UNDERSTANDING THE BASICS of HEALTH ECONOMICS

FOR ENHANCED POLICY DISCUSSIONS

THE LIGHT CONSORTIUM

UKaid
from the British people

Authors

Ewan Tomeny
(Liverpool School of Tropical Medicine)

Copyediting: Dr Kerry Millington

Design: Joy Gilroy

Contact

Email: ewan.tomeny@lstmed.ac.uk

Twitter: @LIGHTonTB

LinkedIn: The LIGHT Consortium

YouTube: @LIGHTonTB

Website: https://light.lstmed.ac.uk/

Version 4 **Sept 2024**

Overview of this Learning Pack

Purpose

This learning pack has been produced by the LIGHT consortium and is primarily aimed at policymakers and programme managers based in-country.

The purpose of the pack is to provide the reader with an accessible route to (re)familiarising themselves with concepts of health economics that commonly arise in health-policy discussions. We believe that, when communicating research, we have our best discussions when all stakeholders share a common understanding of the central concepts. This resource pack aims to provide newcomers to health economics with a valuable foundation across several key ideas, while also assisting in complementing and updating understanding among readers with some prior exposure.
Ultimately, through supporting more researchers and stakeholders to partake in effective and constructive policy discussions, we can ensure the best decisions are made relating to future investment in TB interventions.

How to use

Health Economics is a large and growing discipline, the learnings of which could today fill a bookshelf. This pack cannot be seen as a formal introduction to health economics, nor is it intended to be. Moreover, it is a select introduction to some key concepts to provide a baseline understanding for engaging with health economic research. The booklet assumes no prior knowledge of the discipline and is written in a straight-forward manner, introducing specialist terms when first used, and minimising the use of outside jargon where possible.

Sections are arranged such that the pack follows logically from start to finish, introducing ideas that build upon those that came before. As such, concepts appear in a different order to that which they might in larger health economic textbooks. However, all sections are clearly labelled and signposted in the contents page and throughout, with the understanding that many readers will prefer to 'dip in and out' at individual sections.

This learning pack can be downloaded in its entirety to improve general knowledge on health economics or as separate chapters. Topics are mostly covered in basic detail, giving definitions and brief explanations, often along with intuitive examples with a focus in the tuberculosis field but illustrative for other health areas. Throughout the learning pack, the reader is directed to other papers and sources for further reading, to learn more about a specific topic should they wish, however these references are in no way exhaustive. The LIGHT team would be happy to provide additional references if requested, and to direct the reader to recent studies related to tuberculosis or otherwise.

Ongoing development

This resource has been designed as a 'working document', and so if there are additional concepts that you'd like to see explored, or areas which you feel deserve additional attention, please do let a member of the LIGHT team know, or get in touch directly (ewan.tomeny@lstmed.ac.uk).
All comments are welcome.

CONTENTS

1 INTRODUCTION TO HEALTH ECONOMICS

2 HEALTH-RELATED QUALITY OF LIFE

3 THE DISABILITY-ADJUSTED LIFE-YEAR (DALY)

4 COSTS

CONTENTS CONTINUED

TABLE OF FIGURES

ACRONYMS

ABC	Activity-Based Costing
AIDS	Acquired Immunodeficiency Syndrome
AUC	Area Under the Curve
CBA	Cost-benefit Analysis
CEA	Cost-effectiveness Analysis
CER	Cost-effectiveness Ratio
CET	Cost-effectiveness Threshold
CFR	Case Fatality Ratio
CMA	Cost-minimisation Analysis
COPD	Chronic Obstructive Pulmonary Disease
CUA	Cost-utility Analysis
DALY	Disability-adjusted Life-year
DCE	Discrete Choice Experiment
EQ-5D	Euroqol 5-Dimensions

ACRONYMS

GBD	Global Burden of Disease
HIV	Human Immunodeficiency Virus
HRQoL	Health-related Quality of Life
ICER	Incremental Cost-effectiveness Ratio
LIGHT	Leaving No One Behind: Transforming Gendered Pathways to Health for Tuberculosis
LSTM	The Liverpool School of Tropical Medicine
MDR-TB	Multidrug-resistant Tuberculosis
NTP	National Tuberculosis Programme
OECD	Organisation for Economic Co-operation and Development
OOP	Out of Pocket
QALY	Quality-adjusted Life-Year
QoL	Quality of Life
SDoH	Social Determinants of Health
SF-6D	Short-form Six-dimension
SGRQ	Saint George's Respiratory Questionnaire
SRTP	Social Rate of Time Preference
TB	Tuberculosis
UHC	Universal Health Coverage
VAS	Visual Analogue Scale
WHO	World Health Organization
WTP	Willingness to Pay
XDR-TB	Extensively Drug-resistant Tuberculosis
YLD	Years Lost to Disability

1 Introduction to Health Economics

Chapter Summary

This section introduces some common economic terms and principles, outlines how health and healthcare differ from other goods and services, and provides an idea of the kind of work a health economist might do.

1.1 What is Economics?

Economics is a social science concerned with how things are produced, shared, and used. The 'things' in an economy are typically referred to as 'goods' when we can see, feel, or touch them, and 'services' when we can't. Economists tend to refer to our usage of goods and services as 'consumption', and the satisfaction we gain from this consumption is termed 'utility'.

Economics is a broad discipline which has grown over hundreds of years, spreading into many branches of economic theory, each of which makes different assumptions about how people act, comprising a range of philosophies about the best way to, produce, divide, and share (or 'distribute') goods and services.

Economists are often interested in the resources required for creating goods and providing services. These resources include labour, land, and other input goods (normally called 'capital').

Put simply, economics can be thought of as the study of choices. That is, choices about what to do with scarce resources, when these resources have more than one use.

While typically people may think of the discipline of economics in terms of 'money', and associate it with business, finance, accountancy and commerce, economic analysis is applied throughout many areas of society, including, engineering, education, government, warfare, the environment, and — of particular interest to us— ***healthcare***.

1.2 What makes Health and Healthcare Special?

When a shopkeeper decides at what price to sell an item, this will depend on how popular the item is (the *demand*), and how easily they can get hold of the item (the *supply*). These concepts are central to economics and have been studied throughout history.

That being said, certain principles that usually apply within usual markets don't work as well when the goods we're dealing with are *health* and *healthcare*.

Many consider the birth of health economics to have been in 1963, catalysed by a paper written by the economist Kenneth Arrow in the American Economic Review. Arrow's paper focusses on the healthcare industry and sets out a number of factors which – in his words – '*establish a special place for medical care in economic analysis*'.

Demand

Let's firstly consider the unusual aspects of health from the demand side.

- Unlike our demand for goods such as food or clothes, our demand for health care is irregular and unpredictable; we don't choose when we fall ill, or what illness we fall ill to.

- Many non-health goods we might at some point purchase (a television, a book, a bicycle…) we could typically forgo and carry on with our lives. This is rarely true of health care. In the worst instances, not receiving health care can lead to disability and death.

  As far as goods go, more so than almost anything else, *health care is essential.*

- Nevertheless, providing health care often requires a lot of resource and can therefore be very expensive. This combination of essential and expensive can be catastrophic.

Supply

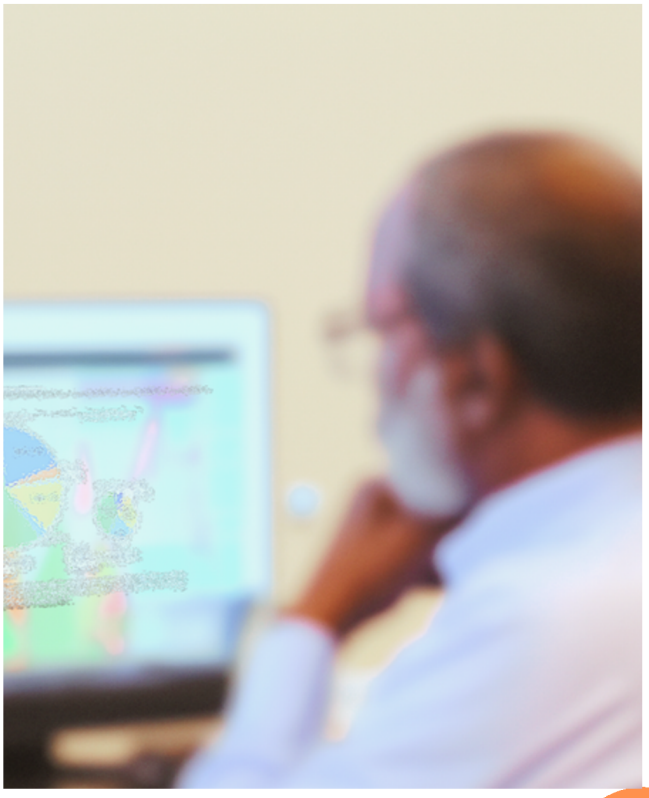
- Let's consider the example of purchasing a mobile phone. Before entering the phone shop, consumers are able to prepare by researching the specific characteristics of each model on the market. This kind of preparation, however, is rarely possible when a person enters the doctor's surgery. This imbalance in knowledge is referred to as 'asymmetry of information'. As patients, we are required to trust our doctor/s, placing our care in their hands.

- If we again take the example of buying a mobile phone, it's reasonable to assume that throughout the exchange, the owner of the phone shop is predominantly looking out for their own interests, just as we as customers are looking out for ours. This is clearly quite different from the dynamic at the doctors. Doctors are of course bound by ethical codes of conduct – after all, it would be outrageous to think a doctor is treating us based exclusively on their own self-interest, rather than guided by our medical need.

- Finally on the supply-side, we can consider the commitments it takes for a doctor to become qualified. Not everyone is able to become a doctor, and even among those with the potential and determination, sadly not all can afford the investment. Economists term such impediments 'barriers to market entry'.

1.3 What do Health Economists do?

While economic ideas can usually be expressed in words, economists typically investigate relationships and recommend policies based on the results of computer models using statistics and mathematics. Much of a health economist's time today is spent analysing data and building such models. The questions they hope to answer, however, will depend on the area of health economics in which they work.



There are many branches of health economics, covering diverse topics such as behaviour, value, efficiency, effectiveness, and equity.

As health economists work within a discipline of economics, we can surmise that, they are all—whether *directly* or *indirectly*— interested in the use of resources in healthcare.

One of the key ideas health economists have for many years been grappling with, is 'what is health?', and as importantly, how do we measure it?

What is health and how do we measure it?

2 Health-Related Quality of Life

Chapter Summary

This section looks at how we can define health and healthiness, and how this is measured. It covers health-related quality of life, health utilities, the EQ-5D instrument and finally the QALY.

2.1 Natural Measures of health

When evaluating an intervention, we need to be able to measure the intervention's effects. Many interventions may choose a 'natural health unit' that is deemed important to the objective of the intervention and is straightforward to measure.

Let's say a health researcher is considering a trial of interventions aimed at reducing the likelihood of a stroke. The most obvious unit of effect in a trial might be number of strokes averted. If all the interventions express their effect using this as their unit, they can be straightforwardly compared against one another. Similarly, if considering a trial of interventions for hypertension, they might consider the average drop in blood pressure in patients in each arm of the trial; interventions for rehabilitating patients who have breathing difficulties might choose to consider the distance a person is able to walk in a certain amount of time.

While this offers a useful way of comparing between interventions, there is a clear issue: what about the other effects of the interventions? The interventions for preventing stroke may cause terrible nausea, the interventions for hypertension may cause side-effects of anxiety, and the interventions for rehabilitating people with breathing difficulties may cause wheezing at night. By focussing on just the 'natural measures' mentioned above, these other effects would be entirely missed.

What we require, therefore, is a way of capturing the wider impact that a given intervention has on a person.

2.2 Health related quality-of-life

Defining health and 'healthiness' is not straightforward. If you wish, before reading on, have a think about how you would define this concept. What important things should be included? In truth, there is no single fixed definition, and how a person may choose to define it will be influenced by many things.

Our understanding of health has evolved over many years, and while we won't explore this in detail here, for those interested, see [1]-[3].

When the WHO constitution was written in 1948, it began with the following statement, which still exists today:

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

WHO constitution, 1948 [4]

This definition illustrates an important idea of health economics, that health is not just about biological functioning, but is about our quality of life (QoL).

While the World Health Organization's definition didn't use this term, it has been used in the medical literature since the 1960s.[5] This idea became especially important with the growth in the number of interventions able to help a patient live for more years though at a 'sub-optimal' level of health. Shortly after the introduction of 'QoL' came the emergence of the term 'health-related quality-of-life' (HRQoL). Both terms appear in the literature today and are often used interchangeably,[6] though QoL is generally considered a broader concept, encompassing elements such as education and employment.[7] Besides disagreement on the nomenclature, there are interesting debates on much of the philosophy underlying health economic ideas, which have generated a world of fascinating papers available for the interested reader to discover. In this context, for example, "Is HRQoL determined by expectation or experience?".[8] While this learning pack is not designed to explore these ideas, the LIGHT team would be happy to engage with an interested reader on any topics of relevance to their work.

In this resource pack we will use the term 'HRQoL'.

We now have a useful term that captures more than just 'illness' and 'disease'.

While differing schools of thought argue on the exact definition, all definitions of HRQoL reflect key elements:

HRQoL is:

- **Multidimensional**
- **Linked to medical conditions** – whether chronic/acute; diagnosed or otherwise
- **'Self-perceived'** – a person's HRQoL is not objectively determined by the conceptions of others, but by the individual's subjective experience
- **Relates to 'wellbeing'** - including elements such as physical, mental, and social domains of health

Below is a model of HRQoL suggested by Ferrans et al.

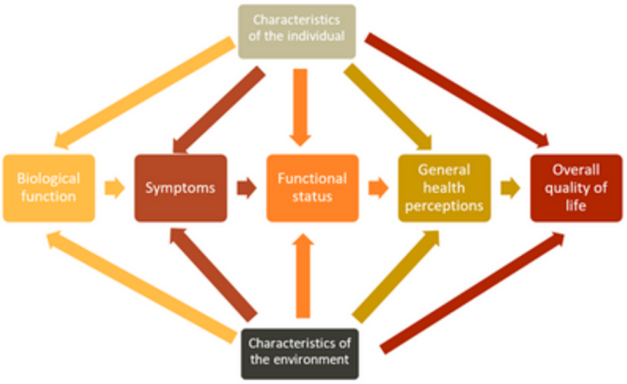


Figure 1 – Model for Health-related quality of life. (Ferrans et al, 2005)[7]

2.3 How do we measure HRQoL?

From our discussion of HRQoL above, it should be clear that no attempt could ever hope to measure our HRQoL in its entirety. It's a complex construct affected by many things, some of which may not even be known to us. A person might consider their HRQoL differently if asked in the morning rather than the evening; their assessment might even vary based on the weather. When trying to collect this data and measure a person's HRQoL, the best we can hope for is a proxy, that is, to capture some of the important relevant elements to be able to get a useful idea about it.

Assessing HRQoL at a point in time - the conceptual steps

Our ultimate aim as researchers in capturing a measurement of HRQoL is to include it in decision-making calculations. We will later consider how to capture changes over time, but first we will focus on capturing HRQoL at one specific point in time.

To do this, we can broadly think of four stages:

First First we need to be able to breakdown the vast multi-dimensional spectrum of HRQoL into specific well-defined 'states', typically referred to as 'health states'.

Second Second, for each of our defined health states we need an understanding of how negatively being in the state affects a person's HRQoL, which we must be able to represent numerically for our calculations.

Third Third, we require a practical way of establishing 'in the field' which of the states in our list a patient is in at a given point in time.

Finally Finally, bringing it all together, we need a clear system for assigning each of the patients in our study the numerical value, known as an 'index', for their health state at each time point.

The good news is that much of this work has been done for us, and when embarking on our economic evaluation, we don't need to worry about the complexities of Steps 1 and 2. Due to the scope of this guide, we will focus on the practicalities of steps three and four, those followed when conducting an economic evaluation.

Nevertheless, when using values in calculations, it is useful to have a general understanding of where these values come from. For this reason, some brief information is included in the sections below to explain the process behind Steps 1 and 2, and references are included for the interested reader.

Health-related quality of life instruments

As discussed above, HRQoL is a subjective personal measure. It follows, therefore, that the process of assessing patients' HRQoL requires information related from patients themselves. Quite simply, we get this information by asking patients questions. This is done using questionnaires, which we often see called 'instruments'.

Different diseases and conditions will affect our HRQoL in different ways. A patient undergoing treatment for MDR-TB will have a vastly different experience to a person undergoing eye surgery, which again is very different from a person managing their Parkinson's disease. To ensure that the relevant considerations are factored into our measurement, we can use a HRQoL measurement focussed on a condition of interest. These are called 'disease-specific instruments'.

Disease-specific instruments

There are many disease-specific instruments, often with multiple to choose from for a single disease. Here we'll focus on one specifically: the St George's Respiratory Questionnaire (SGRQ).[9] We should also note that there are in fact multiple versions even of the SGRQ – here we'll consider the original.

The SGRQ was designed to measure the impact on overall health, daily life, and perceived well-being in patients with asthma and COPD, but has since been validated for use in various other respiratory conditions, including bronchiectasis, interstitial lung disease, post tuberculosis lung disease (PTLD), pulmonary hypertension, pulmonary leiomyomatosis, and sarcoidosis. The word 'validated' in this context means that it has been shown to measure that which it claims to measure, and does so reliably and accurately. [10]

Before reading on, we recommend taking a look at the questionnaire here.

The SGRQ contains 51 multiple choice questions over seven sections. Most of these are true/false questions, while some have 3, 4, or 5 possible options. The questions relate to many aspects of life, including symptoms (wheezing, coughing, breathlessness), daily activities (dressing, walking up stairs, exercise), and social functioning (embarrassment, panic, effect on friends/family). There is also a free text section at the end for a respondent to detail other specific impacts on their life. Once completed, the combination of responses places the respondent into a 'health state'. While the questionnaire is only six pages long, the number of different combinations of answers allows a huge number of potential health states (16 Quintillion!). The questionnaire creators provide an Excel sheet with the questionnaire that allows researchers to calculate a number from 0-100 for each respondent, with higher scores indicating a more severe impact on HRQoL. For more information on the SGRQ you can find a list of publications here, and a study which uses the SGRQ to measure post-TB lung disease here.

Generic HRQoL Instruments

Whilst the benefit of disease-specific instruments should be clear, there are times when we may want something that isn't disease specific. This is especially necessary when we wish to compare interventions between different disease areas. As the name suggests, a 'generic instrument' is not tied to a specific disease or condition and is designed to be completed by anyone regardless of their health conditions.

There are many to choose from, but in this research pack we'll walk through an example using the most common – the EQ-5D.

When designing an intervention in which HRQoL will be collected, we recommend also investigating the SF-6D and the HUI. Comparisons for how these compare to the EQ-5D can be found here and here, and members of the LIGHT team would be happy to discuss these instruments further.

The EQ-5D

Though you may have heard people talk of 'the' EQ-5D, there are several types. The two most common are the EQ-5D-3L and the EQ-5D-5L. The 'EQ' stands for EuroQol, the research organisation who created it and manage its use.

The '5D' refers to the 5 dimensions which are asked about in the questionnaire, namely: mobility; self-care; how well the individual can carry out their 'usual activities'; their level of pain/discomfort; and finally any experience of anxiety/depression.

The questions are multiple choice, and the '5L' or '3L' refers to how many options each question has. For example, the 3L's three options for mobility are: "I have no problems in walking about"; "I have some problems in walking about"; "I am confined to bed".

The EQ-5D is available in over 200 languages, and is advertised by EuroQol to be valid, reliable, and responsive.[11]

Take a look over the first page of the questionnaire on the next page **(Figure 2)**. You may even choose to take a moment to complete this questionnaire yourself, thinking about your situation today.

The questionnaire is intentionally short so that patients can fill it out quickly. That said, often there can be obstacles to this. Some are immediate, such as patients who are not able to read, but some are conceptual - being asked to immediately reflect on these concepts is unfamiliar for most of us. As outlined earlier, HRQoL is 'self-perceived', so for all patients that are able, the form should be completed by them alone. There will of course be times when patients are unable to complete their own questionnaire, for example in the case of severe intellectual disabilities. In these cases, EuroQoL allow for a 'proxy' (typically a caregiver who knows the patient) to complete the questionnaire on the patient's behalf. The proxy makes a judgement of what they consider the patient's responses would be, were the patient able to understand and answer. There are four different proxy versions available, and more information can be found here.

Across all EQ-5D questionnaires, the five dimensions asked aim to capture HRQoL. The EQ-5D also comes with a second page, upon which is printed what looks like a ruler, numbered from 0 to 100, known as the '**Visual Analogue Scale**' or 'VAS'. At the '100 end' is written *the best health you can imagine*, and at the zero end *the worst health you can imagine*.

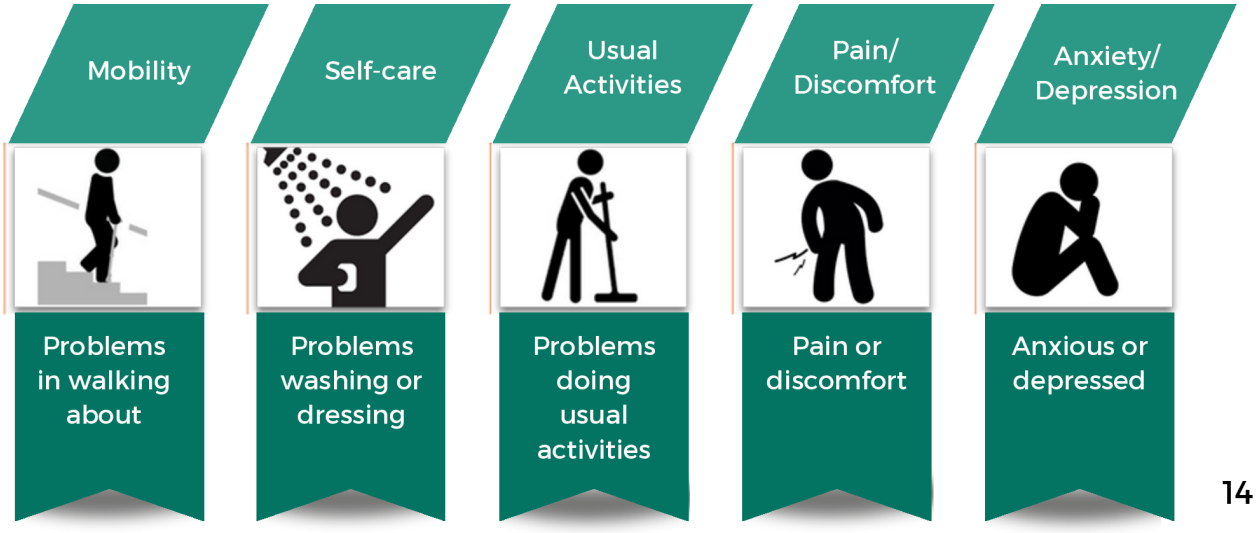
Patients are then asked to mark on the scale where they consider their health to be TODAY. This provides an extra value to use alongside the responses given to the five questions.

A patient's response to the five questions places them into one of several different 'health states'. If someone answered '1' for the first question, '2' for the following three questions, and '3' for the last question, we'd call this health state '12223'. The total number of health states for the 3L can be calculated by considering that there are 5 questions with 3 answers for each, so 3*3*3*3*3 = 243. The 5L has 3125 potential distinct health states (5^5).

Once we have a health state for a person, we convert this into an index value using what's know as a 'value set' or sometimes called a 'tariff'.

EQ-5D value sets

It has been shown—as you might expect—that people in different countries value different health states differently. As such, different countries have different value sets, used for converting a health state such as 12223 seen above to a numeric value. The index values usually range from 0 to 1, although sometimes for the very worst states these values can drop below zero, known as 'states worse than death'. We won't explore this here, but see [12] for more information.



Under each heading, please tick the ONE box that best describes your health TODAY.

MOBILITY

I have no problems in walking about ☐
I have slight problems in walking about ☐
I have moderate problems in walking about ☐
I have severe problems in walking about ☐
I am unable to walk about ☐

SELF-CARE

I have no problems washing or dressing myself ☐
I have slight problems washing or dressing myself ☐
I have moderate problems washing or dressing myself ☐
I have severe problems washing or dressing myself ☐
I am unable to wash or dress myself ☐

USUAL ACTIVITIES (*e.g. work, study, housework, family or leisure activities*)

I have no problems doing my usual activities ☐
I have slight problems doing my usual activities ☐
I have moderate problems doing my usual activities ☐
I have severe problems doing my usual activities ☐
I am unable to do my usual activities ☐

PAIN / DISCOMFORT

I have no pain or discomfort ☐
I have slight pain or discomfort ☐
I have moderate pain or discomfort ☐
I have severe pain or discomfort ☐
I have extreme pain or discomfort ☐

ANXIETY / DEPRESSION

I am not anxious or depressed ☐
I am slightly anxious or depressed ☐
I am moderately anxious or depressed ☐
I am severely anxious or depressed ☐
I am extremely anxious or depressed ☐

Figure 2 - The EQ-5D questionnaire [13]

Where do health utilities come from?

There is a rather complex process that is carried out to calculate the various tariffs for each country. In brief, this involves finding a population of people within the country and asking them survey questions about different health states. For different value sets and instruments different methods are used. Some popular methods used are known as the 'standard gamble',[14] 'time-trade off',[15] and 'discrete choice experiments' (DCEs).[16] Essentially, they all share one thing in common: the people responding to the survey are asked 'would you rather' type questions relating to specified situations, each involving health states. In the standard gamble, part of the question includes a risk of death; in the time trade-off the question participants choose between different 'lives' of different lengths and in different health states; the DCE offers the responder a choice of two lives with various additional considerations in each.

Of main interest to us is: where do we get these value sets from?; how do we use them to get our index value for a patient's health state?; and what do we do if the country we're conducting our study in doesn't have a value set?

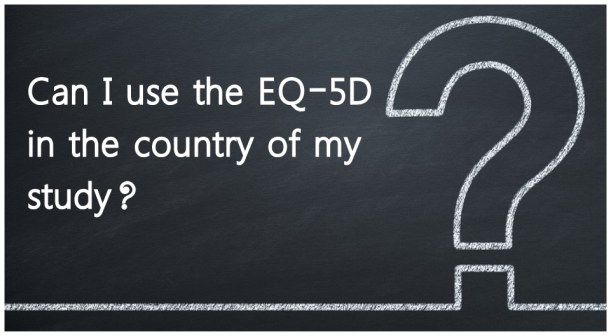
Where do I find utilities for my study?

EuroQol has lists of the countries for which value sets currently exist. As of August 2022, there are **33 countries/territories with published value sets:**

Belgium, Canada, China, Denmark, Egypt, England, Ethiopia, France, Germany, Hong Kong, Hungary, India, Indonesia, Ireland, Italy, Japan, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Portugal, Romania, South Korea, Spain, Taiwan, Thailand, The Netherlands, Uganda, Uruguay, USA, and Vietnam.[17]

There are also studies completed in Australia Saudi Arabia, Singapore and Sweden, and ongoing studies developing value sets for Austria, Ghana, Norway, Slovenia, Trinidad & Tobago, UAE, and Uzbekistan.

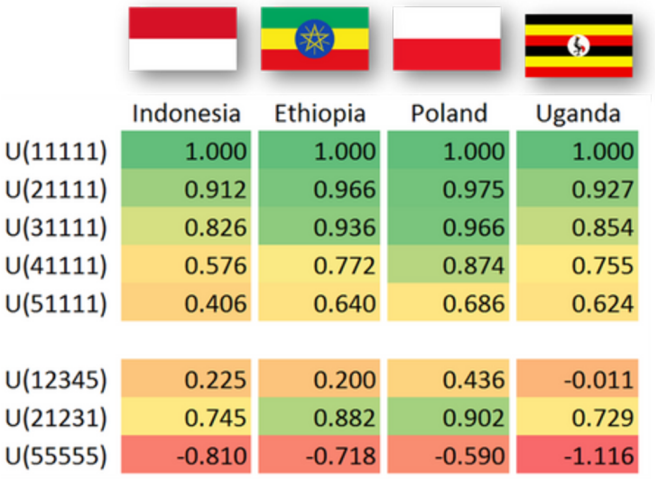
EuroQol provides a calculator which can be used to convert states (eg. 12134) to utilities for each of their value sets. It is worthwhile however, if you are conducting a study which will use these values, to read over the original paper which was used to generate the weights first, which you'll be referencing this in your study. All EQ-5D-5L value set study papers can be found here.



The first consideration is whether there is a copy of the EQ-5D questionnaire translated into the language of the population. If not, unfortunately this isn't something your study team would be allowed to translate, and so an enquiry would have to be made to EuroQol to request a translation. This can take time, and comes with a cost. If you have questions about this, the LIGHT team would be happy to have a discussion and provide further information.

The next issue is what if your study country doesn't have a value set? To demonstrate why we use different value sets, consider the states in Figure 3 overleaf, which demonstrate different values for the same health states across four different countries.

If there are no value sets for the country being studied, it is often the case that another country's value set can be chosen to use. This does however need to be thought carefully about. As we can observe in Figure 3, different countries consider different states differently.



	Indonesia	Ethiopia	Poland	Uganda
U(11111)	1.000	1.000	1.000	1.000
U(21111)	0.912	0.966	0.975	0.927
U(31111)	0.826	0.936	0.966	0.854
U(41111)	0.576	0.772	0.874	0.755
U(51111)	0.406	0.640	0.686	0.624
U(12345)	0.225	0.200	0.436	-0.011
U(21231)	0.745	0.882	0.902	0.729
U(55555)	-0.810	-0.718	-0.590	-1.116

Figure 3 - Comparison of utility values using tariffs from different countries

2.4 HRQoL over time

We've seen now how we can take this complex concept of health-related quality of life at a point in time, and attach a number to it. If a policymaker involved with research in two nearby towns wished to know which town's residents felt healthier, she could sample 1000 people from each town, ask them all to complete an EQ-5D, and then compare the results in each. Just as if a researcher wanted to know how residents' weight varied between the two towns, she might weigh a sample from each.

In a different situation, the managers of a clinical trial might wish to understand how the different treatments they're evaluating affect HRQoL. To do this they'd need to capture HRQoL over time, which would usually require asking repeated EQ-5D questionnaires. If the trial lasted for exactly six months, the researchers may wish to ask an EQ-5D at the very start, and then again on the first day of each month, until the patients finish treatment at the end of 6 months, at which point they would fill out their 7th and final questionnaire. Managers of a weight-loss trial may again follow the same schedule with weighing their participants.

If we imagine the weight loss trial, we may wonder how weight changes between two data points. For example, someone may weigh the same on the 1st January and the 1st February, but may have gained and then lost 2kg between these time points; with only our two data points we're unable to know this, and therefore would typically assume they had not. Similarly, for HRQoL, we make assumptions about what happens between our data points. In general, we often assume that the change between two time points is constant. That is, if we measure someone's HRQoL as 0.7 on 1st March, and then when we measure it 1st May it has raised to 0.9, we'd assume that on 1st April —half-way between these time points— their HRQoL had been 0.8.

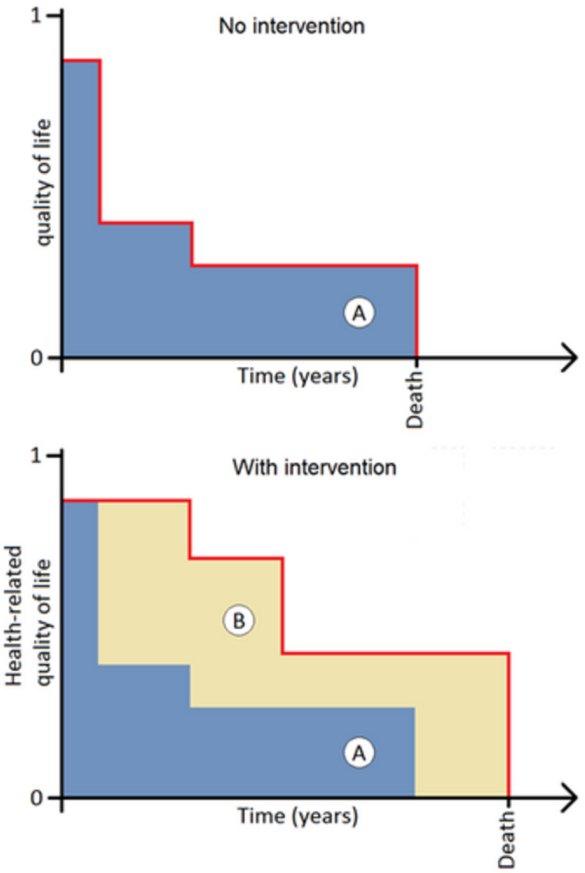
However, we must concede that there are limitless possibilities for what had happened between (e.g., their HRQoL could in fact have improved to 0.9 on 2nd March and remained constant until 1st May).

2.5 The quality-adjusted life-year (QALY)

Being able to measure and quantify health-related quality of life allows us to capture non-fatal loss of 'quality life'. But of course, many conditions—including tuberculosis—can lead to death. Regardless of which value set is being used, or which version of the EQ-5D is being used, patients who are dead are considered to have an index value of 0.

Figure 4 demonstrates two hypothetical lives for a patient. Running along the x-axis from left to right is time, and going up the y-axis is HRQoL. The graph on the left with the blue shaded area A represents the life that the person would live without an intervention, with the red line tracking their HRQoL. The right-hand side chart shows the effects of an intervention which can postpone the onset of ill health, lessen the negative consequences of illness, and extend life. We can think of the benefit of this intervention as being represented by the yellow shaded area B.

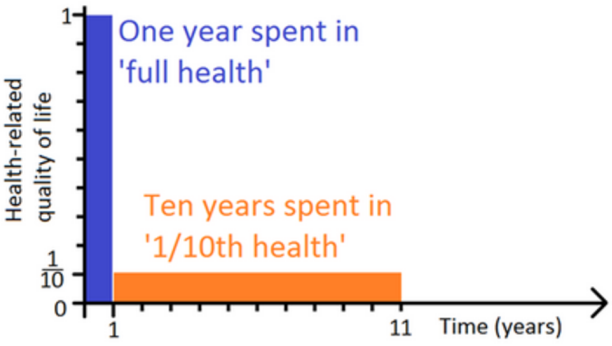
Figure 4 - Graphically representing an intervention's benefit



While the charts both show straight lines at right angles representing sudden changes in HRQoL, gradual changes could be shown with curves. The area beneath the red line – sometimes called 'the area under the curve' (or AUC) reflects the various time spent in health states and the associated HRQoL in each. To communicate the health represented by this area, it's necessary to have a unit (just like if communicating how much water there was in a bucket, we'd need a unit like 'litre'). The unit used is 'one year in full health', known as the 'Quality-adjusted life-year', or 'QALY'. [18]

In **Figure 5** the orange and blue rectangles—while reflecting quite different experiences—represent the same amount of health: 1 QALY.

Figure 5 - Two different experiences both represented as one QALY



It is likely clear that the underlying fabric of the QALY model relies on a series of critical assumptions. For example, the order in which health states are experienced is not relevant when these states are combined; we can add up QALYs from different individuals etc...

While interesting, we won't explore these assumptions here, but for a detailed discussion see Weinstein 2009.[19]

3 The disability-adjusted life-year (DALY)

Chapter Summary

In this section we will look at the disability-adjusted life-year, considering how it captures loss of healthy life from both morbidity and mortality and we will cover where we can find disability weights.

3.1 Background

While many economic evaluations of tuberculosis interventions use the QALY, the majority today use a metric called the disability-adjusted life-year, or the 'DALY' (pronounced to rhyme with 'Sally').[20]
The DALY emerged in the early 1990s as researchers aimed to quantify the global "disease burden" by measuring the total lost health worldwide. To do this, they needed estimates of mortality and morbidity for different diseases and conditions across various countries. The DALY combines these mortality and morbidity estimates into a single unit to assess the overall impact of diseases on global health.

3.2 Years of Life lost due to premature death (YLL)

Consider a person who is expected to live to age 80 (life expectancy) but dies suddenly aged 70. We can consider that they have 'lost' 10 years of healthy life. This would be reported as '10 years of life lost due to premature mortality', or for short: '10 YLL'. For reasons that will become clear below, we can also think that this person has lost '100% of their health' for these ten years.

3.3 Disability weights and YLD

Imagine now another person who lived to their life expectancy of 80 but developed ear problems at age 30 and lived the final 50 years of their life with 'profound hearing loss'. How much health did they lose? And how should we compare this person's loss of health to the person above who died losing 10 years of potential life? To get both losses of health into the same units, we require a method for assigning a value to how much health is lost per year through profound hearing loss.

For this we need some numerical weighting which reflects the extent of living with a certain condition – a 'disability weight'. These weights are written as decimals, always between 0 and 1 (so can be thought of as percentages if easier). The weight offered by the Global Burden of Disease (GBD) study for profound hearing loss is 0.2, denoting that each year lived with this condition incurs a loss of health equivalent to 20%.

So that we can later combine health lost to disability with health lost to premature death, we use the same unit for both – the 'year'. That is, for one year lived with profound hearing loss, we'd consider 0.2 'years lost to disability', written as 0.2 YLD; for a duration of 10 years this would be 0.2*10 =2 YLD. So, since this person in our example spent 50 years with profound hearing loss, this is equal to 0.2*50 = 10 YLD.

We have seen here that the two people in our examples in this section are judged by DALY methodology to have lost the same amount of health.

For diseases such as TB which cause both fatal and non-fatal health effects, we calculate the total lost health by simply summing the YLL and the YLD to get the total number of DALYs. The name 'disability-adjusted life-year' should now make sense.

3.4 Where do we get disability weights?

All but few studies reporting DALYs opt for disability weights provided by the Global Burden of Disease (GBD) study.[21] These can be downloaded in a spreadsheet HERE. For each condition we have a Disability Weight and a confidence interval.

While the GBD has 15 different individual TB-related Sequela listed, there are only five weights. These weights were established through valuation exercises with survey respondents, which can be read about elsewhere.[22] Critically, when arriving at weights, the GBD process deliberately avoids presenting 'judgers' with disease labels e.g. 'tuberculosis', but with short (max 35 words) lay-descriptions developed through '*consultation with expert groups*' which aim to '*capture the most salient details for each health state*'.[23] The description provided for TB (and MDR-TB) being: '*has a persistent cough and fever, is short of breath, feels weak, and has lost a lot of weight*.'

Note in **Table 1** that both MDR-TB and XDR-TB both are assigned the same weight as drug-susceptible TB which understandably may cause some to raise an eyebrow.

Table 1

Sequela	Health State Name	Health State Lay Description	Disability Weight
HIV/AIDS -Drug-susceptible Tuberculosis with severe anemia HIV/AIDS - Multidrug-resistant Tuberculosis without extensive drug resistance with severe anemia HIV/AIDS - Extensively drug-resistant Tuberculosis with severe anemia	Tuberculosis, HIV infected and anemia, severe	(combined DW)	0.495 (0.353-0.64)
HIV/AIDS - Drug-susceptible Tuberculosis with moderate anemia HIV/AIDS - Multidrug-resistant Tuberculosis without extensive drug resistance with moderate anemia HIV/AIDS - Extensively drug-resistant Tuberculosis with moderate anemia	Tuberculosis, HIV infected and anemia, moderate	(combined DW)	0.439 (0.307-0.577)
HIV/AIDS -Drug-susceptible Tuberculosis with mild anemia HIV/AIDS - Multidrug-resistant Tuberculosis without extensive drug resistance with mild anemia HIV/AIDS - Extensively drug-resistant Tuberculosis with mild anemia	Tuberculosis, HIV infected and anemia, mild	(combined DW)	0.411 (0.278-0.551)
HIV/AIDS - Drug-susceptible Tuberculosis without anemia HIV/AIDS - Multidrug-resistant Tuberculosis without extensive drug resistance without anemia HIV/AIDS - Extensively drug-resistant Tuberculosis without anemia	Tuberculosis, HIV infected	has a persistent cough and fever, shortness of breath, night sweats, weakness and fatigue and severe weight loss	0.408 (0.274-0.549)
Drug-susceptible tuberculosis Multidrug-resistant tuberculosis without extensive drug resistance Extensively drug-resistant tuberculosis	Tuberculosis, not HIV infected	has a persistent cough and fever, is short of breath, feels weak, and has lost a lot of weight	0.333 (0.224-0.454)

4 Costs

Chapter Summary

This section explores the different kinds of costs that a health economist would consider when evaluating an intervention, along with how these costs would be collected and adjusted.

4.1 Perspective

We will cover the basics of economic evaluation in the next section but it's important to note that the perspective the researcher chooses to take is important. This is about whose 'point of view' are we evaluating things from. Typically, this will either be from the side of the people in society such as patients, the hospital/health centre, the programme/health system or most broadly the society. When taking a societal perspective, we are concerned with both health system costs as well as those incurred by patients, factoring in both the 'supply' and 'demand' side.

Generally, we talk of either 'patient costs' or 'health-system'/ 'programme' costs. We will firstly consider issues relating to how we collect health system costs, and then look at patient costs.

4.2 Health system or programme costs

These are costs that an intervention will cost to implement. They will include things such as medicines and treatment (including management of adverse events), administration and monitoring. This will include costs for all the staff time that is required to implement the intervention or deliver the programme, and the running costs of the buildings and equipment used. The level of depth that these costs include will differ for each project, and we recommend that those who are planning a costing activity discuss with a health economist which costs are necessary to include, and how best to do so.

4.3 Costing methods

There are two general considerations when choosing how to approach costing. We must first think about to what extent we will be disaggregating the resources or 'cost-components' that are used. If we opt for an approach in which we split-out the resources used in a very detailed manner, this is typically referred to as 'micro-costing'. On the other hand, a costing approach in which cost-components are handled at aggregated level is referred to as 'gross costing'.

These definitions admittedly aren't too precise, and it's not unusual to have approaches somewhere in-between, with decisions guided by the availability of data.

In addition to deciding to what level of detail we'll consider the use of resources, we also need a process for attaching a monetary value —the cost— to the resources being used. Like the above, there are broad labels given to the two extents of the approaches, in this case 'top-down' and 'bottom-up'. Readers with a background in management science may be familiar with these terms, and their use here are somewhat similar. In short, top-down costing begins with looking at collected high-level costs (big amounts) and then attempting to break them down to the level we're interested in, whereas bottom-up approaches begin with much smaller costs (eg. consumables required for an individual procedure) and then adding these up.

In practice there is often overlap between these two decisions, and in the definitions used. In general, the above definitions lead two four broad approaches: top-down micro-costing, top-down gross costing, bottom-up micro-costing, and bottom-up gross-costing. This final category is however not common. More details are provided below, but for a detailed discussion of these terms, please see the literature.[24]

Top-down and bottom-up costing approaches

Top-down costing aims to estimate the mean costs for all the various activities ('cost-objects') incurred during a specified time. We begin with the actual costs that were used over this time, which are usually obtained through financial records and salary bandings from Ministries of Health. etc. and then we apportion these down to the various components. Usefully these data are often collected by the healthcare management themselves to understand where they are incurring costs and for their financial reporting. It is normally the case however that some costs we may be interested in for an economic evaluation aren't included, and other costs which perhaps are might need teasing out. Costs for example for loan repayments and insurances etc may not be relevant for us, depending on our research question. Top-down gross costing would tend to keep costs of different categories grouped together, whereas top-down micro-costing would take the time to break categories up more finely. This is sometimes referred to as 'activity-based costing' (ABC). Often this will involve interviews with those in the finance departments of health settings, to understand more detailed data about activities attempt to quantify the services delivered. We might review Gantt charts and programme records, to unpick where spending goes. Under ABC, we'd usually start by thinking about the activities themselves, and then aim to calculate separate 'unit costs'.

While top-down costing can offer advantages in terms of speed of data collection, it is less sensitive to many costs, and so where possible economists might opt for bottom-up approaches.

Bottom-up methods collect costs from the patient level, and most will engage in micro-costing. Bottom up methods can be thought to have three phases. First, we identify the different activities that incur costs. These aren't typically measured in monetary terms, but in intuitive units, e.g. number of X-rays performed; number of pills given; the amount of time a doctor might spend with a patient for a given activity. Second, we measure these for a given period. This can be done through a combination interviews and direct observation (often done by watching people's movements and timing how long activities take). Finally, we multiply these usage values through by unit costs. Normally unit costs are simply the costs paid by the health service to their

provider (the 'market price'), though in some cases other prices may be used if appropriate. So, if 'X' bandages were used and each bandage costs the health service an amount 'Y', the cost would be X*Y.

We will often see a combination of these methods used. Which are chosen depends on the data that are available and the resources of the study available for costing, which is often linked to the size of the study.

Whichever way is chosen, it's important that unit costs and quantities are presented clearly, and that assumptions are presented with simplicity and transparency.

4.4 Fixed costs and variable costs

Fixed costs

Fixed costs are those that don't change dependent on the level of activity or 'output'. For example, both busy and quiet hospitals will need to heat/cool their waiting room to the same extent, and the rental for buildings won't change if they're busier or quieter.

Variable costs

As the name suggests, variable costs are those which will vary dependent on the level of output. A busy emergency room will use more bandages and give out more painkillers.

In general, it should be possible to calculate which category a cost fall under. Staff costs can be a mixture of fixed and variable. The receptionist is paid his wages whether the hospital is busy or quiet (fixed cost), but if he's required to work overtime and paid for this, this would be considered a variable cost. Similarly, a vehicle is a fixed cost to buy and insure, even if it's not getting much use.

But the more it's used, the more fuel it consumes and the more maintenance it will require. Sometimes you may see such costs referred to under the name 'semi-variable' costs.

4.5 Recurring and non-recurring costs

Recurring cost are those that occur at regular intervals, meaning they can be prepared for. Most people's rent or mortgage payments are recurrent costs.

Non-recurrent costs are those costs that occur at irregular or unpredictable intervals. If a machine breaks down and needs repairing, or a storeroom floods, the costs of rectifying these situations would be classed as non-recurring. **Non-recurring costs may also be referred to as 'one-off' costs.**

4.6 Converting currencies and buying power

The number of goods or services that can be purchased with a given amount of money is known as the 'purchasing power'. Inflation erodes purchasing power meaning typically purchasing power will decrease over time. Often countries will measure purchasing power using the consumer price index, considering the price for a set 'basket of goods'.[25] It's therefore necessary that when calculating total costs over a timeframe, we can adjust for changes in purchasing power in our calculations.

Another challenge exists though. Lots of global health work is conducted between institutions working in different countries, often using different currencies. Comparing costs between countries requires expressing these costs in a common unit.

While we can of course use exchange rates to convert to a common currency, we also need to take into account differences in purchasing power between different countries. Consider, we have $US and wish to go shopping. If we were to convert our money to Rupees and go shopping in New Delhi we could purchase more goods than exchanging our US$100 to Swiss Francs and going shopping in Geneva.

One solution that addresses the above issues together is the artificial currency known as the 'international dollar', denoted as **int.US$**. Quite simply, the purchasing power of 1 int. US$ is equivalent to the purchasing power of 1 US$ in the United States of America. By converting every amount to this currency allows us to overcome purchasing power differences between currencies.

The rates of currency conversions used for this adjustment are called 'purchasing power parities', and usefully a database of these have been put together by the OECD, which can be downloaded for individual countries and individual years.[26]

When dealing with amounts in different timeframes and currencies, the important thing is to ensure that we are comparing 'like for like'.

4.7 Opportunity Cost

The costs we've mentioned above, reflecting things we 'pay for' are often referred to as 'financial costs'. There are other costs though we must be mindful of. The concept of opportunity cost is one which we will all be familiar with, but perhaps not under this name. Each time we use resources on a particular activity we necessarily can't use these resources on anything else – i.e. we forgo this opportunity. **The 'opportunity cost' refers to the value or benefit we give up.**

Imagine you receive a wedding invitation from your boss, but the wedding is due to be the same day as your mother's birthday party in your hometown. If you choose to attend your mother's celebration, the 'opportunity cost' of this choice is missing your boss's wedding. Similarly, if someone leaves their job to study a one-year post-graduate degree at university, the 'opportunity cost' would be one year's earnings.

4.8 Discounting

The concept of discounting is concerned with the idea that *when* something happens—i.e. the event's position on a timeline— changes its inherent value. That is, money and/or benefits in the future are worth less than money/benefits today. The process of 'discounting' aims to adjust for this change in value. Note that this change in value is unrelated to changes in value due to inflation.

Discounting is an interesting concept that is perhaps not obvious, so it's helpful to consider a non-health example. Let's say you were offered a choice between two options, A and B. Option A is receiving $100 today; B is receiving $100 in a year's time (let's assume no inflation in this year). Most would take the money today. Many would even take $100 today over $105 in one year's time.

An additional consideration is what we call the 'Social Rate of Time Preference'.[27] This is the idea that for a number of reasons – *investment opportunities aside* – we prefer things now rather than in the future. There have been many reasons suggested for this (the future is uncertain; we're often myopic; generally, people tend to be more financially comfortable as they age etc...). Different attempts have been made to estimate the social rate of time preference

Additionally, since we discount costs, it's important to also consider discounting benefits, or the 'effects'. If we imagine a health system as a way of converting 'money' to 'health' (money in; health out), then we should be able to see why to discount one and not the other would distort value.

There are times costs and effects may be discounted at different rates – known as 'differential discounting'. The specifics behind when to do this are not covered in this pack, but one such case might be if there was evidence to suggest that the cost-effectiveness threshold was due to change, with higher discount rate for costs if this was growing, and a lower discount for costs if it were shrinking (and only if we were aiming to maximise health rather than 'welfare').[28] We suggest seeking advice from an experienced health economist before choosing such an approach.

When we have costs occurring over multiple points in time, we wish to represent all costs in terms of their 'present value', which will allow for meaningful comparability. Typically, the present value of a cost is less than the value at the time they are experienced.

So, the question then for us is, what is an appropriate discount rate?

For country-specific analysis, often economists would choose to use the local rate of return on long-term government bonds. In many situations though, especially if considering more than one country, a flat rate of 3% is chosen for costs and benefits.[29]

If 1 million dollars today yielded 60 QALYs in 5 years' time, then we may wish to know, what is the 'present value' of these QALYs today.

If we were using a discount rate of 3%, the equation would be as follows:

Present value of 60 QALYs gained in 5 years' time using discount rate of 3% = $\frac{60}{(1+0.03)^5} =$ 51.76 QALYs

4.9 Patient Costs

Patient costs are costs incurred by a patient associated with health care. Let's take a look at the different types.

Direct Patient Costs

Direct costs are those costs which patients — or rather 'people seeking care' — pay for 'directly'. We can think of these as costs which people might pay for by taking cash out their wallets. For this reason, often these costs are referred to as 'out-of-pocket' costs. Typically, in reporting and policy discussions, these direct costs are further split into 'direct medical costs' and 'direct non-medical costs'. Direct medical costs include costs for consultations, medications, diagnostic tests etc, whereas direct non-medical costs refer to expenditure such as transportation to a clinic, buying food while on this journey, hotel stays while visiting an out-of-town clinic etc. Occasionally there is some disagreement about how costs associated with hospitalisation should be categorised, with some including all these costs under direct medical, but some wishing to categorise some of the cost (e.g., for meals) as direct non-medical.

Indirect Patient Costs

Indirect costs are perhaps less obvious costs than direct costs, but their financial impact on patients can often be more severe. If we imagine a patient has to travel to a tuberculosis diagnostic centre that is several hours from their home, it is likely that they will have to take some time out of their work to make this return trip. For patients who work informally – often the majority of patients high-burden TB countries - this will mean a loss of earnings. Considering a patient who takes the morning of work and misses out on $20 of earnings, while they will not have had to pay this $20 'out-of-pocket', it nevertheless means that they have $20 less money to spend that month, that is, these lost earnings are a cost. Furthermore, if we imagine that once on treatment this patient is unable to work as they usually would be due to the occurrence of side effects due to their medication. This reduction in productivity may lead to reduced earnings, which again would be considered as an indirect cost. It is worth noting that while reduced productivity is an indirect cost, as this can often be difficult to calculate, some studies simply focus on the costs of lost time, and do not include the indirect costs due to loss of productivity.

When including indirect costs in analysis, some studies may choose to ask patients directly about lost earnings, whereas others may simply ask about lost time, and then multiply this through by an estimated wage (perhaps minimum wage) when running their calculations.

Intangible Costs

Intangible costs are in some ways like indirect costs but differ in that they're often more difficult to accurately measure. In fact, most definitions for intangible cost will specifically define them as 'costs hard to measure'. These tend to be costs such as impaired goodwill, a drop in morale or even reputational damage.

Specifically relevant to tuberculosis, many of the effects of stigma would also be considered intangible, though some effects might be picked up in HRQoL instruments. It's common for intangible costs to not be included in the types of analysis this pack aims to support.

Why are Patient Costs Important?

Patient costs are important for several reasons. First, they place a burden on household finances. Thinking specifically about tuberculosis, the vast majority of the world's TB burden is within the world's poorest countries. Additional unexpected costs such as those incurred during TB care seeking and diagnosis can be devastating. Furthermore, it has been well-documented that TB patient costs are a barrier to seeking care, and are a common reason for patients not completing treatment.

The WHO post-2015 Global TB Strategy (End TB Strategy) set a third target of eliminating catastrophic costs for TB-affected families by 2020, in line with efforts to move health systems closer to universal health coverage.[30]

Only by fully understanding the origin, trends, extent, and drivers of these patient costs can effective steps be made to curtail them.

Measuring Patient Costs

While there are different ways of measuring patient costs for TB, the most common is to use the **WHO TB patient costing survey**. This survey has a detailed handbook which accompanies it, providing all the information needed to conduct a full-scale TB patient costing survey. Often researchers may wish to calculate costs within certain populations of their own study, and in such cases the instrument provided by the WHO can be adapted.[31-32]

The WHO patient cost survey is a cross-sectional design, meaning that patients aren't interviewed more than once. TB treatment is usually split into two phases, the 'intensive phase' and the 'continuation phase', and the magnitude and breakdown of patient costs in each phase differs. For this reason, the WHO TB patient cost protocol specifies that patients from each phase are interviewed, and the costs later combined to estimate total TB-patient costs for the population. The instrument additionally asks patients in the Intensive phase about their care-seeking pre-diagnosis costs.

Catastrophic Health Expenditure

Families are considered to incur catastrophic expenditure if 20% or more of their annual household income is spent on TB-related costs. This 20% threshold aims to capture the point at which households would forgo basic sustenance expenditure. Research in Peru also found that this threshold was associated with poor biomedical outcomes from TB treatment.[33]

5 Economic Evaluation

Chapter Summary

In this section we will cover the common types of economic intervention within healthcare appraisal, along with the ICER, the cost-effectiveness plane and the cost-effectiveness threshold.

5.1 What is an economic evaluation?

Let's imagine that the National Tuberculosis Programme (NTP) of a high-burden country has been presented with plans for two different interventions to tackle the incidence of tuberculosis. The two teams that have put forward the competing interventions have each put together a summary pack containing details of how their intervention would bring down TB incidence, how their intervention would be rolled out, and each proposal contains an estimate for how many cases could be prevented.

While the NTP might read over the proposals and judge them for their feasibility and various strengths and weaknesses, they would be entirely unable to reach a decision without knowing how much each intervention would cost the health system. Knowing the cost allows the NTP to better judge whether the interventions would provide 'value for money'. This concept of value for money, or 'efficiency' is at the heart of an economic evaluation.

*Is the **cost input** worth if for the **effect** we can expect as an output?*

Let's imagine too that the two interventions are 'mutually exclusive', i.e., both cannot be chosen together (this might be the case if there are conflicting overlaps in the proposals). Once the NTP are aware of the costs, they can make one of three choices: Implement the first intervention; implement the second intervention; or implement *neither*. This third option is important, for reasons we'll explore in more detail below when we look at *thresholds* (Section 5.8)

Essentially, all economic evaluations have two key features:

Firstly — they compare more than **one course of action** or 'intervention'. Bear in mind though, that one of these interventions may be 'do nothing', that is, 'carry on as things currently are'.

Secondly — they must know all the relevant **costs** associated with each course of action (see Chapter 4), as well as what can be expected as the **consequence**. We can think of these as the cost-inputs and the outputs.

Economic evaluations are conducted in many different fields, but here we will focus on their application in healthcare decision making.

There are four main types, cost-benefit analysis, cost-effectiveness analysis, cost-utility analysis, and cost-minimisation analysis.

In all four types, the cost-inputs are expressed in monetary amounts, for example $US.

Type of Economic Evaluation	How inputs are measured	How are outputs/consequences measured?	How are consequences expressed/valued?
Cost-benefit analysis	All inputs are costs, measured in monetary units e.g. $	Wide range possible, not necessarily common to the interventions being evaluated	Monetary units
Cost-effectiveness analysis		Some defined measure of health, typically a 'natural measure'. Must be same across interventions.	
Cost-minimisation analysis		Not required	Not required
Cost-utility analysis		Can bring in different outcomes, which can differ between interventions	QALYs

Cost-benefit analysis

This is a term we've probably all come across before but often it's used in an imprecise rather general way. In a cost-benefit analysis, in addition to inputs being expressed in monetary units, we also consider the outputs in terms of monetary units. Shop owners do this frequently: they consider how much something will cost to buy, and how much it will make their business in return. In the context of healthcare, when conducting a cost-benefit analysis we must find a way to represent the various consequences of interest in terms of a monetary gain. These consequences might include factors such as gains in productivity in a system or individual, or even reduced school absenteeism.

Cost-effectiveness analysis

Cost-effectiveness analyses expresses inputs as costs just as in a cost-benefit analysis, but for the outputs can use any measure of effect, in our case often a relevant clinical measure such as those we looked at earlier (drop in blood pressure, premature births averted etc).

Cost-utility analysis

Cost-utility analysis is quite simply cost-effectiveness analysis where the unit of effect used is the QALY. This allows us to understand how our cost-inputs will improve health, including reduced mortality and improvement of HRQoL. We can do something similar if we use the DALY as our measure of effect, though technically speaking this would still be a cost-effectiveness analysis, as doesn't make use of health utilities.

Cost-minimisation analysis

This is perhaps the most intuitive of the four. We have choices of action whereby all choices will provide the same result. If each choice has a different cost, the obvious decision is to go for the cheapest. That is, we minimise the cost. As an example, think of buying paracetamol in the supermarket. The branded products are often considerably more expensive, but they contain the same paracetamol as the cheaper unbranded product. We would choose the lowest price. Not all interventions can be evaluated

using a cost-minimisation analysis due to the requirement of outputs being equal. Note that some also consider cost-minimisation analysis to be a subset of CEA.

5.2 The cost-effectiveness ratio

Let's imagine we're evaluating an intervention aimed at increasing TB diagnosis in a high-risk population by encouraging more people to visit a TB diagnostic centre to get tested. Bearing in mind an economic evaluation must always compare at least two things, the relevant alternative we're comparing to is therefore the system we have in place today – standard practice. A natural measure of effect would relate to the number of people tested. If prior to the intervention 1000 people per year people were coming in for testing, and under the intervention this increased to 1500, the effect is an additional 500 people tested per year.

If our intervention was badly designed and actually deterred many of the people who'd have come for testing under the pre-existing system and saw the number tested fall from 1000 to 800 people per year, our effects would be negative. At times an intervention may also be cost-saving, meaning the costs of the intervention would be negative.

The first thing we might be interested in when we've collected our cost and effect data is checking for these situations. We can we make an easy decision about the intervention if we observe that it costs more money but provides a negative effect – it's unlikely we'd want to roll this intervention out! Similarly, if an intervention were to save the health system and patients money AND it provided a positive effect, we've got a winner that we'd likely hope to implement. Usually however, interventions tend to be a bit more complicated, having positive effects and costing more.

When describing the relationship in amount (or size, quantity), between two or more things we often use ratios. Ratios are expressed as two numbers, or as percentage. For a familiar example, a baking recipe might ask for two cups of sugar and three cups of flour; the ratio of sugar to flour is 2:3. You may also be familiar with the case fatality ratio (CFR) in the case of TB. That is, the percentage of people with TB who die from the disease. The End-TB strategy hopes to see this ratio fall to 6.5% globally by 2025.

We can similarly express the relationship between the cost of an intervention and the effects it provides as a ratio. This proves very useful when comparing two interventions. For example, imagine we we're asked which of the following two (mutually exclusive) interventions is better value for money?

Intervention A	Cost $1000	prevents 5 TB deaths
Intervention B	Cost $1400	prevents 8 TB deaths

By creating a ratio showing '$/death prevented' for each we can compare more easily:

Intervention A	Additional $200 / death prevented
Intervention B	Additional $175 / death prevented

So, we can see B provides better value for money, and —if we can afford it— would be a better use of money. This ratio is known as the 'cost-effectiveness ratio' or CER

5.3 The cost-effectiveness plane

It's often helpful to present our cost-effectiveness findings in a cost-effectiveness graph, known as the 'cost-effectiveness plane', allowing us to visually communicate the relative costs and effects of interventions.

The cost-effectiveness plane has two axes. The vertical y-axis is always used for costs, meaning the higher up on the graph an intervention, the more expensive it is. On the horizontal x-axis we have the effects; the further to the right, the better the intervention. The axes divide the plane into four sections, known as quadrants. These are commonly referred to using directions on a compass **(Figure 6)**

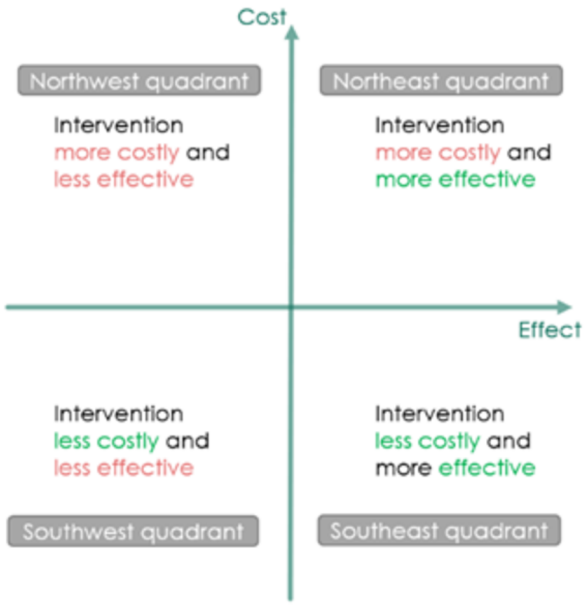


Figure 6 - **Quadrants of the cost-effectiveness plane**

Figure 7 shows eight theoretical interventions on this graph. Let's consider that these are competing interventions – that is, they address the same health problem, and we can only implement one. Intervention G is the type we discussed that provides a positive effect at a lower cost, in the southeast quadrant. Interventions E and F are those we'd be unwise to ever implement, as they cost more and have a worse effect.

Note that as they're the same height above the x-axis, E and F would cost the same. Let's now consider interventions A and D in the northeast quadrant. Which of these do we think is better?

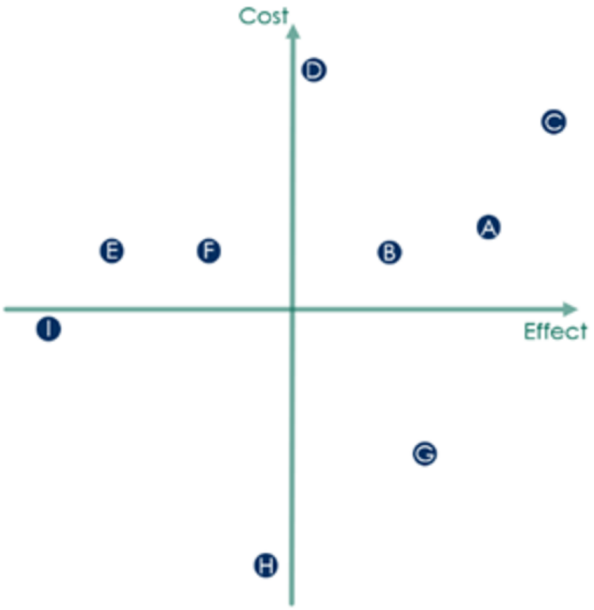


Figure 7 - **representing interventions on the cost-effectiveness plane**

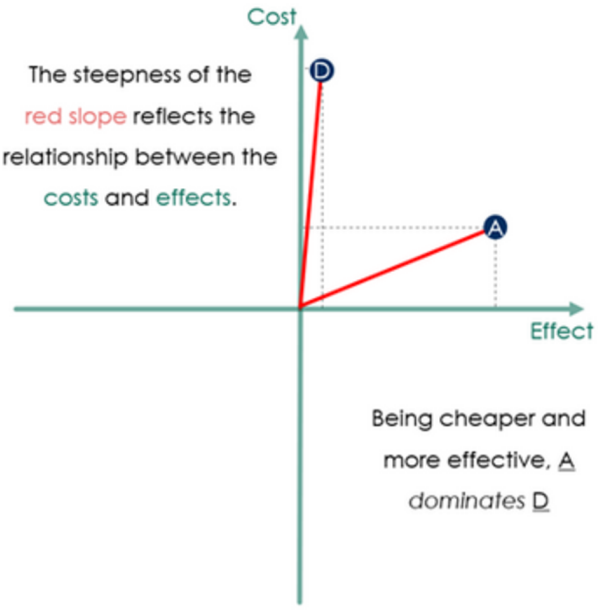


Figure 8 - Visualising the cost-effectiveness ratio

Figure 8 shows interventions A and D, with red lines drawn from the centre of the graph ('the origin') to each of the interventions. The steepness of a line encapsulates the ratio of costs to effects for the intervention. The closer the line is to the horizontal, the more favourable the relationship – that is, we get more health for a given amount of money. In this case, as A is more effective than D **and** costs less, we would say that A 'Dominates' D, or equally, D is 'Dominated by' A. It's worth spending some time to make sure that you understand this graph.

5.4 Cost-effectiveness thresholds

Most interventions will be in this northeast quadrant where we see A, B, C and D; costing money and providing health. We learned earlier about how the QALY allows us to measure and express the outcomes of a health intervention in a generic way in a cost-utility analysis. The powerful advantage of this is that when our outcomes are all in QALYs, we can compare the cost-effectiveness ratios of activities across our health system, regardless of the disease or condition they address.

A critical question, therefore, is: *"How do we know when an intervention is worth it?"*

Generally speaking, we can deem there to be a cut-off point for our cost-effectiveness ratios, above which we would consider the ratio of money to health to be too high. This cut-off is known as the 'cost-effectiveness threshold', sometimes abbreviated to 'CET' or at times the letter k is used. You may be wondering how we decide where such a cut-off should be?

There are different methodological approaches for determining a CET. Some methods take a 'willingness-to-pay' approach, whereby the CET is estimated based upon what members of the society would be 'willing to pay' for some unit of health, established through interviews with members of the population, or indirectly from looking at data on things such as health spending habits.[34] Another approach, sometimes termed the 'opportunity cost method' will look specifically at the health displaced by implementing an intervention. In truth, many studies overlook these distinctions, and use terms like WTP threshold and CET interchangeably. A final approach you may come across for establishing a CET is the 'precedent method'. The basis for this method is to find an intervention already in place, and —assuming the decision behind its implementation was sound— if we demonstrate that our intervention has a lower CER than this, then it would seem reasonable to implement it.

In **Figure 9** we have displayed a cost-effectiveness threshold represented by the light-blue line. Cost-effectiveness thresholds always pass through the origin, and always slope upwards from left to right. CERs (red lines here) steeper than this threshold – whereby the intervention would be in the red-coloured area such as D – would be deemed not cost-effective. We can see that the entire northwest quadrant is red, and the entire southeast quadrant is green.

This is not however the end of the story. When comparing interventions A, B and C, things can get interesting.

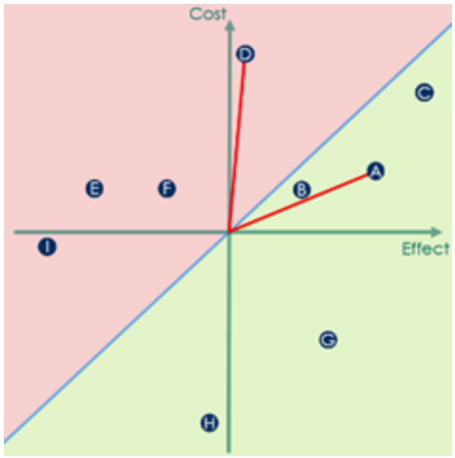


Figure 9 - the cost-effectiveness threshold

5.5 The incremental cost-effectiveness ratio (ICER)

Sticking with the four interventions in the northeast quadrant in the earlier graphs, it will be helpful to work with some numbers.

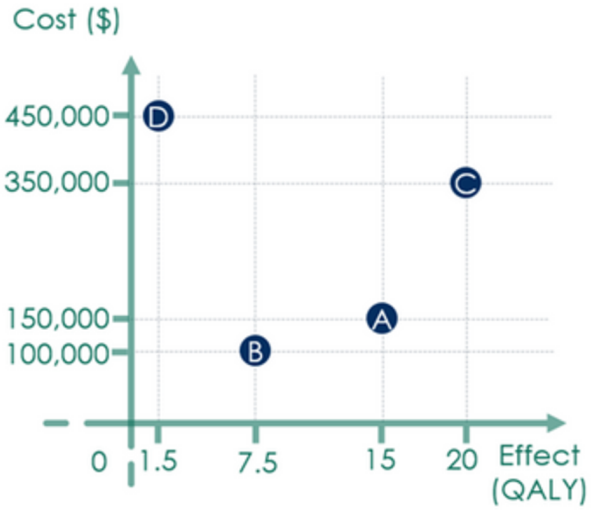


Figure 10- worked example of interventions

Intervention	Cost ($)	Effect (QALYs)	CER ($/QALY)
A	150,000	15	10,000
B	100,000	7.5	13,333
C	350,000	20	17,500
D	450,000	1.5	300,000

We established earlier that D was dominated by A (and also by B). We can confidently rule out D – no matter what our CET, D would not be implemented.

Let's imagine that we're working with a cost-effectiveness threshold of $20,000/QALY.

We can immediately see that even if D had been the only option and had not been dominated, it's CER would still have been considerably above this threshold and deemed 'not acceptable'.

Now let's look at B. We see firstly that its CER is 13,333 – below the threshold. This is however greater than that for A (10,000), meaning A is better value for money.

While A is more expensive than B, it provides better value for money. That is, a dollar spent on A generates more health than a dollar spent under intervention B. Theoretically if we were able to implement some combination of what we're doing today (the point at the origin where the axes cross) along with partly rolling out intervention A, we would could achieve the same health as intervention B would provide, but at a lower cost.

Of course, this assumes that intervention A could be done in part, which may not be the case. Nevertheless, a decisionmaker would consider intervention B to be dominated by these two other strategies (A and standard of care today, Origin), and would rule out B.

This type of domination is known as 'extended domination', or sometimes 'weak domination'.

So we're therefore left with A and C.

We've confirmed that A has the lowest CER, is a good deal below the threshold (10,000 < 20,000), making it acceptable. Now it may feel sensible to judge C similarly, by comparing its cost-effectiveness ratio (17,500) with our threshold (20,000). If we didn't have other interventions on offer, this indeed would be the correct approach. But the fact that we do still have intervention A available changes things.

So, we know that through implementing A we can expect an effect of 15 QALYs, coming at a cost of $150,000. Considering it has the lowest of all of the CERs, we can be confident this would be a good use of money.

Now when assessing intervention C, we don't want to simply compare it against what we're doing today (at the origin) by considering the CER. Moreover, the appropriate comparison for C is actually against A.

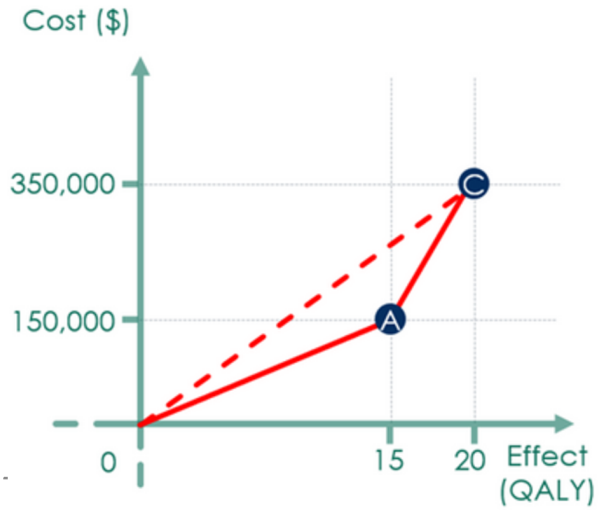


Figure 11

We saw earlier that cost-effectiveness ratios (CERs) are the lines drawn from the origin. What we're going to do with C however is to take a line from A, to understand what the additional costs and benefits are relative to intervention A (**Figure 11**).

This brings us to a new type of cost-effectiveness ratio – the incremental cost-effectiveness ratio or 'ICER' (pronounced as the word 'nicer' without the n).

We can simply calculate this by calculating the difference in costs between the two (350,000 – 150,000) divided by the difference in effect (20-15).

This gives $\frac{350,000-150,000}{20-15} = \frac{200,000}{5} = 40,000.$

In other words, if we had implemented intervention A, moving then to intervention C would come at a cost of $40,000 per additional QALY. And importantly, this is above our threshold of $20,000/QALY.

It's worth noting that it's common to see ICER used as a broad term to include CERs also, a term going somewhat out of fashion.

6 Equity in Healthcare

Chapter Summary

This section takes a brief look at what we mean by social determinants of health and cover the concepts of equity and universal health coverage.

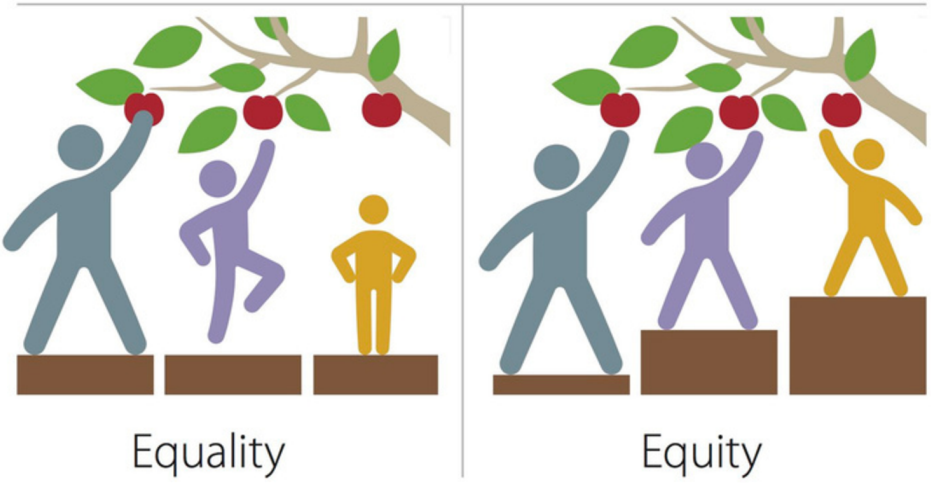


Figure 12

6.1 What is meant by Equity?

The World Health Organization defines Equity as:

The absence of unfair, avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically, or geographically or by other dimensions of inequality (e.g. sex, gender, ethnicity, disability, or sexual orientation).[35]

Health is a fundamental human right, or in the language of economics, a 'necessity good'. We only achieve equity in health when all people are able to attain their full health potential.

6.2 Horizontal vs Vertical Equity

Often equity is split into two separate types – horizontal and vertical equity. Simply put, horizontal equity means treating people who are similar in a similar way, whereas vertical equity relates to treating people in different situations *differently*. While this is how most definitions will present vertical equity, it's perhaps easier to understand this concept by thinking about it as being 'redistributive'. That is, providing additional support to those who need it more.

Policies aimed at achieving vertical equity may look to share resources from the more advantaged (e.g. wealthier) to the less advantaged (poorer).

6.3 Measuring Equity

Equity is another complicated concept which includes a large number of different factors, some measurable and some unmeasurable. Like when attempting to capture HRQoL, in setting out to *quantify* health equity, or indeed inequity, we accept that the best we can hope for is a reasonable approximation.

To measure inequity and ensure efforts to reduce it are successful, researchers often aim to represent it as a number, or 'index'. There are many approaches to creating these indices, and none are universally agreed upon. Often the index used in one area won't be appropriate to another, due to the many different contextual factors. For a detailed discussion and examples, please see [36].

6.4 Social Determinants of Health

All adults, and indeed most children, will have some understanding of *social determinants of health* even though they probably won't know them collectively under this name. Social determinants of health (SDoH or SDH) are the many factors which influence our health (or 'health outcomes') that themselves aren't medical or genetic. These include the various conditions (viewed by some as 'privileges') of our economic and social situation and upbringing, including where we are born (the village, country, continent), where we live, the job we have (and our income), our age, our gender, the education we've received, the food we have access to, and the type of house we live in - even down to the type of plumbing it has. The importance of these factors to our health can't be overstated. In fact, research shows that, of all of the wider 'determinants of health', the *social* determinants have a considerably greater impact on our health outcomes than the level of health care we receive, which is estimated by some to be responsible for as little as 11% of health.[37]

SDoH are typically beyond an individual's direct control, influenced by forces and systems such as economic policies, social norms, laws, and our political system.

Behaviours are closely linked to SDoH, though usually considered to be separate. For example, while smoking is not considered a SDoH, the number of tobacconists in a person's neighbourhood is.

6.5 Universal Health Coverage

In 2012, the UN General Assembly endorsed a resolution urging countries to speed up their progress towards Universal Health Coverage (UHC). While UHC sounds like a term about the *availability* of health services in an area, it's perhaps more appropriate to think of UHC as being about *affordable access*. It strives for fairness, linking to the idea that an individual should receive the care they *need*, rather than the care they can *afford*.

While again there are different understandings and definitions for UHC, a population can be thought to achieve UHC when all of the people's health needs can be met without them having to suffer financial hardship.

Often UHC is thought of as having three dimensions of coverage:

- Which **services** are covered
- Who is covered, ie. the **population**
- Costs, or the level of **financial protection**

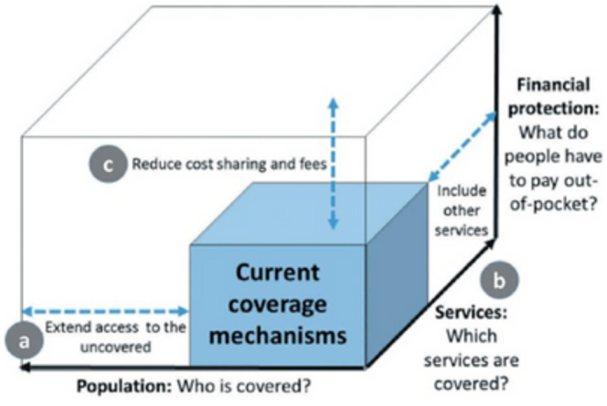


Figure 13 - Dimensions of UHC [38]

7 References and further reading

1. Badash, I., Kleinman, N. P., Barr, S., Jang, J., Rahman, S., & Wu, B. W. (2017). Redefining Health: The Evolution of Health Ideas from Antiquity to the Era of Value-Based Care. Cureus. https://doi.org/10.7759/cureus.1018

2. Tobiasz-Adamczyk, B. (2013). The Genesis of Health: Evolution of the Concept of Health-Related Quality of Life. In M. and T.-A. B. and B. C. J. Kawecka-Jaszcz Kalina and Klocek (Ed.), Health-Related Quality of Life in Cardiovascular Patients (pp. 1–8). Springer Milan. https://doi.org/10.1007/978-88-470-2769-5_1

3. Rosser, R., Phd, M. A., & Frcpsych, F. (1993). The history of health related quality of life in 101/2 paragraphs. In Journal of the Royal Society of Medicine (Vol. 86).

4. World Health Organization. WHO Constitution. https://www.who.int/about/governance/constitution

5. Elkinton JR. Medicine and the quality of life. *Ann Intern Med*. 1966;64(3):711-714. doi:10.7326/0003-4819-64-3-711

6. Karimi M, Brazier J. Health, Health-Related Quality of Life, and Quality of Life: What is the Difference? Pharmacoeconomics. 2016;34(7):645-649. doi:10.1007/s40273-016-0389-9

7. Ferrans CE, Zerwic JJ, Wilbur JE, Larson JL. Conceptual model of health-related quality of life. *Journal of Nursing Scholarship*. 2005;37(4):336-342. doi:10.1111/j.1547-5069.2005.00058.x

8. Carr AJ, Gibson B, Robinson PG. Measuring quality of life is quality of life determined by expectations or experience? *Br Med J*. 2001;322(7296):1240-1243. doi:10.1136/bmj.322.7296.1240

9. Jones, P. W., Quirk, F. H., Baveystock, C. M., & Littlejohns, P. (1992). A self-complete measure of health status for chronic airflow limitation. The St. George's Respiratory Questionnaire. The American Review of Respiratory Disease, 145(6), 1321–1327. https://doi.org/10.1164/ajrccm/145.6.1321

10. Cohen RD. Validation of health-related quality of life instruments. *Hepatology*. 1999;29(6 Suppl):7S-8S.

11. Buchholz, I., Janssen, M.F., Kohlmann, T. et al. A Systematic Review of Studies Comparing the Measurement Properties of the Three-Level and Five-Level Versions of the EQ-5D. PharmacoEconomics 36, 645–661 (2018). https://doi.org/10.1007/s40273-018-0642-5

12. Hillman, K., Athari, F., & Forero, R. (2018). States worse than death. Current Opinion in Critical Care, 24(5). https://journals.lww.com/co-criticalcare/Fulltext/2018/10000/States_worse_than_death.15.aspx

13. https://euroqol.org/eq-5d-instruments/sample-demo/

14. https://yhec.co.uk/glossary/standard-gamble/

15. Lugnér AK, Krabbe PFM. An overview of the time trade-off method: concept, foundation, and the evaluation of distorting factors in putting a value on health. Expert Rev Pharmacoecon Outcomes Res. 2020 Aug;20(4):331-342. doi: 10.1080/14737167.2020.1779062. Epub 2020 Jun 17. PMID: 32552002.

16. de Bekker-Grob, E.W., Ryan, M. and Gerard, K., 2012. Discrete choice experiments in health economics: a review of the literature. Health economics, 21(2), pp.145-172.

17. https://euroqol.org/eq-5d-instruments/all-eq-5d-versions/

18. Prieto L, Sacristán JA. Problems and solutions in calculating quality-adjusted life years (QALYs). Health Qual Life Outcomes. 2003 Dec 19;1:80. doi: 10.1186/1477-7525-1-80. PMID: 14687421; PMCID: PMC317370.

19. Weinstein MC, Torrance G, McGuire A. QALYs: The basics. In: *Value in Health*. Vol 12. Blackwell Publishing Inc.; 2009. doi:10.1111/j.1524-4733.2009.00515.x

20. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/158

21. http://ghcearegistry.org/ghcearegistry/

22. Salomon JA, Haagsma JA, Davis A, et al. Disability weights for the Global Burden of Disease 2013 study. Lancet Glob Health. 2015;3(11):e712-e723. doi:10.1016/S2214-109X(15)00069-8

23. Salomon JA, Vos T, Hogan DR, et al. Common values in assessing health outcomes from disease and injury : disability weights measurement study for the Global Burden of Disease Study 2010. Published online 2012:2129-2143. doi:10.1016/S0140-6736(12)61680-8

24. Špacírová Z, Epstein D, García-Mochón L, Rovira J, Olry de Labry Lima A, Espín J. A general framework for classifying costing methods for economic evaluation of health care. European Journal of Health Economics. 2020;21(4):529-542. doi:10.1007/s10198-019-01157-9

25. Wynne, M.A. and Sigalla, F.D., 1994. The consumer price index. Federal Reserve Bank of Dallas Economic Review, 2, pp.1-22.

26. https://data.oecd.org/conversion/purchasing-power-parities-ppp.htm#indicator-chart

27. West McNabb AGH Thompson TA Sheldon J Grimley Evans RR. Estimating Implied Rates of Discount in Healthcare Decision-Making HTA Health Technology Assessment NHS R&D HTA Programme. Vol 7.; 2003. www.hta.ac.uk/htacd.htm

28. John J, Koerber F, Schad M. Differential discounting in the economic evaluation of healthcare programs. Cost Effectiveness and Resource Allocation. 2019;17(1). doi:10.1186/s12962-019-0196-1

29. Johns B, Baltussen R, Hutubessy R. Cost Effectiveness and Resource Allocation Programme Costs in the Economic Evaluation of Health Interventions.; 2003.
http://www.resource-allocation.com/content/1/1/1

30. Uplekar, M., Weil, D., Lonnroth, K., Jaramillo, E., Lienhardt, C., Dias, H.M., Falzon, D., Floyd, K., Gargioni, G., Getahun, H. and Gilpin, C., 2015. WHO's new end TB strategy. The Lancet, 385(9979), pp.1799-1801.

31. Bates, M.J., Namisango, E., Tomeny, E., Muula, A., Squire, S.B. and Niessen, L., 2019. Palliative care within universal health coverage: the Malawi Patient-and-Carer Cancer Cost Survey. BMJ Supportive & Palliative Care.

32. Ghazy, R., Ashmawy, R., Reyad, O., Abd ElHafeez, S., El-Shishtawy, M., Khedr, H., El-Rewiny, E., El-Saeh, H., Yacoub, M., Ali, N. and Mosallam, R., 2022. Translation and cultural adaptation of the WHO generic tuberculosis patient cost survey to an Egyptian context. Eastern Mediterranean Health Journal, 28(9), pp.649-657.

33. Wingfield T, Boccia D, Tovar M, et al. Defining Catastrophic Costs and Comparing Their Importance for Adverse Tuberculosis Outcome with Multi-Drug Resistance: A Prospective Cohort Study, Peru. PLoS Med. 2014;11(7). doi:10.1371/journal.pmed.1001675

34. Pichon-Riviere, A., Drummond, M., Palacios, A., Garcia-Marti, S. and Augustovski, F., 2023. Determining the efficiency path to universal health coverage: cost-effectiveness thresholds for 174 countries based on growth in life expectancy and health expenditures. The Lancet Global Health, 11(6), pp.e833-e842.

35. https://www.who.int/health-topics/health-equity

36. Liburd, L.C., Hall, J.E., Mpofu, J.J., Williams, S.M., Bouye, K. and Penman-Aguilar, A., 2020. Addressing health equity in public health practice: frameworks, promising strategies, and measurement considerations. Annual Review of Public Health, 41, pp.417-432.

37. determinantsofhealth.org

38. Evans, D.B. and Etienne, C., 2010. Health systems financing and the path to universal coverage. Bulletin of the World Health Organization, 88, pp.402-403.

THE LIGHT CONSORTIUM

About the LIGHT Programme

LIGHT is a six-year cross-disciplinary global health research programme funded by UK aid, led by LSTM in collaboration with partners in Kenya, Malawi, Nigeria, Uganda, and the UK. LIGHT aims to support policy and practice in transforming gendered pathways to health for people with TB in urban settings. This will lead to enhanced overall health and well-being, improved socio-economic outcomes, equity, and help prevent the spread of TB.

Disclaimer and copyright

This material has been funded by UK aid from the UK government, however the views expressed are those of the individual speakers and do not necessarily reflect the UK government's official polices. LIGHT is not responsible for any errors or consequences arising from the use of information contained herein.

UKaid
from the British people