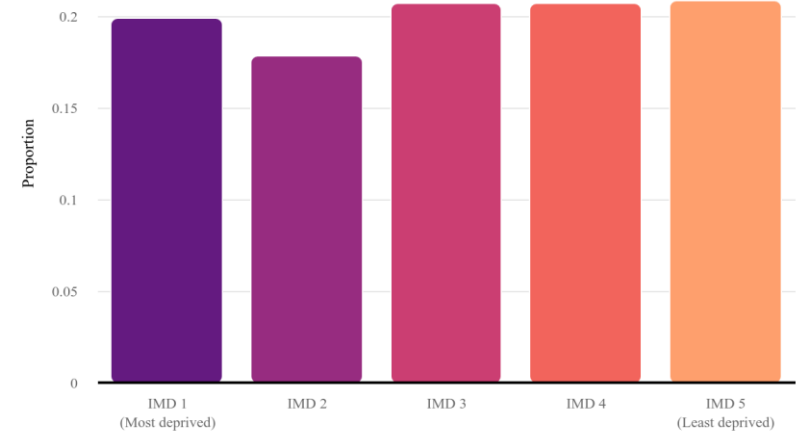
Hypertension

("I10 essential primary hypertension")



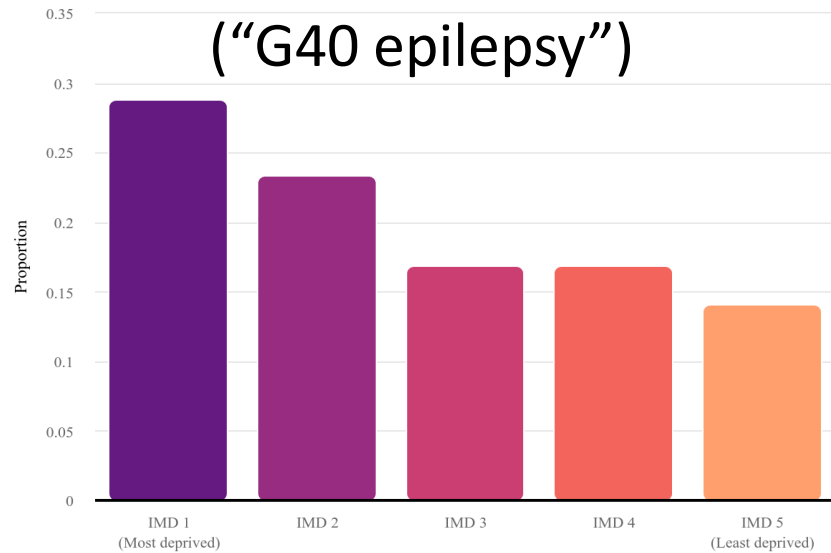
Bowel cancer

("C20 malignant neoplasm of rectum")



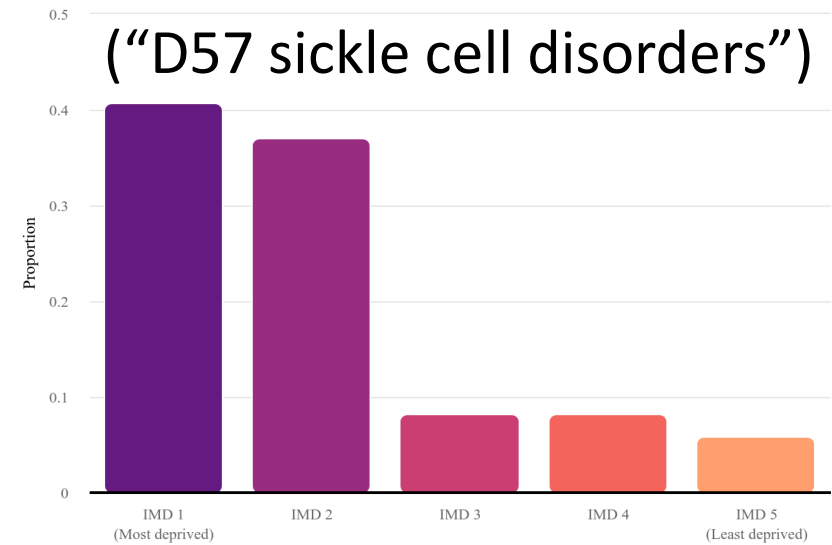
Epilepsy

("G40 epilepsy")



Sickle cell disease

("D57 sickle cell disorders")

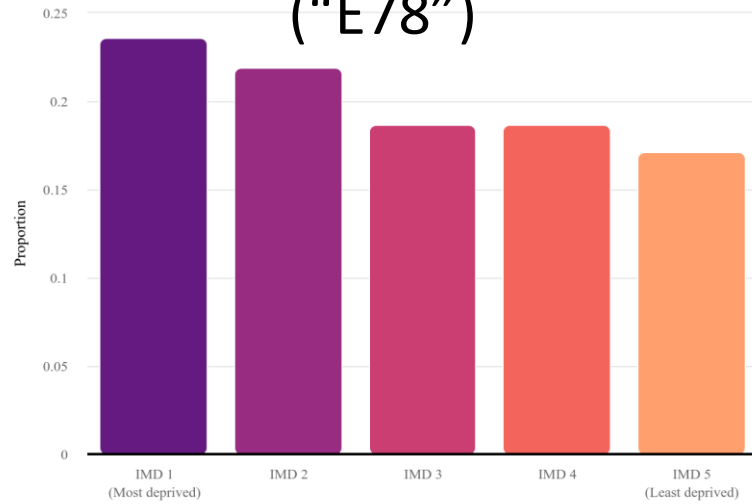


More advantaged =>

More advantaged =>

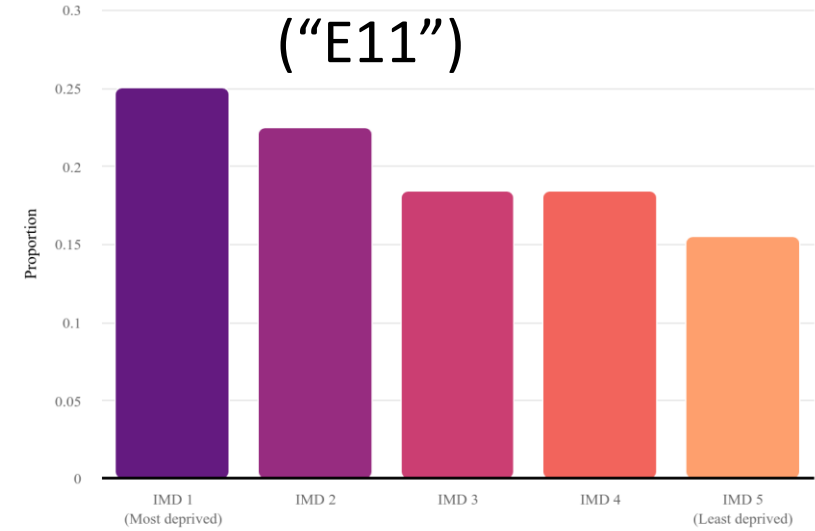
Hyperlipidaemia

("E78")



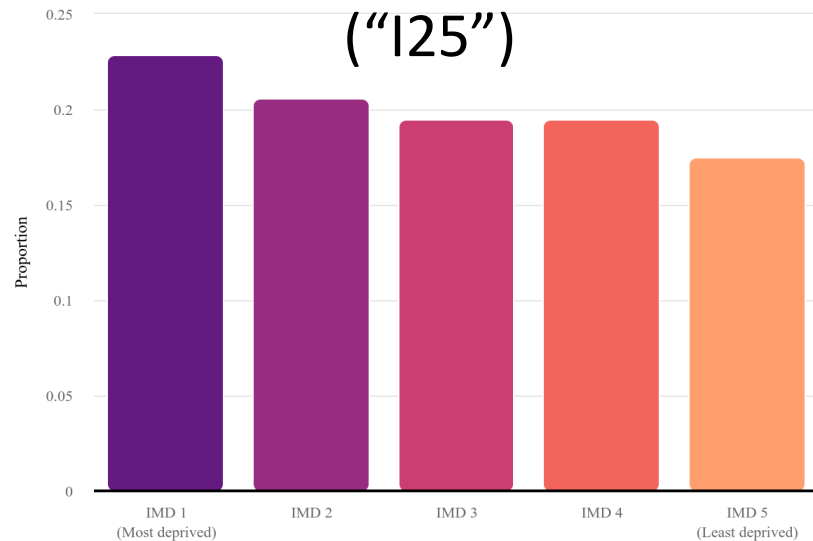
Diabetes (type 2)

("E11")



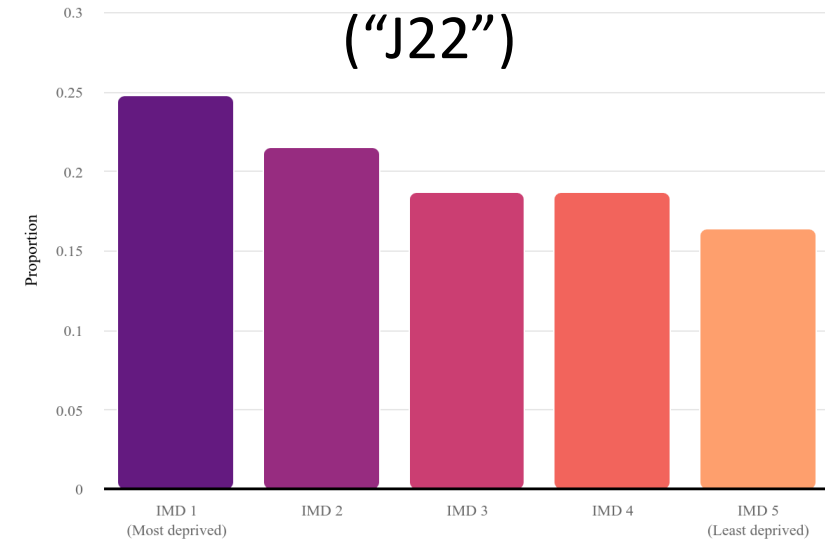
Ischaemic heart disease

("I25")



Lower respiratory tract infections

("J22")



More advantaged =>

More advantaged =>

Why this matters

- Prevalence inequality varies considerably between diseases
- Some cost-effective new medicines will therefore reduce health inequality considerably more than others
- Quick and simple distributional analysis can quantify this impact alongside standard cost-effectiveness analysis
- This additional information would allow health inequality considerations to be considered in a consistent and evidence-informed way
- Preliminary analysis suggest that health inequality considerations usually do not modify standard cost-effectiveness findings but might potentially justify increasing the ICER threshold by up to 30% in some cases, based on data on UK general public views

Two conflicting “equity” concerns

Health inequality vs. severity of illness

Concern for severity of illness tends to prioritise emergency and acute hospital care for older people with late stage disease

Concern for reducing health inequality tends to prioritise primary and community care for children and working age adults with early stage disease or risk factors

e.g. Is it fairer to prioritise (1) a new drug for late stage skin cancer or (2) screening for maternal depression?

- Severity of illness
 - Priority to late stage skin cancer
 - Very short life expectancy (“end-of-life”, “rule of rescue”)
- Health inequality
 - Priority to maternal screening
 - Babies with depressed mothers can expect below-average lifetime health and wealth
 - Most skin cancer deaths occur age 70+ among people with above-average lifetime health and wealth

What is DCEA?



- Analysis of equity in the distribution of costs and effects within the general population, as well as efficiency in terms of aggregate costs and effects.
 - Typically, looking at distributional breakdowns between multiple social advantage groups broken down by one or two equity-relevant variables such as neighbourhood deprivation and/or ethnicity
 - Can also do 2-group DCEA comparing recipients versus non-recipients
 - Data permitting, can also look at other kinds of distribution

How can DCEA help decision makers?



- To take a more transparent, consistent and evidence-informed approach to addressing equity concerns
 - Faster access to equity-improving interventions that disproportionately benefit worse-off groups of people
 - Especially “health inequality” concerns to reduce unfair differences in health between more and less socially advantaged groups
 - But also concerns about “severity”, “rarity”, and other criteria for giving higher priority to the health needs of worse-off groups
- To help clarify and quantify the trade-offs that sometimes arise between cost-effectiveness and equity, and between different equity concerns

Strengths of DCEA



- Quantitative
 - What doesn't get measured, gets marginalised
- Comparative
 - Allows comparisons between different interventions for different populations in different disease areas
- General population perspective
 - Broad focus on inequality in health within the general population, allowing for differences in prevalence, uptake and opportunity cost, not just sub-group analysis of treatment effect within the patient population
- Integrated with standard cost-effectiveness analysis
 - Allow analysis of trade-offs with cost-effectiveness

Limitations of DCEA

- Incomplete and imperfect
 - Not possible to capture all equity concerns in a single number
 - Fairly straightforward for most new medicines – only needs prevalence inequality data – but harder for interventions with unequal uptake and long-term effect
- Resource intensive
 - Fixed costs: country-specific set up needed (DCEA “building blocks”)
 - Variable costs: simple DCEA is much less resource intensive than full DCEA
- Hard to communicate as the concepts are unfamiliar (for now)
- Quantitative, comparative, general population perspective, integrated with standard cost-effectiveness analysis
 - Plenty of commentators and lobby groups dislike all of those things, and see them as limitations rather than strengths! 😊

When and by whom could health inequality impact information be used?

- Payer decision making about reimbursement and delivery
 - Potentially relevant to any kind of health technology
 - New and existing, curative and preventive
 - Potentially relevant to “yes-no” decisions about coverage, and price negotiations, as well as decisions about delivery
- Industry decision making about R&D, pricing and market access
- Wider health and social policy making and regulation

In the context of new treatments, the main driver of impact on health inequality is inequality in diagnosed prevalence

- Inequality in prevalence varies between conditions and can be large
- Robust real-world evidence is available on inequality in diagnosed prevalence by deprivation quintile group
 - Undiagnosed prevalence can also drive health inequality impact if the new technology can change social patterns of early diagnosis (e.g., genetic testing)
- Inequalities in uptake and effect of a new treatment are usually small
 - Inequalities in uptake and effect are usually larger in the context of preventive care (e.g. vaccination, screening) than in the context of new treatments (e.g. new cancer drug)
 - Inequality in uptake of the *comparator* treatment may influence the health inequality impact of a new treatment (e.g. more convenient medication may disproportionately benefit disadvantaged patients with especially low uptake of standard medication)

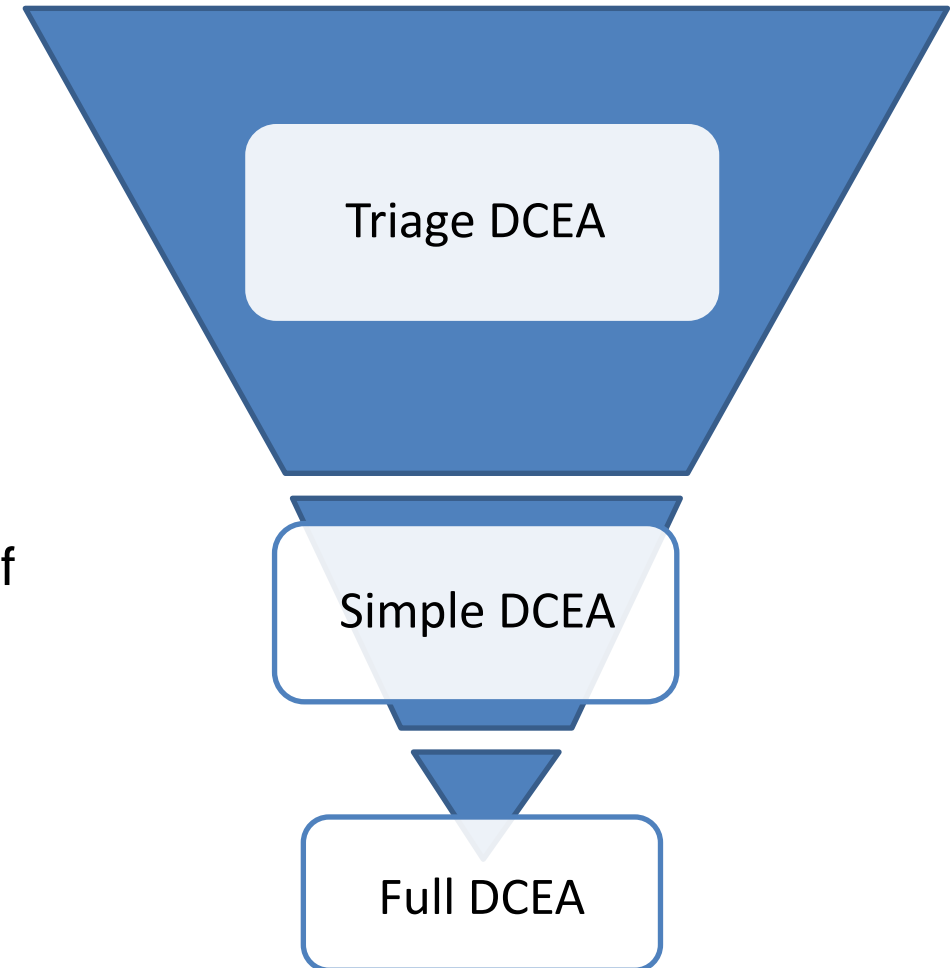
Types of “Distributional” Cost Effectiveness Analysis (DCEA): Triage DCEA and Simple vs. Full DCEA

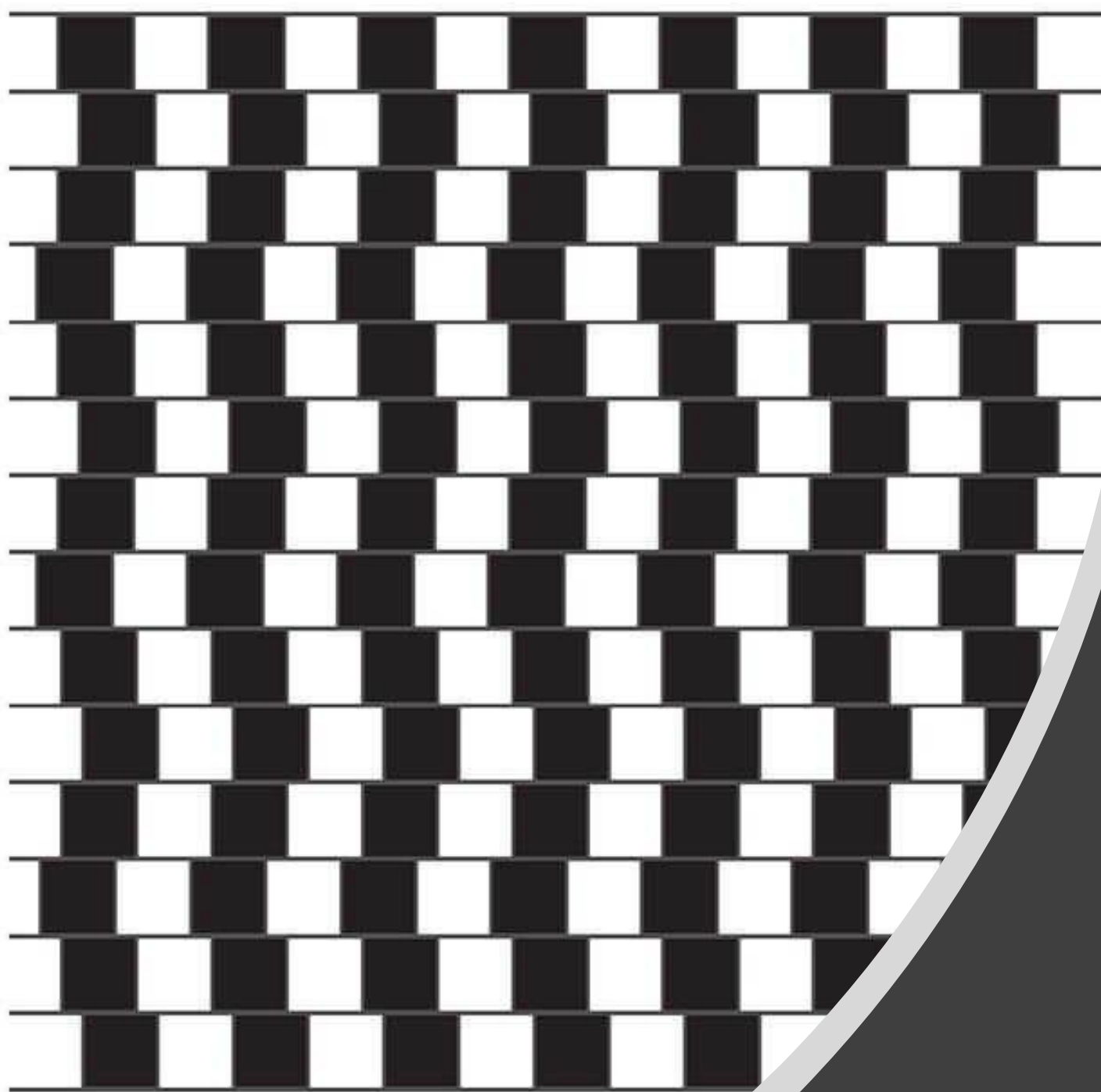
Quick and simple early indication of whether health inequality impact might be decision relevant (maximum potential impact on ICER).

<https://shiny.york.ac.uk/dceasimple>

Based on aggregate CEA results and bespoke estimates of inequality in prevalence, uptake and effect.

Full DCEA goes “under the bonnet” and conducts a more complicated version of standard CEA decision modelling.





The direction of health inequality impact is not always obvious - let alone the magnitude

[The image to the left is a classic optical illusion: Do these lines slope up or down?]

General DCEA building blocks

Getting DCEA ready to use in your country or decision context

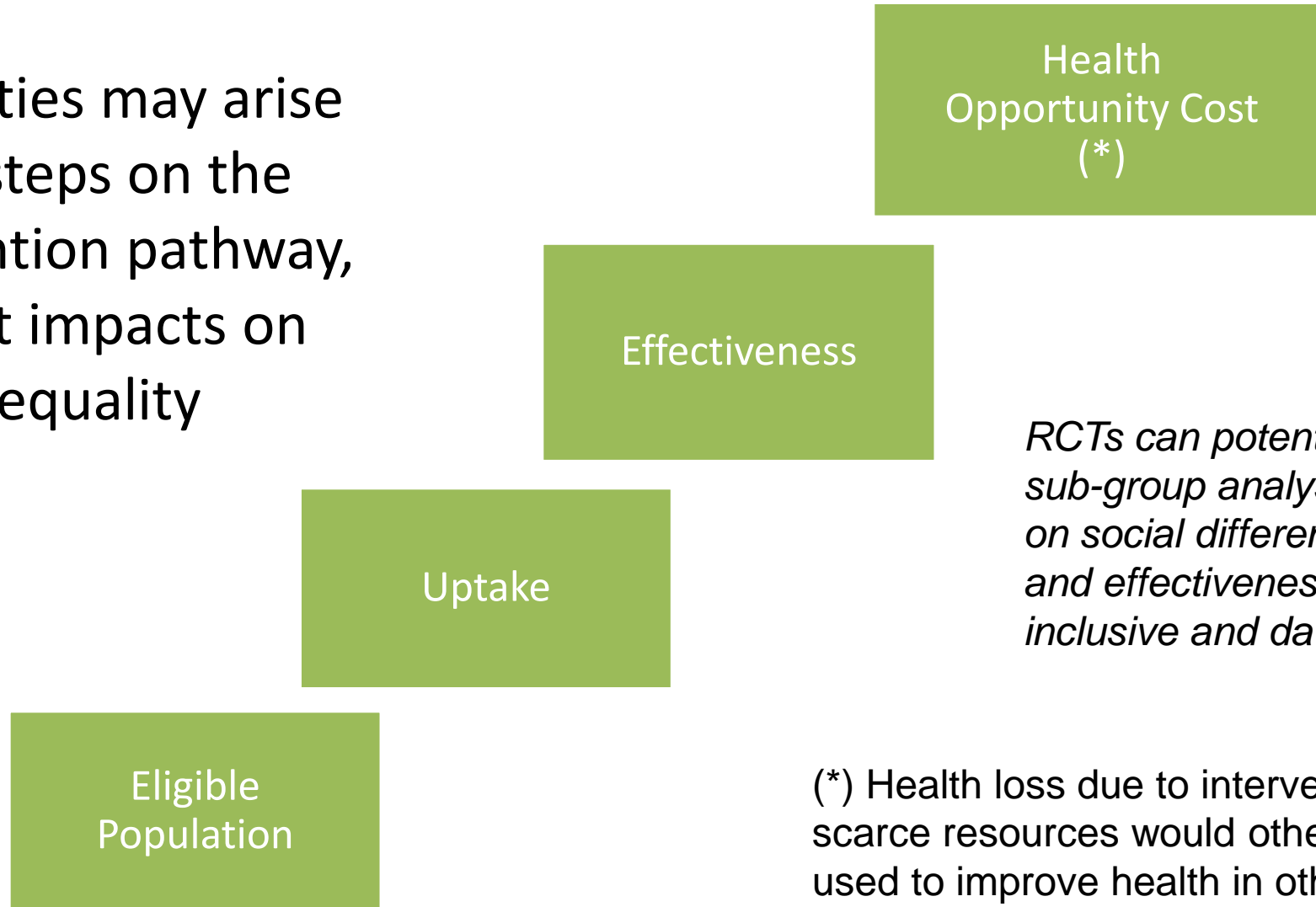
- 1 Generic social disadvantage classification system (“equity-relevant” variables)**
 - E.g., five SES groups based on neighbourhood deprivation, e.g., 25 deprivation-ethnicity groups
- 2 Social distribution of baseline health**
 - Quality adjusted life expectancy, requiring mortality and health-related quality of life by social group, age and sex
- 3 Social distribution of opportunity cost: Benchmark and plausible range**
 - E.g., benefit incidence analysis (average healthcare utilization by social group), e.g., instrumental variable regression
- 4 Equity weights: Plausible range of health inequality aversion values**
 - E.g., survey of public or decision maker views
- 5 Headline equity metric: Reference case**
 - E.g., slope index of inequality in population net health benefits; e.g., maximum plausible ICER threshold weight



KEY CONCEPTS

The Staircase of Inequality Impact

Social inequalities may arise at different steps on the health intervention pathway, with different impacts on health inequality



RCTs can potentially provide sub-group analysis information on social differences in uptake and effectiveness, if samples are inclusive and data are collected

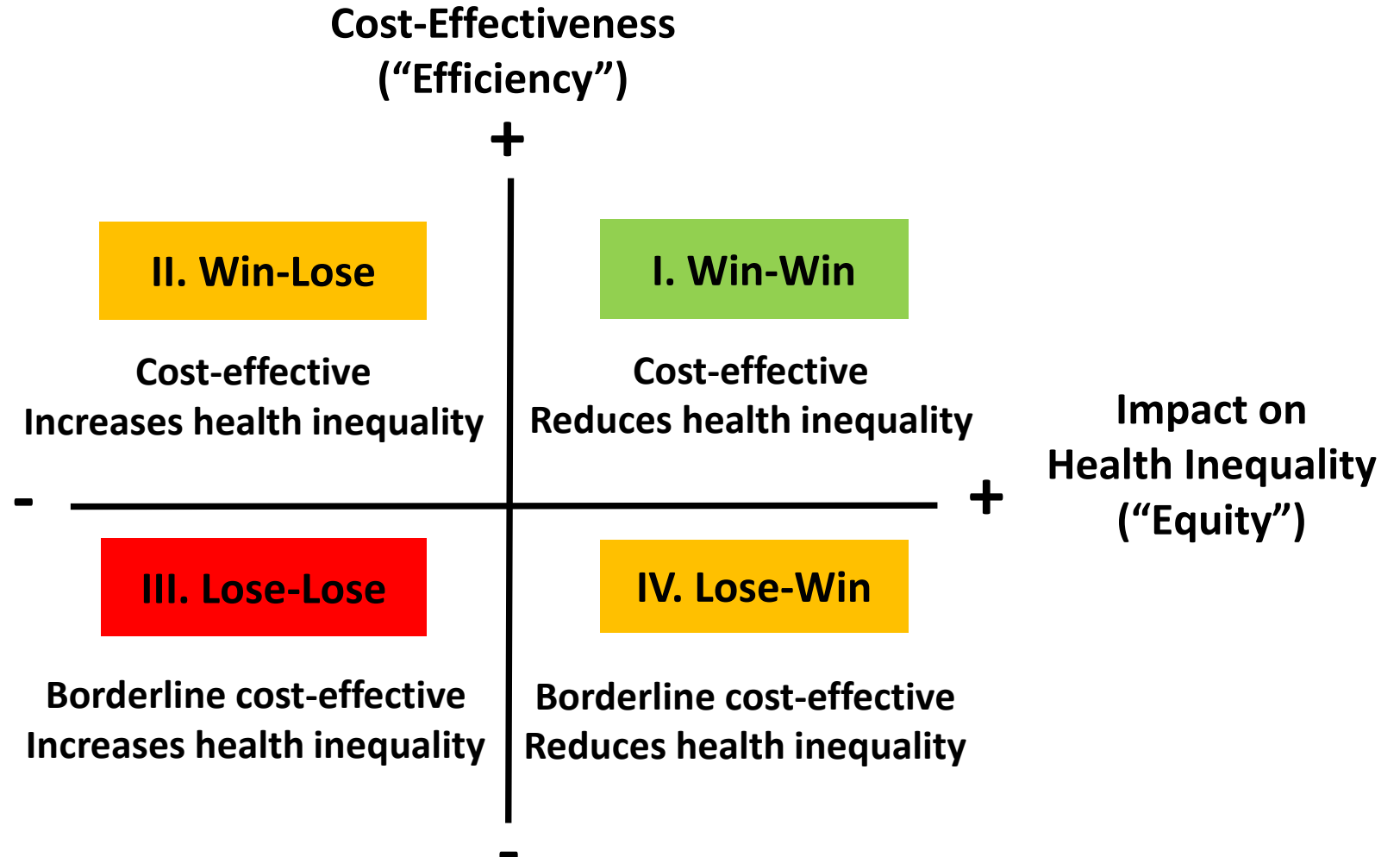
(*) Health loss due to intervention costs: scarce resources would otherwise be used to improve health in other ways.

Equity-Efficiency Impact Plane

Currently, decision makers focus on the vertical axis: cost-effectiveness.

Need to add the horizontal axis: impact on health inequality.

Need to do this in a general way that allows comparisons of impact between disease areas and interventions.

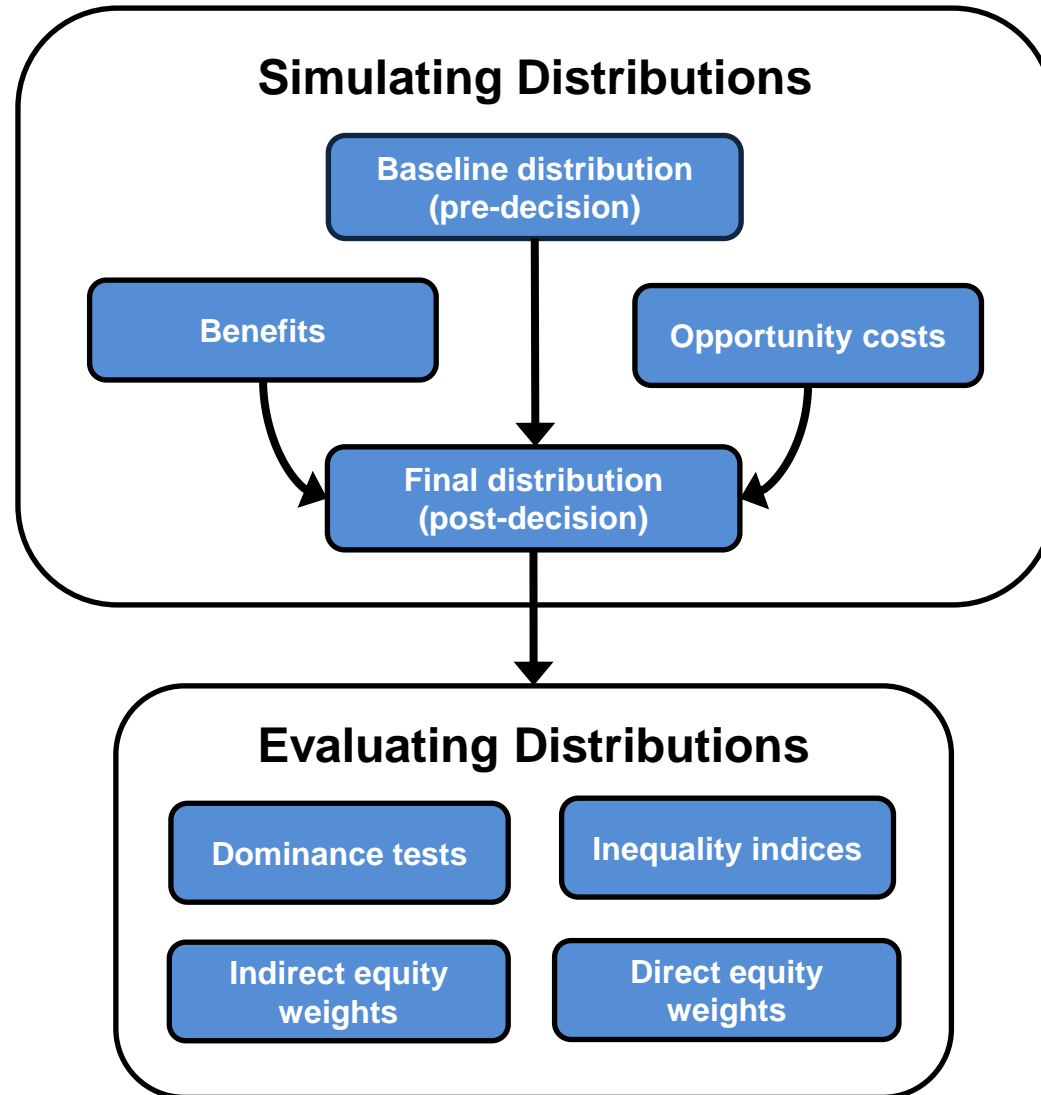


Equity-Efficiency Trade-Offs

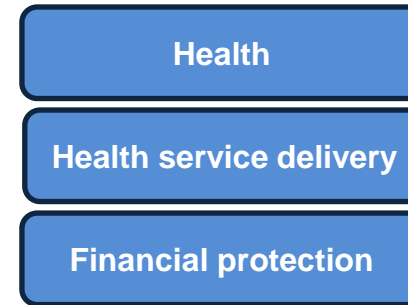


- How much credit or “equity weight” to equity-enhancing interventions that are borderline cost-effective?
- Potential trade-off with maximising total health benefit
 - Health opportunity cost of funding borderline cost-effective options
 - How much health benefit would you forgo to reduce inequality?
- Standard economic concept: “health inequality aversion”
 - Minimum plausible value of 0 (same as standard cost-effectiveness)
 - Maximum plausible value of 11 (various surveys of public opinion)

Designing a Distributional Analysis



Health-related consequences



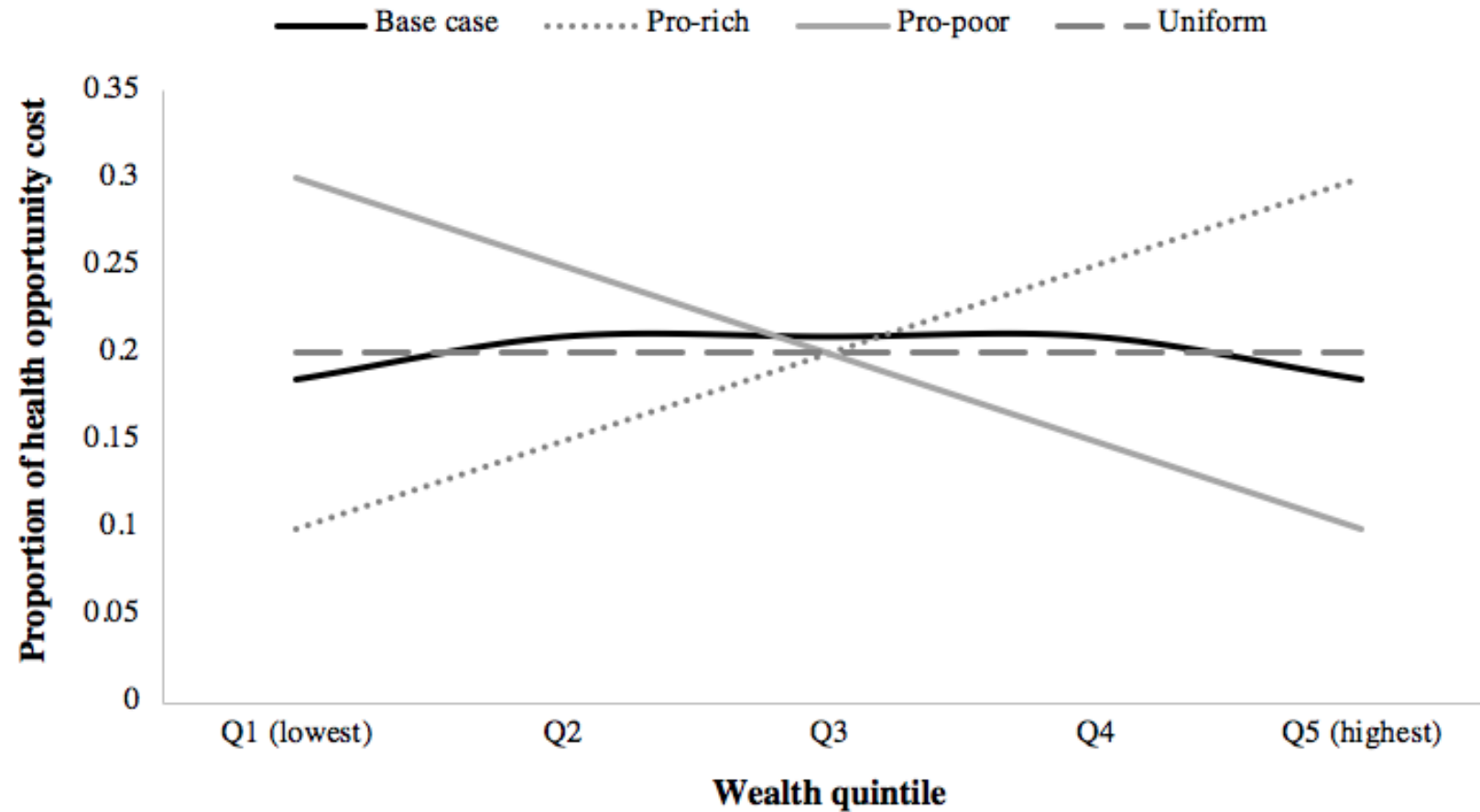
When financial protection effects are included, this is known as “extended” cost-effectiveness analysis

Key inputs for DCEA

1. Baseline social distribution of quality-adjusted life expectancy by social group (*)
2. Social distribution of effects (and delivery costs and savings)
3. Social distribution of health opportunity costs (*)
4. Benchmark health inequality aversion parameter value (*)

* If no data is available, can use sensitivity analysis or proxies

Health Opportunity Cost: Example Scenario Analysis



Source: Dawkins, B., Mirelman, A., Asaria, M., Johansson, K.A., Cookson, R., 2018. Distributional cost-effectiveness analysis in low- and middle-income countries: illustrative example of rotavirus vaccination in Ethiopia. *Health Policy and Planning*. 33, 456–463.

**EXAMPLES
FROM ENGLAND
USING “SIMPLE”
OR
“AGGREGATE”
DCEA**



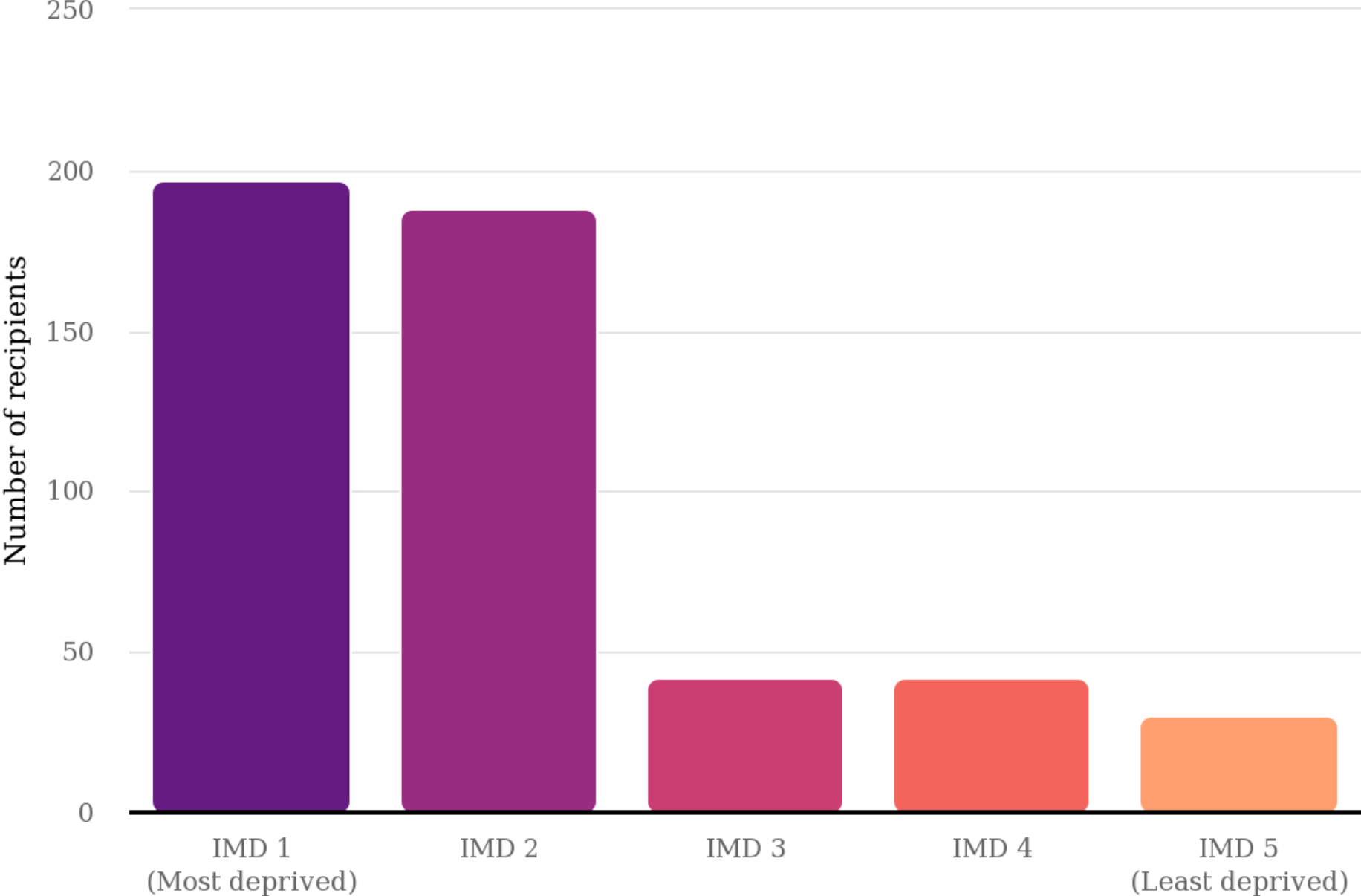
“Lose-Win”

Not cost effective but reduces health inequality

Hypothetical medicine for sickle cell disease

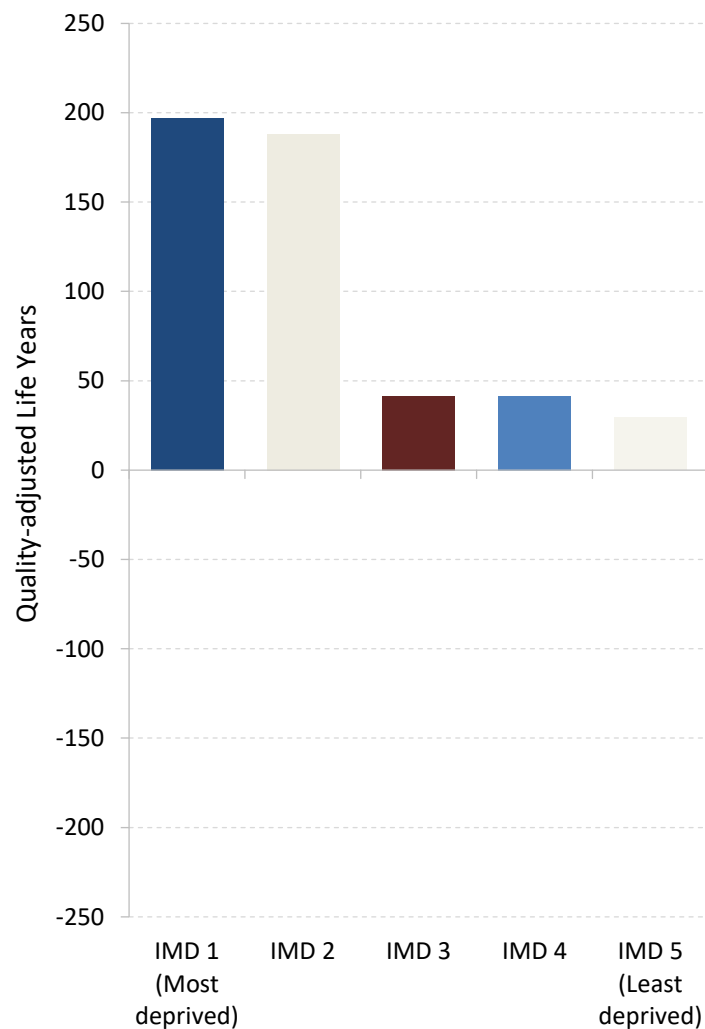
Simple hypothetical example, based loosely on [NICE TA743 published in November 2021](#) and [CEA evidence from the USA](#). NICE did not see DCEA information in this appraisal, the real CEA estimates used by NICE are commercial-in-confidence, and this technology was subsequently withdrawn after proving less cost-effective than originally assumed.

Estimated annual number of recipients via managed access scheme

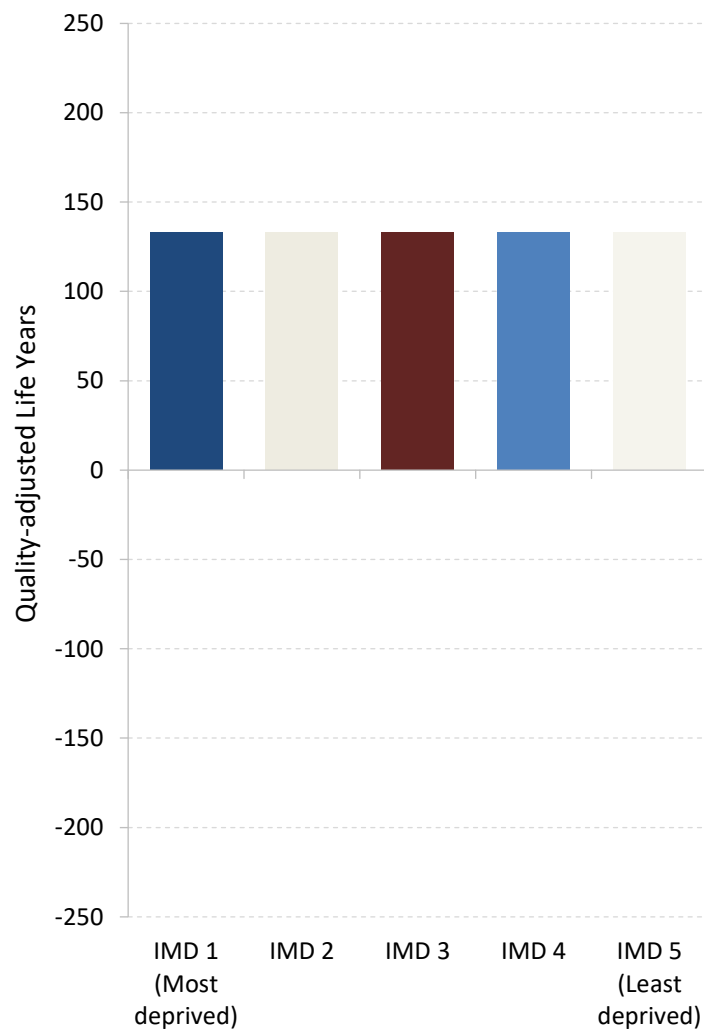


Example: Crizanlizumab for preventing sickle cell crises in sickle cell disease

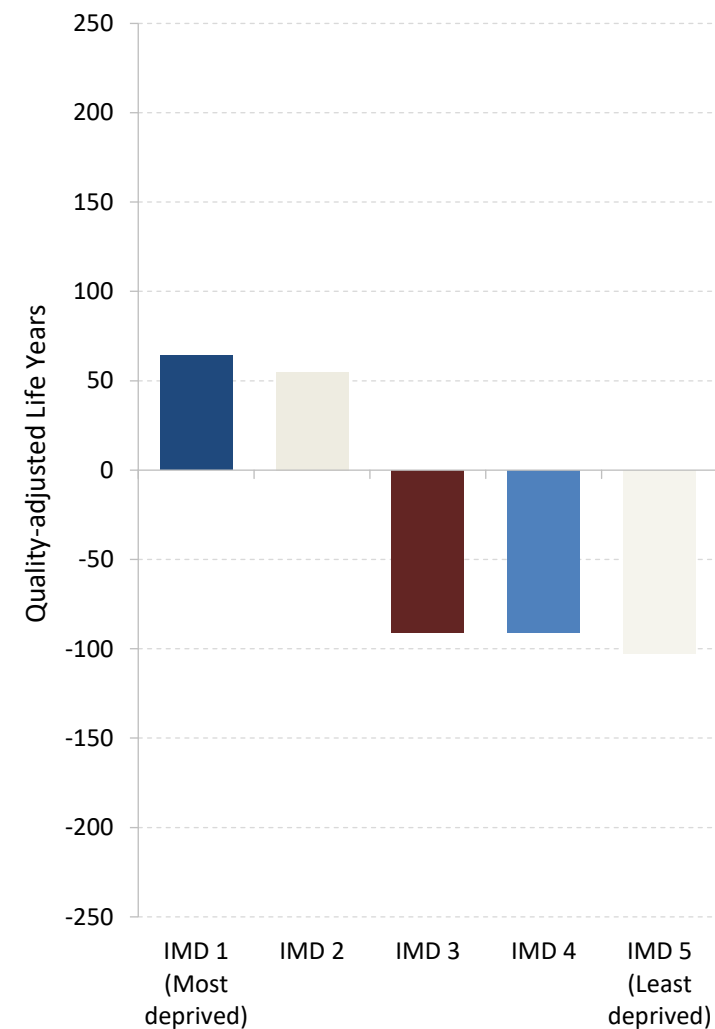
Health benefit



Health opportunity cost¹

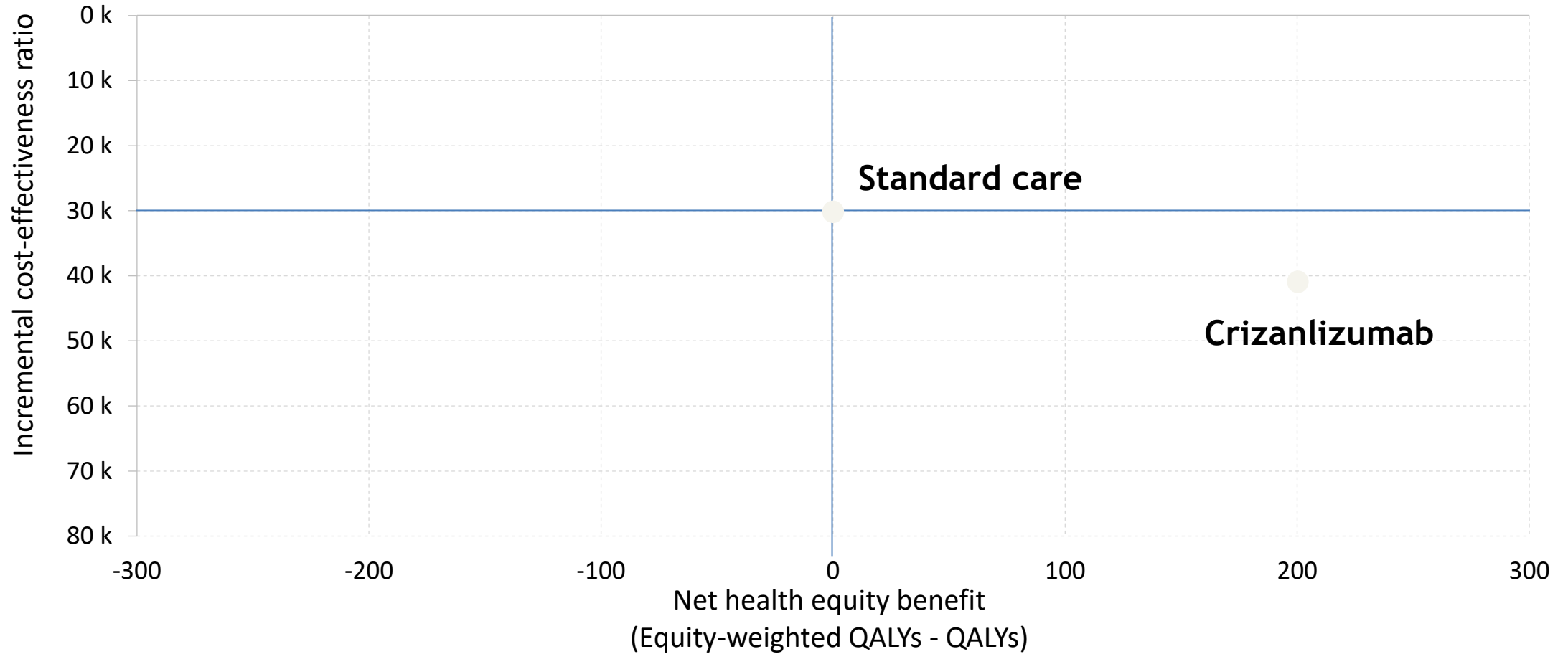


Net health benefit



¹ Based on health opportunity cost threshold of £30k

Equity-ICER impact plane



Health inequality impact

Example: Crizanlizumab for preventing sickle cell crises in sickle cell disease

Net Health Inequality Benefit¹

246 QALYs

Equity-Weighted Net Health Inequality Benefit²

197 Weighted QALYS

Notes

¹ Reduction in total health gap between most and least deprived fifth of England (~135m QALYs)

² Based on an Atkinson inequality aversion parameter of 10, which gives 467% more weight to the worst-off group (IMD 1) compared with the best-off group (IMD 5)

Health inequality trade-offs

(1) Incremental Cost-Effectiveness Ratio (ICER) ¹	£40,000/QALY
(2) Cost-Effectiveness Decision Threshold ²	£30,000/QALY
(3) Equity-Weighted ICER ³	£28,125/QALY
(4) Relative ICER impact ³	-29.7%
(5) Implied threshold ICER weight ³	1.42
(6) Required health inequality aversion ⁴	8

Notes

¹ Based on guesstimated lifetime cost of £40,000 and lifetime health benefit of 1 QALY per recipient

² Above £30,000/QALY, NICE Technology Appraisal committees need stronger justifications to recommend funding

³ Based on a maximum plausible Atkinson health inequality aversion parameter of 10, which gives 467% more weight to the worst-off group (IMD 1) compared with the best-off group (IMD 5)

⁴ Atkinson value required to bring the intervention below the cost-effectiveness threshold of £30,000

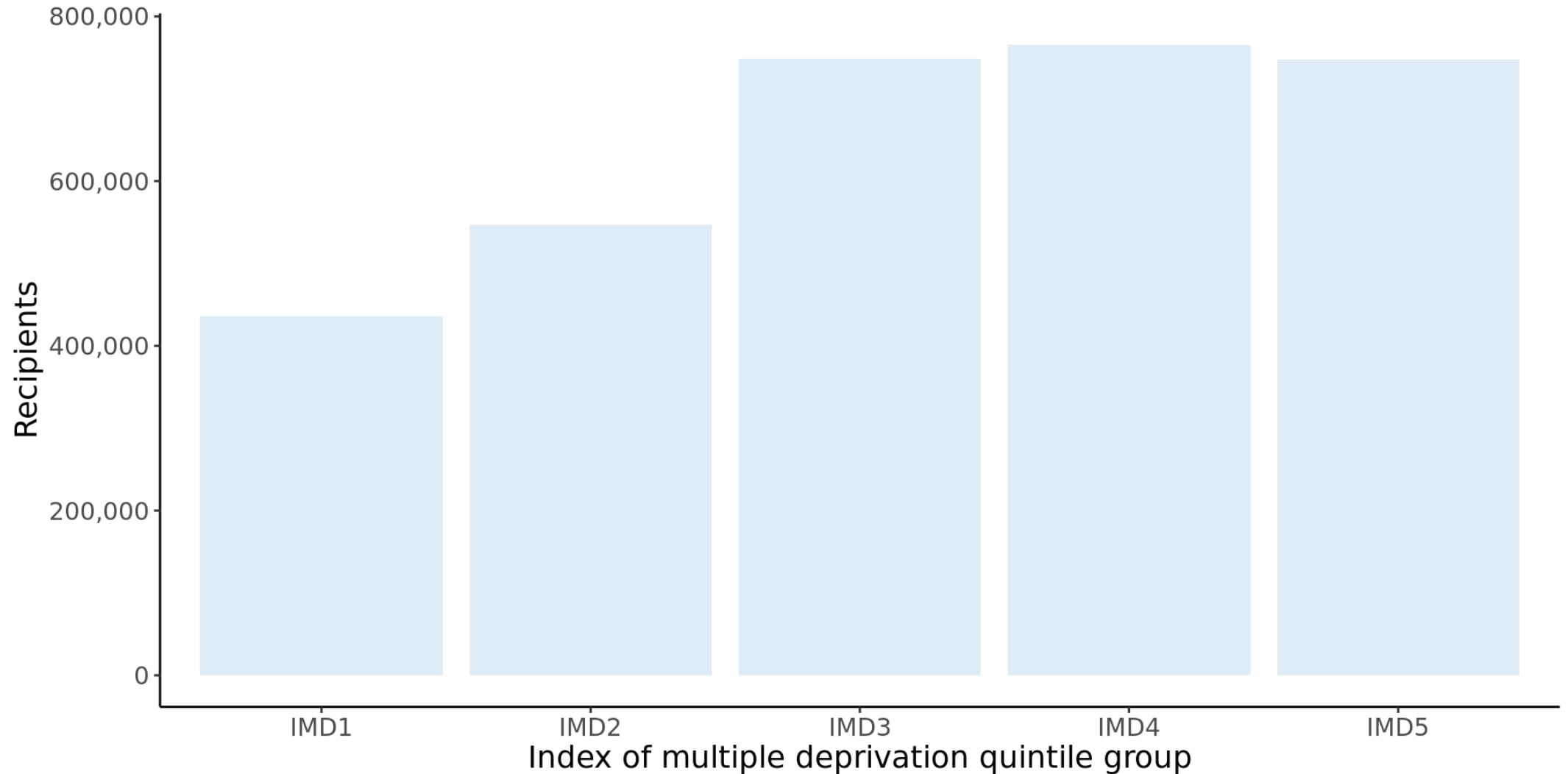
“Win-Lose”

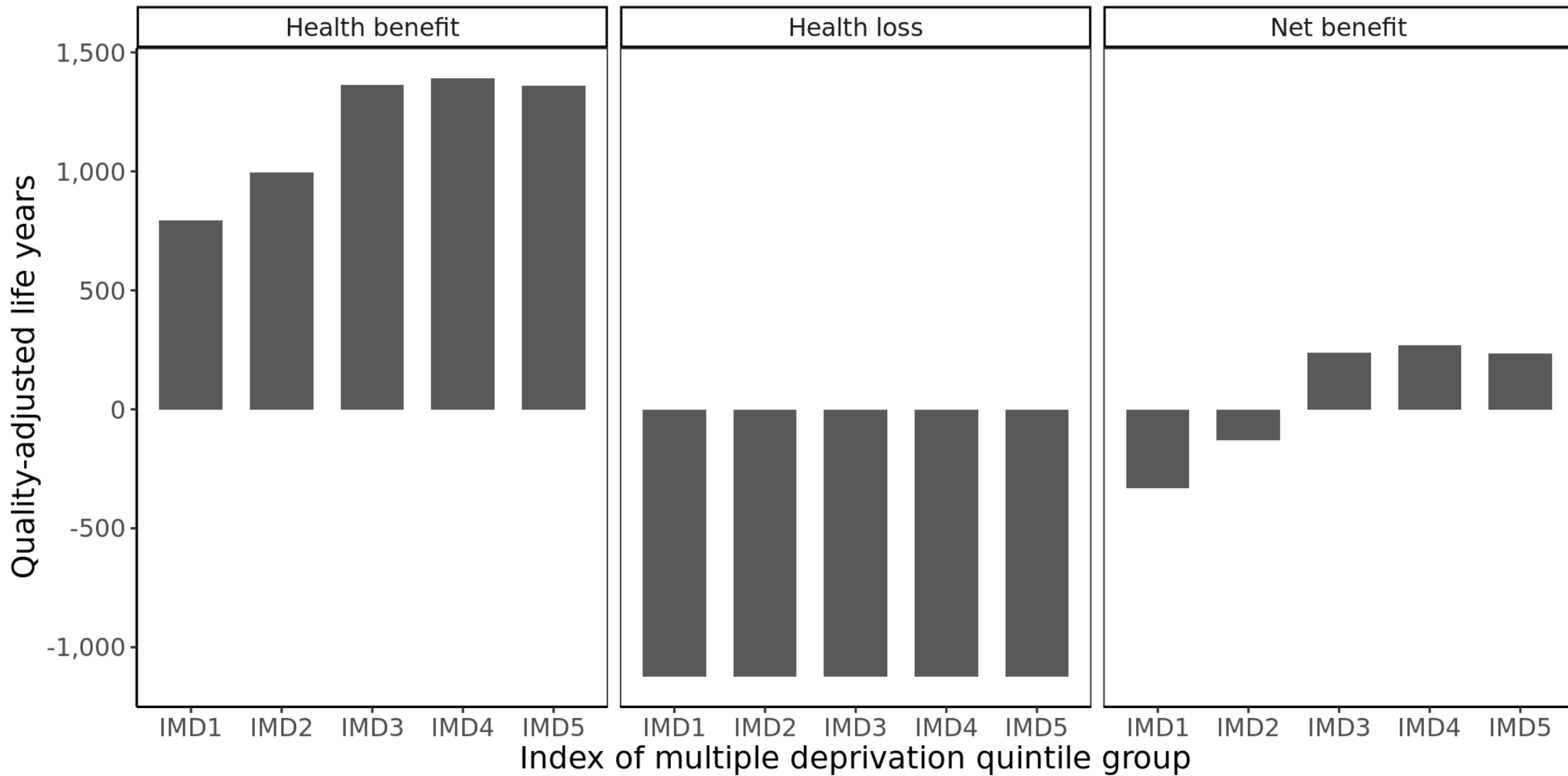
Cost effective but increases health inequality

Lung health checks for adults aged 55 to 75 at risk of lung cancer

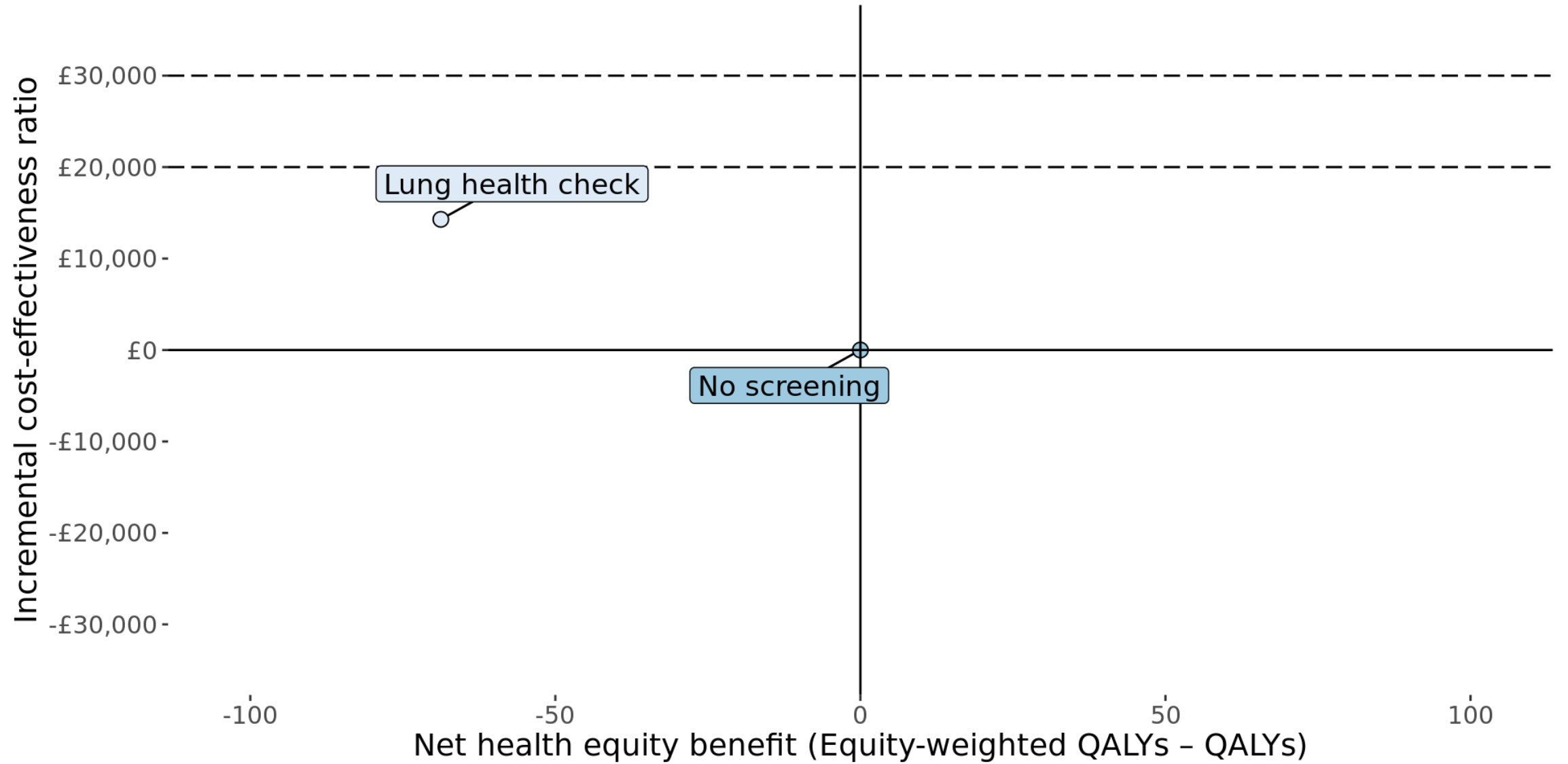
This is a simple hypothetical example relating to potential future national roll-out of lung cancer screening in England, building on various ongoing [local pilot programmes](#). It is based on cost-effectiveness input data from [Griffin et al. 2020](#) and [Field et al. 2017](#), which use models calibrated to effectiveness data from the US National Lung Screening Trial and the UK Lung Cancer Screening Trial, respectively.

Estimated number of people invited for screening by deprivation group (current and former smokers age 55 to 75 in England)





Equity-ICER Impact Plane



Main DCEA Estimates

Net health inequality benefit	712 QALYs
Incremental Cost-Effectiveness Ratio (ICER) ^{1, 2}	£14,286/QALY
Equity-weighted ICER ³	£16,341/QALY

Notes

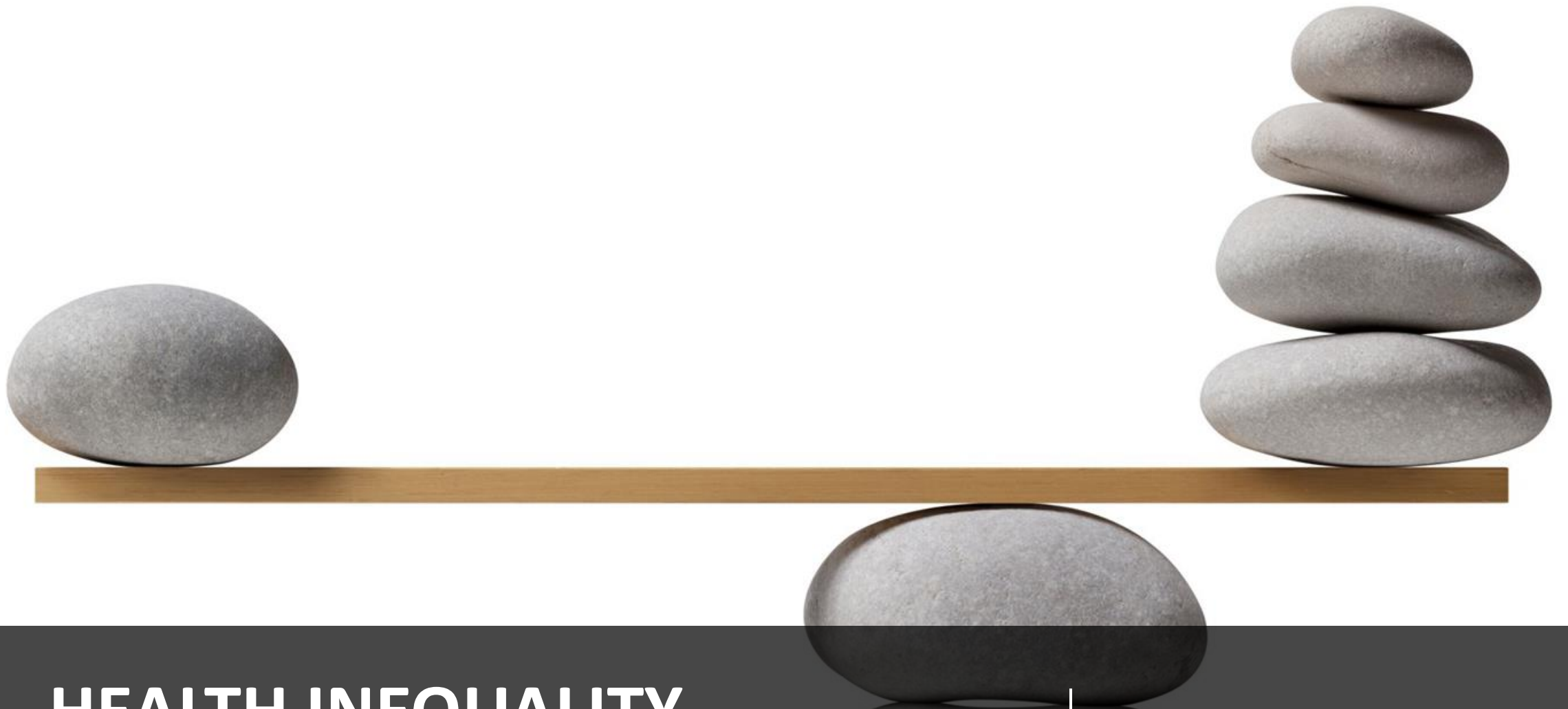
¹ Based on a hypothetical cost of £26 and benefit of 0.00182 QALYs per recipient of screening invitation (approximately 6.25m current and former smokers in the England general population age 55 to 75)

² The customary NICE decision threshold is around £30,000/QALY

³ Based on an Atkinson inequality aversion parameter of 10, which gives 467% more weight to the worst-off group (IMD 1) compared with the best-off group (IMD 5)

Policy implications

- Paradoxically, lung health check programmes may increase health inequality if delivered in the same way as the UK Lung Cancer Screening Trial (UKLS) in the early 2010s
 - The prevalence of lung cancer is higher and rates of early detection lower among more disadvantaged groups
 - But uptake of the UKLS screening pilot was substantially lower
- It may be worthwhile to re-design lung health check programmes to increase uptake among more disadvantaged populations – e.g. vans in supermarket car parks – shifting the programme closer to the “Win-Win” quadrant...



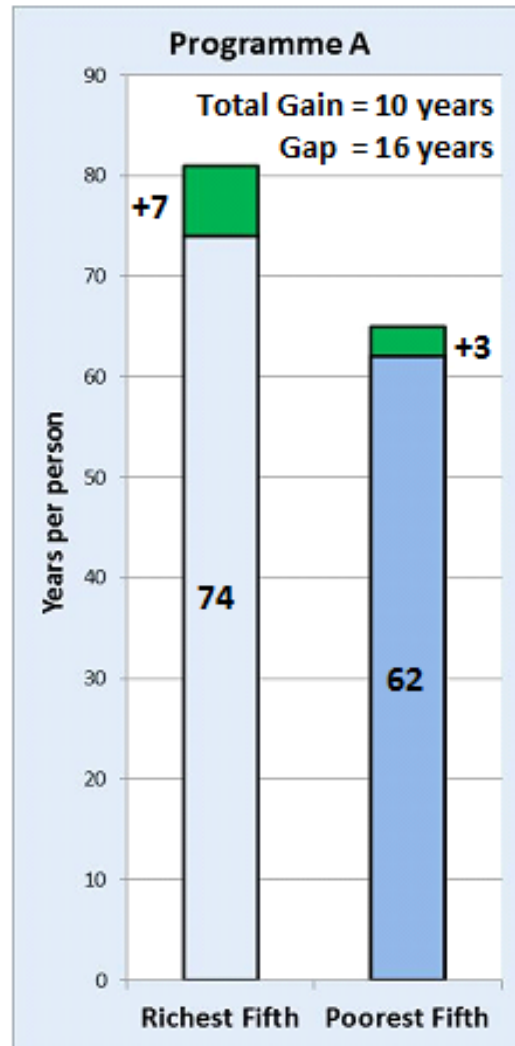
**HEALTH INEQUALITY
TRADE-OFFS**

Reducing health inequality vs. improving total health

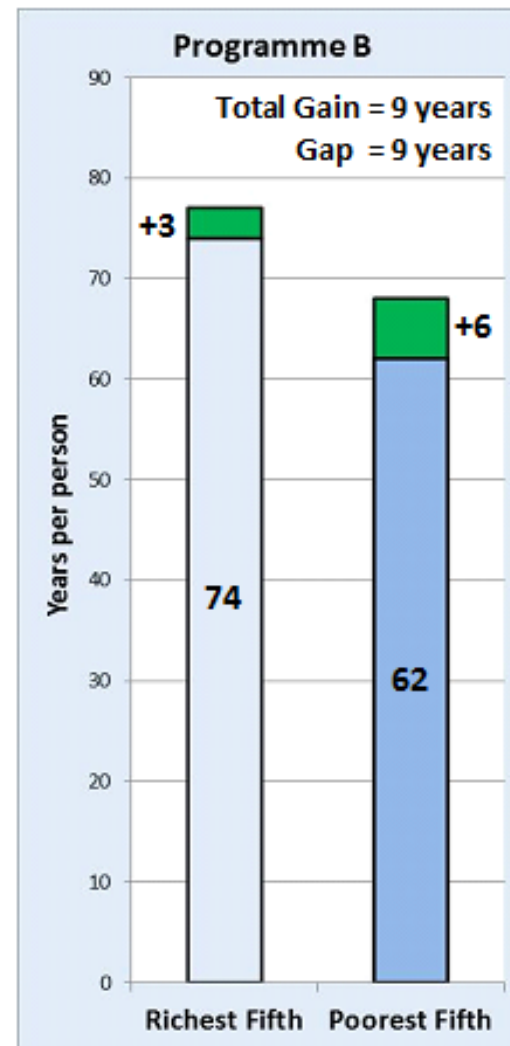
Eliciting “health inequality aversion”

Equity-efficiency
trade-offs –
one common
survey instrument

3.



After: 81 years 65 years



After: 77 years 68 years

Programme A

Programme A and B
are equally good

Programme B

Further Reading



NICE Position statement on using DCEA in NICE's technology appraisal and highly specialised technologies programmes

See pages 980-990 of the Committee Papers for the following Single Technology Appraisal: **Exagamglogene autotemcel for treating transfusion-dependent beta-thalassaemia in people 12 years and over**, Technology appraisal guidance, Reference number: TA1003, Published: 11 September 2024.

- <https://www.nice.org.uk/guidance/ta1003/evidence>
<https://www.nice.org.uk/guidance/ta1003/evidence/committee-papers-pdf-13497440797>

“This position statement provides clarity on how health inequalities can be presented in TA and HST submissions. Its aim is to:

- *encourage submission and use of quantitative assessments of health inequalities to show the potential scale of effect for the eligible population*
- *support evaluation committees to carefully consider analyses showing the impact of new technologies on health inequalities, recognising the remit of the programmes*
- *exclude any consideration of a quantitative modifier using quality-adjusted life year (QALY) weights or estimates of health inequality impact that use an inequality aversion parameter.”*

NICE Clinical and public health guideline development

See Chapter 7, Section 7.8 Using economic evidence to formulate guideline recommendations, of **Developing NICE guidelines: the manual** NICE process and methods [PMG20] Published: 31 October 2014 Last updated: 29 May 2024.

<https://www.nice.org.uk/process/pmg20/chapter/incorporating-economic-evaluation#the-role-of-economic-evaluation-in-guideline-development>

"Considering health inequalities

We recognise the important role NICE guidance can play in the national drive to reduce health inequalities, defined by the UK Government and the NHS as unfair differences in health between more and less socially disadvantaged groups.

To support our commitment to addressing health inequalities, we have commissioned a [prototype tool](#) to explore the approach of providing quantitative estimates of the impact of NICE recommendations on health inequalities. The tool uses distributional cost-effectiveness analysis to model changes in health inequalities between 5 socioeconomic groups in England based on the neighbourhood index of multiple deprivation.

We encourage piloting the tool, when data allows, to determine its usefulness in informing committee consideration of health inequalities during guideline development. Piloting will also enable an exploration of operational considerations, possible trade-offs between cost-effectiveness and health inequality effects, and identify any limitations of the tool.



HEALTH INEQUALITY IMPACT CALCULATOR

Old Version: https://shiny.york.ac.uk/nice_equity_tool

New Version: <https://shiny.york.ac.uk/dceasimple/>

COMMENTARY | VOLUME 24, ISSUE 1, P118-120, JANUARY 01, 2021

Distributional Cost-Effectiveness Analysis Comes of Age

Richard Cookson, PhD • Susan Griffin, PhD • Ole F. Norheim, PhD • Anthony J. Culyer • Kalipso Chalkidou, PhD

Open Access • Published: November 07, 2020 • DOI: <https://doi.org/10.1016/j.jval.2020.10.001>



Introduction
Background
Distributional
Cost-
Effectiveness
Analysis

Introduction

Distributional cost-effectiveness analysis (DCEA) provides information about the equity impacts of health technologies and programs and the trade-offs that sometimes arise between equity and efficiency. This field has now come of age with a growing applied literature,¹ new training resources,² and a formal professional network: a special interest group on equity-informative economic evaluation within the International Health Economics Association.³

Cookson, R, Griffin, S, Norheim, O F, Culyer, A J and Chalkidou, K. (2020). Distributional Cost-Effectiveness Analysis Comes of Age. *Value in Health*. <https://doi.org/10.1016/j.jval.2020.10.001>

DISTRIBUTIONAL COST-EFFECTIVENESS ANALYSIS

Quantifying Health Equity Impacts and Trade-Offs

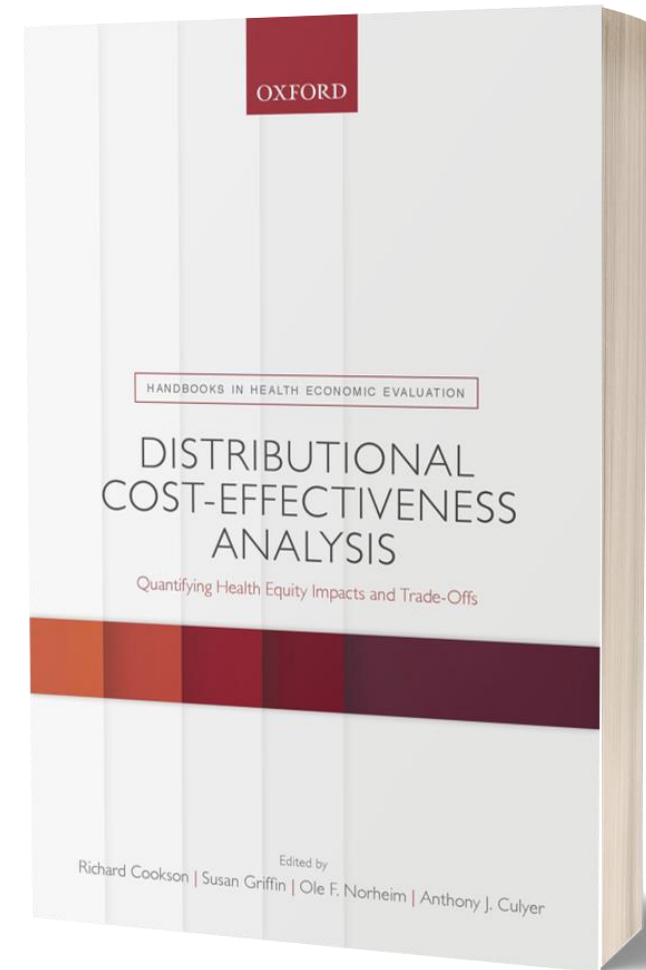
An Oxford University Press
Handbook in Health Economic Evaluation

Edited by Richard Cookson, Susan Griffin, Ole F. Norheim,
and Anthony J. Culyer

- Flexible methods for any decision context
- Practical [spreadsheet training exercises](#)
- Clear overview for decision-makers

'The definitive guide to equity methods in health economic
evaluation - a landmark in the field.'

*Michael Drummond, Professor of Health Economics, University
of York, UK*



Health Equity Research

Special Interest Group

▼ Special Interest Groups

- Biosimilars
- Clinical Outcome Assessment
- Digital Health
- Health Equity Research**
- Health Preference Research
- Medical Devices and Diagnostics
- Medication Adherence and Persistence
- Nutrition Economics
- Oncology
- Open Source Models
- Patient-Centered
- Precision Medicine and Advanced Therapies

Mission

To advance equity-informative methods and data for health economics and outcomes research that help to reduce unfair differences in health.

Goal

- Advance novel methods for assessing the health equity impacts of decisions on unfair differences in health, including application of equity-informative cost-effectiveness analysis across markets, conditions, and payer types.
- Establish a forum for members to engage in discussion related to the challenges of measuring and addressing health inequities in HEOR and healthcare decision making.
- Foster multi-stakeholder dialogue between policy makers, regulators, payers, advocacy groups, prescribers, patients, and researchers about health equity considerations at all stages of decision making from inclusive clinical trials through health technology assessment (HTA) and implementation.
- Improve data sources used by the HEOR community to study health inequities.

[https://www.ispor.org/
member-groups/
special-interest-groups/
health-equity-research](https://www.ispor.org/member-groups/special-interest-groups/health-equity-research)



<https://healtheconomics.org/sigs/eee/>



[Congress](#) [Events](#) [Awards](#) [Resources and Opportunities](#) [Latest News](#)

[JOIN NOW](#)

Equity Informative Economic Evaluation

Equity in health and healthcare is an area of growing global policy interest.

This group will seek to be at the forefront of the application and development of methods for using economic evaluation to provide useful information about equity impacts and trade-offs in health care and public health decision-making.

The group will seek to be inclusive and eclectic. We welcome researchers working on equity issues in both HIC and LMIC countries, using diverse methods, and addressing the full range of distributional equity concerns that arise in economic evaluation and health technology assessment.

Readings

Asaria, M, Griffin, S and Cookson, R. (2016). "Distributional Cost-Effectiveness Analysis: A Tutorial." *Medical Decision Making* 36(1): 8-19.
<http://mdm.sagepub.com/content/36/1/8.abstract>

Avanceña ALV, Prosser LA. Examining Equity Effects of Health Interventions in Cost-Effectiveness Analysis: A Systematic Review. (2021). *Value in Health* 24(1):136-143
<https://doi.org/10.1016/j.jval.2020.10.010>

Cookson, Richard Andrew , Griffin, Susan , Norheim, Ole F, Culyer, A J and Chalkidou, K. (2020). Distributional Cost-Effectiveness Analysis Comes of Age. *Value in Health*.
<https://doi.org/10.1016/j.jval.2020.10.001>

Cookson, R., A. J. Mirelman, S. Griffin, M. Asaria, B. Dawkins, O. F. Norheim, S. Verguet and A. J. Culyer (2017). "Using Cost-Effectiveness Analysis to Address Health Equity Concerns." *Value in Health* 20(2): 206-212. <https://doi.org/10.1016/j.jval.2016.11.027>

Cookson, R and Koh, J. (2023). Quantifying Impact on Health Inequality in England: Revised Final Report and Web-Based Calculator. CHE Research Paper 193, Centre for Health Economics, University of York. <https://www.york.ac.uk/che/publications/in-house/>

Kowal, S., Ng, C. D., Schuldt, R., Sheinson, D., & Cookson, R. The Impact of Funding Inpatient Treatments for COVID-19 on Health Equity in the United States: A Distributional Cost-Effectiveness Analysis. (2022). *Value in Health*.
[https://www.valueinhealthjournal.com/article/S1098-3015\(22\)02176-3/fulltext](https://www.valueinhealthjournal.com/article/S1098-3015(22)02176-3/fulltext)

Robson M, Asaria M, Cookson R, Tsuchiya A, Ali S (2017) Eliciting the level of health inequality aversion in England. *Health Economics* 26(10): 1328–1334
<http://onlinelibrary.wiley.com/doi/10.1002/hec.3430/full>



Thank you