Happiness Research Institute

leaps

Wellbeing Adjusted Life Years

A universal metric to quantify the happiness return on investment

Colophon

Wellbeing Adjusted Life Years
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FOREWORD

Let’s measure what matters

The world is getting richer - but are we also getting happier? While wealth may be on the rise - so are sea levels, air pollution, and mental health disorders. Despite continued economic growth, it seems we sometimes fail to convert our wealth into wellbeing. So where should we invest our resources to improve quality of life? If we could choose between breakthrough innovations that could fundamentally change the world for the better, which one should we choose? Would it be better to develop a cure for Alzheimer’s or prostate cancer? Would it be better to reduce loneliness, diabetes, or air pollution by 50%? How can we produce the greatest happiness return for humankind?

In light of COVID-19, the need for evidence-based tools to weigh disparate consequences has never been more urgent. How are we to weigh the costs of disease against the benefits of economic output? How are we to weigh the threat of illness against the dangers of social isolation? This is not the first time that decision-makers have had to balance seemingly incomparable interests - and it will not be the last.

In this report, we lay the groundwork for a new metric to help us address these difficult questions. Wellbeing Adjusted Life Years: a common currency of impact based on evidence and experience to help us make better decisions that lead to better lives and a better world. A metric that can predict which leap for humanity would take us the furthest. For Leaps by Bayer, it is a starting point to begin moving beyond financial return and measure the happiness return on investment.

Because if there is one thing that defines humankind – it is our audacity and ability to push the boundaries of what is possible. To leap forward. To explore.

That is what this publication is about. To expand our understanding of wellbeing and push forward our ability to quantify it - or in the words of Galileo to “measure what is measurable, and make measurable what is not so.”

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EXECUTIVE SUMMARY

How can we create the greatest leaps for humanity?

Introducing a new measure of progress

Public and private institutions have conventionally evaluated their investments in terms of financial return, in the hope that maximising returns will produce cascading positive effects in society. However, recent paradoxes of progress have demonstrated that the two are not always so neatly aligned. In many countries around the world, wellbeing levels have stagnated or even declined despite continued economic growth. While increases in income have brought about substantial improvements in longevity, health, and literacy, they have also been accompanied by rising inequality, persisting poverty, and worsening climate change. In the modern world, raising general welfare requires a broader understanding of progress than the one given by standard economic and financial indicators.

Policymakers and investors have therefore started to look for new ways to evaluate the impact and sustainability of their investments. Standard assessment tools including the Sustainable Development Goals (SGDs) have opened up new avenues of exploration, but on their own cannot always provide actionable guidance or priorities.

This report offers a new way to evaluate impact, one that reflects the lived experience of citizens and consumers. The metric we propose considers progress in terms of gains or losses in **Wellbeing Adjusted Life Years** (or WALYs). WALYs can be used for two primary purposes: discovery and evaluation. Discovery relies on existing data sources to estimate potential benefits while evaluations measure the actual benefits of ongoing interventions.

This approach, rooted in decades of research and extensively validated measures of subjective wellbeing, has two primary benefits relative to existing impact measures:

1. **WALYs are based on empirical measurements of human experience and therefore do not rely on fallible proxies and simplified assumptions about human nature.**

2. **WALYs can measure and model impact across social, economic, and environmental domains.**

A deeper understanding of health and wellbeing

This report takes its point of departure in healthcare. Disease is often one of the greatest sources of suffering in both high and low income countries. By offering WALY estimations of individual and societal wellbeing burdens for 16 diseases in 28 European countries, we find that depression and anxiety disorders are responsible for greater wellbeing losses on both an individual and societal level than almost any other illness under consideration. The main sample includes roughly 110,000 European adults (45+) from 2006 to 2017 for a total of 250,000 observations. Parkinson's and Alzheimer's also prove to substantially burdensome on an individual basis. We then analyse 90 symptoms of disease, and find that the most important predictors of wellbeing across all disease groups also tend to be social and mental, not physical.

In turn, we demonstrate how public and private agents can use these estimations to inform decision-making and ensure the effectiveness of their investments. While cures are likely to provide more long-lasting gains, in some cases treating social and mental symptoms could potentially raise patient wellbeing to an equal or even greater degree. This paints a vastly different picture of health and disease than the one offered by conventional metrics. Our analysis strongly suggests that continuing with business-as-usual may lead us to undervalue potent sources of patient suffering and even disregard promising interventions to raise patient wellbeing.

Towards universal impact

In the final chapters of this report, we broaden our view to consider how WALYs could be applied to domains other than healthcare as a universal key performance indicator (KPI). We do so by introducing a list of techniques capable of producing WALY estimates from complex domains and offer an in-depth case study of the wellbeing implications of air pollution.

Overall, this report demonstrates how Wellbeing Adjusted Life Years can be used to empirically assess the fundamental determinants of good lives by providing a common currency of impact across economic, social, and environmental domains.

WALYs offer a fresh perspective from which to consider the effectiveness of public and private investments, one that promises to shine new light on previously untapped opportunities and generate meaningful and lasting impacts on individual and societal wellbeing.

INTRODUCTION

Enabling leaps for humanity by investing in wellbeing

How should we measure human progress?

It's a question philosophers and scientists have attempted to answer for centuries, but in the last decade the debate has resurfaced as it has become evident that unprecedented economic development hasn't uniquely translated into better lives for all.

While economic prosperity has brought about substantial improvements in longevity, health, and literacy, it has also been accompanied by rising inequality, persisting poverty, and worsening climate change. The drawbacks of using traditional economic indicators as proxies for social progress become even more evident when subjective wellbeing is taken into account. In many countries around the world, average wellbeing levels have stagnated or even declined despite continued economic development.

Take for example India. From 2006 to 2018, GDP per capita doubled in size, while the average life satisfaction of the population dropped from 5.35 to 3.82 on a 0 to 10-point scale, a staggering 29% decrease (Figure 1). Today, only 3% of the Indian population can be considered 'thriving' according to the Gallup World Poll, one of the lowest rates recorded around the world.[1]

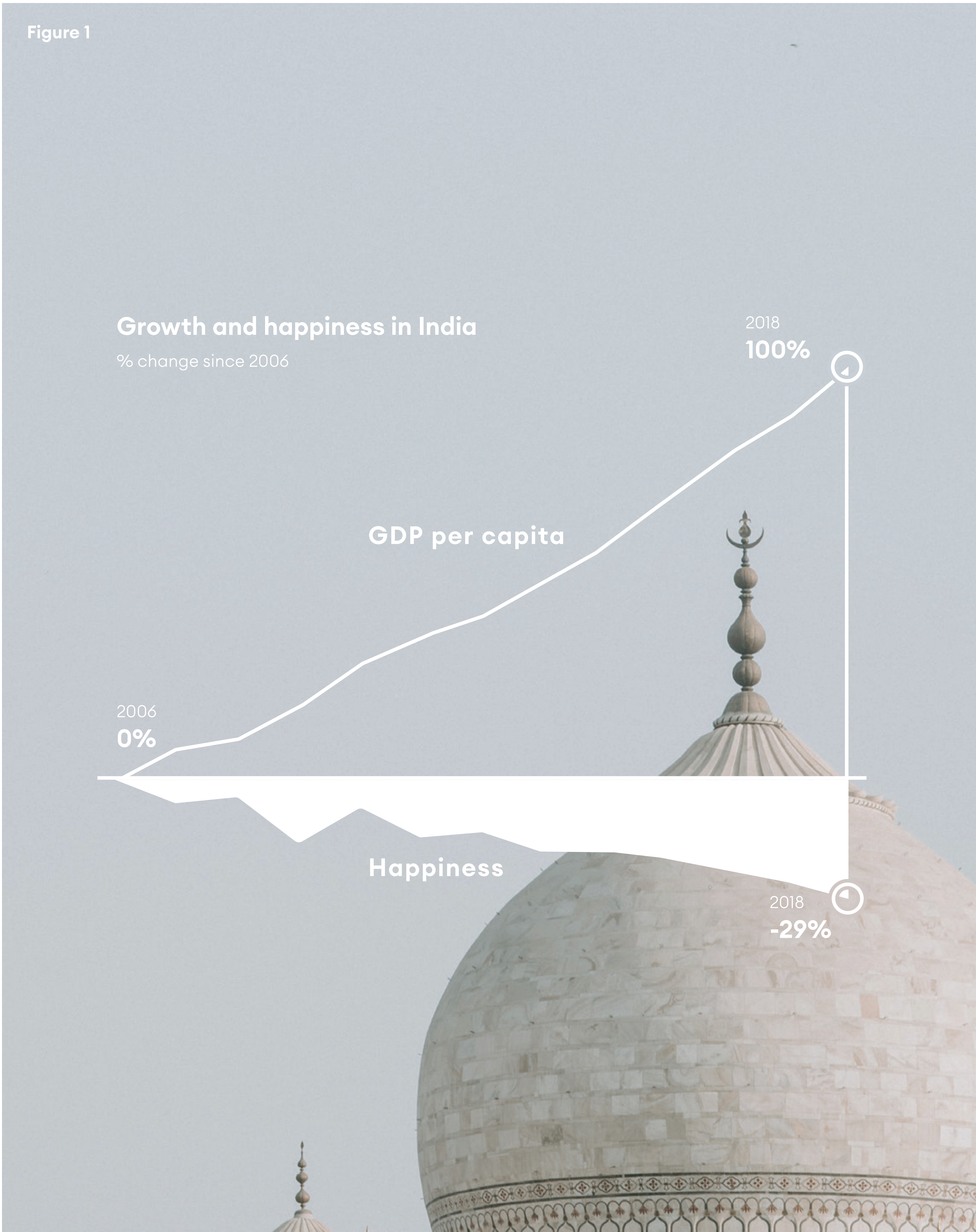
A similar pattern can be detected in China – a country that is perhaps the most impressive example of economic growth and poverty reduction in human history. Between 1990 and 2010, GDP per capita swelled by a rate of fourteen, while average subjective wellbeing levels declined and suicide rates climbed to one of the highest in the world.[2]

Many developed countries have also been subject to a decoupling of wealth and wellbeing. Steady economic growth and record low unemployment in the United States haven't safeguarded the country against a rise of adolescent depression, suicidal ideation, and self-harm.[3] In Denmark, one of the world's happiest countries, the rise in GDP per capita since the financial crisis has also been accompanied by increasing loneliness, rising stress, and poor mental health.[4]

Today, public and private organisations around the world have begun to notice these paradoxes of progress. Intergovernmental organizations including the United Nations, World Health Organization (WHO), and the Organisation for Economic Co-operation and Development (OECD) have called for subjective measures of wellbeing to be incorporated into national accounts and used to inform policymaking.[5]

Much of the interest in subjective wellbeing has been driven by a growing dissatisfaction with the widespread use of conventional objective economic indicators as the default benchmarks of social progress.[6] As noted by the

Figure 1



Source: World Happiness Report (2019). Happiness measured by the Cantril Life Ladder scale.

Nobel Prize winning economist Joseph Stiglitz, "What we measure, affects what we do. If we focus only on material wellbeing – on, say, the production of goods...we become distorted in the same way that these measures are distorted; we become more materialistic."[7] Today, institutions around the world are being asked to do more than facilitate material wealth. They are being asked to ensure wellbeing. This presents an entirely new challenge, and one that many institutions are currently ill-equipped to handle.

However, some governments around the world have already begun taking the lead. In New Zealand, the Treasury recently instituted a Living Standards Framework which can be used to evaluate new government policy in terms of its ability to improve citizens lives according to 12 wellbeing domains.[8] Here, benefits are measured in much broader terms than fiscal impacts, and subjective wellbeing is given a central role. This approach was used to inform the government's 2019 budget priorities.

In the United Kingdom, the UK Treasury Green Book – which provides official guidance for conducting evidence-based appraisals of policy proposals – now considers evaluations based on subjective wellbeing to be of fundamental importance for delivering social value to citizens.[9] Related initiatives to put subjective wellbeing at the centre of policymaking are also underway in France, Germany, the Netherlands, Japan, the United Arab Emirates, Bhutan, and Australia among others.[10]

In the coming years, the need to direct human activity towards sustainable pursuits of individual wellbeing will only become more urgent. Many nations around the world are already reeling from the destabilising effects of a diminishing sense of meaning in people's lives, a trend that is likely to be exacerbated by rising automation and climate change. Tackling these challenges requires a new approach, one that gives central importance to measuring, tracking, targeting, and improving subjective wellbeing over time and across generations.

The role of private organisations

Traditionally, the role of corporations to address social issues has been somewhat limited. The core objective of private industry has been to maximise profit and deliver 'shareholder value'.[11] Corporations and private investors have therefore conventionally evaluated their investments in terms of financial return, in the hope that maximising returns will produce cascading positive effects in society. Generating profit has traditionally been considered to be the most efficient and effective way for corporations to deliver social impact. It became the private sector's most sacred responsibility.

Today, many private organisations are moving away from this conventional view. As business operations have become globally distributed, their societal, environmental, and economic impact has increased substantially. In response to these changes, attention has begun to shift from shareholders to stakeholders. Businesses around the world are adopting notions of 'shared value' in an effort to ensure that economic profitability creates value for society.[12] In 2019, the Business Roundtable, representing chief executive officers from many of the most powerful American companies including Apple and Amazon, redefined the purpose of the company away from delivering value to shareholders in favour of delivering value to consumers, employees, and communities.[13]

Examples of concepts for private sector obligations

- → **Corporate Social Responsibility (CSR)**
- → **Environment, Social, and Governance (ESG)**
- → **United Nations' Sustainable Development Goals (SDGs)**

This broadening view of private sector obligations to society has often been captured by concepts such as Corporate Social Responsibility (CSR), Environment, Social, and Governance (ESG) and concrete initiatives such as the United Nations' Sustainable Development Goals (SDGs). These initiatives place much more emphasis on long-term value creation in an attempt to ensure that social and environmental impact be given priority in private companies' decision-making processes.

In response to these developments, novel investment evaluation tools such as Social Return on Investment (SROI) have been developed to quantify and evaluate social impact. However, in an effort to monetise social value, SROI measures often rely on highly inconsistent selection processes and are founded on a number of questionable assumptions and hypotheses.[14] Put simply, although firms place increasing emphasis on social value creation, no harmonised social impact indicator has yet been developed to help them evaluate the success or failure of their investments.

One fundamental limitation inherent to these existing metrics is their overwhelming reliance on objective indicators as opposed to subjective measures of human wellbeing. While objective indicators provide important knowledge about fundamental life circumstances, they cannot on their own address the full extent of what matters most to people. Objective measures can inform us about levels of income and employment in a society, but they can never tell us what it feels like to be poor or rich, to be overworked or underemployed.

In this report, we will provide arguments and evidence in favour of a new standardised social impact indicator capable of capturing subjective wellbeing for public and private decision-making. Rooted in the economic and psychological science of human happiness, the model we propose is designed to enable paradigm-shifting advances in impact investment by identifying market opportunities that conventional metrics are blind to. Ultimately, it is the goal of this report to provide public and private decision-makers, investors, and institutions with an evaluative tool capable of directing energy and investment towards improving wellbeing and facilitating greater leaps for humanity.

Notes

1 Lall (2018)

2 Graham et al. (2017); Li & Raine (2014); World Bank data on China GDP retrieved from: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?end=2010&locations=CN&start=1990

3 See Chapter 7 in Helliwell et al. (2019).

4 Statens Institut For Folkesundhed (2019).

5 United Nations (2013); WHO (2012); Stiglitz et al. (2018).

6 Stiglitz et al. (2014).

7 Stiglitz (2018).

8 New Zealand Treasury (2019).

9 Fujiwara & Campbell (2011).

10 Bronsteen et al. (2013); Helliwell et al. (2019).

11 Friedman (1970).

12 Porter & Kramer (2011).

13 Business Roundtable (2019).

14 Then et al. (2018).

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CHAPTER ONE

Happiness Return on Investment

The overarching ambition of this report is to demonstrate how measuring and modelling subjective wellbeing can help facilitate greater leaps for humanity. However, to begin, it is worth confronting the first challenge any decision-maker is bound to encounter when considering using wellbeing as a benchmark to evaluate social impact: the matter of how to define it.

KEY INSIGHTS

- Conventional social impact indicators are often measured in terms of *utility* or *objective wellbeing*. While these indicators can provide important and useful information, by design, they cannot take into account fundamental realities of lived experience.
- HROI (Happiness Return on Investment) is a proposed evaluative tool designed to determine wellbeing outcomes of public policy and private investments. Unlike conventional metrics, HROI is rooted in empirical evidence of subjective wellbeing.
- Using subjective wellbeing data to assess social impact allows for comparisons of vastly different investments and ensures that impact is measured in terms of lived experience.

1.1 Utility

For the better part of the last century, economists have tended to think about wellbeing in terms of welfare, or utility. Wellbeing by this account consists in the fulfilment of desires or preferences. The more desires a person is able to fulfil, the better off they become.[4] This approach is rooted in the idea that, given the right conditions, people will always act rationally to maximise wellbeing. It is therefore often argued that the goal of public policy should be first and foremost to ensure that individuals are able to freely fulfil their desires.

This view became particularly prominent in mainstream economics during the so-called 'marginalist revolution' of the 1870s and later 'ordinalist revolution' of the 1930s.[5] Although many thinkers of the time aspired to one day measure wellbeing directly, economists including William Jevons and Vilfredo Pareto began to recognise the difficulty in doing so and instead argued for adopting choice behaviour as a suitable proxy. Since it was assumed that individuals would always act rationally to maximise utility, individual wellbeing could simply be inferred by aggregating individual choices in a marketplace. These ideas were eventually canonised in rational choice theory and revealed preference theory and came to dominate mainstream economic thought throughout much of the 20th century.

The establishment of utility as a proxy for wellbeing also did much to eliminate the subjective quality of wellbeing from economic consideration. In doing so, utility theory paved the way to begin focusing on income-based indicators like GDP to evaluate human progress.[6] Since the degree to which desires are fulfilled is largely determined by economic opportunities and market prices, it became entirely logical to use national income as a proxy for national wellbeing, as any increase in the former could be interpreted to indicate a corresponding increase in the latter.

In the private sector, ROI measures are often justified on similar grounds. Inasmuch as any return on investment is the consequence of increased consumption in a marketplace, it can be interpreted as a reflection of individual consumers fulfilling their desires and maximizing their wellbeing. The larger the return, the greater the gain in welfare.

While economic indicators such as GDP and ROI may well be suitable proxies for human wellbeing in certain contexts, they have a number of important drawbacks. For one, equating value with market price often ignores important differences between the two. Sneakers are more expensive than water in many developed countries, though it would obviously be a mistake to assume the former is more valuable than the latter. At the turn of

To philosophers, wellbeing is a concept generally used to describe how well someone's life is going for that person.[1] It is a state of being that is inherently or non-instrumentally good.[2] Theories of wellbeing have tended to fall into one of three categories: (1) utility, (2) objective wellbeing, or (3) subjective wellbeing (Table 1.1).[3]

Table 1.1

<table>
<tr><th colspan="5">Meta theory</th></tr>
<tr><td colspan="2">Utility</td><td>Objective wellbeing</td><td colspan="2">Subjective wellbeing</td></tr>
<tr><th colspan="5">What is observed</th></tr>
<tr><td>Revealed preference</td><td>Stated preference</td><td>Social indicators</td><td>Affect</td><td>Evaluation</td></tr>
<tr><th colspan="5">What guides decisions</th></tr>
<tr><td colspan="2">Gross Domestic Product (GDP)

Return on Investment (ROI)</td><td>Corporate Social Responsibility (CSR)

Environment, Social, and Governance (ESG)

Sustainable Development Goals (SDGs)</td><td colspan="2">Happiness Return On Investment (HROI)</td></tr>
</table>

the 20th century, it was already acknowledged by many economists that choice behaviour was not a reliable proxy for underlying wellbeing for these sorts of reasons. As summarised by the neo-classical pioneer Alfred Marshall in 1890, “It cannot be too much insisted that to measure directly, or per se, either desires or the satisfaction which results from their fulfilment is impossible, if not inconceivable. If we could, we should have two accounts to make up, one of desires, and the other of realised satisfactions.”[7]

Nonmarket activities are also left largely unaccounted for in standard GDP and ROI calculations. Both metrics struggle to capture the societal benefit of raising a child or volunteering at a homeless shelter. Along similar lines, it becomes difficult to distinguish between equivalent levels of output that are more or less beneficial to society. From the perspective of financial maximisation, international trade in nuclear weapons may be indistinguishable from international trade in food stocks as long as both produce the same level of returns.

To make matters worse, Nobel prize winning contributions from psychologists and economists including Daniel Kahneman and Richard Thaler have revealed an impressive array of cognitive biases that lead people to persistently irrational decision-making.[8] In reality, human beings often do not behave as rational wellbeing maximisers in the way conventional economic models have tended to assume. The effect of much of this work has been to relegate choice behaviour an insufficient indicator of human wellbeing. Today, many mainstream economists have begun moving away from a hard-line view of wellbeing as utility.

In response to many of these challenges, stated preferences (or contingent valuation) techniques rose to prominence in the 1980s as a way of eliciting valuations of non-market goods through carefully worded survey questions. By asking participants to choose a desired outcome from a variety of possibilities, researchers are able to capture important information about individual preferences that may not be easily inferable from behaviour. Stated preference theory can therefore also be considered an outgrowth of the conception of wellbeing as utility. This approach has become particularly influential in healthcare and environmental arenas and will be discussed at length in the next chapter.

1.2 Objective wellbeing

A second position with deep roots in the history of western philosophy considers wellbeing in terms of an objective list of inherent goods. These could include (but are not limited to) friendship, love, knowledge, autonomy, pleasure, health, and achievement. Importantly, friendship here is not considered to be valuable because it is desirable or enjoyable, it has value in its own right and on its own terms. Certain states of affairs are often thought to be beneficial to people regardless of how they experience them.[9] Aristotle, Adam Smith, and Karl Marx have all been considered prominent advocates of objective list theories of wellbeing.

In the mid 1960s, objective wellbeing indicators started to gain traction following the emergence of the social indicators movement. Many social scientists of the time began to argue for the need to develop new comprehensive quantitative markers of social progress that went beyond standard economic indicators. The economist Amartya Sen and philosopher Martha Nussbaum have recently advanced the so-called ‘capabilities approach’ along similar lines.[10] By this account, wellbeing is best understood in terms of capabilities: people’s real opportunities to pursue projects that are inherently valuable.[11] The primary objective of public policy may therefore be to ensure that individuals have the ability to engage in that which makes life most worth living. These ideas have gained particular prominence in development studies and inspired a new generation of statistics and social indicators research, most notably exemplified by the Sustainable Development Goals (SDGs)[12] and OECD Better Life Index.[13]

Many objective indicators of wellbeing have also been adopted by private organisations. The growing prominence of Corporate Social Responsibility (CSR) and Environment, Social, and Governance (ESG) metrics exemplifies the changing role of business in society. There is now not only a common understanding that businesses should be responsible for their non-market impacts – such as pollution and community health effects – but also an emerging need to objectively measure these impacts for shareholders and stakeholders.[14] On an international level, the SDGs and UN Global Compact have challenged the private sector to do more than just mitigate negative externalities, and instead to positively contribute to making the world a better place.[15]

In recent years, the investment community has also begun to move away from standard indicators of financial profitability in favour of socially responsible and social impact investing, characterised by the incorporation of non-financial returns into investment strategies. However, while standard financial indicators such as ROI, Internal Rate of Return, and Net Present Value are solidly well established, metrics capable of measuring and modelling non-financial returns are mostly lacking.

Current practices in impact measurement are diffused rather than harmonised. They typically rely on a combination of objective indicators and other methods to account for the social impacts of business operations. The most widely used metric in this respect is the Social Return on Investment (SROI) tool, which attempts to "measure the value added to society caused by different investment decisions."[16] However, in an effort to monetise social impacts, SROI relies on a highly subjective selection process with a number of postulates and unreliable assumptions.[17] While some attempts have been made to create a unified metric, none have emerged as particularly dominant or successful.[18]

In sum, what all of these approaches lack is a unified way of measuring impact across domains. While investment decisions inevitably rely on the professional judgement of the individual investor, standardised measurement practices should always be used to inform decision-making. Developing a common currency of impact is essential to ensure sustainable development and consistently measure social returns across domains.[19] Without it, evaluating investment outcomes in terms of their actual or expected social value is bound to be imprecise.[20]

Even more importantly, none of the leading investment evaluation strategies account for subjective wellbeing.[21] Objective indicators alone are likely to miss essential elements of how individuals experience the impacts of an investment for themselves. If the private sector is truly interested in delivering value to consumers, it becomes fundamentally important to account for their experienced quality of life. In the remainder of this chapter, we will turn to a closer inspection of this idea to demonstrate how subjective wellbeing can be used to guide both public and private decision making.

Box 1.1 Examples of objective social impact indicators

Two of the most popular tools to conduct social impact measurement are IRIS+ and the GIIRS/B Impact Assessment.

IRIS+

IRIS+ is a system of measuring and managing the impact of investments. This resource is publicly available and managed by the Global Impact Investing Network (GIIN). Companies interested in monitoring their impact can navigate the IRIS Catalogue of Metrics or fill out some information based on their objectives, and IRIS will produce a comprehensive list of metrics that can be used together to generate a comprehensive picture of the company's impact.[22]

GIIRS / B Impact Assessment

The Global Impact Investing Rating System (GIIRS) is a rating tool and analytics platform developed by B Corp that assesses the social and environmental performance of companies and investment funds. The rating system uses IRIS metrics in addition to in-house developed metrics to come up with an overall investment rating for the company or fund. These ratings are also used to develop industry benchmarks.[23]

The B Impact Assessment (BIA) is an assessment tool that individual companies can use to evaluate social impact for stakeholders. This assessment is a judgement based on objective information provided by the company being evaluated.[24] While BIA tool is a free online platform, most other services offered by B Lab (including GIIRS) are not.

1.3 Subjective wellbeing

Subjective wellbeing – or happiness – is typically understood to refer to a third understanding of wellbeing that places a high value on subjective experience.[25] Happiness researchers are concerned with understanding how people experience and assess the quality of their lives for themselves. This report takes this definition of wellbeing as its starting point.

Subjective wellbeing in this context is generally measured in terms of two distinct dimensions: affect and evaluation. Affect refers to the day-to-day experience of positive or negative emotions. These may include joy, anxiety, interest, boredom, pain, pleasure, and so on.[26] Evaluation refers to a general assessment of how one's life is going as a whole, most commonly represented in terms of life satisfaction. In so-called hybrid accounts of subjective wellbeing, both affect and evaluation are considered relevant in assessing overall happiness.[27] In one widely cited report published by the OECD, happiness is neatly summarised as "good mental states, including all of the various evaluations, positive and negative, that people make of their lives and the affective reactions of people to their experiences."[28]

Although subjective wellbeing research has experienced somewhat of a renaissance in economics in recent years, its core ideas actually outdate many of the principles that came to be most closely associated with the field. Largely influenced by the ideas of utilitarians including Jeremy Bentham and John Stuart Mill, many classical economists of the 19th century including Francis Edgeworth and Philip Wicksteed envisioned a world in which happiness could be measured directly and used as the primary measure of utility in policymaking.[29] However, while mainstream economics of the 20th century become increasingly separated from this goal, recent advances in survey and statistical modelling have begun to revive interest in using direct measures of subjective wellbeing to inform policymaking and investments.

This revival was also born in the social indicators movement in 1960s. Early attempts to capture self-reported experience in this period did much to position subjective wellbeing as something that could be measured, tracked, and targeted by policy.[30] In the intervening years, careful research has begun to reveal robust and reliable insights into the nature and causes of human happiness. As a result of these efforts, an economic psychology founded on validated measurements of self-reported wellbeing has emerged – what Nobel laureate Daniel Kahneman calls *experienced utility*.[31] This is distinct from standard models of utility that attempt to infer wellbeing from choice behaviour or stated preferences. Today, international subjective wellbeing data is routinely collected, analysed, and published in academic journals and yearly reports including the World Happiness Report, Social Indicators Research, Journal of Happiness Studies, and the Global Happiness Policy Report.

1.3.1 Measuring subjective wellbeing

The model presented in the following chapters is motivated by the growing need to develop evaluative tools capable of measuring and modelling subjective wellbeing for policymaking and private investing. The objective is to empower policymakers, investors, and private industry to measure outcomes in terms of their real or potential effects on human wellbeing. For both practical and ethical reasons, life evaluations – self-reported global assessments of quality of life – are particularly well suited to this purpose.

One initial appeal of using life evaluations as a benchmark for valuing outcomes is that they are relatively easy to work with. The most widely used life evaluation measure, life satisfaction, asks participants to respond to the following prompt: *All things considered, how satisfied are you with your life as a whole these days?*[32] Responses are typically recorded on a scale of 0 to 10, with 0 being completely dissatisfied and 10 being completely satisfied. Over the last three decades, life satisfaction scales have been used by the Gallup World Poll, United States Social Survey, UK Office for National Statistics, European Social Survey, Eurobarometer, World Values Survey, Pew Global Attitudes Survey, and others to assess subjective wellbeing in over 160 countries.

Life satisfaction has also been repeatedly proven to be a valid and reliable measure of wellbeing across domains in a wide variety of contexts. Life satisfaction scores tend to remain stable over time and across individuals, predict national differences that align with societal differences in objective conditions, correlate with third party reports, associate with genetic and physiological markers, respond to changes in life circumstances, converge with the number of good versus bad life events that people can recall in timed periods, and even predict future behaviours including suicide.[33]

Life evaluations perform so well because they are capable of determining what matters most to people without actually having to ask them directly. This is also the core advantage of using subjective wellbeing to evaluate outcomes as opposed to stated preferences.[34] With regression analyses, researchers can detect patterns in response data indicating the extent to which factors like wealth, income, social relationships, and health status are predictive of wellbeing, without requiring people to value each dimension individually. This has significant advantages over current health state evaluations and willingness-to-pay measures which, as we will document in the following chapter, can be subject to a wide array of cognitive biases and ultimately misrepresent crucially important realities of lived experience.[35] When individuals are simply asked to evaluate how their lives are going for themselves, they tend to perform much better.

Moreover, by offering a general assessment of how people judge their life to be going by their own standards, life evaluations also provide a useful umbrella measure against which other important life dimensions can be weighted and compared.[36] This is a distinct benefit of focusing on evaluative wellbeing as opposed to affective wellbeing. While affect measurements can tell us about the experienced emotional character of someone's life, they cannot provide insights into which emotions the person experiencing them considers to be valuable. For example, it would be implausible to suggest that the good life requires constant pleasant emotional experiences. If affect measures were given a central role in the policymaking process, it would be difficult to determine if and to what extent certain emotional states ought to be given priority over others. For example, an artist may be stressed or frustrated yet still be satisfied with her life if she considers these emotions to be a necessary part of the creative process.[37]

This is not to say that positive and negative affect shouldn't play key roles in our understanding of wellbeing. Affective wellbeing can and should still be factored into the equation. Life evaluations simply provide a way for us to determine if and to what extent different emotional states actually benefit the person experiencing them. It may not be necessary to worry about the artist in the prior example from a policymaking perspective, though it might be necessary to consider a person with clinical anxiety experiencing the same frequency of negative emotions. The difference between these two individuals is likely to be revealed by differences in life evaluations.

Finally, in democratic societies, respecting people's values and views regarding their own lives is also considered fundamental.[38] Life evaluations offer decision-makers a way to democratically assess individual and societal progress without having to commit themselves to one particular definition of the good life for everyone.[39] As long as we are committed to the assumption that individuals would judge their lives to be going well by their own standards if they really were in fact going well, life evaluations can offer important insights into the causes and contents of wellbeing. As noted by the philosopher Daniel Haybron, "The great attraction of life satisfaction is that it doesn't presume that only pleasure ultimately matters for you, and it doesn't reduce life to nothing more than a summation of moments, with no regard to the bigger picture. If you regard your life as going well for you, by whatever standard you deem fitting, then life satisfaction will seemingly reflect that."[40]

None of this is to assume that life evaluations are capable of representing everything there is to care about wellbeing or quality of life. They simply provide a reliable and ethical way of assessing subjective wellbeing for decision-making purposes that offer distinct benefits over existing metrics. Future iterations of the model we propose in this report may be adapted to incorporate additional indicators of subjective wellbeing as our scientific understanding of human happiness continues to evolve.

1.4 Towards a Happiness Return on Investment

If the core goal of an impact investor is to produce the greatest possible wellbeing outcome for the greatest number of people, accounting for the lived experience of citizens and consumers is of fundamental importance. While budget restrictions and financial maximisation play key roles in determining investment strategies, subjective wellbeing is almost always absent from the picture. The insights and arguments put forward in this chapter have attempted to (1) demonstrate the potential benefits of subjective wellbeing for impact investment and public policymaking, and (2) motivate the need to focus on life evaluations as a means to ensure what is being measured reflects the most important realities of lived experience. In short, we need to move away from standard indicators of financial maximisation and diffuse social impact towards a metric capable of measuring and modelling the Happiness Return on Investment (HROI).

Three benefits of evaluating Happiness Return on Investment:

1. **HROI can operate as a reliable common currency in evaluating the impact of investments**

   HROI provides a unifying metric to compare vastly different investment opportunities across social impact domains.

2. **HROI ensures that value is measured in terms of lived experience**

   If an HROI assessment reveals a positive outcome of given investment decision, this will empirically reflect a gain in experienced wellbeing of those impacted by the investment. This is not guaranteed with measures rooted in utility or objective wellbeing theory.

3. **HROI can guide innovation and decisions to address wellbeing scarcities**

   HROI assessments can reveal new market opportunities by uncovering areas of wellbeing scarcity that utility measures and objective measures are blind to.

Three criteria for measuring Happiness Return on Investment:

1. **HROI should allow for cost utility analysis**

   Cost utility analysis (CUA) is a form of economic appraisal in which costs are presented in monetary terms, while utility is measured in non-monetary terms – in this case subjective wellbeing. The use of separate units of measurement for costs and outcomes distinguishes CUA from cost benefit analysis (CBA), where both costs and benefits are often expressed in the same unit of effect. In developing a model for evaluating HROI, we must allow for CUA to facilitate unified comparisons of vastly different investment opportunities in the social impact space.

2. **Wellbeing should be measured in terms of life evaluation, not inferred from stated or revealed preferences**

   For both practical and ethical reasons, life evaluations are well positioned to serve as the measure of utility in HROI assessments. Life evaluations can provide fair and valid quantitative comparisons of subjective wellbeing between and within groups over time. They have proven to be scientifically valid and predictive of important objective conditions, biomarkers, and third-party evaluations. Life evaluations also allow for benefits to be weighted in terms of lived experience, thereby avoiding the biases associated with contingent valuation techniques or revealed preferences. This argument will be explored further in Chapter 2.

3. **The model should be scalable to enable fair comparisons across domains**

   The overarching ambition of measuring HROI is to establish a common currency for both impact investing and policymaking purposes. While we will focus primarily on the context of healthcare in this report, the model we propose can also be adapted to evaluate impact in a number of other fields. We will provide a detailed discussion of these issues in Chapters 8 and 9.

Notes

1 Crisp (2017).

2 It is important to distinguish "good" understood as "moral" and "good for" in this context. It is often assumed that someone could lead a "good" or "moral" life while at the same time experiencing a very low level of wellbeing. For instance, they could devote their life to increasing the wellbeing of others at great personal cost.

3 Past categorizations have considered utility in terms of "desire-fulfilment", "preference satisfaction", or "welfare". Subjective wellbeing has also often been referred to as a "hedonistic", "mental state", or simply "happiness" account of wellbeing. See Parfit (1984) and Crisp (2017).

4 Crisp (2017).

5 Read (2007)

6 Dolan & Peasgood (2008).

7 Marshall (2009).

8 Kahneman (2011); Thaler & Sunstein (2009).

9 Rice (2013).

10 Sen (1990); Gasper (1997).

11 Seligman & Royzman (2003).

12 Conceição (2019).

13 OECD (2019).

14 Carroll (2008); World Bank (2017)

15 UN Global Compact (2017).

16 Then et al. (2018)

17 Then et al. (2018); Godsall & Sanghvi (2016)

18 Actis (2019); B Analytics (2019).

19 Malik (2019).

20 Woodland (2019).

21 Hajnal & Hajdu (2017).

22 For more information, visit IRIS+ at https://iris.thegiin.org/; Sullivan (2019).

23 StartingUpGood (2018).

24 B Analytics (2019).

25 Haybron (2016).

26 Watson & Clark (1994).

27 Haybron (2016).

28 OECD (2013).

29 Colander (2007).

30 Angner (2005).

31 Kahneman et al. (1997).

32 Annex A in OECD (2013).

33 Diener et al. (2012).

34 Bronsteen et al. (2013).

35 This is an advantage over objective list accounts such as Amartya Sen's that rely public or political preferences to determine what ought to be prioritised. See Jacobson & Chang (2020).

36 Haybron (2016); Global Happiness Council (2018).

37 Example drawn from Haybron (2016).

38 Haybron & Tiberius (2015).

39 This is another benefit over objective list theories of wellbeing, which have often been characterised as paternalistic. For a thorough discussion, see Claassen (2014).

40 Haybron (2016).

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PASO
PEATONAL
EN DOS
TIEMPOS
DE LUZ VERDE

CHAPTER TWO

Bridging the greatest wellbeing divides

No matter where in the world we look, health is one of the most important determinants of human subjective wellbeing. However, current healthcare metrics often rely heavily on stated preferences that are not reflective of patient experience. In this chapter, we demonstrate how HROI can deliver value to the health investment sector by shining new light on patient subjective wellbeing. This patient-centred approach can help to uncover hidden sources of unhappiness, reveal new market opportunities, and guide investments towards wellbeing scarcities.

KEY INSIGHTS

- Health disparities are to blame for some of the greatest wellbeing divides within populations. Even in low income countries, physical and mental illness often pose a greater threat to people's quality of life than many other factors including unemployment.
- Currently, the most influential ways to evaluate benefits and costs of interventions in the health sector rely on the calculation of Quality Adjusted Life Years (QALYs) and Disability Adjusted Life Years (DALYs). However, neither QALYs nor DALYs factor in how patients of various diseases actually experience their lives. Instead, they are often based on public perceptions that may or may not hold true to reality.
- There is an immense amount of patient suffering in the world associated with symptoms that are either insufficiently addressed or ignored entirely. Using subjective wellbeing data in healthcare evaluations and assessments can uncover uncharted market opportunities for impactful investments.

While HROI may ultimately scale to compare benefits across various domains, it is vital to start by addressing its applicability in the health sector. All around the world, disease and disability are potent sources of human suffering. In both high and low income countries, physical and especially mental illness often pose a greater threat to quality of life than unemployment or poverty.[1]

The health industry is also one of the largest and fastest growing industries in the world. In 2016, more than 7.5 trillion US dollars was spent on healthcare, almost 10% of global GDP, and in many countries substantially more.[2] For the last two decades, health-related expenditures have grown at a rate of 4% per year, even faster than the 2.8% annual growth rate of the global economy.[3] Faced with mounting responsibilities and expanding budgets, stakeholders in both the public and private sector are increasingly relying on economic evaluations to make effective resource allocation and investment decisions. However, for healthcare interventions and medical technologies to be successful in reducing disease burdens and increasing general welfare, it becomes imperative to determine which health problems are the most urgent and potent sources of misery, and to identify cost-effective solutions that can provide for better lives for as many people as possible. As we will demonstrate, these are all issues HROI is poised to address.

However, it is first worth considering currently available and influential health evaluation tools. While these tools can be indispensable in ensuring efficiency and effectiveness in certain contexts, a growing body of evidence is beginning to question the extent to which they may be undervaluing patient experience.

2.1 What makes a good decision?

To understand the limitations of conventional approaches to measuring social impact in the health sector, imagine that a medical supplier is deciding which technology to design, or an investor is considering which technology to invest in. In both cases, each party would have to undertake some sort of economic evaluation to determine how to effectively and efficiently allocate their resources.

As part of this evaluation, two dimensions for each potential decision have to be taken under consideration: the associated *cost* and the expected *effect*.

While the cost would likely remain constant regardless of the evaluation model being applied, the effect or impact can – as we established in Chapter 1 – be defined in terms of financial return, or in changes to objective or subjective wellbeing. As we will demonstrate, depending on the perspective taken, how agents choose to evaluate their decisions can ultimately result in varying levels of impact.

2.1.1 Return on Investment

To begin, let's consider how decisions might be informed using the Return on Investment (ROI) tool. In traditional investing, ROI is often used to determine the impact of investments. It is one of the most well-understood evaluation tools currently available, and it provides a clear picture of the financial benefits of an investment.

If agents exclusively rely on ROI metrics to guide decision-making, they are likely to favour investments that produce the largest financial returns and ensure financial sustainability. However, relying on ROI alone may not encourage investments that produce the largest social impact or return on wellbeing. For example, an investor relying solely on ROI (or other financial metrics) would likely consider the following conditions:

- **What is the cost of developing a new product or service?**
- **What is the target population's ability to pay for it?**
- **What is the potential of the investment to produce sustainable profits?**

To make this thought experiment a bit more concrete, imagine that an investor is considering whether to invest in a new treatment for malaria or type-2 diabetes. In this case, the three aforementioned conditions could lead to the cost benefit analysis presented in Table 2.1.

Given the relatively large prevalence of malaria in low income countries, investing in a treatment would likely have a high social impact, but lower profit potential as the target population may not be able to afford even modestly priced treatments.[4] Relying exclusively on ROI in this case may therefore tempt investors to direct their capital towards a treatment for type-2 diabetes over a treatment for malaria.

Now consider a similar thought experiment, but rather than compare two treatments, let's consider the expected difference between investing in a treatment for type-2 diabetes and investing in a cure (Table 2.2).

As in the previous example, relying on financial metrics alone could tempt investors to invest in a treatment for diabetes over a cure. Especially for a disease that costs the United States healthcare system upwards of $327 billion USD per year, continuous treatment holds the potential for sizable profit margins.[5]

While these examples are obviously oversimplified, they highlight important drawbacks of relying exclusively on financial metrics as a means to guide decision-making. If the goal is to create social impact and maximise wellbeing, we need more than financial metrics to ensure the effectiveness and efficiency of our investments. While financial sustainability is undoubtedly essential for the continued ability of an investor to support socially impactful programmes and products, delivering true value to consumers, citizens, and societies requires a much broader perspective. In fact, there may even be financial incentives to measuring non-financial returns as doing so may uncover untapped market potential.[6]

2.1.2 QALYs

In response to many of the shortcomings associated with financial metrics, one of the most influential ways to evaluate costs and benefits in the health sector relies on the calculation of Quality Adjusted Life Years (QALYs). QALYs provide a common currency by which to compare a wide variety of medical interventions in terms of their impact on longevity and quality of life. Longevity is measured in terms of the number of potentially added life years. Quality of life is based on public preferences regarding various health states. To elicit these sorts of public preferences, health experts usually rely on questionnaires such as the EQ-5D.[7]

Table 2.1	Treatment for Malaria	Treatment for Type-2 Diabetes
Cost of technology	The treatment for malaria is well known and relatively inexpensive.[8] ✓	Researching and developing a new treatment for diabetes is expected to be costly. ✕
Target population	Patient population is predominantly poor and therefore unable to afford treatment.[9] ✕	Patient population is spread out across a variety of affluent and ageing countries and therefore more likely to be able to afford treatment.[11] ✓
Sustainable profits	Malaria often becomes resistant to new treatments and the populations affected are not becoming substantially richer.[10] ✕	Requires continued supply with a growing population base in need of treatment. ✓

Table 2.2	Cure for Type-2 Diabetes	Treatment for Type-2 Diabetes
Cost of technology	Developing a cure is generally more expensive than a treatment given the immense cost of exploratory R&D. ✕	Developing a new treatment for diabetes is expected to be costly, though a variety of current treatments already exist upon which to base new research. ✓
Target population	Patients with diabetes	Patients with diabetes
Sustainable profits	Depending on the price that a cure could be sold for, profits are generally finite. Once an individual is cured, they no longer need treatment. ✕	Requires continued supply with a growing population base in need. ✓

Developed in the late 1980s by an international panel of health experts and medical professionals, the EQ-5D has become the most widely used instrument to measure subjective health.[12] It asks respondents to evaluate their health in terms of five dimensions: (1) mobility, (2) self-care, (3) usual activities, (4) pain/discomfort, and (5) anxiety/depression. There are three potential levels for each dimension: (1) no problems, (2) some problems, and (3) severe problems.[13] Responses to these questions are then used to generate summary scores representing one of 243 possible health states. For example, those with *some problems walking about* (mobility = 2), *some problems washing or dressing* (self-care = 2), *no problems performing usual activities* (usual activities = 1), *no problems with pain or discomfort* (pain/discomfort = 1), and *some problems with anxiety or depression* (anxiety/depression = 2) are given a health summary score of 2-2-1-1-2. In clinical trials these scores are collected regularly to track patient progress over time. Ultimately, they allow medical professionals to make determinations regarding the effects of medical interventions in fields ranging from oncology to dermatology.[14]

However, the responsibility of judging which health states are actually better or worse than others is then conferred upon the general public. The standard justification for this approach is that since the public bears most of the costs associated with resource-allocation decisions made in the healthcare sector, public preferences should play a role in determining how these decisions are made.[15] To elicit these sorts of preferences, researchers typically present a representative sample of the general population with ten to fifteen health states, most often elicited from the EQ-5D. Participants are then often asked to respond to the following scenario for each health state using the Time Trade Off (TTO) method: *Imagine you have* *ten years left to live. You can either live in [health state] for all ten years or choose to give up some years to live for a shorter period of time in full health. Indicate the number of years in full health that you think is of equal value to ten years in [health state].*[16]

Using this methodology, one widely cited study in the United States found that most people would be willing to give up three years of full health to avoid living ten years in the health state 2-2-1-1-2 described above.[17] Quality weights for each health state are then calculated by dividing the total number of years participants would rather live in full health by ten years. For instance, the quality weight for the health state 22112 is 0.7 (seven years divided by ten years), implying that one year in full health is equivalent to 0.7 QALYs in this state.

Studies conducted along these lines have been carried out throughout Western Europe, the Americas, Asia, and Africa.[18] Once public preferences are collected and aggregated, they can then be used to infer which health dimensions on the EQ-5D are generally considered to be more or less desirable.[19]

Remarkably, all around the world, a similar story emerges. Across cultures, demographics, and generations, physical health is usually considered to be more important than mental health. To most people, a life that is physically challenging seems harder than one that is mentally challenging.[20]

Armed with this knowledge, policymakers and healthcare professionals can then go about allocating resources towards medical interventions that can efficiently and effectively address public health priorities. Cost-effectiveness for new technologies is assessed in terms of the amount of QALYs they produce. In the United Kingdom for instance, the National Institute of Care and Excellence (NICE) recommends a cost-effectiveness threshold of £20,000 to £30,000 per QALY for new medical treatments.[21] This process of conducting healthcare appraisals based on quality weights elicited from public preferences has also become standard practice in Australia, Canada, China, France, the Netherlands, South Africa, Sweden, and many more countries around the world.[22] In practice, these methods are most often used to evaluate the cost-effectiveness of pharmaceuticals, followed by surgical procedures, non-diagnostic procedures, and then screening processes.[23]

2.1.3 DALYs

In the developing world, Disability Adjusted Life Years (DALYs) are more often used to asses comparative health benefits. DALYs can be considered as an inverted version of QALYs, as the outcome is measured in terms of Disability Adjusted Life Years *saved* rather than Quality Adjusted Life Years *gained*. More specifically, one DALY is equal to one year of healthy life lost. This takes into account both years lived with disability (YLD) and any years of life lost due to disease (YLL). Similar to QALYs, DALYs assign so-called "disability weights" to various diseases based on elicited health preferences from the general population using pairwise comparisons of diseases.[24]

DALYs are generally considered to be an extremely efficacious tool in comparing disease burdens globally and prioritising impact in resource allocation decisions. Prominent international organisations including the World Health Organization (WHO) and the Bill and Melinda Gates Foundation both use an "average cost-per-DALY averted" metric to guide their global health investments.

The WHO for example has previously used DALYs to compare the effect of different treatment options for HIV in East Africa with the following results.[25]

Mass-media education efforts, treatments for female sex workers, and treatment of STIs in the general population.

Cost: <$150 per DALY saved

School-based education strategies and various antiretroviral treatment strategies.

Cost: $500 - $5000 per DALY saved

The Bill and Melinda Gates Foundation has also used DALYs to evaluate the impact and cost-effectiveness of a number of potential healthcare investments.[26] One particular analysis of interventions designed to support the health of mothers and newborn babies found the following results:

Promoting breastfeeding from birth until 6 months of age.

Cost: $2 - $7 per DALY saved

Fortifying foods with zinc, iodine, and other key vitamins.

Cost: $8 - $30 per DALY saved

Promoting a comprehensive package of interventions for mothers and newborns, including: (1) discouraging mothers from washing their babies immediately after birth, which can induce hypothermia and introduce abrasions and infections; (2) teaching "kangaroo mother care" where mothers are encouraged to breastfeed and hold babies as much as possible until they are strong enough to maintain their own body temperature; and (3) providing two very inexpensive drugs to prevent postpartum bleeding so mothers do not haemorrhage during childbirth.

Cost: $1 - $18 per DALY saved

However, while QALYs and DALYs represent important and encouraging steps to measure and model impact beyond financial return, there are a number of ways even these metrics can fall short of capturing hidden realities of lived experience. In the next section, we will briefly touch upon several gaps in the understanding of 'quality of life' they provide.

2.2 Revealing uncharted opportunities with HROI

Despite their widespread implementation, QALYs, DALYs, and similar health related cost-utility measures have become increasingly controversial in recent years. Two of the most forceful objections are (1) the health dimensions they cover are not sufficiently comprehensive, and (2) by relying on public preference elicitation methods, they are not necessarily reflective of patient experience.

For example, there is no empirical evidence suggesting that the five health dimensions addressed by the EQ-5D and related instruments used in QALY calculations are the only or even most important determinants of health and wellbeing.[27] In fact, our analysis in this report suggests an entirely different reality. As we will demonstrate in Chapter 6, social and mental symptoms including *loneliness* and *lack of optimism* are significantly more predictive of life satisfaction for actual patients than those related to physical discomfort and mobility. In fact, the only dimension currently addressed in the EQ-5D that we also find to be highly predictive of life satisfaction is the mental health dimension representing anxiety and depression.

However, because utility weights for each dimension are derived from public preferences, mental health also tends to be undervalued in QALY and DALY estimations.[28] The fact that people consistently estimate the impact of physical health to be greater than social and mental health may be attributed to so-called 'focusing illusions.'[29] The focusing illusion is a common cognitive bias that occurs when our attention is directed to a specific event or aspect of our lives in such a way that makes it seem more important to than it actually is. This can severely distort health evaluations based on stated preferences. When prompted to imagine what life must be like with any number of health conditions, most people tend to assume that physical disabilities have more deleterious effects on quality of life than they actually do. For most of us, it is simply much harder to imagine the true effects of mental illness or social isolation. The more overt the symptom – like immobility or chronic pain – the more vivid it becomes in our minds. When samples of the general public are asked to evaluate the impact health symptoms on wellbeing used for QALY and DALY estimations, their attention is immediately drawn to physical disabilities as if they were the only thing that matters. Other domains of life that may matter more, such as relationships and mental health, are not taken into account.

These misperceptions are reflected in a growing body of empirical evidence.[30] One recent analysis of 15,184 hospital patients in Wales found that anxiety and depression had degrading effects on self-assessed quality of life that were ten times more severe than extreme pain.[31] Struggling to walk, even being bedridden, had no effect at all. This result was later replicated in a similar analysis of American adults.[32] Yet another study identified no significant difference in wellbeing between those who had lost limbs to cancer as compared to a control group.[33]

One possible explanation for these gaps between expectations and reality could be the relative difficulty of adaptation to poor mental health compared to poor physical health. While the most extreme cases of pain and discomfort are likely to cause near constant misery, most physical symptoms only affect patient wellbeing in the moment.[34] They are unlikely to be endless daily sources of frustration. On the other hand, almost by definition, mental health conditions remain front of mind throughout the day, constantly demanding attention. Their enduring presence can make them exceedingly difficult to get used to.[35]

These insights strongly suggest that estimations of disease burdens using QALYs or DALYs are likely to be suboptimal from a subjective wellbeing perspective, as they are inherently reliant on stated preferences and a relatively narrow conception of health and wellbeing. The ultimate implication of using QALYs and DALYs to make resource allocation decisions is that diseases and symptoms that are primarily mental or social in nature may not become adequately funded or sufficiently understood, precisely because no one knows how to properly evaluate the potential impact of investing in efforts to address them.

As long as subjective wellbeing measures are not embedded into our investment tools, we may continue to be blind to fundamental determinants of experienced wellbeing. There is an immense amount of unhappiness in the world that remains untreated and populations in need that remain underserved. This uncharted territory can be revealed by HROI.

In the following chapter, we will introduce the particular metric we have developed to inform HROI assessments: the Wellbeing Adjusted Life Year, or in short, WALY.

Notes

1 Global Happiness Council (2018).

2 World Bank data on current health expenditure (% of GDP) retrieved from: https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS?locations=1W-XD-XM-XP

3 Xu et al. (2018).

4 WHO (2019).

5 National Center for Chronic Disease Prevention and Health Promotion (2017).

6 Schiff et al. (2016).

7 While the EQ-5D remains the most commonly used questionnaire, other related measures including the SF-36 and HUI can also be used to calculate QALYs. These will be discussed in more detail in Chapter 4.

8 WHO (2019).

9 Gelband et al. (2004).

10 WHO (2019).

11 OECD (2017).

12 Whitehead & Ali (2010).

13 This original version, the EQ-5D-3L, was later expanded to five levels in the EQ-5D-5L, although the former remains much more widely used.

14 Rabin & Charro (2001).

15 Weinstein et al. (1996). For theoretical critiques, see Dolan (1999) and Gandjour (2010).

16 Attema et al. (2013).

17 Shaw et al. (2005).

18 Xie et al. (2014).

19 For a detailed methodology, see Shaw et al. (2005).

20 Xie et al. (2014).

21 However, recent estimates have suggested that the actual figure is closer to £13,000. See Claxton et al. (2013).

22 Brazier et al. (2019); Rowen et al. (2017); Zhao et al. (2018).

23 Neumann et al. (2009).

24 Vos et al. (2017).

25 Prices measured in 2000 international dollars. Hogan et al. (2005).

26 Gates (2010).

27 Dolan (2011).

28 Shaw et al. (2005).

29 Dolan & Kahneman (2008).

30 Binder & Coad (2013); Graham et al (2011).

31 Mukuria & Brazier (2012).

32 Dolan & Metcalfe (2012)

33 Tyc (1992).

34 Dolan (2011); Dolan & Kahneman (2008).

35 Dolan (2011); Levack et al. (2004).

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CHAPTER THREE

A model for Wellbeing Adjusted Life Years

In this chapter, we present a new method for measuring and modelling outcomes in public and private decision-making. Fuelled by the emerging science of subjective wellbeing, this method aims to put seemingly incommensurable outcomes on the same scale by analysing their actual and potential net effects on human wellbeing. The final output will be a universally applicable cost-benefit metric that can be used to assess the Happiness Return on Investment where benefits are combined into a single unit of effect: Δ Wellbeing / Δ Cost.

KEY INSIGHTS

- WALYs attempt to represent two fundamental properties of human life in one unit: quality and time. Quality is understood in terms of subjective wellbeing assessed in terms of life evaluation.
- WALYs can be used to understand the amount of wellbeing experienced or lost by one person or within a given population.
- In the health sector, WALYs can be used to estimate and predict gains in subjective wellbeing from both existing treatments and potential cures by identifying and evaluating their relative benefits.
- WALYs are well suited as an alternative to QALYs or DALYs, but their applicability may ultimately reach far beyond healthcare. WALYs are theoretically capable of comparing seemingly incommensurable outcomes such as the impact of diabetes compared to the impact of air pollution in terms of their net effects on subjective wellbeing.

In the pages that follow, we will conceptualise impact in terms of gains or losses in Wellbeing Adjusted Life Years (WALYs). This chapter will provide a step-by-step guide to the methodology behind calculating WALYs, as well as an overview of its theoretical foundations, empirical requirements, and normative implications.

3.1 Introduction

Like QALYs and DALYs, WALYs attempt to represent two fundamental properties of human life in one unit: quality and time. However, unlike QALYs and DALYs, WALYs consider 'quality of life' more broadly in terms of overall wellbeing as opposed to specific health states. The number of WALYs experienced by an individual in one year can range from 0 to 1 depending on the level of wellbeing he or she actually experiences in that year, with one WALY representing one year lived in full wellbeing. This initial framework gives rise to the following two formulas that will be explored throughout the remainder of this report:

$$\text{WALYs}_{\text{experienced}} = \frac{\text{actual wellbeing}}{\text{potential wellbeing}} \quad (3.1)$$

$$\text{WALYs}_{\text{lost}} = 1 - \frac{\text{actual wellbeing}}{\text{potential wellbeing}} \quad (3.2)$$

As we will demonstrate, these formulas can be applied at both individual and societal levels. WALYs can be used to understand the amount of wellbeing experienced or lost by one person or within a given population. Although we will mostly focus on WALYs experienced or lost over the course of one year, in Chapter 7 we will also present a case study of Parkinson's patients to demonstrate how WALYs can be used to consider wellbeing changes over longer periods of time.

To better understand the implications of this approach, we will first turn to a preliminary example of WALYs applied to international happiness rankings provided by the *United Nations World Happiness Report*.

3.2 A case study of national wellbeing

For the last eight years, the World Happiness Report has tracked life evaluation, positive affect, and negative affect in more than 150 countries around the world using data provided by the Gallup World Poll.[1] Each addition offers global happiness rankings. Rankings are based on average country responses to the Cantril Life Ladder question: *"Please imagine a ladder with steps numbered from zero at the bottom to ten at the top. Suppose we say that the top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. If the top step is 10 and the bottom step is 0, on which step of the ladder do you feel you personally stand at the present time?"* The life ladder and life satisfaction are both types of life evaluations.[2]

Average life ladder scores for the top ten happiest countries are presented in the first column of Table 3.1. Take for example Denmark. In 2018, the average wellbeing of a person living in Demark was 7.6 out of a possible 10 points on the life ladder scale.[3] To convert this figure into Wellbeing Adjusted Life Years, we can employ equation (3.1) where WALYs experienced = 7.6 / 10 = 0.76. In other words, when taking the full range of potential wellbeing into account, this would suggest that one year of life in Denmark for the average person in 2018 was equivalent to 0.76 WALYs.

Using this framework, we can also ask an even more interesting question from a policymaking perspective: how much wellbeing was lost in the same period? To answer this question, we can employ equation (3.2) where WALYs lost = 1 - 0.76 = 0.24. This indicates that, on average, 0.24 WALYs were lost per person in Denmark in 2018. Using this general methodology, we can also zoom out and consider wellbeing experienced or lost on a broader societal level. We may for example seek to understand how many WALYs were lost per 100,000 people, or within a given country overall. Both indicators may be useful and important to understand for different reasons. These are provided for each country in the last two columns of Table 3.1.[4]

Notably, average per person WALY losses balloon significantly when considering entire populations. How WALYs are used in a decision-making process can therefore have important ethical implications depending on the level of analysis. Whether to consider WALYs at an individual or societal level ought to be informed by the priorities and objectives of the institution employing them. The model presented in this report is not intended to be normative but rather descriptive, flexible, and adaptable to a wide variety of ends. These issues will be explored in greater detail in the concluding sections of this chapter.

With this preliminary framework in mind, it is worth sharpening our focus to consider how WALYs can be used to evaluate outcomes and interventions in healthcare.

3.3 WALYs applied to healthcare

In economies primarily governed by free market principles, it is traditionally assumed that individuals will choose products and services that maximise wellbeing. Any goods or services that do not reliably improve quality of life are not easily sold. Over time, market prices are expected to adjust to reflect societal needs. The "invisible hand" of the market is expected to eventually determine the most efficient allocation of goods and resources.

Table 3.1	Life Ladder (0 to 10)	WALYs experienced (per person)	WALYs lost (per person)	WALYs lost (per 100,000)	WALYs lost (population)
1 Finland	7.769	0.777	0.223	22,300	1,231,000
2 Denmark	7.600	0.760	0.240	24,000	1,391,000
3 Norway	7.554	0.755	0.245	24,500	1,302,000
4 Iceland	7.494	0.749	0.251	25,100	89,000
5 Netherlands	7.488	0.749	0.251	25,100	4,325,000
6 Switzerland	7.480	0.748	0.252	25,200	2,146,000
7 Sweden	7.343	0.734	0.266	26,600	2,709,000
8 New Zealand	7.307	0.731	0.269	26,900	1,314,000
9 Canada	7.278	0.728	0.272	27,200	10,080,000
10 Austria	7.246	0.725	0.275	27,500	2,433,000

Rankings are elicited from 2019 edition of the World Happiness Report and based on average country responses to the Cantril Life Ladder question. WALYs experienced and lost are calculated using equations (3.1) and (3.2), respectively. Population estimates used in the final column are drawn from the World Bank.

Whether or not this general story always holds true in practice, there are many sectors in which consumers simply do not have the freedom of choice or access to information necessary to fulfil these requirements of a free market. Institutions and investors operating in these industries are often left to their own devices to determine optimal allocations of resources. This is especially true in healthcare.

In the absence of reliable consumer preferences upon which to guide decision-making, many institutional and individual actors in the health sector rely on metrics to ensure the efficiency of their investments. As discussed in the previous chapter, these metrics often use preference elicitation techniques to assign weights to different symptoms and diseases based on their imagined effects on patients' quality of life. By providing guidance for healthcare spending without having to rely on consumer behaviour, metrics like QALYs and DALYs are intended to be something of an artificial substitute for the free market. However, while absolutely essential, they are often prone to bias and inaccuracies.[5]

Wellbeing Adjusted Life Years are therefore well positioned to complement existing metrics by shedding more light on the realities of patient experience. In doing so, they can help to provide a fuller understanding of how different diseases, symptoms, treatments, and interventions affect patients' lives. However, for these efforts to be successful, we must first figure out how to properly assess "potential wellbeing" in the context of health.

3.4 Estimating potential wellbeing

Earlier in this chapter, we assumed that potential wellbeing included 10 out of 10 possible points on the life ladder scale. This accounts for the maximum range of wellbeing that could potentially be experienced by an individual in a given year. However, once we turn our focus to health, this no longer seems appropriate. Good health is one important constituent of wellbeing, but certainly not all that matters. We cannot simply assume that sick patients would be perfectly happy if they were perfectly healthy. So how then can we then reliably estimate their potential wellbeing?

One way to answer this question would be to simply ask patients themselves how happy they think they might be if they were to become healthy. However, this would likely produce erroneous results. Numerous investigations have shown that how one expects to feel in the face of an event and how one actually feels after the event takes place are rarely the same.[6] In these instances, our judgements are prone to all sorts of forecasting errors. We simply are not very good at predicting our own happiness.[7]

Another possible method might be to assume that the wellbeing of a patient without his or her illness would be equal to the average wellbeing of a healthy individual in the general population. For example, we might assume that a patient with Parkinson's disease in Austria would be just as happy as the average healthy person in Austria. However, while initially appealing, this solution also emerges as problematic. In reality, Parkinson's patients have a unique sociodemographic profile. They are often older, predominantly male, and have lower levels of educational attainment.[8] All of these conditions are expected to play significant roles in determining their level of wellbeing, and would not be subject to change even if a cure for Parkinson's became available.

Following this line of argument, we may therefore expect that patients' potential wellbeing would be equal to the wellbeing of those similar to them in all respects except for the fact that they are healthy. For this purpose, econometrics and statistical analysis provide the necessary tools to perform such estimations. We will rely primarily on the ordinary least squares (OLS) multivariate linear regression model throughout the remainder of this report. Using OLS linear regressions, we can theoretically estimate average differences in wellbeing between patients with a given disease and healthy counterparts in the general population, controlling for relevant background characteristics.

To better understand the implications of this technique, consider the regression equation (3.3).

$$\text{Wellbeing} = \alpha + \beta_1 \cdot \text{Demographics} + \beta_2 \cdot X + \varepsilon \tag{3.3}$$

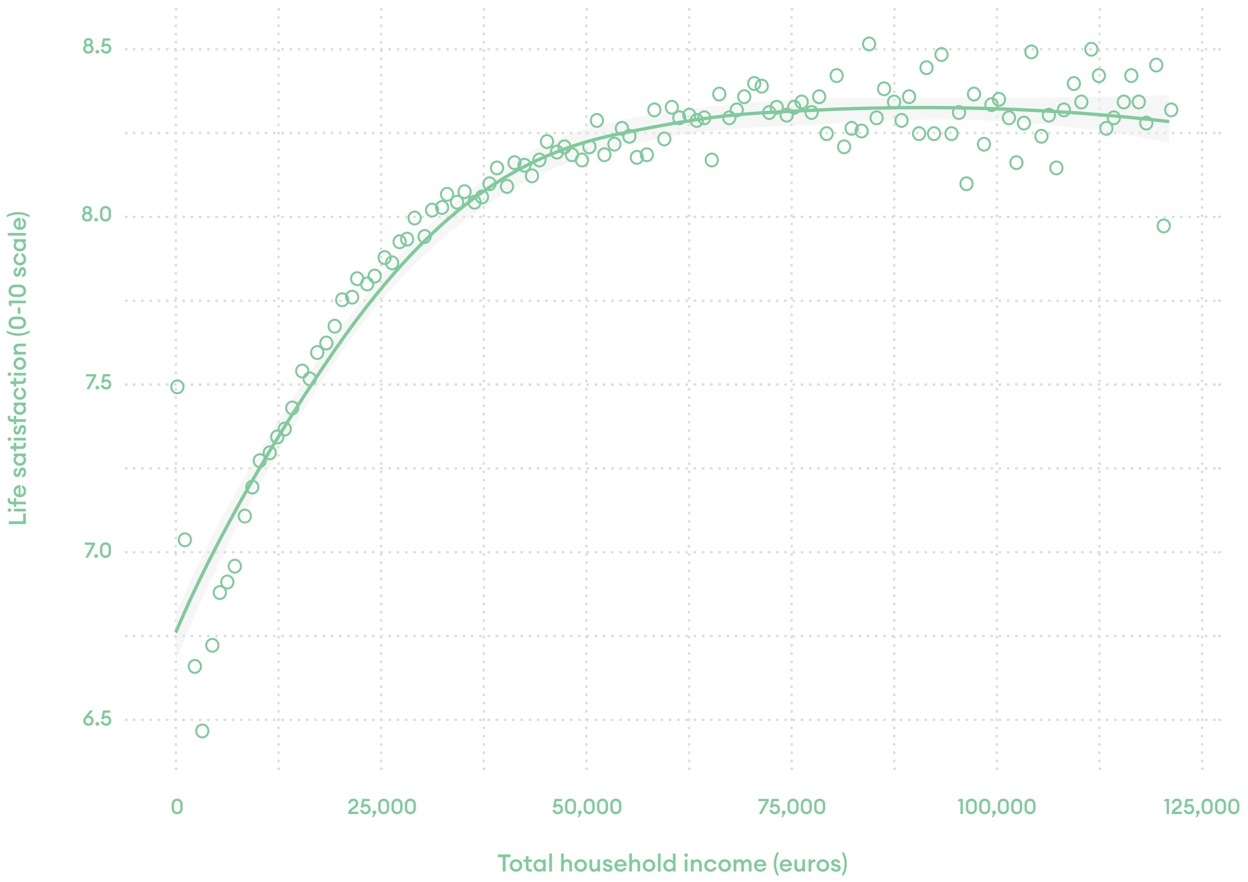
Here, wellbeing is represented as a function of demographic variables and a key variable of interest. More specifically, this model assumes that an individual's wellbeing is determined by an average base level (α), demographic circumstances such as salary or level of education, a key variable of interest (X), and random variations captured by the error term (ε). By applying this formula to large-scale datasets containing information on thousands of respondents, we are able to determine the average contribution of each variable on the right hand side of the equation to an individual's overall level of wellbeing on the left hand side.

To put it a bit more concretely, the first coefficient (α) represents the base wellbeing, or the level of wellbeing that remains consistent across all respondents in our dataset regardless of varying personal circumstances. The second coefficient (β_1) represents average changes in wellbeing due to differences in demographic characteristics. These could include differences in income, level of education, or age. More specifically, this coefficient indicates the average change in wellbeing for every one unit change in the demographic variable of interest. Along similar lines, the third coefficient (β_2) represents the change in wellbeing brought about by differences in whichever key variable of interest we want to study, for example an individual's level of pain or the effect of being diagnosed with a particular disease.

This approach is justified by a simple and fundamental fact: wellbeing levels tend to follow clear and stable patterns across individuals. To illustrate this point more clearly, take the example of income. Happiness researchers have long understood that knowing someone's household income can provide a reliable indication of their overall level of wellbeing. In Figure 3.1, we plot the relationship between income and life satisfaction using data collected from the Survey of Health, Aging, and Retirement in Europe (SHARE) from 2005 to 2017.[9]

Figure 3.1 The relationship between life satisfaction and income

Data collected by the Survey of Health, Aging, and Retirement in Europe (SHARE) from 2005 to 2017 for individuals over the age of 45 in 28 European countries. Each dot represents the average life satisfaction for each income level, comprising a total of 306,177 responses overall.



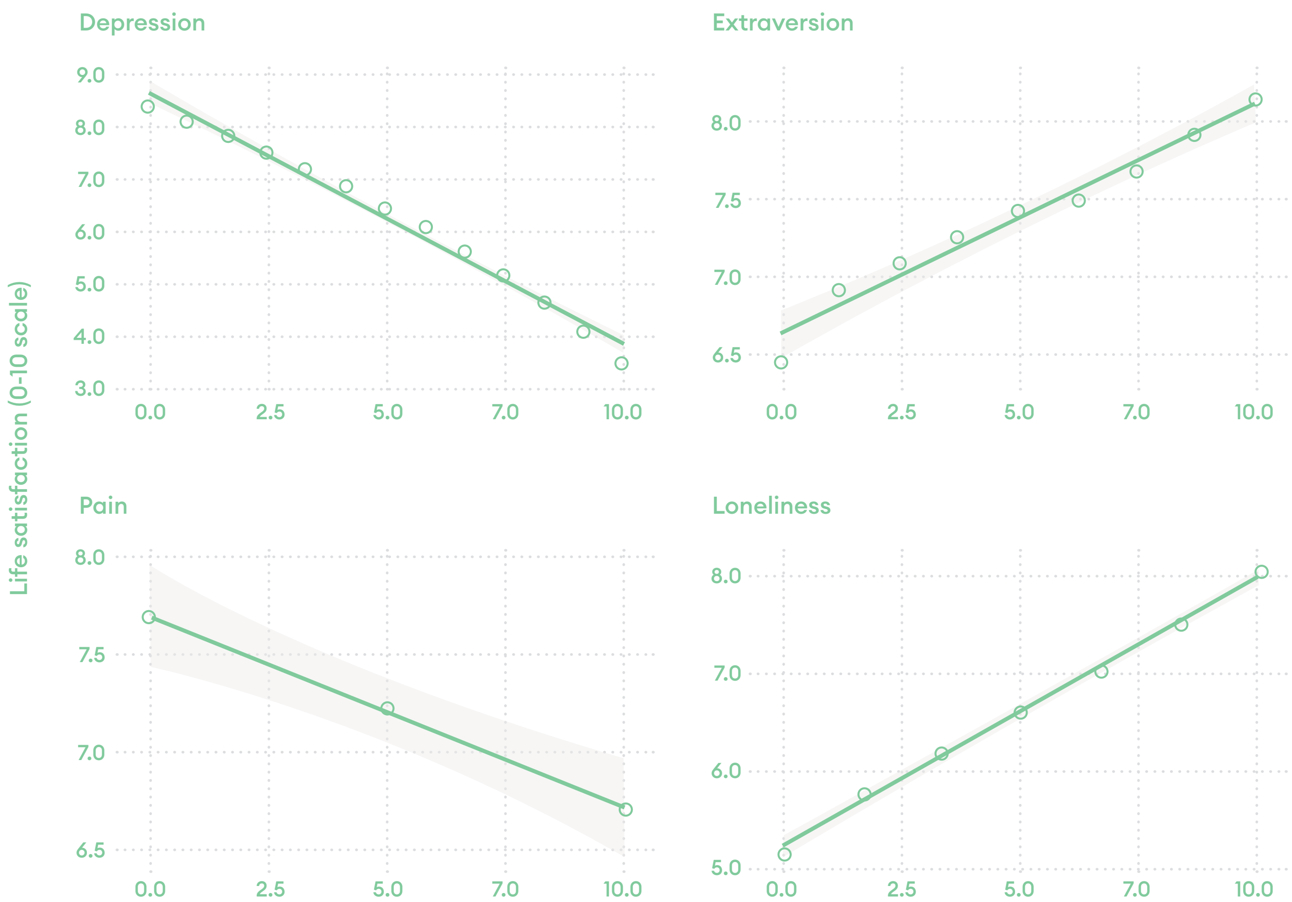
Here, total household income in euros is given on the x-axis, while life satisfaction is plotted on the y-axis. Each dot represents the average life satisfaction for each income level, comprising a total of 306,177 responses overall. Needless to say, it is of course possible to be relatively unhappy with a high level of income, and relatively happy with a low level of income. However, on average, higher levels of income do tend to predict higher levels of life satisfaction, at least up until a certain point. As we move up the income distribution, gains in wellbeing delivered by gains in household income become increasingly marginal.[10]

These sorts of stable relationships are also observable for many other personal characteristics and circumstances. In Figure 3.2, we plot the associations between life satisfaction and depression, extroversion, pain, and loneliness using SHARE data. On the x-axis, each of these indicators is represented on a 10-point scale, while life satisfaction is again represented on the y-axis. Here we see for example that for every one point increase in pain, the average life satisfaction of respondents in our dataset decreases by 0.1 points. For every one point increase in loneliness, average life satisfaction decreases by 0.3 points, and so on.

By exploiting these sorts of statistically significant relationships revealed by linear regressions, we can make reliable predictions about life satisfaction for a wide variety of indicators. Using this method, we can for instance isolate the potential wellbeing effects of hypothetically turning individual symptoms and circumstances "on" or "off". In the next chapter, we will use this procedure to es-

Figure 3.2 Relationships between life satisfaction and depression, extroversion, pain, and loneliness

Data collected by the Survey of Health, Aging, and Retirement in Europe (SHARE) from 2005 to 2017 for individuals over the age of 45 in 28 European countries. Depression assessed using the EURO-D scale. Extraversion assessed on a 9-point scale from low to high using the Big Five personality inventory. Pain assessed on a 3-point scale including mild, moderate, and severe. Loneliness assessed using the UCLA 3-item loneliness scale. All four dependent variables rescaled to 0 to 10. Shaded bars represent 95% confidence intervals for the linear model.



timate potential changes in wellbeing brought about by theoretically treating symptoms or even curing diseases on both an individual and societal level.

3.5 Ethical considerations

Before moving on, it is worth touching upon several important ethical implications of the model proposed thus far. As with any metric or measure of utility, WALYs come furnished with a number of assumptions that can have important consequences in certain contexts. In this section, we will discuss five key issues that all stakeholders should keep in mind when considering using WALYs for decision-making purposes.

3.5.1 Objectives

Perhaps the most obvious assumption of the WALY model is that wellbeing can be understood in terms of subjective mental states and assessed using life evaluations. This approach is rooted in decades of research and motivated by the need to develop reliable metrics capable of evaluating impact in terms of lived experience.[11] However, subjective wellbeing may not necessarily be all that matters from a policymaking perspective. Many of the problems associated with prevailing measurements of progress stem from an overreliance on individual indicators to guide decision-making. These metrics are intended to be descriptive tools, they are not intended to offer normative prescriptions. It is our goal to present WALYs as one additional tool in the decision-makers' toolbox, one that can capture important aspects of human life that other metrics miss out on. However, how this tool is used can vary depending on the particular institution or individual employing it. The appropriateness of the WALY model should always be judged in the context of the purpose it is being used to serve. In Chapter 8, we will discuss some limitations of the WALY model in further detail, and highlight key areas where using subjective wellbeing to evaluate progress may be misguided.

3.5.2 Aggregation

When WALYs are used to measure wellbeing within a given population, there can be significant transformations depending on the number of people being considered. Relatively minor losses in wellbeing on an individual level can grow substantially when aggregated across large groups. This is an inevitable outgrowth of any metric intending to capture differences in quality of life across populations. For example, Canadians may be happier than Austrians on a per person basis, but there is vastly more wellbeing lost in Canada than Austria due to the relative size of the two countries (Table 3.1). These dynamics will become even more evident in the next chapter when we begin to look at WALY losses across different patient populations. Relatively rare diseases with hugely significant personal costs can become dwarfed by milder ailments that are much more widespread.[12] While certain institutions may wish to tackle the most potent sources of misery on an individual level, others may wish to address milder sources of unhappiness that are more common. On its own, the WALY model cannot distinguish between the rightness or wrongness of either approach.[13]

3.5.3 Prioritisation

Because WALYs are calculated using the ratio of actual to potential wellbeing, gains at the lower end of the spectrum are inevitably weighted more than gains at the top. For example, a one point increase in wellbeing from 4 to 5 would represent a gain of $1 - 4/5 = 0.2$ WALYs, while a one point increase in wellbeing from 9 to 10 would only represent a gain of $1 - 9/10 = 0.1$ WALYs. By design, WALYs will therefore always attach more weight to helping those who are worse off. This is a sharp departure from QALYs and DALYs. Neither metric distinguishes between background conditions or personal circumstances. A broken leg is considered to have the same impact on quality of life whether you are poor or rich, young or old, married or single, with or without children. As the saying goes, "a QALY is a QALY is a QALY."[14] This has caused some to question the extent to which QALYs and DALYs adhere to foundational principles of distributive justice. It is often assumed that limited resources in a just society should be devoted to helping those who are least advantaged.[15] WALYs are necessarily committed to the assumption that marginally improving the life of someone who is worse off ought to be prioritised over marginally improving the life of someone who is better off.[16]

3.5.4 Anchoring

The matter of death is also a tricky one to resolve in the context of subjective wellbeing as it becomes necessary to calibrate the cost of death in terms of losses in potential wellbeing that could have been experienced by someone if they were still alive.[17] There are several important points worth noting here. First, this implies that the wellbeing cost associated with living the worst possible life (scoring a zero out of ten on a life evaluation scale) may be equivalent to the wellbeing cost of death, at least within a one year period. For example, if we are only interested in the total number of WALYs lost due to Alzheimer's disease in a given year, it would be impossible to distinguish between patients who reported the lowest life evaluation score that year and patients who died due to the disease. Luckily, these sorts of cases are extremely rare in practice. Most individuals, even those suffering from debilitating chronic diseases, rarely report the lowest possible life evaluation scores. Moreover, for policymaking purposes, we are almost always interested in the average wellbeing across large groups of people. In these contexts, the average wellbeing of living patients will practically never be equal to zero.

However, once we take into account WALY gains and losses over the course of multiple years, the wellbeing cost of death does begin to significantly outweigh the wellbeing cost of living the worst possible life. In these contexts, it becomes important not only to account for an individual's level of wellbeing within a given year period, but also, in cases of death due to disease, to account for the potential wellbeing that could have otherwise been experienced had the patient survived. This is calculated in terms of the remaining years of healthy life expectancy at time of death. By implication, deadly diseases that primarily affect young people will therefore tend to be weighted more than those that primarily affect older populations. We will revisit this issue in greater detail in Chapters 5 and 7.

3.5.5 Adaptation

One final point worth mentioning is the well-known issue of adaptation. A wide body of evidence indicates that people exhibit a remarkable degree of adaptation to both positive and negative life circumstances.[18] In the context of health, this can become particularly relevant as patients often adapt to a variety of health conditions. For example, patients suffering from physical disabilities tend to report higher levels of life satisfaction than patients suffering from mental disabilities, even though many assume the former to be objectively worse off.[19]

There has been much discussion about whether the issue of adaptation renders subjective wellbeing unsuitable for policymaking purposes.[20] To many commentators, there seems to be something inherently wrong or at least misleading about wellbeing scales if they are incapable of distinguishing between a happy disabled person and a happy able-bodied person.

In addressing this issue, it is once again important to note that WALYs are not intended to be used in isolation or in the service of offering normative prescriptions. It may very well be the case that a particular institution cares deeply about eradicating deafness, even if deaf people are on average relatively satisfied with their lives. In this particular instance, it may be inappropriate to use WALYs as a benchmark to evaluate progress. We will address these sorts of issues in greater detail in the final chapters of this report.

However, in general, we take it to be a benefit and not a disadvantage of the WALY model that it can capture hidden realities of subjective experience, however surprising they may be. By design, WALYs are capable of uncovering and representing sources of human suffering that have long been ignored or deprioritised by current metrics. Viewed from this perspective, it may even seem morally questionable to deprioritise those who are suffering more in favour of those who are suffering less.

Notes

1 Helliwell et al. (2019).

2 However, while both of these measures are closely correlated and capture the same evaluative dimension of wellbeing, each has its own distinct benefits and drawbacks depending on the context. For a thorough discussion and best practices, see: OECD (2013).

3 Happiness scores reported for each country in the World Happiness Report are represented as an average of the three preceding years, but for the sake of this example we will assume consistency.

4 Population estimates for 2018 were drawn from the World Bank data retrieved from: https://data.worldbank.org/indicator/SP.POP.TOTL?locations=FI-DK-NO-IS-CH-NL-CA-IL-NZ-AT

5 For a thorough discussion, see Chapter 2.

6 Wilson & Gilbert (2003).

7 Preference elicitation techniques are also prone to these sorts of forecasting errors. See Chapter 2.

8 Dorsey et al (2018).

9 Available from www.share-project.org. Additional details regarding SHARE data will be discussed in Section 4.1.

10 For a recent analysis of the relationship between life satisfaction, positive affect, negative affect, and income levels around the world, see Jebb et al. (2018).

11 For a thorough discussion, see Chapter 1.

12 These dynamics are also present in QALY and DALY estimations of disease burdens. For instance, lower back pain is often found to be one of the largest sources of misery in high-income countries. For additional examples, visit the Global Burden of Disease Compare Visualization Hub: https://vizhub.healthdata.org/gbd-compare/

13 In the literature this is also referred to as aggregation. This is by no means settled in philosophical discourse, and many commentators have different views about the extent to which welfare costs or benefits can or should be aggregated. For a detailed discussion, see Voorhoeve (2014).

14 Cohen, J. (2019).

15 See Rawls (1971); Arneson (2013).

16 In this philosophical literature these conditions are often referred to impartiality and prioritarianism. For an introductory discussion, see Pummer & MacAskil (forthcoming).

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CHAPTER FOUR

Wellbeing and healthcare

In the previous chapters we laid the theoretical groundwork for a new metric capable of evaluating outcomes in terms of subjective wellbeing. In this chapter, we will take a closer look at how this approach can be used in the context of healthcare by considering the wellbeing burdens of sixteen chronic and non-chronic diseases: depression, anxiety disorders, Parkinson's disease, Alzheimer's disease, strokes, rheumatoid arthritis, ulcers, lung disease, arthritis, osteoporosis, osteoarthritis, asthma, diabetes, cataracts, hypertension, and high cholesterol. Here, we will focus on the wellbeing lost due to disease per year at an individual level. Our analysis focuses on individuals over the age of 45 in European countries.

KEY INSIGHTS

- Differences in life satisfaction between patients with different diseases cannot solely be explained by differences in health status. To some patients, other life circumstances such as unemployment or living without a partner may also have negative effects on their subjective wellbeing. These sorts of background conditions must be taken into account in assessing the individual wellbeing burden of disease.
- Among the sixteen diseases investigated, depression and anxiety disorders are associated with the greatest wellbeing at an individual level, followed by Alzheimer's and Parkinson's.
- Putting a greater focus on combating poor mental health could dramatically raise wellbeing among older patient populations in Europe.

4.1 Data and methodology

To understand the wellbeing burden of disease at an individual level, we will first need to estimate actual and potential levels of patient wellbeing. Following the approach laid out in the previous chapter, it is therefore necessary to collect life satisfaction data from as many patients and healthy counterparts as possible, including relevant sociodemographic information known to influence wellbeing for both groups.[4] In this report, we have compiled this information the Survey of Health, Aging, and Retirement in Europe (SHARE), which provides detailed information about health status and subjective wellbeing for individuals over the age of 45 in 28 European countries.[5]

Using this information, we will first assess the wellbeing burden of disease on a per person and per year basis. In later chapters, we will broaden our view to consider wellbeing lost due to disease within entire populations and over the course of multiple years.

4.2 Differences in life satisfaction

In Table 4.1, we present coefficients representing differences in life satisfaction between patients living with sixteen different diseases and healthy counterparts.[6] Coefficients were arrived at using OLS linear regressions of SHARE data controlling for gender, age, marital status, number of children, employment, education, country, wealth, income, residential area, country, and year. All diseases except depression were represented as dummy variables indicating whether or not the respondent had been clinically diagnosed by a doctor.[7] Depression was considered in terms of scoring a 5 or higher on the EURO-D scale. (Issues regarding the estimation of depression are discussed in Box 5.1 of the next chapter.) All differences are found to be highly statistically significant at a 99% confidence level. Additional details regarding the empirical stategy can be found in the online appendix.

Out of all the diseases available for consideration in the SHARE dataset, depression predicts the largest drop in life satisfaction. Keeping all else constant, someone who is depressed is likely to be 1.32 points less satisfied with their lives. To put this figure into context, it is about twice as large as the difference between being employed and unemployed, and three times large as the difference between living with a married partner and being divorced (Figure 4.1).[8] In a similar vein, patients suffering from anxiety disorders also tend to report much lower levels of life satisfaction relative to healthy counterparts, with an average difference of 0.91 points.[9] These results are largely in line with an emerging body of literature indicating that mental health can have profoundly important implications for subjective wellbeing, even more so than physical health.[10]

However, it is also crucially important not to understate the importance of physical health. In our analysis, we find that Parkinson's and Alzheimer's disease predict substantial differences in life satisfaction relative to healthy

Survey of Health, Aging, and Retirement in Europe (SHARE)

SHARE is an international survey of older populations in 29 European countries and Israel that has been conducted every two years since 2005. It contains detailed information on life satisfaction, health, socioeconomic status, and social networks of more than 150,000 individuals aged 45 or older, comprising over 380,000 individual interviews. More information is available at *www.share-project.org*.[1]

As discussed in Chapter 3, our analysis of SHARE data primarily relies on the use of cross-sectional OLS linear regressions.[2] In all of our estimations, we have included control variables for gender, age, marital status, number of children, employment, education, country, wealth, income, residential area, country, and year. In doing so, we have attempted to isolate the specific effect of health on wellbeing, regardless of background conditions and circumstances.[3] Additional information regarding our empirical strategy as well as summary statistics, regression tables, and robustness checks can be found in the online appendix available at *www.happinessresearchinstitute.com*.

counterparts (Table 4.1). Stokes, rheumatoid arthritis, ulcers, and chronic lung disease also have substantial negative associations with subjective wellbeing.

Patients living with diabetes, cataracts, hypertension, and high cholesterol seem to be relatively less affected by their conditions. However, negative differences in life satisfaction between these patient populations and healthy counterparts are still statistically significant. By way of context, the difference in wellbeing between patients living with cataracts and healthy counterparts is about half as big as the difference between being divorced and living with a married partner (Figure 4.1).

Part of the reason we only register minor wellbeing burdens for diseases like diabetes, asthma, and high cholesterol may also be because, historically, they have received a lot of attention. As a result, there are a wide array of treatment options available. If these diseases went untreated, they too would likely be associated with significant wellbeing burdens.

4.3 Individual wellbeing burden of disease

Using these differences in life satisfaction, we can now begin to calculate individual wellbeing burdens of disease in terms of Wellbeing Adjusted Life Years. Calculating WALYs requires two inputs: actual and potential wellbeing.[11] In this case, we are interested in the actual wellbeing of patients living with a certain disease. This is represented by the average life satisfaction of the patient group. Potential wellbeing can then be understood in

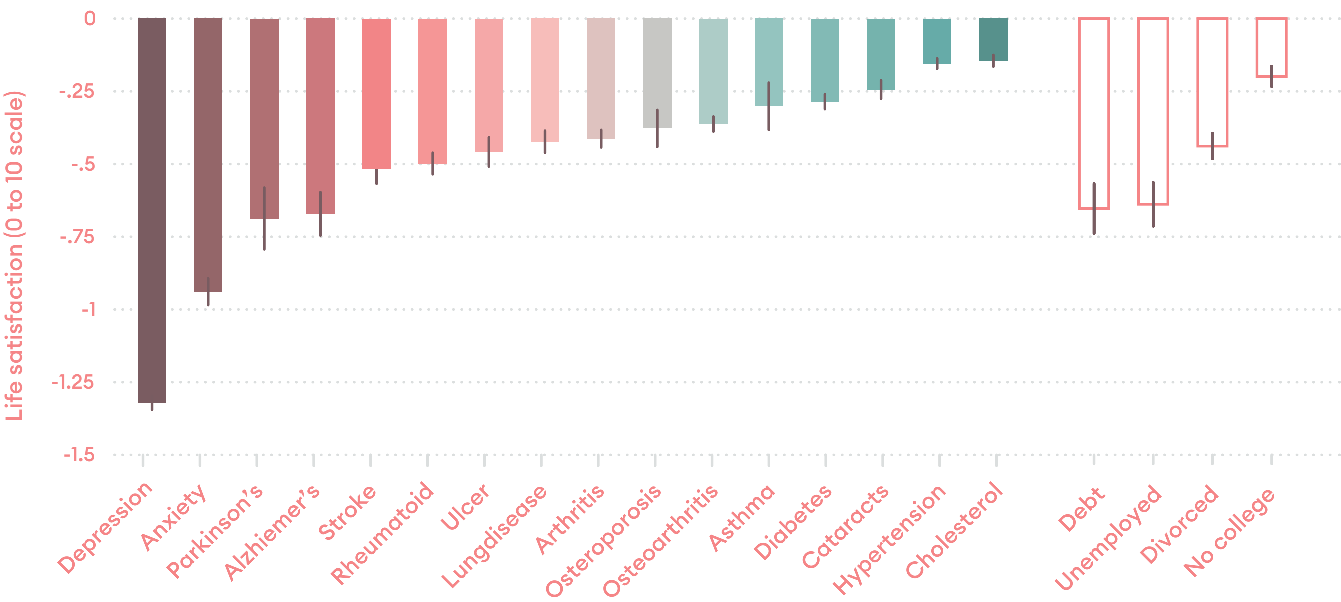
Table 4.1 Differences in life satisfaction between patients and healthy counterparts

*** p<0.01. Each row represents a separate OLS regression with life satisfaction as the dependent variable. Clustered robust standard errors are reported. Control variables included in each regression for gender, age, marital status, number of children, employment, education, country, wealth, income, and year. Samples include adults over the age of 45 in 28 European countries. Additional details in the online appendix.

	Coefficient	Standard error	Observations	R-squared
1 Depression	-1.321***	0.012	224278	0.218
2 Anxiety	-0.939***	0.023	191365	0.151
3 Parkinson's	-0.687***	0.054	281192	0.142
4 Alzheimer's	-0.671***	0.038	279541	0.144
5 Stroke	-0.515***	0.027	278134	0.142
6 Rheumatoid arthritis	-0.498***	0.019	183678	0.147
7 Ulcer	-0.458***	0.026	276405	0.141
8 Lung disease	-0.423***	0.019	273091	0.144
9 Arthritis	-0.413***	0.015	86267	0.160
10 Osteoporosis	-0.377***	0.032	43389	0.163
11 Osteoarthritis	-0.362***	0.013	179030	0.147
12 Asthma	-0.301***	0.041	43725	0.160
13 Diabetes	-0.285***	0.013	275653	0.144
14 Cataracts	-0.244***	0.017	274645	0.142
15 Hypertension	-0.155***	0.009	245350	0.137
16 Cholesterol	-0.145***	0.010	261365	0.141

Figure 4.1 Differences in life satisfaction between patients and healthy counterparts

Context variables estimated using a single OLS linear regression controlling for gender, age, number of children, country, income, year, and remaining categories for marital status, education, and employment. Married used as the reference category for divorced. Bachelor's degree used as the reference for no college (ISCED-3). Employed full-time used as the reference category for unemployed. Debt coded as dummy variable for negative or non-negative household net worth. Health status was also controlled for by adding additional control variables for all sixteen diseases except arthritis and asthma due to data limitations. Additional details in the online appendix.



terms of the life satisfaction we would have expected patients to report if they were healthy. This is calculated by adding the estimated difference in life satisfaction between patients and healthy counterparts – given by the absolute value of the disease coefficient – to the actual average life satisfaction of the patient group. These figures are presented in the first three columns of Table 4.2.

It is worth noting that average patient wellbeing corresponds strongly to the severity of the disease coefficient.[12] This seems somewhat intuitive. The higher the wellbeing cost of a disease, the less happy someone affected by that disease is likely to be. However, the relationship between disease severity and potential wellbeing is not quite as clear cut.[13] This may reflect the fact that not all diseases are equally important in explaining overall wellbeing. For example, the potential wellbeing of patients with depression is quite high, approximately 7.58 points out of 10 on a life satisfaction scale, while the potential wellbeing of patients living with osteoporosis slightly lower, 7.39 points.[14] This may suggest that the difference in wellbeing between patients with depression and healthy counterparts is almost entirely explained by the fact that they have depression. On the other hand, patients with osteoporosis may be unhappy for other reasons.[15]

In the fourth and fifth columns of Table 4.2, we present per person estimates of WALYs experienced and lost due to disease for each of the sixteen diseases considered in our dataset. These estimates were arrived at using equations (3.1) and (3.2) introduced in the previous chapter. Error margins are given for WALY estimates based on the upper and lower bounds of actual wellbeing levels and disease coefficient estimates.

In this case, we find for example that one year lived with depression is equal to 0.83 WALYs. In other words, one year with depression is equal to 0.83 years without depression. Conversely, this also implies that depression is associated with an individual wellbeing burden of 0.17 WALYs. This is equivalent to saying that in any given year, a patient suffering from depression loses 17% of the potential wellbeing they may have otherwise experienced. Relatedly, patients living with Parkinson's or Alzheimer's disease lose approximately 9% of the potential wellbeing they could have otherwise experienced, and so on.

From this vantage point, we begin to see a fuller picture of wellbeing than the one offered by conventional healthcare metrics. While losing 9% of potential wellbeing may seem relatively small, it serves as an acknowledgement

		(1) Actual wellbeing	(2) Coefficient	(3) Potential wellbeing	(4) WALYS experienced (per person)	(5) WALYS lost (per person)
1	Depression	6.254 (6.234 - 6.275)	-1.321 (1.309 - 1.333)	7.575 (7.563 - 7.587)	0.826 (0.824 - 0.827)	0.174 (0.173 - 0.176)
2	Anxiety	6.522 (6.480 - 6.563)	-0.939 (0.893 - 0.985)	7.461 (7.373 - 7.548)	0.874 (0.871 - 0.877)	0.126 (0.121 - 0.130)
3	Parkinson's	6.711 (6.621 - 6.800)	-0.687 (0.581 - 0.793)	7.398 (7.202 - 7.593)	0.907 (0.901 -0.914)	0.093 (0.081 - 0.104)
4	Alzheimer's	6.73 (6.667 - 6.792)	-0.671 (0.597 - 0.746)	7.401 (7.264 - 7.538)	0.909 (0.905 -0.914)	0.091 (0.082 - 0.099)
5	Stroke	6.972 (6.923 - 7.020)	-0.515 (0.463- 0.568)	7.487 (7.386 - 7.588)	0.931 (0.928 -0.935)	0.069 (0.063 - 0.075)
6	Rheumatoid arthritis	6.935 (6.904 - 6.966)	-0.498 (0.461 - 0.535)	7.433 (7.365 - 7.501)	0.933 (0.931 -0.935)	0.067 (0.063 - 0.071)
7	Ulcer	6.918 (6.871 - 6.965)	-0.458 (0.408- 0.509)	7.376 (7.279 - 7.474)	0.938 (0.935 -0.941)	0.062 (0.056 - 0.068)
8	Lung disease	7.053 (7.022 - 7.084)	-0.423 (0.385- 0.461)	7.476 (7.407 - 7.545)	0.943 (0.941 -0.946)	0.057 (0.052 - 0.061)
9	Arthritis	7.052 (7.025 - 7.078)	-0.413 (0.383 - 0.443)	7.465 (7.408 - 7.521)	0.945 (0.943 -0.947)	0.055 (0.052 - 0.059)
10	Osteoporosis	7.012 (6.950 - 7.075)	-0.377 (0.314 - 0.441)	7.389 (7.264 - 7.516)	0.949 (0.945 -0.953)	0.051 (0.043 - 0.059)
11	Osteoarthritis	7.322 (7.302 - 7.342)	-0.362 (0.337 - 0.388)	7.684 (7.639 - 7.730)	0.953 (0.951 -0.955)	0.047 (0.044 - 0.050)
12	Asthma	7.198 (7.113 - 7.284)	-0.301 (0.22 - 0.382)	7.499 (7.333 - 7.666)	0.960 (0.955 -0.965)	0.040 (0.030 - 0.050)
13	Diabetes	7.205 (7.185 - 7.225)	-0.285 (0.259 - 0.311)	7.490 (7.444 - 7.536)	0.962 (0.960 -0.964)	0.038 (0.035 - 0.041)
14	Cataracts	7.316 (7.286 - 7.345)	-0.244 (0.211 - 0.276)	7.560 (7.497 - 7.621)	0.968 (0.966 -0.970)	0.032 (0.028 - 0.036)
15	Hypertension	7.467 (7.454 - 7.480)	-0.155 (0.137 - 0.173)	7.622 (7.591 - 7.653)	0.980 (0.979 -0.981)	0.020 (0.018 - 0.023)
16	High cholesterol	7.479 (7.463 - 7.495)	-0.145 (0.125 - 0.165)	7.624 (7.588 - 7.660)	0.981 (0.980 -0.982)	0.019 (0.016 - 0.022)

Table 4.2 The wellbeing burden of disease at an individual level

Actual wellbeing represented as the average life satisfaction of the patient group on a 0 to 10 scale. Disease coefficients are drawn from Table 4.1. 95% confidence intervals are given in parentheses in columns (1) and (2). Potential wellbeing is calculated by adding the absolute value of column (2) to actual wellbeing in column (1). WALYs experienced = actual wellbeing / potential wellbeing. WALYs lost = 1 - (actual wellbeing / potential well-being). Error bars in columns (3), (4) and (5) are calculated based on the upper and lower bounds of actual wellbeing levels and coefficient estimates.

that subjective wellbeing is multifaceted and nuanced, and not always entirely dependent on health.

In Table 4.3 we present a handful of WALY losses compared with DALY losses for the same conditions. Encouragingly, both estimations of disease burdens are similar in several key respects.[16] In both cases, the costs of Alzheimer's and Parkinson's are substantial. Depression also ranks highly on both lists, although this comparison is likely biased by important measurement differences. (This will be discussed in more detailed in the next chapter). Asthma and diabetes are also considered to be relatively less severe on both accounts.

However, there are also important differences. Most notably, stroke and cataracts are particularly burdensome in DALY estimations, while anxiety disorders are considered to be somewhat less so. This may reflect the fact that DALYs are derived from general population valuations of health states, while WALYs are based on patient self-reports (Chapter 2). Imagining what it might be like to live with an illness, especially one that is unfamiliar, does not always align with how patients experience it.[17]

WALY estimations also tend to be somewhat smaller than DALY estimations. While DALYs only measure quality of life in terms of health status, WALYs are capable of reflecting a wider range of human experience. This leaves room for other life conditions and circumstances exogenous to health but important for wellbeing to be valued, measured, and targeted by policy. We will turn to a discussion of these possibilities in Chapters 8 and 9. For now, in the next chapter, we will broaden our view to consider wellbeing lost due to disease at a societal level.

	WALY loss (per person per year)			DALY loss (per person per year)	
1	Depression	0.174	1	Stroke	0.171
2	Anxiety	0.126	2	Depression	0.157
3	Parkinson's	0.093	3	Alzheimer's	0.151
4	Alzheimer's	0.091	4	Parkinson's	0.141
5	Stroke	0.069	5	Rheumatoid arthritis	0.129
6	Rheumatoid arthritis	0.067	6	Lung disease	0.104
7	Ulcer	0.062	7	Anxiety	0.092
8	Lung disease	0.057	8	Cataracts	0.065
9	Osteoarthritis	0.047	9	Diabetes	0.048
10	Asthma	0.040	10	Ulcer	0.045
11	Diabetes	0.038	11	Asthma	0.038
12	Cataracts	0.032	12	Osteoarthritis	0.031

Table 4.3 WALY and DALY comparisons of disease

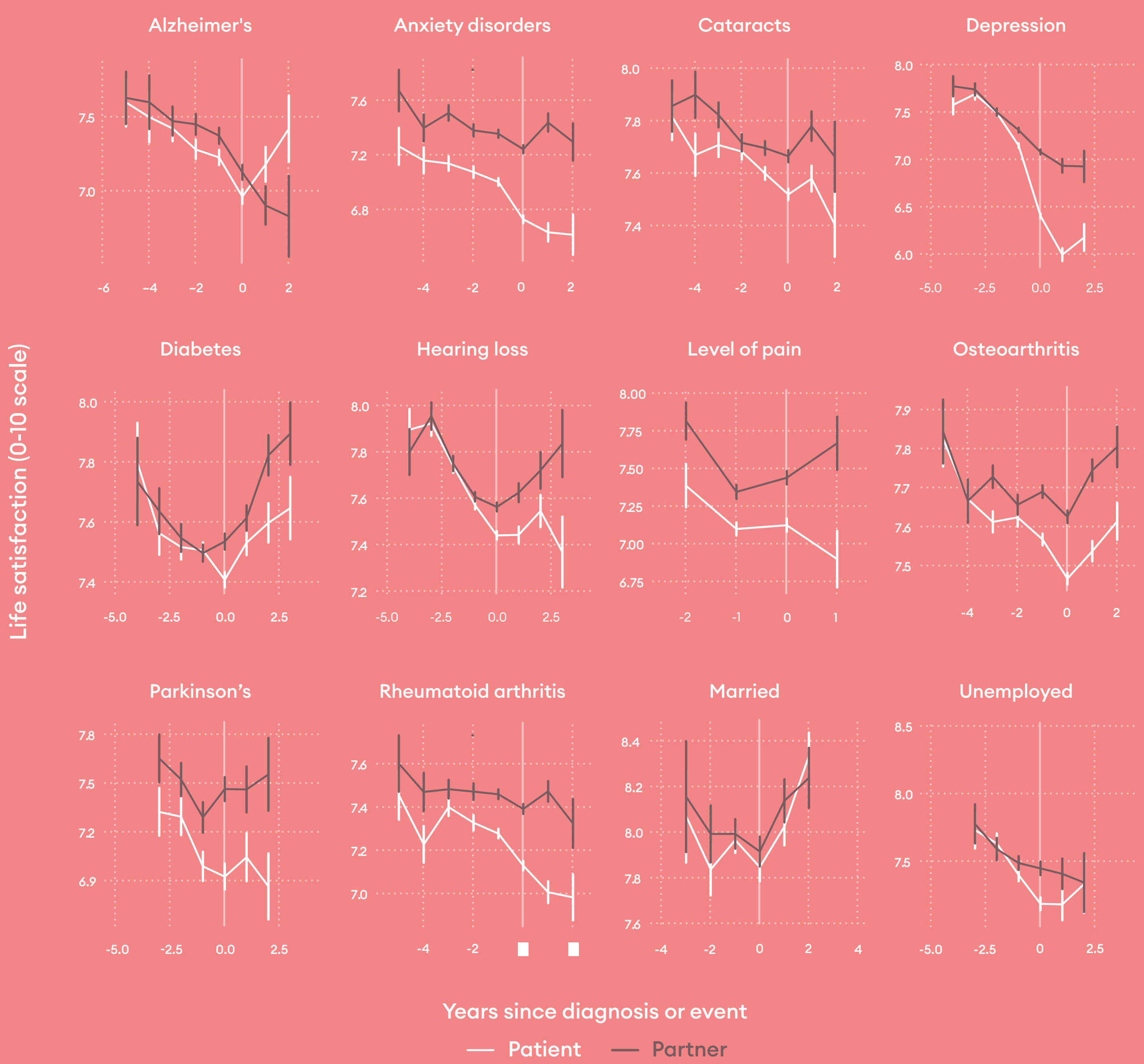
Estimates for individual DALY losses are calculated by dividing YLDs by prevalence rates provided in the Global Burden of Disease database for individuals aged 45 and over in the European countries considered in our analysis. These estimates differ slightly from standard disability weights used in DALY calculations as there are more mild cases of disease represented in the general population than there are severe cases. For additional details regarding YLD estimates and disease weights, see Vos et al. (2012) and Salomon et al. (2015).

Box 4.1 Considering the burden of disease on partners and caretakers

In this chapter, we considered the wellbeing burden of disease at an individual level. However, our analysis only accounted for the wellbeing of patients themselves. While this is standard practice, it is by no means sufficient. Patients are never the only ones affected by disease.

In Figure 5.1, using SHARE data on the wellbeing of patients and their partners, we illustrate the changing dynamics of life satisfaction for both individuals before and after the disease was first reported. In most cases, the couple's life satisfaction fluctuates in parallel. However, some conditions prove more burdensome for partners than others. This is especially true of depression and anxiety disorders. In the case of Alzheimer's, partners even seem to become more negatively affected than patients.

In the future, WALYs could be used in this way to further contextualise the true burden of disease by accounting for its effects on the subjective wellbeing of loved ones and caretakers.[18]



Average life satisfaction of patients and their partners on a 0-10 point scale before diagnosis or event (negative x-axis) and after diagnosis or event (positive x-axis). In the case of depression, hearing loss and pain, zero represents the year in which the patient exceeded the relevant threshold in the respective scale. Patients who recovered after being diagnosed have been excluded from the sample. Data drawn from SHARE for individuals over the age of 45 in 28 European countries. Error bars represent 95% mean confidence intervals.

Notes

1 This report uses data collected from SHARE waves 1, 2, 4, 5, and 6. See Börsch-Supan et al. (2013) for methodological details regarding data collection. The SHARE data collection has been funded by the European Commission, Horizon 2020, and by DG Employment, Social Affairs & Inclusion. Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging and from various national funding sources. See *www.share-project.org* for additional information.

2 A robustness check using fixed effects are also provided in the online appendix. Disease rankings and proportional effects are largely similar across both estimation procedures. However, while fixed effects models have the benefit of controlling for omitted variable bias, they are only capable of capturing changes in wellbeing related to changes in health status from one period to the next. For the purposes of this report, this is a significant drawback as our primary variables of interest are dummy variables (diagnosed or not diagnosed) that exhibit little variation across periods. Fixed effects models may therefore produce biased or insignificant estimations of long term chronic diseases including Parkinson's and Alzheimer's. For a more detailed discussion of the benefits and drawbacks of each estimation procedure, see Binder & Coad (2013).

3 While these variables are standard inclusions in subjective wellbeing regressions, it is worth noting that resulting estimations of disease burdens may be overly conservative. For example, it seems plausible to suggest that a certain percentage of Parkinson's patients may be unemployed because their disease prevents them from finding adequate work. If they are unhappier as a result, one could reasonably argue that this drop in wellbeing ought to be attributed to Parkinson's, and not to unemployment per se. Investigating and adjusting for these sorts of influences may be a promising avenue for future research.

4 Recommendations for estimating subjective wellbeing in the context of health are drawn from OECD (2013); Dolan (2011); Graham et al. (2011); Binder & Coad (2013).

5 Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and Switzerland. Additional details and summary statistics are provided in the online appendix.

6 Diseases were selected on the basis of data availability. Perhaps most importantly, we were unable to estimate wellbeing burdens associated with cancer. Responses to questions regarding cancer diagnoses in SHARE were either too limited to elicit reliable estimations, or did not distinguish between different types or stages of cancer.

7 In SHARE data, this is assessed by asking respondents to respond to the following prompt: *Do you currently have any of the conditions on this card? With this we mean that a doctor has told you that you have this condition, and that you are either currently being treated for or bothered by this condition.* However, self-reports of diagnoses may not be as reliable as hospital administrative data.

8 0.64 and 0.44, respectively. Context variables were estimated using a similar procedure as disease variables, with added controls for health status. Additional details are provided in the online appendix.

9 Anxiety disorders refer to being diagnosed with *"affective or emotional disorders, including anxiety, nervous or psychiatric problems."*

10 Binder & Coad (2013); Graham et al (2011).

11 See Chapter 3.

12 Pearson's correlation: 0.96.

13 Pearson correlation: 0.24. Excluding depression: 0.58.

14 It is also worth noting that these life satisfaction averages are notably higher than standard international estimates. Our sample only contains respondents over the age of 45 and older people tend to be on average more satisfied with their lives than younger people. For a recent analysis, see Blanchflower (2020).

15 We do find preliminary support for this hypothesis in the data. Osteoporosis patients are for instance less likely to be employed and more likely to be widowed than patients with depression. 10% of osteoporosis patients are employed and 28% are widowed. Among those with depression, these figures are 17% and 23%, respectively.

16 Pearson correlation: 0.61.

17 Dolan (2011); Mukuria & Brazier (2012).

18 Recent research has even suggested that nurses' subjective wellbeing can predict the wellbeing of their patients. See: Leea et al. (forthcoming).

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CHAPTER FIVE

The societal perspective

In this chapter, we will shift our perspective from an individual level to consider the wellbeing burden of disease in Europe more broadly. By matching wellbeing data provided by SHARE with prevalence and mortality rates provided by the Global Burden of Disease, we estimate the wellbeing burden of disease in Europe in 2017 for twelve diseases: depression, anxiety disorders, Parkinson's disease, Alzheimer's disease, strokes, rheumatoid arthritis, ulcers, lung disease, osteoarthritis, asthma, diabetes, and cataracts.[1] Once again, our population of interest will be Europeans over the age of 45.

KEY INSIGHTS

- Although depression and anxiety disorders are the most burdensome conditions at an individual level, diabetes proves to be more burdensome at a societal level due to its high prevalence rate. Depression and anxiety disorders come in second and third place, respectively.

- However, when the societal burden of disease is conservatively adjusted for mortality rates due to suicide among patients with depression, it becomes the most burdensome disease at a societal level in Europe.

- The burden each disease changes with age. While diabetes remains a significant burden for all ages, depression and anxiety disorders primarily affect younger people, and Alzheimer's is the largest single wellbeing burden for those over the age of 85. As populations around the world continue to expand and get older, it will become increasingly important to address these sources of unhappiness in the years to come.

5.1 Data and methodology

To assess the wellbeing burden of disease at a societal level, it is necessary to factor in prevalence and mortality rates for each disease. This information is provided by the Institute for Health Metrics and Evaluation as part of the Global Burden of Disease Study (GBD).

Using GBD data alongside estimations of individual wellbeing losses provided in the previous chapter, we will be able to estimate the overall wellbeing burden of twelve diseases in Europe: depression, anxiety disorders, Parkinson's disease, Alzheimer's disease, strokes, rheumatoid arthritis, ulcers, lung disease, osteoarthritis, asthma, diabetes, and cataracts.[1]

5.2 Estimating the societal wellbeing burden of disease

Importantly, now that we are considering the wellbeing burden of disease at a societal level, we need to consider both the wellbeing lost due to disease for living patients as well the wellbeing lost due to death. This is expressed formally in Equation 5.1. Here, *p* is the group of patients living with the disease within a given year, while *d* is the group of patients who died due to the disease in the same period. The first term therefore represents wellbeing lost to disease among living patients, while the second term represents the amount of wellbeing lost due to death. Because actual wellbeing in the case of death will always be equal to zero, deaths due to disease in a given year will always be equivalent to one WALY lost.[2] This is represented graphically in Figure 5.1.

Global Burden of Disease Study (GBD)

To understand the societal impact of disease, we rely on data collected for the most recent edition of Global Burden of Disease Study. This database is maintained by the Institute for Health Metrics and Evaluation and provided by the Global Health Data Exchange. It includes prevalence, incidence, and mortality rates of disease every year from 1990 until 2017, as well as population and life expectancy data broken down by age and gender for more than 190 countries around the world. More information is available at *ghdx.healthdata.org*.

Equation 5.1

$$\text{WALYs}_{\text{lost}} = \sum_{i \in p} 1 - \frac{\text{actual wellbeing}}{\text{potential wellbeing}} + \sum_{i \in d} 1 - \frac{0}{\text{potential wellbeing}}$$

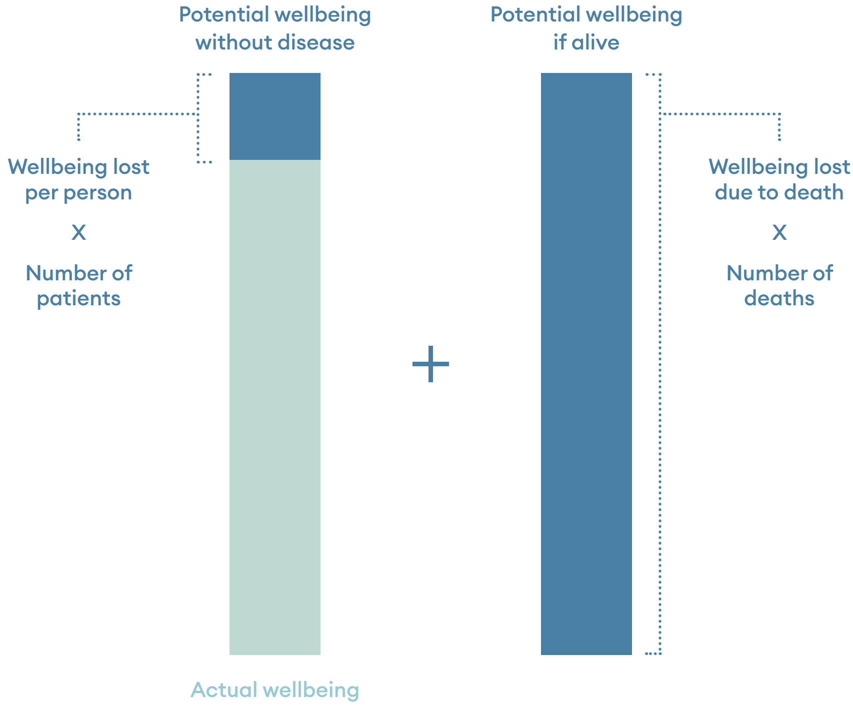


Figure 5.1 Estimating wellbeing losses at a societal level

Throughout this chapter, actual and potential wellbeing will once again be understood in terms of life satisfaction. Number of patients will be expressed in terms of prevalence while number of deaths will be expressed in terms of mortality rates for each disease under consideration.

The societal wellbeing burden of disease can then be understood in terms of the wellbeing lost due to a disease at an individual level multiplied by the number of patients, plus the number of deaths due to the disease. Using this procedure, we present estimates for societal WALYs lost due to disease for individuals over the age of 45 in Europe in Table 5.1.

From this vantage point, our understanding of disease begins to change. Most notably, diabetes, even though it was associated with one of the smallest wellbeing burdens at an individual level, now jumps to the top of the list. This is largely due to the fact that diabetes is hugely prevalent within our observed population (Europeans over the age of 45) and has a relatively high mortality

		(1) Prevalence	(2) Mortality	(3) WALYs lost (individual)	(4) WALYs lost (population)
1	Diabetes	64,500,000 (58,900,000 – 70,500,000)	183,000 (163,000 – 206,000)	0.038 (0.035 - 0.041)	2,637,272 (2,212,401 – 3,115,534)
2	Depression	10,700,000 (9,260,070 – 12,400,000)	0	0.174 (0.173 – 0.176)	1,865,923 (1,602,690 – 2,178,570)
3	Anxiety	11,900,000 (10,600,000 – 13,300,000)	0	0.126 (0.121 - 0.130)	1,497,668 (1,283,870 – 735,588)
4	Osteoarthritis	30,400,000 (26,400,000 – 34,900,000)	0	0.047 (0.044 - 0.050)	1,432,171 (1,164,614 – 1,751,775)
5	Alzheimer's	6,981,335 (5,710,000 – 8,457,830)	443,000 (409,000 – 477,000)	0.091 (0.082 - 0.099)	1,075,952 (878,307 – 1,313,981)
6	Stroke	8,059,130 (7,180,298 – 8,921,276)	429,000 (380,000- 486,000)	0.069 (0.063 - 0.075)	983,354 (830,079 – 1,153,820)
7	Asthma	12,000,000 (9,924,678 – 14,400,000)	5,481 (4,162- 7,093)	0.040 (0.030 - 0.050)	487,145 (301,928 – 724,655)
8	Cataract	5,748,562 (4,204,404 – 7,750,000)	0	0.032 (0.028 - 0.036)	185,536 (118,330 – 280,665)
9	Parkinson's	1,090,000 (794,000 – 1,420,000)	53,879 (44,941- 64,828)	0.093 (0.081 - 0.104)	155,100 (108,991 – 213,138)
10	Rheumatoid arthritis	1,840,000 (1,580,000 – 2,133,653)	2,891 (2,091- 4,033)	0.067 (0.063 - 0.071)	126,168 (100,990 – 156,206)
11	Ulcer	826,000 (619,206 – 1,080,000)	15,533 (12,541- 19,229)	0.062 (0.056 - 0.068)	66,822 (47,247 – 92,783)
12	Lung disease	541,000 (458,000 – 633,000)	15,992 (9,834- 22,314)	0.057 (0.052 - 0.061)	46,602 (33,640 – 60,989)

Table 5.1 Wellbeing burden of disease at a societal level

Prevalence and mortality drawn from the Global Burden of Disease study in 2017 for individuals over the age of 45 in 28 European countries. Estimates for WALYs lost at an individual level are drawn from Table 4.2. WALYs lost at a societal level are estimated using Equation 5.1, or column (1) x column (3) + column (2). 95% confidence intervals are presented in columns (1) and (2). Error margins are given for WALY estimates based on these upper and lower bounds.

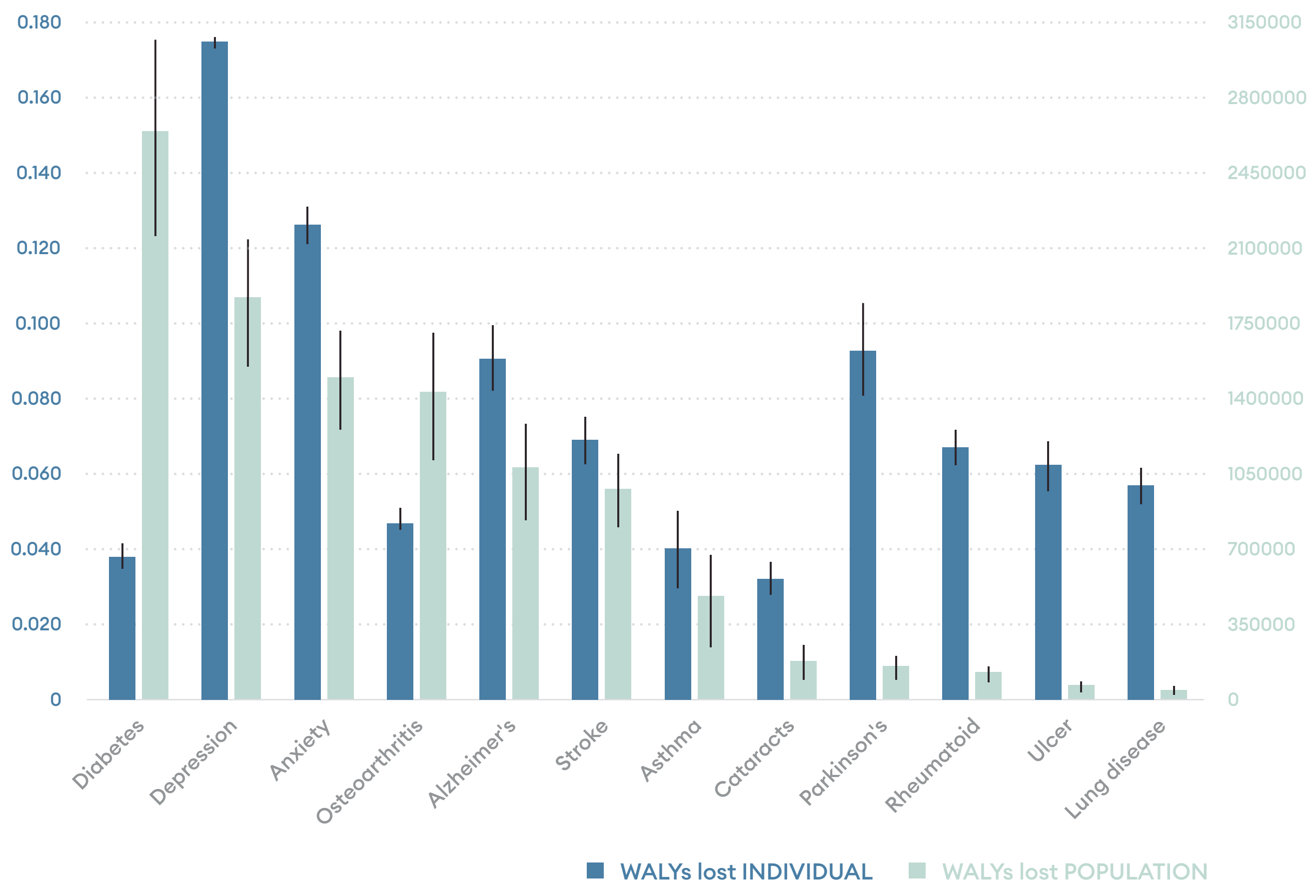
rate compared to other diseases. As discussed in Chapter 3, small wellbeing losses on an individual level can inflate substantially on a societal level if the disease is particularly common or deadly.

Nevertheless, depression and anxiety disorders still predict significantly large wellbeing losses on a societal level even though both are less prevalent than diabetes and problematically have mortality rates of zero according to GBD data. (This issue is discussed in more detail in Box 5.1.) However, because both diseases are severely burdensome at an individual level, and because they are still widely prevalent compared to other diseases, they remain at the top of the ranking. Osteoarthritis also predicts large wellbeing losses at a societal level primarily because it is so widespread. Finally, largely because of their high mortality rates, Alzheimer's disease and strokes are also associated with substantial wellbeing losses. Taken together, these dynamics indicate that different diseases can be considered burdensome at a population level for a number of reasons.

In Figure 5.2, we plot differences between WALYs lost at an individual and population level for each disease. It is important to keep these differences in mind when using WALYs as a guide for public or private decision-making. In fact, there may even be important reasons not to consider wellbeing from either perspective depending on the context. For example, while Parkinson's disease is relatively less common and therefore relatively less burdensome at a societal level, it can be severely debilitating for those individuals experiencing it. Depending on the goals and priorities of a particular institution, it may be inappropriate to ignore the reality of a disease at an individual basis, while for others it may be necessary to devote attention to those that are more widespread. Once again, WALYs are meant as a descriptive tool, they are not intended to offer normative prescriptions.

Figure 5.2 Wellbeing burden of disease at an individual and societal level

Data from 2017 is drawn from SHARE and GBD for individuals over the age of 45 in 28 European countries. Estimates and error margins for WALYs lost at an individual level are drawn from Table 4.2. Estimates and error margins for WALYs lost at a societal level are drawn from Table 5.1.



Box 5.1 Rethinking the wellbeing burden of depression in Europe

Although depression emerges as one of the most significant contributors to wellbeing lost at both an individual and societal level, even these burdens are likely underestimated.

Our estimation of WALYs lost on an individual level due to depression is based on self-reports using the 13-point EURO-D scale.[3] This scale consists of the following twelve items: depression, pessimism, suicidality, guilt, sleep, interest, irritability, appetite, fatigue, concentration, enjoyment, and tearfulness. In line with previous research, we consider anyone scoring a five or higher as a case of depression.[4]

However, our estimation of WALYs lost on a societal level are based on GBD prevalence data for patients who have been diagnosed with a depressive disorder by a doctor in a clinical setting according to the ICD-10 guidelines, *not* according to the EURO-D.[5] Using these two sources in conjunction with one another may therefore lead to biased estimations.

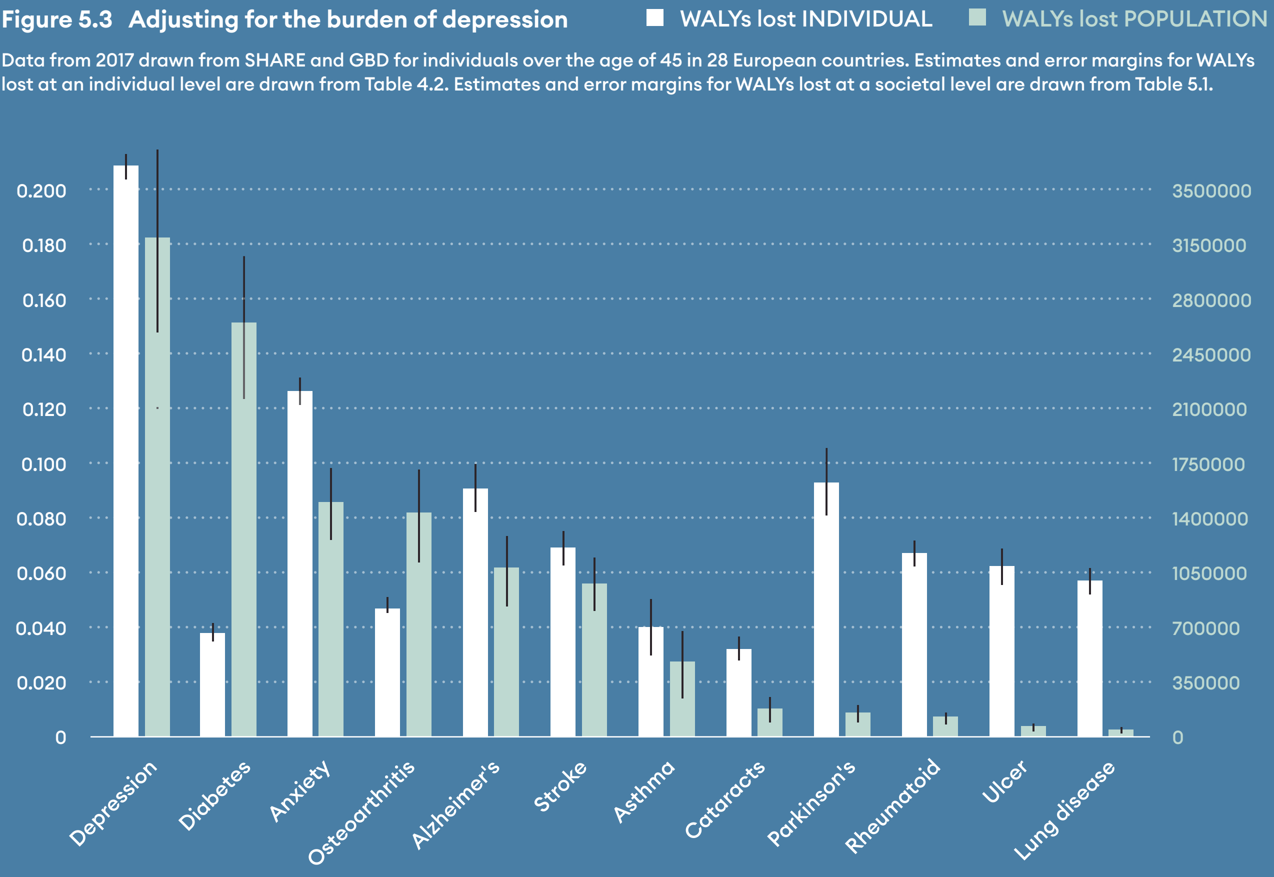
At an individual level, it is likely that by relying on self-reports, the EURO-D ends up capturing a certain percentage of depression cases that would not meet the threshold of a clinical diagnosis according to the ICD-10 guidelines. In fact, prevalence rates for depression assessed using the EURO-D have been found to be more than twice as large as large as those assessed using the ICD-10.[6] Because people experiencing somewhat milder cases of depression are expected to be relatively more satisfied with their lives, using the EURO-D scale may drive down individual level WALY estimations regarding the burden of the disease.

At a societal level, prevalence and morality rates collected for GBD data also do not attribute any percentage of suicides to depression or even mental health more broadly. Instead, suicides are considered separately as deaths due to self-harm. Mortality rates for depression and anxiety disorders are therefore listed as zero. This is particularly worrying as one recent study found that approximately 90% of those who die by suicide were previously diagnosed with a mental health condition. The same study found that 5-8% of depression patients are likely to take their own lives.[7] Without accounting for suicides and self-harm as potential by-products of mental illness, societal wellbeing burdens associated with mental health are likely to be dramatically underestimated even further.

Even by moderately adjusting for these potential biases, the wellbeing burden of depression on both an individual and societal level grows substantially. In Figure 5.3, we estimate WALY losses due to depression using a cut-off of 6 on the EURO-D scale instead of 5 to reflect the more stringent requirements of the ICD-10 diagnosis, and we assume a 6.5% mortality rate to account for the elevated risk of suicide. With these conservative adjustments taken into account, depression becomes the most burdensome disease in Europe.[8]

Figure 5.3 Adjusting for the burden of depression

Data from 2017 drawn from SHARE and GBD for individuals over the age of 45 in 28 European countries. Estimates and error margins for WALYs lost at an individual level are drawn from Table 4.2. Estimates and error margins for WALYs lost at a societal level are drawn from Table 5.1.



5.3 Dynamics of disease

By further subdividing our sample into age groups, we can also consider the changing dynamics of wellbeing burdens over the lifecycle. These dynamics are presented in Figure 5.4. While diabetes remains a significant burden for all ages, depression and anxiety disorders primarily affect younger cohorts. On the other hand, osteoarthritis and strokes become larger sources of wellbeing lost in old age, while Alzheimer's is the largest single wellbeing burden for those over the age of 85.

In Figure 5.5, we also present rates of WALYs lost by age group per 100,000 people. Perhaps unsurprisingly, once the number of people in each age group is standardised, wellbeing losses become increasingly dramatic through the aging process. For example, although the total number of WALYs lost for those over the age of 95 is rel-

**Figure 5.4
Wellbeing lost due to disease by age (total)**

Prevalence and mortality considered separately for each age group. Data from 2017 drawn from SHARE and GBD for individuals in 28 European countries. Estimates for WALYs lost at an individual level drawn from Table 4.2. Stacked bars represent total WALYs lost per age group.

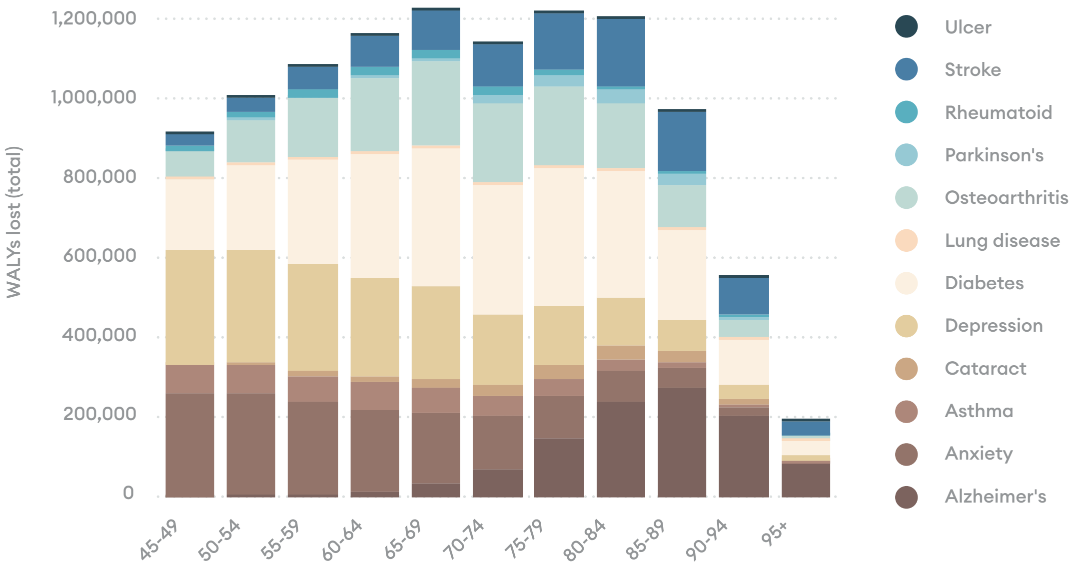
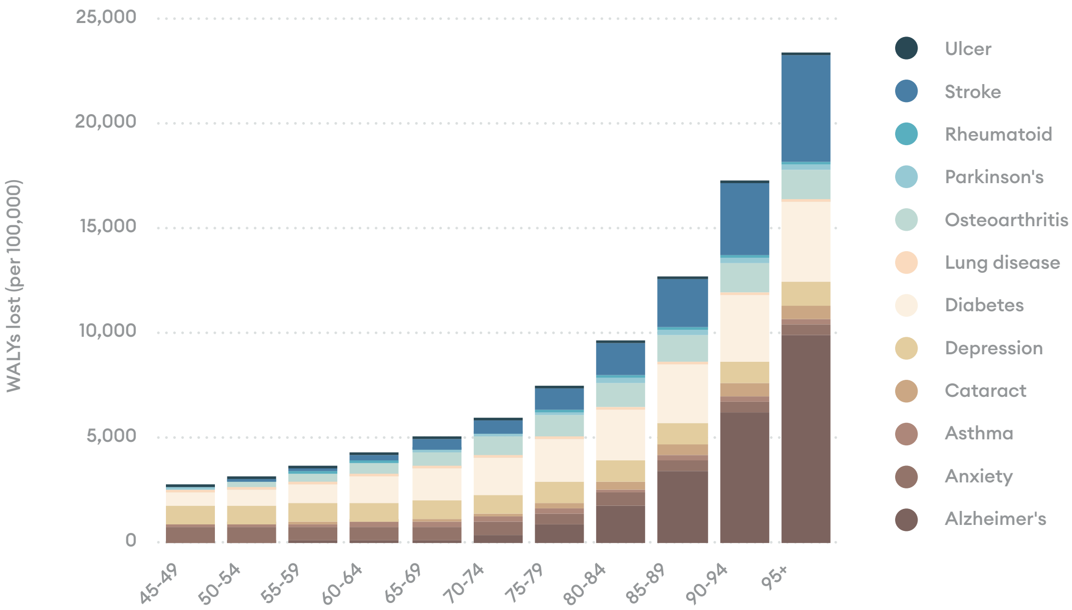


**Figure 5.5
Wellbeing lost due to disease by age (per 100,000)**

Prevalence and mortality rates (per 100,000) considered separately for each age group. Data from 2017 drawn from SHARE and GBD for individuals in 28 European countries. Estimates for WALYs lost at an individual level drawn from Table 4.2. Stacked bars represent WALYs lost per 100,000 in each age group.

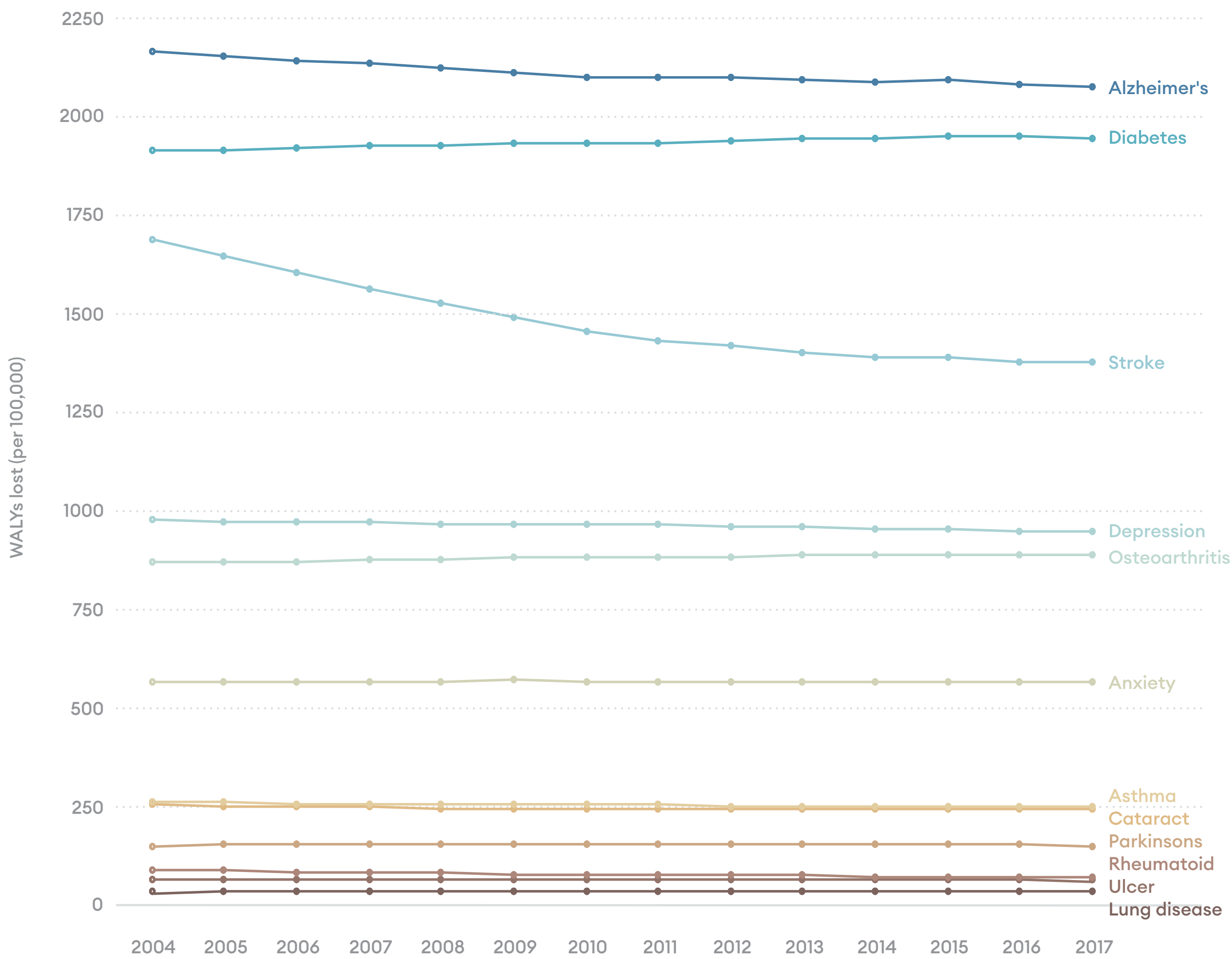


atively small, the rate of WALY losses for that age group is substantial. This is once again an important reminder that wellbeing burden of disease estimations can change dramatically depending on the perspective taken.

Finally, in Figure 5.6, we present estimations of the wellbeing burden of disease (per 100,000 people) every year from 2004 to 2017, the most recent year for which data is available.[9] While wellbeing losses associated with Alzheimer's and especially stroke show encouraging signs of decline, wellbeing burdens of many other diseases have remained stubbornly persistent. Trend lines for depression, anxiety, and osteoarthritis have stayed mostly flat, while wellbeing lost due to diabetes has steadily increased. As populations around the world continue to grow and get older, it will become increasingly important to address these sources of unhappiness in the years to come.

Figure 5.6 Wellbeing lost due to disease in Europe over time (per 100,000)

Data drawn from SHARE and GBD for individuals over the age of 45 in 28 European countries. Estimates for WALYs lost at an individual level drawn from Table 4.2 and assumed to remain constant over time. Prevalence and mortality rates (per 100,000) considered separately for each year. Lines represent WALYs lost per 100,000 people.



Notes

1 GBD data does not offer prevalence and incidence rates for arthritis, osteoporosis, hypertension, and high cholesterol. European sample in this chapter includes Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and Switzerland.

2 However, this story will change in Chapter 7 once we start considering WALY losses over longer periods of time. Here, the age of the patient will become relevant as deaths due to disease at younger ages predict more potential years of life lost than deaths at older ages.

3 Prince et al. (1999).

4 Guerra et al. (2016).

5 WHO (2016).

6 Guerra et al. (2016).

7 Brådvik (2018).

8 However, it is again worth noting that that our sample population consists only in older Europeans over the age of 45. Because depression tends to primarily affect younger cohorts, the wellbeing burden of the disease is likely to be even larger than we have demonstrated here.

9 Here we assume that the individual wellbeing burden of disease remains constant across time.

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CHAPTER SIX

Symptoms of wellbeing

In this chapter, we will shift our focus from diseases to symptoms to answer the following question: which symptoms have the greatest impact on wellbeing? We will begin by considering current instruments and standard understandings of the most important social, mental, and physical symptoms of disease. Using SHARE data, we will then analyse which symptoms are the most important predictors of subjective wellbeing across patient populations and estimate WALY burdens associated with each category at both individual and societal levels. In the latter case, we take into account symptom prevalence rates across different disease groups and evaluate the potential effects of treatments targeted to alleviate them. Overall, we find that mental and social symptoms of disease are substantially more predictive of patient subjective wellbeing than physical symptoms, and yet remain mostly unaddressed and untreated.

KEY INSIGHTS

- The most common health utility instruments used to measure the effect of symptoms on patient wellbeing often fail to acknowledge the importance of mental and social wellbeing. When symptoms are weighted in terms of their effect on subjective wellbeing, a picture of health begins to emerge that is almost the opposite of the one implied by standard health utility instruments.
- Symptoms that seem to have the most substantial effect on wellbeing can be divided into six general categories: loneliness, depression/anxiety, optimism, engagement, vitality and self-sufficiency.
- Across all health conditions, loneliness is the most predictive symptom of decreased wellbeing at an individual level. However, feeling sad or depressed proves to be a greater contributor to lost wellbeing at a societal level.
- While cures are likely to provide more long-lasting gains, in some cases treating social and mental symptoms could potentially raise patient wellbeing to an equal or even greater degree.

6.1 Current approaches

Currently, symptoms of disease and their impact on quality of life are most often assessed using three questionnaires: the EQ-5D, the SF-36, and the HUI. These instruments are designed to measure quality of life for a variety of disease states and have been widely implemented in hospitals and clinical research facilities around the world.[1] All three attempt to break down the key components of disease into distinct symptom categories (Table 6.1). Each category is composed of one or more questions asking patients to rate a particular dimension of their life. For example, bodily pain in the SF-36 is assessed using the following two questions: *How much bodily pain have you had during the past 4 weeks?* [Answers: none / very mild / mild / moderate / severe / very severe]; and (2) *During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)* [Answers: not at all / a little bit / moderately / quite a bit / extremely]. Once a patient fills out the questionnaire, a health state is assigned based on aggregate scores for each set of questions within each category. These scores can then be used to track progress in clinical trials or to conduct cost-benefit analyses of new treatments and interventions in terms of QALYs or DALYs.

In the preamble to the constitution of the World Health Organization, health is defined as "a state of complete physical, mental and social wellbeing."[2] While the three most common instruments used to understand patient self-reported health cover numerous aspects of physical wellbeing, they fall relatively silent on mental and social wellbeing. Of the 20 categories used to assess quality of life across all three questionnaires, 13 pertain to physical wellbeing while only 5 cover mental wellbeing. Social wellbeing is only explicitly addressed once, in the SF-36. However, as we will demonstrate in this chapter, by failing to sufficiently account for mental and especially social wellbeing, these instruments may be failing to capture the most important determinants of how patients experience their lives.

6.2 Which symptoms really determine quality of life?

For this part of the analysis, we will look at how patients belonging to sixteen disease groups rate diverging aspects of their quality of life. Once again, these are patients with depression assessed using the EURO-D, or those who report being diagnosed with anxiety disorders, Parkinson's, Alzheimer's, strokes, rheumatoid arthritis, ulcers, lung disease, arthritis, osteoporosis, osteoarthri-

Table 6.1 Standard instruments to measure health status

EQ-5D Most common, 5 dimensions with 3 levels for each dimension (15 items)	SF-36 Adaptation of the EQ-5D with 6 dimensions (36 items)	HUI (45 items)
Mobility	Energy	Sensation
Self-Care	Physical functioning	Mobility
Usual Activities	Bodily pain	Emotion
Pain / Discomfort	General health perceptions	Cognition
Anxiety / Depression	Physical role functioning	Self-care
	Emotional role functioning	Pain
	Social role functioning	Fertility
	Mental health	

Physical health
Mental health
Social health

tis, asthma, diabetes, cataracts, hypertension, or high cholesterol. In doing so, we will attempt to identify which symptoms are the most important predictors of subjective wellbeing. However, here we are not only interested in the magnitude of the effect on wellbeing. We must also account for how much variation in wellbeing can be explained by individual symptoms across patient groups.

To this end, we tested 90 possible symptoms of disease available in the SHARE dataset.[3] Following a similar procedure as the one employed earlier in previous chapters to measure the wellbeing burden of disease, we then estimated the impact of all 90 symptoms on life satisfaction using individual OLS regressions controlling for age, gender, marital status, number of children, employment, education, country, wealth, income, residential area, country, and year. After each regression, we recorded both the size of the standardised coefficient and the partial R^2 for each symptom being considered. We then created a ranking of symptom importance based on the size of the coefficient and the amount of variation in life satisfaction it was capable of explaining. In the end, widespread symptoms with statistically significant effects on life satisfaction were ranked highly, while uncommon symptoms with relatively weaker effects were ranked lower. The full output of this procedure is available in the online appendix.

In Table 6.2, we present the top 20 symptoms revealed by our analysis to be the most important predictors of subjective wellbeing for the sixteen patient populations under consideration. Symptoms affecting social and mental wellbeing sit at the top of the list. Feeling lonely proves to be the single most important predictor of life satisfaction at an individual level. Feeling left out, isolated or a lack of companionship also emerge as crucially important. In terms of mental health, feeling sad or depressed is the second most important determinant of subjective wellbeing, while feeling nervous comes in fifth place. Importantly, here we are no longer considering depression in terms of the EURO-D scale, but simply as the symptom of feeling sad or depressed at all in the last month. Future oriented mental states also prove to be hugely impactful in explaining differences in subjective wellbeing across patient groups. Feeling optimistic, fearing the worst, feeling hopeful, and fearing death all emerge as key determinants of wellbeing. Physical symptoms including feeling faint or having too little energy also have important implications, while having trouble sleeping, feeling frail, and feeling limited in usual activities round out the bottom of the list.

In sum, when symptoms are weighted in terms of their effect on subjective wellbeing, a picture of health begins to emerge that is almost the exact opposite of the one implied by standard health instruments. Variables capturing social and mental wellbeing prove to be significantly more important to patient self-reported wellbeing than those relating to physical wellbeing. Of the top 20 symptoms we identified, 10 relate to mental wellbeing, 4 of the most important relate to social wellbeing, and 6 relate to physical wellbeing. In Table 6.3, we provide a rough sketch of what a new health utility instrument based on subjective wellbeing might look like if each of these symptoms were slotted into six distinct categories. While categories for vitality, self-sufficiency, and depression/anxiety are roughly analogous to those featured in current instruments, new categories for engagement, optimism, and loneliness emerge. In the next section, we will build on this analysis to consider the wellbeing cost associated with each symptom on an individual and societal level.

6.3 Individual wellbeing burdens associated with social, mental, and physical symptoms

In this section, we will provide an account of wellbeing losses associated with symptoms of disease at an individual level. To capture this effect, we have selected representative variables for each of the six symptom categories identified in the previous section.

Answers to three loneliness questions included in the SHARE dataset *(isolated / feels left out / companionship)* can be aggregated and summed to provide a reliable overall score of social isolation.[4] Following prior recommendations, we consider scores greater than 6 out of 9 to be indicative of loneliness.[5] Variables representing each of the five remaining symptom categories were also selected based on their number of observations, importance for subjective wellbeing, and if they contained clear cut-off points. Final selections included feeling sad or depressed, hopelessness, lack of enjoyment, fatigue, and being unable to engage in usual activities.

In Table 6.4, we present regression estimates for all six variables in terms of their respective associations with life satisfaction. In the last section, we observed that all of

Table 6.2 The most important determinants of patient wellbeing

Assessed with SHARE data using looped OLS linear regressions of 90 symptoms with life satisfaction as the dependant variable. Standardised coefficients and partial R^2 estimates for each symptom were stored from each regression and ranked. Sample included individuals over the age of 45 in 28 European countries and was limited to patients with one or more of the sixteen diseases considered in Chapter 4. Control variables included in each regression for gender, age, marital status, number of children, employment, education, country, wealth, income, and year. Summary statistics and full outputs are available in the online appendix. * Falling down / Fear of falling down / Dizziness, faints or blackouts / Fatigue. ** Dressing, including putting on shoes and socks / Walking across a room / Bathing or showering / Eating, such as cutting up your food / Getting in or out of bed.

1	Feels lonely	How much of the time do you feel lonely? Often / Some of the time / Hardly ever or never
2	Sad or depressed	In the last month, have you felt sad or depressed? Yes / No
3	Feels left out	How often do you feel left out of things? Often / Some of the time / Hardly ever or never
4	Isolated	How often do you feel isolated from others? Often / Some of the time / Hardly ever or never
5	Nervous	In the last week, how often have you felt nervous? Never / Hardly ever / Some of the time / Most of the time
6	Chances of living	What are the chances that you will be alive in ten years? 0 - 100
7	Faint	In the last week, how often have you felt faint? Never / Hardly ever / Some of the time / Most of the time
8	Fear the worst	During the past week, how often have you feared the worst happening? Never / Hardly ever / Some of the time / Most of the time
9	Companionship	How much of the time do you feel you lack companionship? Often / Some of the time / Hardly ever or never
10	Wish to be dead	In the last month, have you felt that you would rather be dead? Any mention of suicidal feelings or wishing to be dead / No such feelings
11	Hopefulness	What are your hopes for the future? Any hopes mentioned / No hopes mentioned
12	Fatigue	In the last month, have you had too little energy to do the things you wanted to do? Yes / No
13	Past depression	Have you suffered from symptoms of depression lasting at least two weeks? Yes / No
14	Irritability	Have you been irritable recently? Yes / No
15	Enjoyment	What have you enjoyed doing recently? Fails to mention any enjoyable activity / Mentions any enjoyment from activity
16	Hands trembling	During the past week, how often did you feel your hands trembling? Never / Hardly ever / Some of the time / Most of the time
17	Fear dying	In the last week, how often did you have a fear of dying? Never / Hardly ever / Some of the time / Most of the time
18	Trouble sleeping	Have you had trouble sleeping recently? Trouble with sleep or recent change in pattern / No trouble sleeping
19	Frailty	For the past six months at least, have you been bothered by [frailty]?* Any of these / None of these
20	Usual activities	Do you have any difficult with [usual daily activities]?** Any of these / None of these

Physical health Mental health Social health

Table 6.3 Symptom categories

Loneliness	Depression/ Anxiety	Optimism	Engagement	Vitality	Self-sufficiency
Feels lonely	Sad or depressed	Chances of living	Enjoyment	Faint	Usual activities
Isolated	Nervous	Fear the worst		Fatigue	
Feels left out	Wish to be dead	Hopefulness		Hands trembling	
Companionship	Past depression	Fear dying		Trouble sleeping	
	Irritability			Frailty	

these variables were key predictors of subjective well-being. Now, we are able to see the size of these effects. Once again, loneliness predicts the single largest drop in life satisfaction at an individual level of 1.49 points. This is about twice as large as the effect of being unemployed (0.64). Feeling sad or depressed predicts a drop in life satisfaction of 0.89 points. This is still a substantial difference and larger than the difference between having household debt or not (0.66). Being unable to perform usual activities and having too little energy also predict decreases in life satisfaction of 0.80 and 0.75 points, respectively. While these are relatively smaller compared to other symptoms, they are still approximately twice as large as the difference between living with a spouse and being divorced (0.44).[6] Coefficients for all six variables are found to be highly significant at a 99% confidence level. Summary statistics and additional details regarding the empirical strategy regression can be found in the online appendix.

By adding the absolute value of these coefficients to the actual average wellbeing of patients experiencing each symptom, we are able to estimate wellbeing losses associated with all six symptoms in terms of Wellbeing Adjusted Life Years. In Table 6.5, we present the inputs and outputs for WALY estimations of wellbeing burdens associated with each symptom at an individual level. Confidence intervals are also included using 95% error margins for the upper and lower bounds of actual average wellbeing and estimated symptom coefficients.

		Coefficient	Standard error	Observations	R-squared
1	Loneliness	-1.491***	(0.027)	133291	0.185
2	Sad or depressed	-0.887***	(0.008)	219636	0.204
3	Hopefulness	-0.859***	(0.013)	219212	0.179
4	Enjoyment	-0.827***	(0.014)	219402	0.172
5	Usual activities	-0.798***	(0.011)	281681	0.168
6	Fatigue	-0.746***	(0.009)	219592	0.186

Table 6.4 Differences in life satisfaction due to symptoms

*** p<0.01, Each row represents a separate regression with life satisfaction as the dependent variable. Clustered robust standard errors are reported. Control variables included in each regression for gender, age, marital status, number of children, employment, education, country, wealth, income, country, and year. Samples include adults over the age of 45 from 28 European countries and restricted to patients with at least one of the sixteen diseases considered in Chapter 4. Loneliness measured in terms of the three-item UCLA loneliness scale with a cutoff of 7. Additional details and summary statistics are available in the online appendix.

It is worth pausing a moment to consider several important implications of this analysis. First, it becomes immediately apparent that social wellbeing stands in a category all on its own. At an individual level, there is a clear and discernible jump between wellbeing lost due to loneliness and wellbeing losses associated with any of the other five symptoms. Moreover, we do see several important differences between symptoms pertaining to mental and physical wellbeing. Feeling hopeless, sad or depressed, or lacking enjoyment all prove to be more important determinants of wellbeing at an individual level than being unable to participate in usual activities or having low energy.

From a methodological perspective, it is also worth noting the relative importance of feeling sad or depressed for subjective wellbeing as compared to feeling hopeless. As discussed in Chapter 3, WALYs are deliberately designed to attach greater weight to wellbeing losses accrued at the lower end of the spectrum. In this way, although effect of feeling sad or depressed on life satisfaction is larger, the WALY cost associated with feeling hopeless is greater (Table 6.5).

In the next section, we will zoom out even further to compare wellbeing burdens associated with each symptom at a population level by looking at each patient group as a whole.

6.4 Comparisons of symptom importance for different patient groups

In Figure 6.1, we present symptom prevalence rates obtained using SHARE data for thirteen different patient populations.[7] Overall, symptom dynamics should look largely familiar. Patients with depression exhibit high

	(1) Actual wellbeing	(2) Coefficient	(3) Potential wellbeing	(4) WALYS experienced (per person)	(5) WALYS lost (per person)
1 Loneliness	5.812 (5.764 - 5.859)	1.491 (1.464 - 1.518)	7.303 (7.228 - 7.377)	0.796 (0.781 - 0.811)	0.204 (0.189 - 0.219)
2 Hopelessness	6.563 (6.542 - 6.585)	0.859 (0.846 - 0.872)	7.422 (7.388 - 7.457)	0.884 (0.877 - 0.891)	0.116 (0.109 - 0.123)
3 Sad or depressed	6.953 (6.940 - 6.966)	0.887 (0.879 - 0.895)	7.840 (7.819 - 7.861)	0.887 (0.883 - 0.891)	0.113 (0.109 - 0.117)
4 Lack of enjoyment	6.656 (6.631 - 6.682)	0.827 (0.813 - 0.841)	7.483 (7.444 - 7.523)	0.889 (0.881 - 0.898)	0.111 (0.102 - 0.119)
5 Limited activities	6.776 (6.759 – 6.793)	0.798 (0.787 -0.809)	7.574 (7.545 – 7.602)	0.895 (0.889 – 0.908)	0.105 (0.100 - 0.111)
6 Fatigue	6.983 (6.969 - 6.996)	0.746 (0.737 - 0.755)	7.729 (7.706 - 7.751)	0.903 (0.899 - 0.908)	0.097 (0.092 - 0.101)

Table 6.5 Individual wellbeing burdens associated with key symptoms

Actual wellbeing represented as the average life satisfaction of patients experiencing each symptom. Coefficients are drawn from Table 6.4. 95% confidence intervals are given in parentheses in columns (1) and (2). Potential wellbeing is calculated by adding the absolute value of column (2) to actual wellbeing in column (1). WALYs experienced = actual wellbeing / potential wellbeing. WALYs lost = 1 - (actual wellbeing / potential wellbeing). Error bars in columns (3), (4), and (5) are calculated based on the upper and lower bounds of actual wellbeing levels and coefficient estimates.

rates of loneliness, hopelessness, lack of enjoyment, and report feeling sad or depressed last month. Patients with anxiety disorders tend to experience high rates of loneliness and are more likely to feel sad or depressed. Patients with Alzheimer's or Parkinson's struggle to find enjoyment in daily life and have difficulty performing usual activities. The latter is also quite common among those who experienced stroke. Fatigue affects patients in almost every patient group.[8]

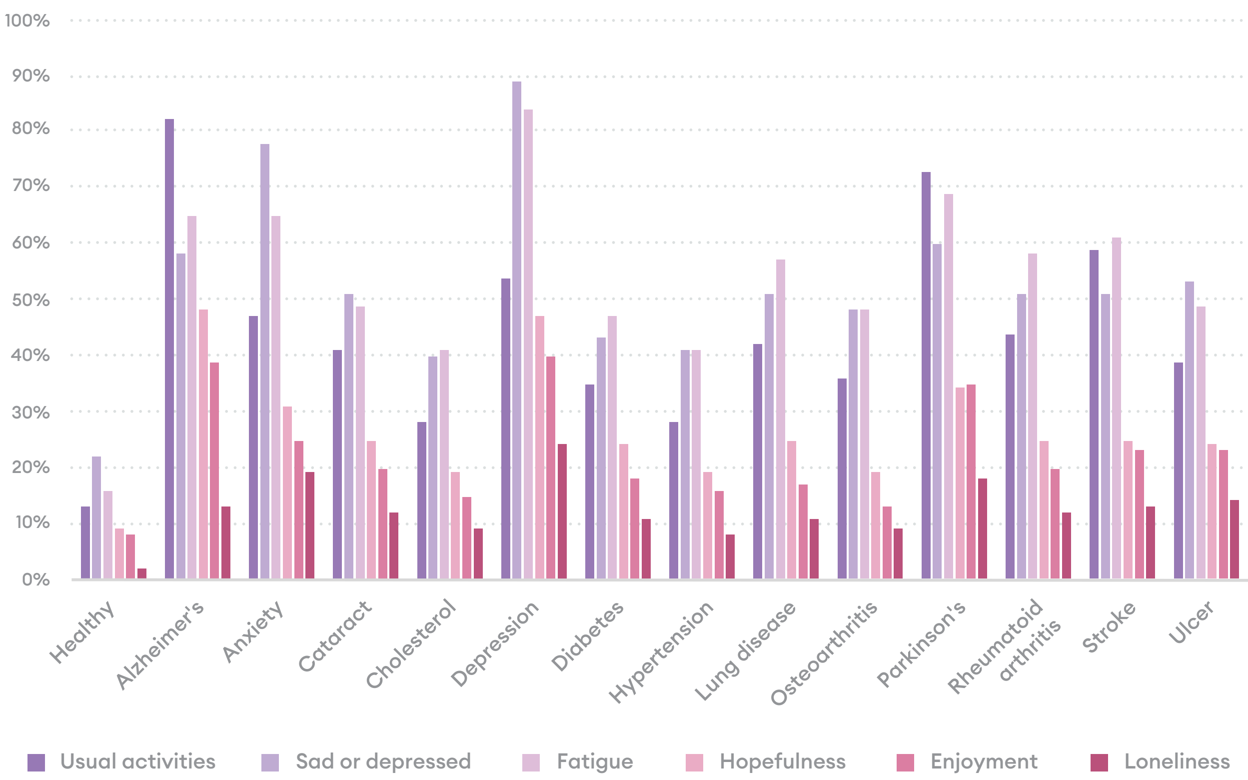
However, while it may not be particularly surprising that patients suffering from depression are more likely to feel lonely than healthy controls, other examples do not seem quite as intuitive. For example, patients with high cholesterol are four times as likely to feel lonely than healthy counterparts, and twice as likely to feel depressed, hopeless, and without joy. They are also more than twice as likely to struggle completing usual daily activities and almost three times as likely to feel fatigued. These are substantial differences. This does not necessarily indicate that having high cholesterol on its own causes such disparities. In fact, the causal arrow may well point in the other direction. A wide body of literature has identified lagged effects of poor subjective wellbeing on physical health later in life.[9] Whatever the explanation, it is nevertheless striking that all patient groups perform worse on average in every symptom category than healthy counterparts, no matter how seemingly mild the condition.

6.5 Wellbeing burdens of social, mental, and physical symptoms at a population level

Using symptom prevalence rates in conjunction with individual WALY estimates provided in Table 6.5, we are now able to estimate wellbeing burdens for each symptom at a population level. In Figure 6.2, we present WALY estimates of wellbeing lost due to symptoms in 2017 for eleven patient populations. Population estimates for each disease were drawn from GBD data.[10] Once again, these estimates are representative only for individuals over the age of 45 in Europe. Black lines indicate the total wellbeing burden associated with each disease.

Figure 6.1 Symptom prevalence rates in different patient populations

Prevalence rates obtained using SHARE data on individuals over the age of 45 in 28 European countries. Additional summary statistics are provided in the online appendix.



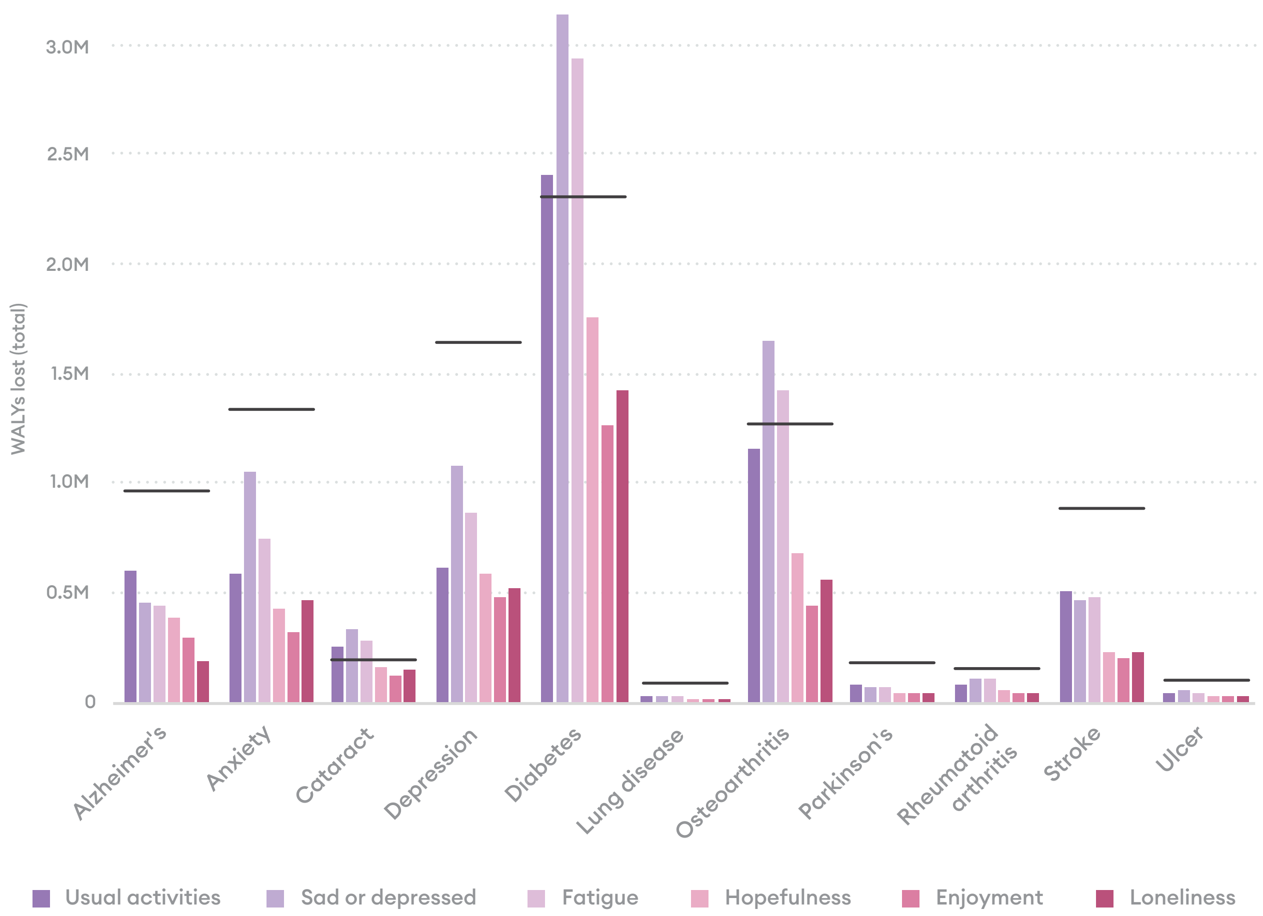
Out of the six symptoms under consideration, feeling sad or depressed emerges as the largest predictor of wellbeing losses at a population level for almost every disease group. However, for patients with stroke, Parkinson's, and Alzheimer's, struggling with daily activities becomes slightly more important. Fatigue also remains a significant contributor to wellbeing loss, primarily because it is so widespread.

Although loneliness was the largest predictor of wellbeing at an individual level, more patients report feeling sad or depressed than report feeling lonely. Therefore, feeling sad or depressed proves to be a greater contributor to wellbeing lost at a population level. While it is perhaps unsurprising that more people are likely to feel sad or depressed than they are to feel lonely, this dynamic once again serves as a reminder that wellbeing losses can look quite different depending on the perspective taken. For example, if the goal of a particular organisation is to raise wellbeing among as many Parkinson's patients as possible, then it would seem appropriate to address difficulties performing usual activities. However, at an individual level, Parkinson's patients struggling with severe loneliness are likely to be worse off than those struggling with any other individual symptom. They may be therefore the most in need of help.

Because we are considering total WALY losses across different disease groups as opposed to rates of WALY losses per 100,000 people, the total number of people living with each disease also becomes hugely important. As there are many more people with diabetes than

Figure 6.2 Population level wellbeing burdens associated with symptoms for each patient population

WALYs lost at a population level are estimated by multiplying individual WALYs lost for each symptom (Table 6.5) with symptom prevalence rate for each patient population (Figure 6.1). Symptom prevalence estimated using SHARE data. Disease prevalence drawn from the Global Burden of Disease study in 2017 for individuals over the age of 45 in 28 European countries. Black bars indicate the total wellbeing burden associated with each disease.



any other disease in our consideration set, the burden of feeling sad or depressed within that group turns out to be significantly higher than it is for any other group. However, once again, this does not necessarily mean that diabetes is responsible for causing each symptom. In fact, it becomes clear that the expected wellbeing gain from curing or vaccinating against diabetes would still not rise to the level of the expected wellbeing gain from eradicating all feelings of sadness or depression among diabetes patients. Similar observations can also be made eradicating fatigue in diabetes, osteoarthritis, or cataracts patients. In this way, for particular patient groups, it may be even the case that treating one particular symptom is more efficient than curing disease in terms of the potential wellbeing gain.[11] However, in most instances, this is not the case. For all other diseases under consideration, it becomes clear that treating any individual symptom is unlikely to rise to the level of a total cure.

To briefly sum up, in this chapter we have analysed the most important determinants of wellbeing across multiple patient groups. By testing the effect of 90 symptoms on life satisfaction, we identified 20 key symptoms spanning social, mental, and physical health. At an individual level, social health proved to be the most important determinant of wellbeing across patient groups, followed by mental and physical health. In particular, we focused on the implications of loneliness, feeling sad or depressed, hopelessness, lack of enjoyment, fatigue, or having limited abilities to perform usual activities. While all are important to patient wellbeing, prevalence rates for each symptom differ across disease groups. For example, while having trouble with usual activities is more widespread among patients with Alzheimer's, feeling sad or depressed is more widespread among patients with osteoarthritis. Feeling sad or depressed also proves to be one of most important symptom predictors of lost wellbeing at a population level.

However, we have still thus far only considered wellbeing gains and losses within one year. In the next chapter, we will turn our gaze to the case of Parkinson's in order to provide an in-depth case study of how WALYs can be also be used to track real and potential changes in wellbeing over the course of multiple years.

Notes

1 For more information regarding the EQ-5D, see: *www.euroqol.org*. For the SF-36, see: *www.rand.org/health-care/surveys_tools/mos/36-item-short-form*. For the HUI, see: *www.healthutilities.com*.

2 Preamble to the Constitution of WHO as adopted by the International Health Conference, New York, 19 June - 22 July 1946. Signed on 22 July 1946 by the representatives of 61 States (Official Records of WHO, no. 2, p. 100) and entered into force on 7 April 1948.

3 Each symptom variable contained at least 10,000 total observations to ensure reliability.

4 Hughes et al. (2004).

5 Steptoe et al. (2013).

6 See Figure 4.1 in Chapter 4 for context variables. Additional details are available in the online appendix.

7 Symptom level prevalence data for osteoporosis, asthma, and arthritis are not available in SHARE data.

8 This may also be related to advanced age of our sample population, as we have only considered individuals between the ages of 45 and 99.

9 Steptoe et al. (2015); Veenhoven (2008).

10 Population level prevalence data for high cholesterol and hypertension are not available in GBD data.

11 This of course does not take into account future potential gains in wellbeing from curing disease that accrue over time. These dynamics will be explored in more detail in the next chapter.

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CHAPTER SEVEN

A closer look at Parkinson's disease

So far, we have primarily focused on wellbeing burdens within a given one year period. However, curing disease and treating symptoms are likely to have much more than short term effects, and in some cases have implications for wellbeing that last a lifetime. In this chapter, we will offer an in-depth case study of Parkinson's disease. Here we will be interested in measuring and modelling WALYs lost due to Parkinson's in the years following the initial diagnosis. Our analysis relies on the Fox Insight longitudinal dataset provided by the Michael J. Fox Foundation and will focus on patients in the United States.

KEY INSIGHTS

- The life satisfaction of patients with Parkinson's disease varies depending on the number of years since diagnosis. The explanation is partly a "honeymoon" period after the positive effects of treatment sets in as well as a later drop in life satisfaction due to the progression of the disease.
- Using WALYs to assess the wellbeing burden of Parkinson's disease, we find that average Parkinson's patients lose 36% of the wellbeing they could have otherwise experienced.
- We see relatively larger wellbeing burdens of Parkinson's for those diagnosed at younger ages. Patients diagnosed at 40 to 45 years old are expected to lose almost 6 times as many WALYs over the course of their lifetime as those diagnosed at 90 to 95 years old. Due to relative differences in potential wellbeing lost, WALYs will generally attach more weight to those dying of a disease at younger ages.
- Different treatments for Parkinson's disease have different associations with patient wellbeing. Some are more desirable than others. Applying WALYs in this context can help inform patients and medical practitioners in deciding on the best treatment option.

7.1 Data

In this chapter, we will provide an in-depth case study of Parkinson's disease in the United States. Here, we will consider wellbeing changes over multiple years and in response to multiple different treatments to provide a fuller picture of the true cost of the disease. This analysis relies on Fox Insight data provided by the Michael J. Fox Foundation.

7.2 Wellbeing lost over a lifetime

To illustrate our approach to measuring wellbeing changes over time, we will start by modelling wellbeing lost in the lifetime of an average Parkinson's patient diagnosed between the ages of 60 to 64. We will then broaden our scope to consider patients diagnosed at other ages, from 45 to 95 years old. By calculating WALYs lost for each age group, we can arrive at a final estimation of total lifetime WALYs lost due to Parkinson's disease.

Our measure of life satisfaction in this case is drawn from the Geriatric Depression Scale (GDS) used in the Fox Insight Survey: *"Are you basically satisfied with your life? – Yes / No."* Our results will therefore not be shown as a function of average life satisfaction on a scale of 0 to 10 as in previous chapters, but rather as the percentage of patients satisfied with their lives.[1]

In Figure 7.1, we show the percentage of patients satisfied with their life depending on the number of years since their initial diagnosis. Estimates are drawn from a 2017 sample of 25,765 patients diagnosed with Parkinson's between the ages of 60 and 64.

In the first year they are diagnosed, approximately 75% of patients reported being satisfied with their lives. However, one year after diagnosis, life satisfaction begins to rise. This reflects what is often referred to as the "levodopa-honeymoon" period, during which patients start responding well to treatment.[2] For some patients, this can last up to 5 years.[3] However, eventually the loss of dopaminergic nerve terminals in the brain gives way to dyskinesia (involuntary movement) and other symptoms. Over time, the continued progression of the illness steadily reduces subjective wellbeing.

7.3 Potential wellbeing of Parkinson's patients

We can then ask the following question: how happy would Parkinson's patients otherwise be if they were healthy? Following the approach laid out in previous chapters, we can estimate Parkinson's patients' potential wellbeing by comparing them to healthy counterparts in the general population. To this end, we employ an OLS linear regression of the following specification:

Equation 7.1

$$\begin{aligned}\text{Life satisfaction}_{it} = \beta_0 &+ \beta_1 \cdot \text{Employment status}_{it} \\ &+ \beta_2 \cdot \text{Highest education level}_{it} \\ &+ \beta_3 \cdot \text{Household income}_{it} \\ &+ \beta_4 \cdot \text{Gender}_i + \beta_5 \cdot \text{Age}_{it} + \varepsilon\end{aligned}$$

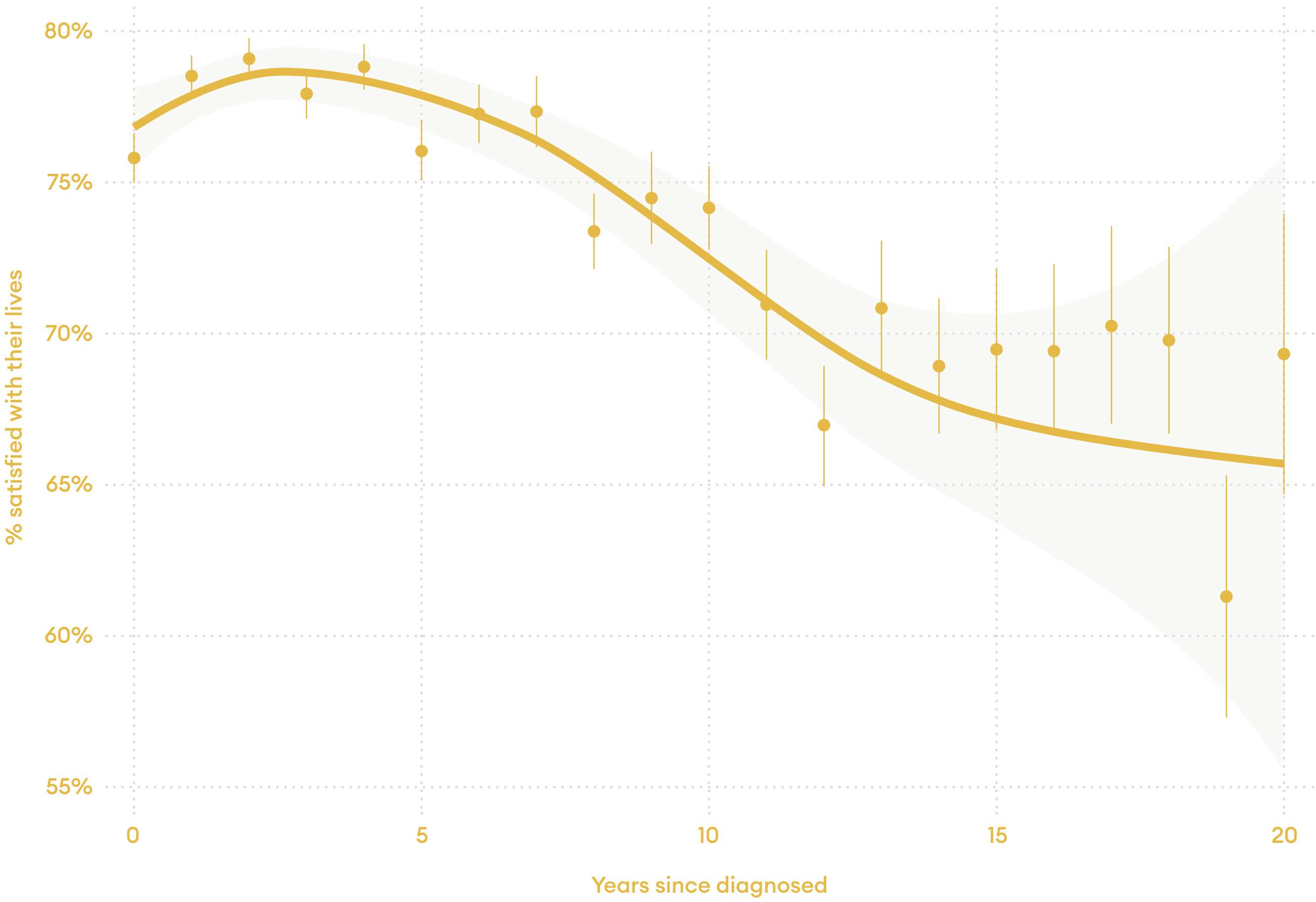
Here, we are interested in measuring the effect of each demographic variable on the life satisfaction of healthy individuals.[4] Using this information, we can then esti-

Fox Insight Database (FI)

The Fox Insight longitudinal database is sponsored by the Michael J. Fox Foundation for Parkinson's Research and maintained in partnership with 23andMe. Founded in 2015, it contains life satisfaction and sociodemographic information for more than 35,000 patients with Parkinson's disease and healthy counterparts in the United States. Questions regarding individual treatments, medications, finances, and social impacts of the disease are regularly aggregated from 42 complementary surveys conducted on a monthly basis. More information is available at *www.foxden.michaeljfox.org*.

Figure 7.1 Life satisfaction of Parkinson's patients in years since initial diagnosis

Estimates are drawn from a 2017 sample of 25,765 patients diagnosed with Parkinson's between the ages of 60 and 64 in the Fox Insight database. Shaded area represents the 95% confidence interval. Each point is made up of more than 100 responses and indicates the percent of patients satisfied with their lives for each year since initial diagnosis.



mate the level of wellbeing they would be expected to experience if they had the same demographic profile of Parkinson's patients. In doing so, we can estimate the proportion of Parkinson's patients we would expect to be satisfied with their lives if they were healthy.

Using this procedure, Table 7.1 shows the evolution of actual and potential wellbeing for patients diagnosed with Parkinson's between the ages of 60 and 64. Age is presented in the first column, followed by the years since initial diagnosis and the number of years in each state. Actual wellbeing is given by the percentage of Parkinson's patients satisfied with their life, while potential wellbeing is given by the same percentage for healthy controls. Over time, the gap between actual and potential wellbeing for Parkinson's patients changes dynamically depending on the progression of the disease. WALYs lost per year are calculated using the standard equation provided in Chapter 3: WALYs lost = 1 – (actual wellbeing / potential wellbeing). In the final column of the table, this figure is then multiplied by the number of years in each state to arrive at an indication of WALYs lost per period, and ultimately lifetime WALYs lost due to Parkinson's.

Table 7.1 WALYs lost due to Parkinson's for patients diagnosed at 60 to 64 years old

Evolution of actual and potential wellbeing for patients diagnosed with Parkinson's between the ages of 60 and 64. Age is presented in the first column, followed by the years since initial diagnosis and the number of years in each state. Actual wellbeing is represented as the percentage of Parkinson's patients satisfied with their lives, while potential wellbeing is represented as the same percentage for healthy controls. WALYs lost = 1 - (actual wellbeing / potential wellbeing). Data is drawn from the Fox Insight database.

Age	Years since diagnosis	Years in this state	Actual wellbeing (% satisfied)	Potential wellbeing (% satisfied)	WALYs lost (per year)	WALYs lost (per period)
60 - 64	0 - 4	5	77.25 (±1.37)	80.87 (±1.2)	0.04 (±0.01)	0.20 (±0.05)
65 - 69	5 - 9	5	79.06 (±1.09)	81.55 (±1.11)	0.03 (±0.01)	0.15 (±0.05)
70 - 74	10 - 14	5	78.77 (±1.26)	82.47 (±1.07)	0.04 (±0.01)	0.20 (±0.05)
75 - 79	15 - 19	1.5	74.32 (±1.98)	81.94 (±1.19)	0.09 (±0.01)	0.14 (±0.02)
75 - 79	15 - 19	3.5	0	81.94 (±1.19)	1 (±0)	3.5 (±0)
80 - 84	20 - 24	3.5	0	81.99 (±1.52)	1 (±0)	3.5 (±0)
				Lifetime WALYs lost:		7.69

To make these figures a bit more concrete, patients diagnosed between 60 and 64 years old who are now are 75 to 79 years old are represented in the fourth row. They have already been living with Parkinson's for 15 to 19 years. At this stage, the disease is likely quite advanced. Actual wellbeing for this cohort is 7.6 percentage points lower than healthy counterparts of the same age, larger than any other age group. The wellbeing burden of Parkinson's disease for these patients is given by 1 – (74.23 / 81.94) = 0.09 WALYs lost per year. However, because life expectancy for Parkinson's patients diagnosed at age 60 is 76.5 years old, the average patient is expected to live 76.5 - 75 = 1.5 years in this state.[5]

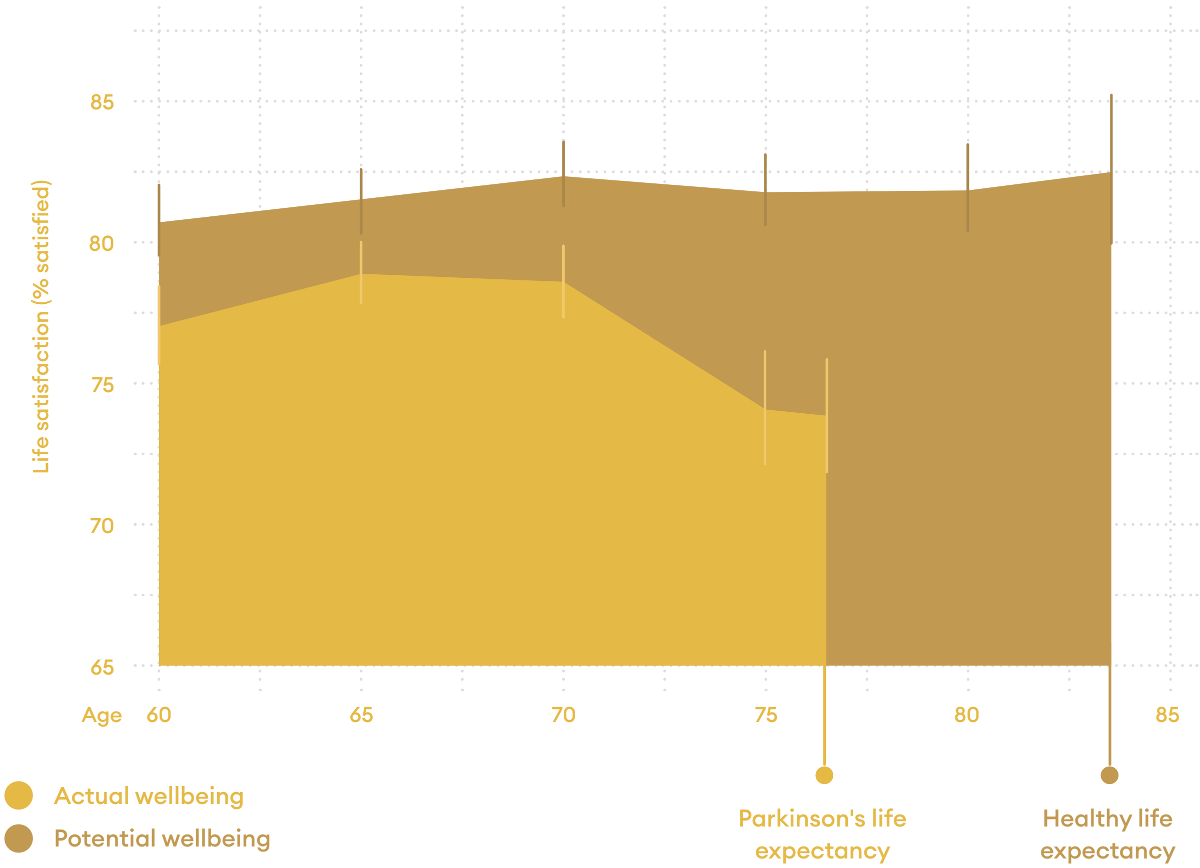
In this way, when considering wellbeing losses over the course of a lifetime, it becomes crucially important to account for mortality and in particular, years of life lost due to the disease. This can be understood in terms of the difference between healthy life expectancy at the age of diagnosis and adjusted life expectancy due to disease. For example, healthy life expectancy for 60 to 64-year-olds in the United States is 83.5 years old.[5] Parkinson's patients diagnosed at age 60 to 64 are therefore expected to lose 7 years of life expectancy on average.

This can be formally understood in terms of Wellbeing Adjusted Life Years by employing equation (7.2). The first term represents the number of WALYs lost for living patients from the age they are diagnosed (a) until their adjusted life expectancy due to the disease (L_d). Using the values provided in the first four rows of Table 7.1, this indicates that Parkinson's patients diagnosed between 60 and 64 are expected to lose 0.20 + 0.15 + 0.20 + 0.14 = 0.69 WALYs over time course of their life. This is equivalent to

$$\text{WALYs}_{\text{lost}} = \sum_{t=a}^{L_d-a} 1 - \frac{\text{actual wellbeing}_p}{\text{potential wellbeing}_p} + \sum_{t=L_d}^{L_h-L_d} 1 - \frac{0}{\text{potential wellbeing}_d} \tag{7.2}$$

Figure 7.2 Actual and potential wellbeing of Parkinson's patients diagnosed between the ages of 60 and 64

Evolution of actual and potential wellbeing for patients diagnosed with Parkinson's between the ages of 60 and 64. Life satisfaction is shown as the percentage of people satisfied with their lives. Data drawn from the Fox Insight database.



approximately 8 months of healthy life lost.[6] As this period encompasses 16.5 years in total, this can also be stated in terms of patients losing 4% of the wellbeing they could have otherwise experienced had they been healthy.[7]

However, it is also necessary to account for wellbeing lost due to death. This is given by the second term in equation (7.2). Because actual wellbeing in the years following death is always equal to zero, WALYs lost due to death can simply be understood as the total number of years between healthy life expectancy (L_h) and adjusted life expectancy (L_d). For Parkinson's patients diagnosed between the ages of 60 and 64, this difference is equal to 7 WALYs lost due to death. It is worth noting that this procedure implies a 1:1 weighted relationship between WALYs lost while alive and WALYs lost after death.[8]

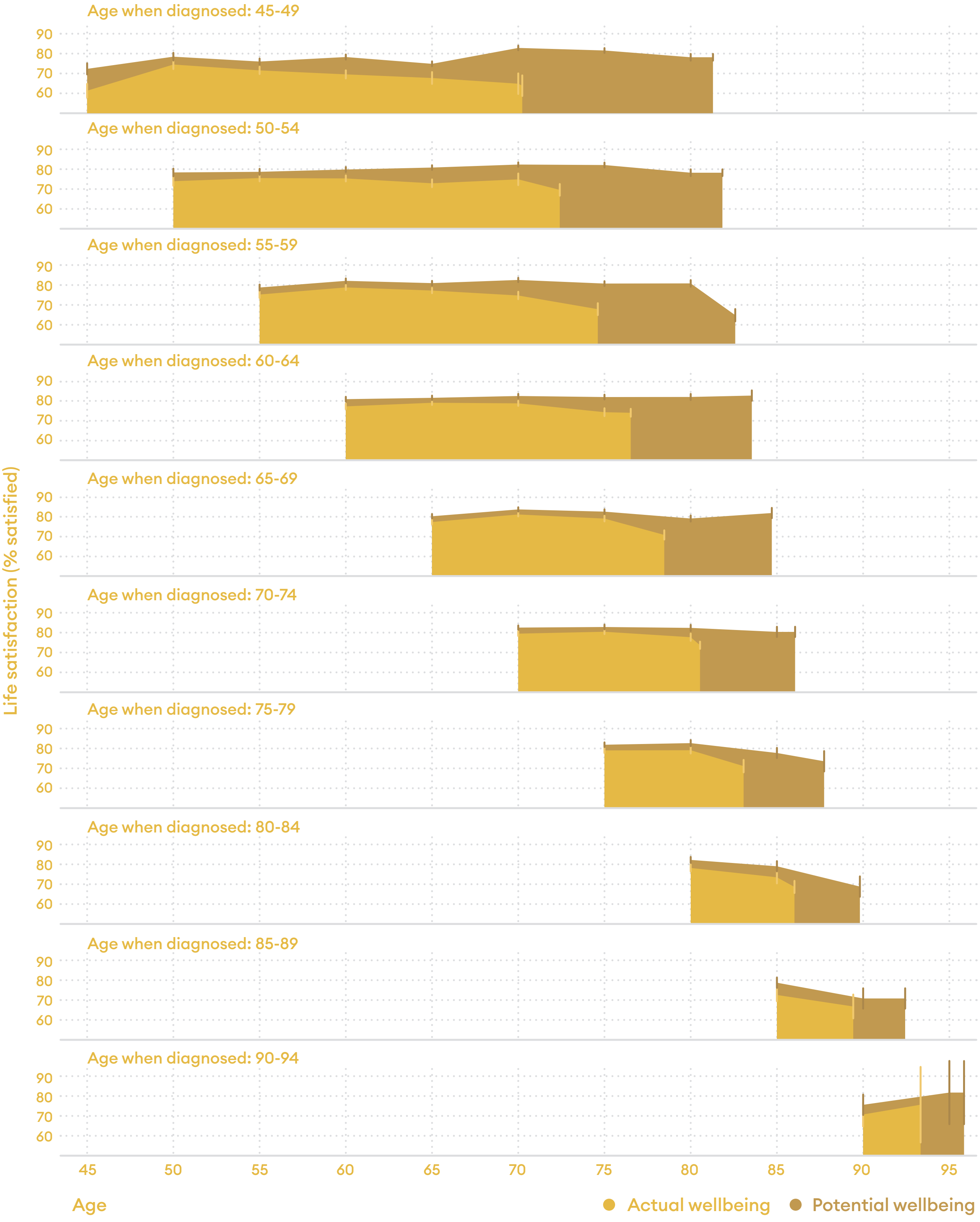
In sum, when accounting for the cost of disease while alive *and* after death, total wellbeing lost for Parkinson's patients diagnosed at age 60 to 64 is equal to 0.69 + 7 = 7.69 WALYs. As this period encompasses 23.5 years in total, these patients are expected to lose about 33% of the wellbeing they could have otherwise experienced.[9]

7.4 Extension to all ages

So far, we have focused on patients diagnosed between the ages of 60 and 64 years old. However, we can also extend our analysis to consider patients diagnosed at different ages. In Figure 7.3, we present the evolution of actual and potential wellbeing for Parkinson's patients diagnosed between the ages of 45 and 94. In the online appendix, we also expand Table 7.1 to include estimates of total lifetime WALYs lost for each age cohort.

Figure 7.3 Actual and potential wellbeing of Parkinson's patients diagnosed at different ages

Evolution of actual and potential wellbeing for patients diagnosed with Parkinson's disease at different ages. Actual wellbeing plotted from the age of diagnoses until adjusted life expectancy due to the disease. Potential wellbeing plotted up until healthy life expectancy for each age group. Error bars represent 95% confidence intervals. Data is drawn from Fox Insight and the Global Burden of Disease.



In this instance, we see relatively larger wellbeing burdens of disease for those diagnosed at younger ages. For example, once we account for healthy and adjusted life expectancies, patients diagnosed at 40 to 45 years old are expected to lose 15.95 WALYs over the course of their lifetime, while patients diagnosed at 90 to 95 years old are expected to lose 2.83 WALYs.[10] Due to relative differences in potential wellbeing lost, WALYs will generally attach more weight to those dying of disease at younger ages.

As a final exercise, we can also estimate the average lifetime WALYs lost due to Parkinson's in the United States. Here, it is again necessary to consider prevalence rates for each age group given by GBD data. As most Parkinson's patients are diagnosed between 70 and 85 years old, a weighted average gives us a final result of 5.69 lifetime WALYs lost.[10] That is to say, average Parkinson's patients lose 36% of the wellbeing they could have otherwise experienced.

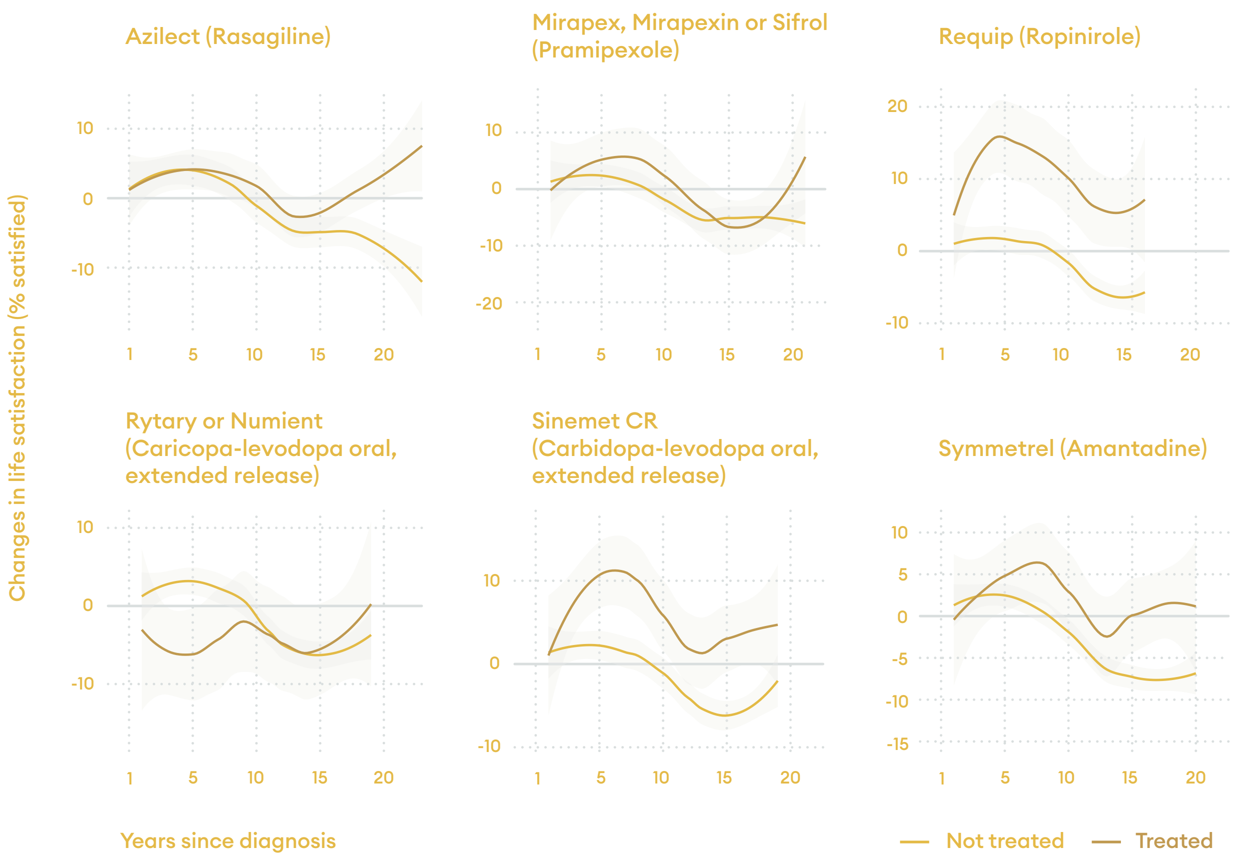
7.5 The wellbeing implications of treatment

In the final section of this chapter, we will turn to an analysis of existing treatments for Parkinson's disease to determine their relationship with patient subjective wellbeing. Positive and negative side effects for many of the treatments we will consider are well documented. They can range from dizziness, drowsiness, weight gain, hallucinations, increased depression, impulse control, and sleep problems. However, determining whether the side effects of a drug are worse than the symptoms it is intended to treat is often a difficult decision. Patients and doctors must decide for themselves whether the risks are worth the potential benefits. WALYs can help inform this decision-making procedure by shining light on associations between treatments and subjective wellbeing.

In Figure 7.4, we plot the relationship between patient life satisfaction and treatment options. Each graph can be understood as a simulation of a clinical trial in which

Figure 7.4 Parkinson's treatments and patient life satisfaction compared to untreated counterparts

Changes in patient life satisfaction since initial diagnosis (t=0) are represented on the y-axis. Patients treated with each medication are compared to untreated counterparts with similar characteristics. Shaded regions represent 95% confidence intervals. Data drawn from the Fox Insight database.



treated patients are compared to untreated controls.

Even just based on this simple analysis, we can already begin to see wellbeing differences for patients taking Requip, Azilect, Sinemet, and Symmetrel as compared to untreated controls. Surprisingly, Rytary or Numient even seem to have the opposite intended effect. Patients taking these medications tend to be less satisfied with their lives than untreated controls in the first eight years after diagnosis.

However, it would be a mistake to interpret this preliminary example as evidence of causation. If a particular medication is only prescribed to patients already suffering from severe symptoms, it may falsely appear as though the drug itself is to blame for low levels of wellbeing. For example, Primavanserin is typically prescribed to combat the onset of hallucinations, while Memantine, Rivastigmine, and Aricept are usually only prescribed when patients begin experiencing symptoms of dementia.[11] If we do not take these differences into account, we may end up drawing false conclusions.

To avoid this sort of selection bias, we can instead consider changes in patient wellbeing before and after undergoing treatment. Wellbeing effects of treatment can then be understood in terms of their positive or negative effects on patient life satisfaction. To estimate these effects, we can employ the OLS specification (7.3).

The key parameter of interest in this case is β_7, indicating the change in patient wellbeing attributable to medication. This difference can then be added to initial patient life satisfaction to give an estimation of potential wellbeing due to treatment. These figures are provided for nine different medications in columns (2) and (3) of Table 7.2.

Estimates for potential wellbeing without Parkinson's disease are also provided for each treatment group in column (4). This is calculated using the same procedure described in the previous section, where equation (7.1) is used to estimate the wellbeing of healthy counterparts with the same demographic profile as the patient group.

Finally, WALYs gained from treatment are given in column (5). This can be understood as the difference between WALYs experienced before and after treatment (equation 7.4).

According to these calculations, **Selegline, Sinemet,** and **Rasagiline** are most effective in terms of increasing patient wellbeing, while **Rytary, Comtan,** and **Mirapex** may even have negative effects. These findings are mostly in line with related studies using quality of life measures to evaluate treatment effectiveness.

In our analysis, **Rasagiline** ranks quite highly, accounting for a 3% increase in life satisfaction. Biglan et al. (2006) also observe improvements in quality of life from Rasagiline. Most of the benefit is attributed to improvements in self-image and sexuality domains.[12] Another study found that Rasagiline predicted slower rates of disease progression relative to other drugs.[13]

In a comparison study, Haycox et al. (2009) identified a 5% gain in QALYs from Rasagiline relative to **Pramipexole**.[14] Using WALYs, we find a corresponding difference of 6 percentage points between both drugs (Table 7.2).

$$(7.3.1)\quad \Delta H_{ji} = \beta_0 + \beta_1 \cdot \text{Employment status}_j + \beta_2 \cdot \text{Highest education level completed}_j + \beta_3 \cdot \text{Household income}_j + \beta_4 \cdot \text{Gender}_j + \beta_5 \cdot \text{Age}_j + \beta_6 \cdot \text{Years since diagnosed}_j + \beta_7 \cdot \text{Treated}_i + \varepsilon$$

$$(7.3.2)\quad \Delta H_{ji} = \text{Life satisfaction before patient } j \text{ treated with } i - \text{Life satisfaction after patient } j \text{ treated with } i$$

$$(7.4)\quad \text{WALYs gained from treatment} = \text{WALYs experienced after treatment} - \text{WALYs experienced before treatment} = \frac{\text{Actual wellbeing after treatment}}{\text{Potential wellbeing without disease}} - \frac{\text{Actual wellbeing before treatment}}{\text{Potential wellbeing without disease}}$$

Table 7.2 Estimating WALYs gained due to treatment among Parkinson's patients

Life satisfaction estimates provided using longitudinal data from the Fox Insight database. Potential wellbeing without disease estimated by the percentage of healthy counterparts satisfied with their lives relative to each treatment group. WALYs gained from treatment estimated using equation (7.4), where column (5) = [(3) - (2)] / (4). Negative WALY estimates indicate that treatment side effects may be worse for patient subjective wellbeing than the benefits produced by medication.

(1) Medication	(2) Actual wellbeing before treatment (% satisfied)	(3) Actual wellbeing after treatment (% satisfied)	(4) Potential wellbeing without disease (% satisfied)	(5) WALYs gained (treatment)
Deprenyl (Selegline)	82.45 (±3.35)	86.04 (±3.59)	83.77 (±1.17)	0.04 (±0.01)
Sinemet (Carbidopa-levodopa oral)	79.35 (±1.38)	81.64 (±1.38)	82.31 (±1.94)	0.03 (±0.01)
Azilect (Rasagiline)	80.37 (±2.15)	83.00 (±2.17)	83.48 (±1.97)	0.03 (±0.01)
Requip (Ropinirole)	80.85 (±3.05)	80.81 (±3.19)	81.64 (±1.64)	0.00 (±0.01)
Symmetrel (Amantadine)	80.58 (±1.81)	78.82 (±1.88)	82.14 (±1.00)	-0.01 (±0.01)
Sinemet CR (Carbidopa-levodopa oral, extended release)	80.68 (±1.94)	79.48 (±1.96)	81.40 (±1.93)	-0.02 (±0.01)
Mirapex, Mirapexin or Sifrol (Pramipexole)	77.35 (±2.58)	75.00 (±2.59)	81.47 (±1.89)	-0.03 (±0.01)
Comtan (Entacapone)	77.54 (±3.5)	74.48 (±3.67)	81.92 (±1.08)	-0.04 (±0.01)
Rytary or Numient (Caricopa-levodopa oral, extended release)	81.71 (±2.36)	77.23 (±2.52)	82.2 (±1.00)	-0.05 (±0.01)

Levodopa has also been found to have a greater impact on quality of life than Pramipexole according to the Unified Parkinson's Disease Rating Scale.[15] In our study, both **Sinemet** and **Sinemet CR** (both forms of levodopa) have more positive effects on patient wellbeing than Pramipexole.

Ropinirole has previously been found to improve motor functions of Parkinson's patients relative to a control group, as well as reduce depressive symptoms.[16] However, our study finds no significant differences in wellbeing due to treatment. **Entacapone** has also been found to reduce motor fluctuations in Parkinson's patients, though our analysis finds a reduction of 4% WALYs after patients begin taking the drug.[17] However, this in and of itself may not be a bad thing, keeping in mind that we are comparing patients' wellbeing before and after undergoing treatment. If patient wellbeing would be expected to decrease substantially in the absence of any treatment at all, medications that do not make patients worse off than they otherwise would be could still be considered useful and important.

Nevertheless, comparisons with all of these studies should be met with caution, considering important differences between the metrics and samples used. Our analyses does not, for instance, take into account doses and time periods for which each medication is prescribed. Clinical trials should still be used as the gold standard to reliably assess WALY gains from treatment in comparison with other quality of life measures.

Notes

1 Ideally, the same question should always be used when comparing illnesses and interventions for decision-making purposes. This demonstration should therefore only taken to be representative of Parkinson's patients in the United States.

2 Müller (2002).

3 Holford & Nutt (2008).

4 All independent variables are represented here as discrete dummy variables as their relationship with life satisfaction is not always linear.

5 Life expectancies are drawn from Global Burden of Disease Collaborative Network (2018).

6 If one WALY is equal to one year lived in full wellbeing, then 0.69 WALYs x 12 months = 8.28 months in full wellbeing.

7 If one WALY is equal to one year lived in full wellbeing, then 0.69 WALYs / 16.5 years in full wellbeing = 4.18% of wellbeing lost.

8 However, this need not be fixed. Future iterations of the model could introduce weighting functions to adjust for a wide array of ethical commitments. For example, by applying a weight ratio of 2:1 to the two terms in equation (7.2), a disease that causes patients to experience the lowest possible level of wellbeing would be considered twice as burdensome as disease that lowers life expectancy by one year. It is beyond the scope of this report to offer normative guidance on this issue.

9 7.69 WALYs / 23.5 years lived in full wellbeing = 32.72% of wellbeing lost.

10 Inputs for these estimates are provided in the online appendix.

11 Aarsland et al. (2002); Cruz (2017).

12 Biglan et al. (2006).

13 Olanow et al. (2009).

14 Haycox et al. (2009).

15 Holloway et al. (2004).

16 Nashatizadeh et al. (2009).

17 Grandas et al. (2007).

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CHAPTER EIGHT

A universal KPI in the making

While, so far, we have primarily focused on applications in healthcare, WALYs can also be scaled up to evaluate HROI in fields and domains ranging far beyond health. It is the ultimate ambition of this project to develop a key performance indicator (KPI) where costs and benefits are combined into a single unit of effect to enable value comparisons across domains – such as the relative benefit of curing diabetes compared to reducing pollution. In this chapter, we will touch on both future possibilities and potential limitations of the WALY metric.

KEY INSIGHTS

- WALYs hold the potential to be scaled up and address values beyond those related to health and disease burdens. In this chapter we demonstrate how WALYs lost due to air pollution can be predicted by relating life satisfaction levels for populations of a number of European cities with respective air pollution levels.
- In some European cities, the wellbeing costs of air pollution prove to be as substantial as losing 15% of household income.
- Even WALYs have wide applicability, there are some limitations to be aware of. These limitations relate to technical issues (where the application may be technically impossible) but also ethical issues (where it is not possible simply by applying the WALY to decide what is the ethically responsible choice, even though it technically plausible).

8.1 Converting wealth to wellbeing

As highlighted in Chapter 1, there is a large and unfinished research agenda on the question of measuring social impact. Valuing impact in terms of financial maximisation is useful and in some case necessary, but it cannot fully account for the multifaceted notion of human progress. In the years to come, it will become increasingly important to revise impact analysis to do justice to hidden realities of subjective experience, without completely discarding the most useful aspects of standard economic indicators such as Gross Domestic Product (GDP) and Return on Investment (ROI).

While GDP and ROI can provide valuable information regarding objective conditions within a given society, they cannot provide insight into how these conditions manifest in lived experience. Financial metrics may tell us how many iPhones are sold in a given year, but they can never tell us what it feels like to own one. Only subjective measures are fit for that purpose. The mission is therefore not to replace financial measures of progress with indicators of subjective wellbeing, but rather to complement and qualify one with the other.

In short, while financial metrics can tell us how well governments and businesses perform in terms of producing wealth, subjective measures like WALYs and HROI can tell us the extent to which wealth is converted into wellbeing.

WALYs can be used to value an array of non-market goods that financial metrics struggle to deal with. These could include the personal and social benefits of volunteering, neighbourhood safety, housing quality, public space, and homemaking, to name a few. Subjective wellbeing valuations for each domain can be elicited from standardised surveys and converted in Wellbeing Adjusted Life Years.

Some of these ideas are already being put into practice around the world. In New Zealand, the government has recently introduced a “Wellbeing Budget” which incorporates measures of subjective wellbeing into cost-benefit analyses.[1] In the annual budget, it is now for instance possible to value “contact with neighbours” by its contribution to individual wellbeing. Using secondary valuation techniques, these domains can then be monetised and assessed in terms of financial worth. In New Zealand, “contact with neighbours” has been estimated to be worth $8,572 annually in terms of its net contribution to individual subjective wellbeing.[2] In turn, these sorts of predictions can be factored into budget priorities, and in that way help direct energy and investment towards important determinants of meaningful lives that financial metrics fail to capture.

However, there are also a number of areas in which it may not be appropriate to rely exclusively on subjective wellbeing to inform decision-making. In the next section, we will address some potential boundaries and limitations of the model proposed thus far.

8.2 Boundaries and limitations

Up until now, this report has mostly focused on the ways WALYs can complement, and in some cases even outperform existing cost-utility metrics. However, as with any metric of utility, there are circumstances where using WALYs to assign value would have important limitations. We may still judge a particular outcome to be desirable even if its impact on subjective wellbeing is negligible or even negative. In these instances, WALYs would likely be insufficient guides to action. In what follows, we will present three such case studies in which measuring progress or effectiveness exclusively in terms of subjective wellbeing may be inappropriate:

- **Does democratisation lead to improvements in subjective wellbeing?**
- **Does parenthood lead to improvements in subjective wellbeing?**
- **Can WALYs be used to evaluate the ethics of medically assisted dying?**

Democracy

Assessing the wellbeing value of democracy can be somewhat difficult. The relationship between political order and subjective wellbeing is complex, and often influenced by factors that go far beyond the level of representativeness. Some research has demonstrated that delivery of government services can even be more predictive of life satisfaction than democratic quality.[3] One study relying on the World Bank's six indicators of governmental quality found that corruption, control, and quality of regulation were for instance more important for citizen subjective wellbeing than accountability or political stability.[4] Using subjective wellbeing as the primary measure of value in this context might then suggest deprioritising democratisation in favour of effective regulation.

However, even if democracy had negative impacts on subjective wellbeing, many would still consider it to be a worthwhile pursuit. In this context, given the complex and interwoven relationship between political organisation and life satisfaction, using WALYs exclusively as a decision-making tool could lead to counterintuitive and possibly even counterproductive results.

Parenthood

The relationship between parenthood and subjective wellbeing is also somewhat difficult to parse. Empirical research has often found parents to be less happy than non-parents, all things considered.[5] However, a study from 2016 analysing data from the European Social Survey (ESS) and the International Social Survey Programme (ISSP) found that parental wellbeing was also largely dependent on parental support policies including paid leave. In countries such as the United States that tend to rank relatively low in these domains, parents are often in fact less happy than childless counterparts. However, in countries like Sweden and France with more generous parental support, having children tend to be associated with increases in happiness.[6]

Using WALYs in this context to estimate the value of parenthood may therefore provide misleading results. Because parental subjective wellbeing is often influenced by country-specific policies, cross country comparisons would present a challenge. Becayse subjective wellbeing is so dependent on contextual factors, using WALYs exclusively to evaluate the costs or benefits of any particular life circumstance may not provide the whole picture, and perhaps even a distorted one. In these scenarios, caution and context is warranted.

Assisted Dying

WALYs would also likely be unsuitable for considering the costs and benefits of medically assisted dying. Because WALYs are inherently a measure of experience and time, deaths short of healthy life expectancy are often considered to be negative, especially for young people. Wellbeing assessments of assisted death may therefore be likely to produce negative results. However, there may be legitimate reasons to support or oppose medically assisted death beyond its effects on subjective wellbeing.

The anaesthesiologist Ronald W. Dworkin has highlighted a number of related ethical conundrums in his book Artificial Happiness. Dworkin imagines a world in which it were possible to prescribe medication to patients so that they may feel perfectly happy, even if their external circumstances remained the same.[7] If such a drug were to come on the market, some might worry that assessing its utility in terms of WALYs could justify the use of a mass medication policy.[8]

While the above cases may be theoretical, they are indicative of the kinds of situations in which using WALYs in isolation to evaluate impact and effectiveness could produce misleading results. WALYs, and cost-utility metrics more broadly, should always be used properly and applied in the right circumstances. Failing to understand the limitations and assumptions inherent to any measure of utility can lead to biased estimates and unqualified decisions. Subjective wellbeing may justifiably not be all that matters to consumers, citizens, investors, or policymakers. Political, social, and cultural motivations should always be taken into account in determining how best to allocate resources and pass legislation. WALYs are intended as one additional tool in the decision-maker's toolbox, not necessarily all that matters.

With these limitations in mind, in the next section we will turn to several additional domains in which WALYs are poised to add value to existing forms of evaluation and impact assessment.

8.3 Towards a universal KPI

Evaluating the wellbeing impact of policies and interventions is often riddled with complexity. One way to address this problem could be to conduct a randomised control trial (RCT) to assess the impact of a given intervention on wellbeing. Using this methodology, Abhijit V. Banerjee, Esther Duflo, and Michael Kremer were recently awarded the 2019 Nobel Prize in Economics for their research addressing global poverty. In one study, an RCT was used to demonstrate the effectiveness of a training program for informal healthcare providers in India.[9]

While experiments can be invaluable resources, many research questions are not suitable for experimental designs. For example, it may be unethical to conduct randomised control trials to evaluate the impact of stimulating crop health in developing countries if doing so would require depriving the control group of lifesaving technologies.

Other research questions may simply be practically impossible. In addition to obvious ethical concerns, conducting randomised control trials to test the effects of pollution and clean air on subjective wellbeing does not seem feasible. In this particular case, it would also seem unwise to ask citizens themselves about the impacts of air pollution as even they might not realise the full extent of its effects.

In these scenarios, where experimental methods would be unethical, impossible, or unreliable, assessing impact requires creative collection and analysis of existing data sources. By matching data on objective conditions with subjective wellbeing data on personal experiences, WALYs can be used to evaluate the impact of interventions and investments across a wide variety of domains. These could include:

- **Assessing the impact of urban economic policy on resident wellbeing**
- **Assessing the impact of green spaces on wellbeing**

In these cases, evaluating impact in terms of subjective wellbeing requires linking disparate data sources together to find meaningful relationships.

To better illustrate the potential of these opportunities, in the next section we will provide a case study of air pollution. By matching data on air quality with city residents' subjective wellbeing, we will demonstrate how WALYs can be used to assess both the benefits of clean air and costs of pollution for 71 European cities.

Economic policy and wellbeing

City governments often have to choose between an array of policy options to improve city life. When deciding which economic strategy to pursue, it is often not possible to run experiments beforehand. In this context, gathering information regarding the effects of previous policies on subjective wellbeing could be extremely valuable. It may also be worth considering if and to what extent similar economic development plans have improved citizen wellbeing in other cities who adopted them in the past. In both instances, expected gains in WALYs could be calculated by matching data sources.

The first step would be to gather data from comparable cities on relevant economic indicators (e.g. job growth, average percent wage increases, GDP per capita) that are likely to be affected by a given policy. This data is regularly collected and made available on government websites.[10] Subjective wellbeing data can also be gathered from population surveys. For example, in the United States, the Behavioral Risk Factor Surveillance System (BRFSS) has tracked citizen life satisfaction routinely since 2017.[11] Evaluating the subjective wellbeing of citizens in other cities with targeted levels of economic development, or considering changes in subjective wellbeing before and after a particular policy was previously introduced somewhere else, could help city governments to decide on the best path forward.

Green spaces and wellbeing

It may not be terribly surprising that being in nature improves wellbeing. This relationship was even illustrated empirically by a recent longitudinal population cohort study of Danish citizens showing that those who were surrounded by more green space as a child had a 15% to 55% lower risk of developing a psychiatric disorder as an adult.[12] Along similar lines, investors or governmental organisations developing urban green spaces may be interested in evaluating the potential effects of urban green space on subjective wellbeing. WALYs could provide the mechanism by which to do so.

One approach to conducting this sort of analysis is exemplified by the smartphone application Mappiness. The app, originally developed Dr. George MacKerron from the London School of Economics, tracks respondents' happiness using short questionnaires which are then linked to GPS locations.[13] These combined sources of information can be used to model the relationship between urban spaces and resident happiness. However, when these sorts of technologies are not available, other sources of data could also be collected to serve a similar purpose.

For example, data regarding the percentage of land that a city has dedicated to green spaces is currently provided by Eurostat, while average subjective wellbeing scores across major cities can be obtained from Eurobarometer data, both of which are publicly available.[14] Using these two sources in conjunction with one another could serve as the foundation for WALY estimations regarding the relationship between urban green space and resident wellbeing. This could then be useful in determining the likely effects of related city government initiatives.

8.4 Wellbeing cost of air pollution

Addressing the pollution generated by the burning of coal and fossil fuels is poised to be one of the most important challenges of the 21st century. Projections carried out by the Intergovernmental Panel on Climate Change now indicate that average global temperatures will likely exceed 2°C above pre-industrial levels.[15] Climate change is already having a substantial impact on weather patterns, water cycles, and international migrations.

Moreover, pollution has been found to increase the incidence of respiratory infections, heart problems, lung cancer, asthma, chronic bronchitis, and many other negative health conditions.[16] It has even been linked to increased rates of depression and anxiety.[17] In response, a burgeoning number of studies have begun to dig deeper into the relationship between air pollution and subjective wellbeing.[18]

However, it is often exceedingly difficult to tell whether economic development brought about by transport and industry outweigh the costs of air pollution. In an attempt to address this question, we will follow an approach similar to the one laid out in previous chapters to compare the subjective wellbeing of residents living in polluted cities to similar counterparts living in cities with better air quality.

8.4.1 Detecting the effect of something invisible

Unfortunately, it is often difficult to assess the effects of air pollution on individual wellbeing. Not even by asking residents of polluted cities can we get reliable estimations, since many have no way of knowing what their lives would be like in less polluted environments. In fact, one study found that Chinese people living in highly polluted areas tend to be relatively satisfied with the air quality. The authors concluded that this may be due to the lack of reference points to cleaner environments.[19] Most people simply seem to get accustomed to high levels of pollution. In this case, it is again necessary to use statistical tools to uncover the "invisible" effects of air pollution.

In this section, we therefore employ OLS to compare the wellbeing of citizens in different cities with varying levels of air pollution assessed using data from ground monitoring networks and satellite retrievals. In doing so, we can better understand the extent to which people living in cities with cleaner air are statistically happier than counterparts in polluted cities. For this analysis, we have integrated data from the Flash Eurobarometer and the World Health Organization.

However, as in previous cases, the wellbeing effect of pollution can only be estimated if the relationship follows some kind of predictable pattern. A preliminary analysis of Eurobarometer life satisfaction data and WHO pollution data does in fact reveal a clear negative linear trend (Figure 8.1).

Cities like Warsaw (Poland), Torino (Italy), Sofia (Bulgaria) and Zagreb (Croatia) have relatively high levels of air pollution and relatively low levels of life satisfaction, while cities like Malmö (Sweden), Cardiff (Wales) and Belfast (United Kingdom) have relatively low levels of pollution

Flash Eurobarometer

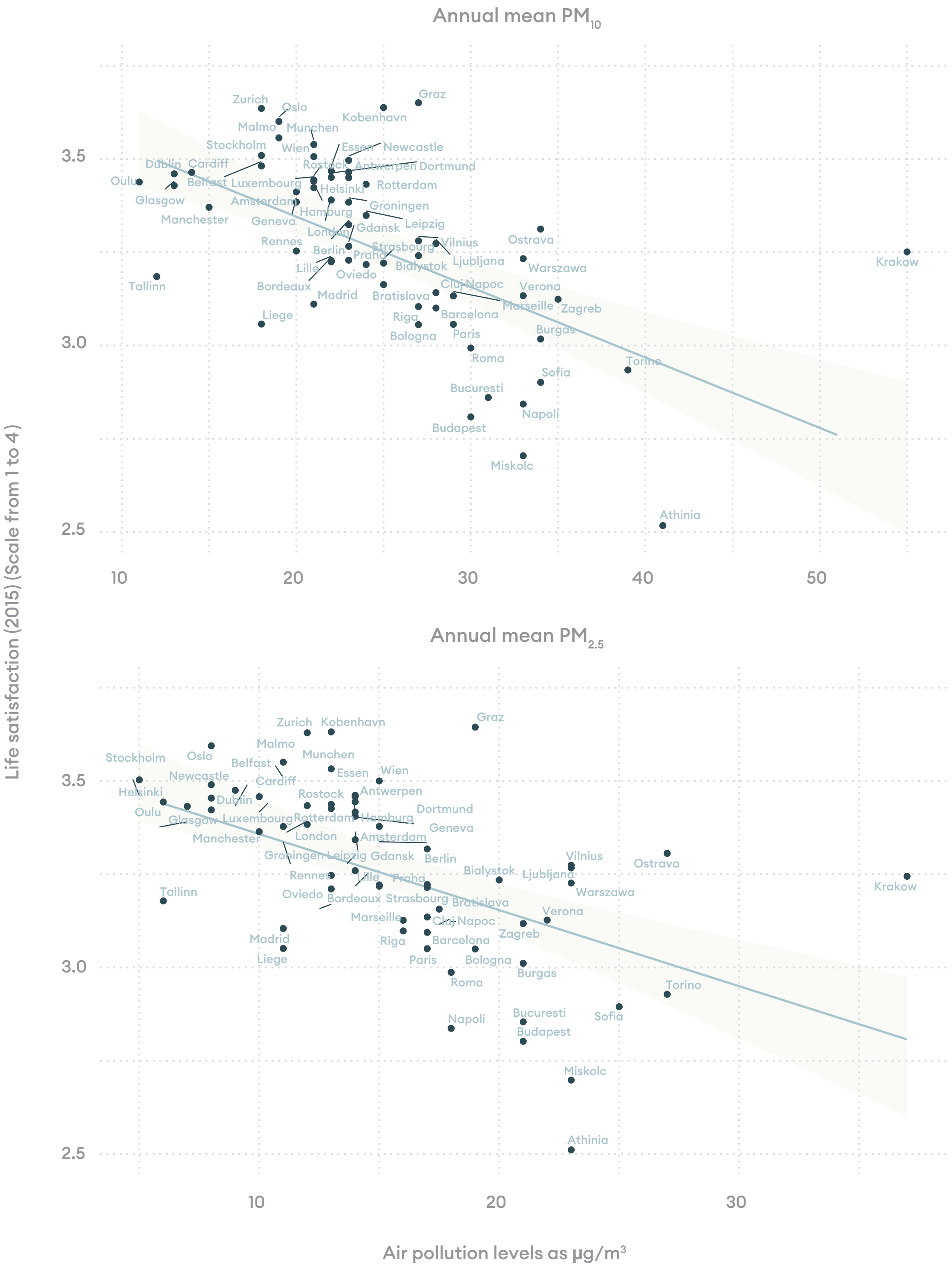
The Eurobarometer survey on quality of life shows how satisfied people are with various aspects of urban life including public transport and pollution. It is designed to enable city comparisons of 30 criteria relating to social, economic, cultural, and environmental issues. This special questionnaire was carried out in 83 European cities across 32 countries in 2013 (41,645 responses) and 2015 (40,798 responses). Both years contain response data on life satisfaction measured on a 4-point scale: *"On the whole, are you very satisfied, fairly satisfied, not very satisfied or not at all satisfied with the life you lead?"*[20]

World Health Organization (WHO)

The WHO Global Ambient Air Quality Database collects annual mean concentrations of particulate matter of less than 10 microns in diameter (PM10) and 2.5 microns (PM2.5) from 4,468 cities in 108 different countries. Measurements are gathered from more than 9000 monitoring locations and satellite retrievals of aerosol optical depth. 71 of these cities coincide with those contained in the Flash Eurobarometer.[21]

Figure 8.1 Life satisfaction and pollutions level in European cities

Relationship between air pollution and average life satisfaction measured on 4-point scale in European cities. Pollution represented as 2015 mean concentrations of particulate matter of less than 10 microns in diameter (PM10) [µg /m³] and 2.5 microns (PM2.5) [µg /m³]. Data drawn from Eurobarometer and the World Health Organization. Shaded regions represent 95% confidence intervals of the linear model.



and high levels of life satisfaction. On average, for every 1 µg/m^3 increase in PM2.5, life satisfaction decreases by about 0.02 points on a 4-point scale. For every 1 µg/m^3 increase in PM10, life satisfaction decreases by 0.01 points.

Going one step further, to ensure that these relationships are not influenced by other factors including access to green space or noise levels, we also need to control for as many background conditions related to quality of life in each city as possible.[22] To do so, we again employ an OLS linear regression model using equation (8.1). In this case, to estimate actual and potential wellbeing in the context of pollution, we are primarily interested in the coefficient β_1, which captures the specific effect of increases in air pollution (PM2.5 or PM10) on life satisfaction.

Applying OLS, this coefficient is estimated to be -0.0055 for each one unit increase in PM10 and -0.006 for each one unit increase in PM2.5.[23] Adjusted to a 0-10 point life satisfaction scale, these figures become -0.015 and -0.017, respectively.[24]

Using these estimates, we can then calculate WALYs lost due to pollution for each of the 71 cities in our analysis. Actual wellbeing in this case is represented as average life satisfaction in each city. Potential wellbeing is the expected life satisfaction in a city if it reduced the level of pollution to zero, keeping all other variables including noise levels and employment status constant. Differences between actual and potential wellbeing for each city are presented in Figure 8.2. These differences are then used to calculate WALYs lost due to pollution in Table 8.1.

Equation 8.1

$$\begin{aligned}\text{Life satisfaction}_{ict} = {} & \beta_0 + \beta_1 \cdot \text{Air pollution}_{ct} + \beta_2 \cdot \text{Employment}_{it} + \beta_3 \cdot \text{Marital status}_{it} \\ & + \beta_4 \cdot \text{Difficulties paying bills}_{it} + \beta_6 \cdot \text{Financial situation}_{it} \\ & + \beta_7 \cdot \text{Gender}_{it} + \beta_8 \cdot \text{Age}_{it} + \beta_9 \cdot \text{Access to green space}_{it}{}^* \\ & + \beta 10 \cdot \text{Public transport}_{it}{}^* + \beta_{11} \cdot \text{Noise}_{it}{}^* + \beta_{12} \cdot \text{City as a whole}_{it}{}^* \\ & + \beta_{13} \cdot \text{Cleanliness}_{it}{}^* + \beta_{14} \cdot \text{House price}_{it}{}^* + \beta_{15} \cdot \text{Household size}_{it}{}^* \\ & + \beta_{16} \cdot \text{Government commitment on pollution}_{it}{}^* + \varepsilon\end{aligned}$$

** Indicates question regarding respondents' satisfaction with particular domain*

Figure 8.2 Potential wellbeing without pollution

Wellbeing assessed in terms of life satisfaction on a 4-point scale. Potential life satisfaction estimated using equation (7.4). Data from Eurobarometer and the World Health Organization.

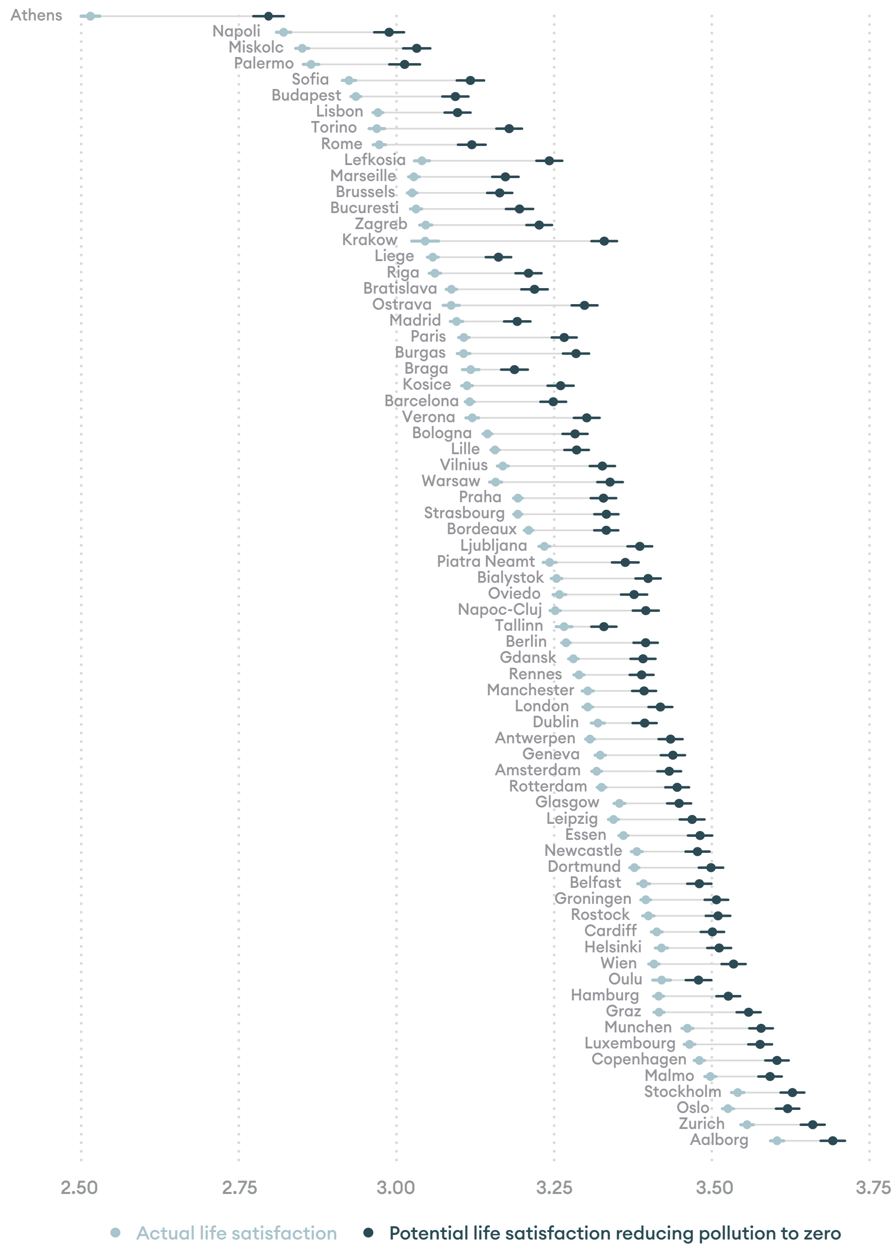


Table 8.1 Wellbeing lost due to pollution in European cities

Actual wellbeing and potential wellbeing represented in terms of life satisfaction on a 4-point scale. WALYs lost = 1 - (actual wellbeing / potential wellbeing). Standard errors presented in parentheses. The table is ordered from highest impact of pollution on wellbeing in Krakow, Poland to the lowest impact of pollution in Aalborg, Denmark. Data drawn from Eurobarometer and the World Health Organization.

City	Actual wellbeing	Potential wellbeing	WALYs lost
Krakow	3.04 (±0.02)	3.33 (±0.02)	0.09 (±0.01)
Athens	2.60 (±0.01)	2.79 (±0.02)	0.07 (±0.01)
Torino	2.97 (±0.01)	3.17 (±0.02)	0.07 (±0.01)
Napoli	2.82 (±0.01)	2.98 (±0.02)	0.06 (±0.01)
Miskolc	2.85 (±0.01)	3.03 (±0.02)	0.06 (±0.01)
Sofia	2.92 (±0.01)	3.11 (±0.02)	0.06 (±0.01)
Lefkosia	3.04 (±0.01)	3.24 (±0.02)	0.06 (±0.01)
Zagreb	3.04 (±0.01)	3.22 (±0.02)	0.06 (±0.01)
Ostrava	3.08 (±0.01)	3.29 (±0.02)	0.06 (±0.01)
Palermo	2.86 (±0.01)	3.01 (±0.02)	0.05 (±0.01)
Budapest	2.93 (±0.01)	3.09 (±0.02)	0.05 (±0.01)
Rome	2.97 (±0.01)	3.12 (±0.02)	0.05 (±0.01)
Marseille	3.02 (±0.01)	3.17 (±0.02)	0.05 (±0.01)
Bucuresti	3.03 (±0.01)	3.19 (±0.02)	0.05 (±0.01)
Riga	3.06 (±0.01)	3.21 (±0.02)	0.05 (±0.01)
Burgas	3.10 (±0.01)	3.28 (±0.02)	0.05 (±0.01)
Paris	3.10 (±0.01)	3.26 (±0.02)	0.05 (±0.01)
Kosice	3.11 (±0.01)	3.26 (±0.02)	0.05 (±0.01)
Verona	3.12 (±0.01)	3.30 (±0.02)	0.05 (±0.01)
Warszawa	3.15 (±0.01)	3.33 (±0.02)	0.05 (±0.01)
Vilnius	3.16 (±0.01)	3.32 (±0.02)	0.05 (±0.01)
Lisbon	2.97 (±0.01)	3.09 (±0.02)	0.04 (±0.01)
Brussel	3.02 (±0.01)	3.16 (±0.02)	0.04 (±0.01)
Bratislava	3.08 (±0.01)	3.21 (±0.02)	0.04 (±0.01)
Barcelona	3.11 (±0.01)	3.24 (±0.02)	0.04 (±0.01)
Bologna	3.14 (±0.01)	3.28 (±0.02)	0.04 (±0.01)
Lille	3.15 (±0.01)	3.28 (±0.02)	0.04 (±0.01)
Strasbourg	3.19 (±0.01)	3.33 (±0.02)	0.04 (±0.01)
Praha	3.19 (±0.01)	3.32 (±0.02)	0.04 (±0.01)
Bordeaux	3.21 (±0.01)	3.33 (±0.02)	0.04 (±0.01)
Ljubljana	3.23 (±0.01)	3.38 (±0.02)	0.04 (±0.01)
Piatra nea	3.24 (0.01)	3.36 (±0.02)	0.04 (±0.01)
Cluj-napoc	3.25 (0.01)	3.39 (±0.02)	0.04 (±0.01)
Bialystok	3.25 (±0.01)	3.39 (±0.02)	0.04 (±0.01)
Oviedo	3.25 (±0.01)	3.37 (±0.02)	0.04 (±0.01)
Berlin	3.26 (±0.01)	3.39 (±0.02)	0.04 (±0.01)

City	Actual wellbeing	Potential wellbeing	WALYs lost
Antwerpen	3.30 (±0.01)	3.43 (±0.02)	0.04 (±0.01)
Leipzig	3.34 (±0.01)	3.46 (±0.02)	0.04 (±0.01)
Wien	3.40 (±0.01)	3.53 (±0.02)	0.04 (±0.01)
Graz	3.41 (±0.01)	3.55 (±0.02)	0.04 (±0.01)
Liege	3.05 (±0.01)	3.16 (±0.02)	0.03 (±0.01)
Madrid	3.09 (±0.01)	3.19 (±0.02)	0.03 (±0.01)
Gdansk	3.28 (±0.01)	3.39 (±0.02)	0.03 (±0.01)
Rennes	3.29 (±0.01)	3.38 (±0.02)	0.03 (±0.01)
Manchester	3.30 (±0.01)	3.39 (±0.02)	0.03 (±0.01)
London	3.30 (±0.01)	3.41 (±0.02)	0.03 (±0.01)
Amsterdam	3.31 (±0.01)	3.43 (±0.02)	0.03 (±0.01)
Geneva	3.32 (±0.01)	3.43 (±0.02)	0.03 (±0.01)
Rotterdam	3.32 (±0.01)	3.44 (±0.02)	0.03 (±0.01)
Glasgow	3.35 (±0.01)	3.44 (±0.02)	0.03 (±0.01)
Essen	3.36 (±0.01)	3.48 (±0.02)	0.03 (±0.01)
Dortmund	3.37 (±0.01)	3.49 (±0.02)	0.03 (±0.01)
Newcastle	3.38 (±0.01)	3.47 (±0.02)	0.03 (±0.01)
Belfast	3.39 (±0.01)	3.48 (±0.02)	0.03 (±0.01)
Groningen	3.39 (±0.01)	3.50 (±0.02)	0.03 (±0.01)
Rostock	3.4 (±0.01)	3.51 (±0.02)	0.03 (±0.01)
Cardiff	3.41 (±0.01)	3.50 (±0.02)	0.03 (±0.01)
Hamburg	3.41 (±0.01)	3.52 (±0.02)	0.03 (±0.01)
Helsinki	3.42 (0.01)	3.51 (±0.02)	0.03 (±0.01)
Munchen	3.46 (±0.01)	3.57 (±0.02)	0.03 (±0.01)
Luxembourg	3.46 (±0.01)	3.57 (±0.02)	0.03 (±0.01)
Copenhagen	3.48 (±0.01)	3.60 (±0.02)	0.03 (±0.01)
Malmo	3.49 (±0.01)	3.59 (±0.02)	0.03 (±0.01)
Oslo	3.52 (±0.01)	3.62 (±0.02)	0.03 (±0.01)
Zurich	3.55 (±0.01)	3.66 (±0.02)	0.03 (±0.01)
Braga	3.11 (±0.01)	3.18 (±0.02)	0.02 (±0.01)
Tallinn	3.26 (±0.01)	3.32 (±0.02)	0.02 (±0.01)
Dublin	3.32 (±0.01)	3.39 (±0.02)	0.02 (±0.01)
Oulu	3.42 (±0.01)	3.47 (±0.02)	0.02 (±0.01)
Stockholm	3.54 (±0.01)	3.62 (±0.02)	0.02 (±0.01)
Aalborg	3.60 (±0.01)	3.69 (±0.02)	0.02 (±0.01)

For example, reducing pollution levels to zero in Krakow could increase average life satisfaction by 0.29 points on a 4-point scale. This would be equivalent to an increase of 0.09 WALYs per person. At the other end of the spectrum, reducing pollution levels to zero in the Danish city of Aalborg could increase resident life satisfaction by 0.09 points, equivalent to a gain of 0.02 WALYs per person.[25]

8.4.2 What would it take to compensate for the wellbeing lost due to air pollution?

Using these numbers, we can also calculate the marginal rate of substitution for air pollution, or the increase in income necessary to compensate for the negative effects of air pollution. However, since Eurobarometer does not include data on household income, for this exercise we must instead rely on SHARE data. The relationship between life satisfaction and monthly household income can be understood in terms of the basic OLS regression equation (8.2).

Limiting our sample to incomes above €2000 per year, we find a value for β_1 of 0.57 (SE = 0.04, $p < 0.001$). The increase in yearly household income needed to counteract the effect of wellbeing can then be calculated using the formula provided in equation (8.3).

Life satisfaction lost due to pollution represents the gap between actual and potential life satisfaction if air pollution was reduced to zero. Thus, the yearly increase in income needed to counteract the effect of pollution in Krakow (0.10 points in life satisfaction) for households earning an average of €5,000 per year can be estimated using the procedure (8.3.1 - 8.3.3).

In other words, the wellbeing lost in Krakow due to pollution concentrations of 53 µg/m^3 PM10 and 37 µg/m^3 PM2.5 is roughly equivalent to a loss of **€782 per year or 15% in annual income** for a household earning €5,000 per year.[26]

To give another example, life satisfaction lost due to pollution in Hamburg is 0.04 (on a scale of 0 to 10) and mean annual household income is approximately €28,000. The effect of pollution on wellbeing is therefore equivalent to losing [€28,000 - (€28,000 / $e^{0.04 / 0.57}$)] = **€1,897 per year** per person. While pollution in Hamburg is lower than in Krakow, the amount of income needed to compensate for its effects is greater. This is because the marginal utility of income becomes smaller as overall income gets larger. This effect is accounted for by the logarithm used to estimate the relationship between household income and subjective wellbeing.

$$\text{Life satisfaction} = \beta_0 + \beta_1 \cdot \text{Log (Household income)} + \beta_2 \cdot \text{Age} + \beta_3 \cdot \text{Gender} + \beta_4 \cdot \text{Education} + \varepsilon \tag{8.2}$$

$$\text{Life satisfaction lost due to pollution} = 0.57 \cdot \text{Log} \left(\frac{\text{Household income}_2}{\text{Household income}_1} \right) \tag{8.3}$$

$$\text{Life satisfaction lost due to pollution} = 0.10 = 0.57 \cdot \text{Log} \left(\frac{\text{Household income}_2}{\text{Household income}_1} \right) \tag{8.3.1}$$

$$0.10 / 0.57 = 0.17 = \text{Log} \left(\frac{\text{Household income}_2}{\text{Household income}_1} \right) \tag{8.3.2}$$

$$\text{Household income}_2 = \left(\frac{\text{Household income}_1}{e^{0.17}} \right) = \left(\frac{€\ 5000}{e^{0.17}} \right) = €\ 4218 \tag{8.3.3}$$

In a related analysis, Levinson (2012) also estimated the wellbeing effects of air pollution in the United States using data from the General Social Survey and Environmental Protection Agency. The level of income necessary to offset the effect of each 1 $\mu g/m^3$ increase in PM10 pollution for a person with the mean annual salary of $42,300 (€38,000) was found to be $969 (€872). Our model finds roughly similar results. Using OLS, we observe a decrease of 0.017 points in life satisfaction (0 to 10-point scale) for every 1 $\mu g/m^3$ of PM10 pollution in European cities, equivalent to a loss of [€38,000 - (€38,000 / $e^{0.0017 / 0.57}$)] = €1,116 in annual income.[27]

Another recent study in China adjusting for endogeneity also found that a 1 mg/m^3 increase of annual PM2.5 concentration results in a loss of subjective wellbeing equivalent to 7.7% percent of household disposable income, or $529 per year.[28]

As these analyses make clear, the costs of urban air pollution can be substantial. In the most polluted European cities, WALYs lost due to pollution even approach average WALYs lost due to Alzheimer's or Parkinson's disease. One potential explanation for these high estimates could be the nature of the Eurobarometer questionnaire itself, which asks respondents a series of questions relating to their satisfaction with the surrounding urban environment. This could potentially bias life satisfaction questions, which are only asked towards the end of the survey. To avoid this bias, it is always advisable to put life satisfaction questions ahead of others.

The wellbeing effects of air pollution could also be explained in terms of its deleterious effects on health. In one particularly striking case, Perez et al. (2009) estimated that reducing pollution in Barcelona to WHO recommended levels would result in 3,500 fewer deaths, 54,000 fewer asthma attacks, 5,100 fewer cases of chronic bronchitis, and 1,800 fewer hospitalisations due to cardio-respiratory diseases. The potential monetary benefits were estimated to be €6.4 billion per year.[29] Another longitudinal study involving 312,944 people in nine European countries revealed that the lung cancer rate rose by 22% for every 10 $\mu g/m^3$ increase in PM10, and 36% for every 10 $\mu g/m^3$ increase in PM2.5.[30] It may be unsurprising then that pollution is often found to have such a substantial effect on average levels of subjective wellbeing.

In another study, researchers looked at what happened when power plants in Germany were fitted with equipment designed to reduce emissions, using data from a longitudinal survey of 30,000 Germans living upwind or downwind from power plants. The study found that those downwind where significantly more satisfied with their lives after the installation, while their upwind neighbours did not seem to benefit.[31] Natural experiments, such as these, help ensure that improvements in subjective wellbeing are in fact possible due to improvements in air quality.

8.5 Moving forward

As illustrated by this chapter, integrating datasets on objective conditions with life satisfaction can provide private and public actors with the tools they need to arrive at nuanced understandings of investment strategies and public policies. From analysing the wellbeing effects of crop enhancements, to isolating the effects of air pollution, to predicting the outcomes of medical interventions, WALYs can help to quantify impact and qualify value in terms of experienced subjective wellbeing across a wide variety of domains. In the final chapter, we will offer several practical recommendations and discuss the path forward to implement WALYs as universal KPI and start measuring the Happiness Return on Investment.

Notes

1 New Zealand Treasury (2019).

2 The wellbeing values for CBAx are provided by the New Zealand Treasury at: https://treasury.govt.nz/publications/guide/cbax-spreadsheet-model-0

3 Ott (2010); Helliwell et al. (2018).

4 Helliwell et al. (2019).

5 McLanahan & Adams (1989); Hansen (2012).

6 Glass et al. (2016).

7 Dworkin (2007).

8 These sorts of thought experiments were also originally made famous by Aldous Huxley's *Brave New World*.

9 Das et al. (2016).

10 For example, the QWI Explorer website is an online tool run by the United States government which provides various indicators by state and region over time. This tool is available at: https://qwiexplorer.ces.census.gov/static/explore.html#x=0&g=0

11 CDC (2018).

12 Engemann et al. (2019).

13 MacKerron & Mourato (2013).

14 Data on green spaces in addition to other data sources are available through the Eurostat website: https://ec.europa.eu/eurostat. Eurobarometer data is available at: http://data.europa.eu/euodp/en/data/dataset/S2070_419_ENG

15 Collins et al. (2013).

16 World Health Organization (2005).

17 Guxens & Sunyer (2012); Marques & Lima (2011).

18 Darçın (2017).

19 Liu & Leiserowitz (2009).

20 Eurobarometer (2016). Data is available at: https://data.europa.eu/euodp/en/data/dataset/S2070_419_ENG

21 World Health Organization (2018). Data is available at: https://www.who.int/airpollution/data/

22 Control variables were selected on the basis of availability in the Eurobarometer dataset and inspired by Levinson (2012).

23 SE = 0.001, $p < 0.0001$; SE = 0.0001, $p < 0.0001$. Additional details are available in the online appendix.

24 These estimates are in line with a previous analysis of air pollution that also identified a decrease of 0.017 points in life satisfaction measured on a 0-10 point scale for every 1 $\mu g/m^3$ PM10 increase in annual air concentration of pollutants. (Orru et al. 2016).

25 A simple fixed effects regression also indicates a significant decrease of 0.007 (SE = 0.002, $p < 0.01$) and 0.005 (SE = 0.002, $p < 0.01$) points for each point increase in $\mu g/m^3$ PM2.5 and PM10 respectively. However, the samples are too small to add all the control variables used before.

26 €5,000 – €4,218 = €782

27 However, it is also important to note these estimates do not account for other pollutants including NO_x and SO_2, nor do they account for the wellbeing burden of deaths due to pollution related diseases. They may therefore be overly conservative.

28 Shi & Yu (2020).

29 Pérez et al. (2009).

30 Raaschou-Nielsen et al. (2013).

31 Luechinger (2009).

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CHAPTER NINE

Putting WALYs into practice

In this report, we have demonstrated how valuing impact through the lens of subjective wellbeing can lead to better policymaking and more impactful investing. Grounding decision-making in subjective wellbeing can reveal uncharted market opportunities and guide innovation to address wellbeing scarcities. Generally speaking, WALYs can be used for two primary purposes: discovery and evaluation. Discovery relies on existing data sources to estimate the potential benefits of proposed interventions while evaluations measure the actual benefits of ongoing interventions. This chapter will provide a step-by-step guide to using WALYs for both ends, including an overview of best practices relating to data, analytical, and experimental methods.

KEY INSIGHTS

- WALYs can be used both for discovery and for evaluation. Discovery utilises existing data to identify expected outcomes of interventions, while evaluation refers to the assessment of ongoing interventions, which ultimately produces new data.
- Future research applying WALYs should go beyond healthcare and investigate how wellbeing is influenced by other crucial domains including: crop health, city infrastructure, or local community support.
- For WALYs to become a global common currency of social impact, insights from the subjective wellbeing literature must be harmonised across domains to enable reliable comparisons. This could be achieved by an open and collaborative Database of Happiness Coefficients that could be used to conduct WALY estimations of past and future potential interventions.
- WALY estimates and underlying methodologies must undergo continuous scrutiny from experts and practitioners to ensure ongoing qualification and refinement.

9.1 Collecting data

Investments and policy decisions should always be made on the basis of strong evidence. Decades of research have revealed valid and reliable ways to measure and track subjective wellbeing in a wide variety of contexts. The first step is to aggregate or collect data from the the relevant groups of interest.

9.1.1 Choosing the right measure

In this report, when collecting data on subjective wellbeing for WALY estimations, we have argued for adopting life evaluations as the primary measure of wellbeing for both theoretical and practical reasons (Chapter 1).[1] Life evaluations have proven to be reliable indicators of wellbeing across domains. They are also easy to implement and quick to administer. The most widely used measure in this respect is life satisfaction, which is typically measured on a 0 to 10 scale from *not at all satisfied* to *complete satisfied*:

- ***All things considered, how satisfied are you with your life as a whole these days?***

9.1.2 Selecting comparison groups

In conducting wellbeing investigations, it is also important to have relevant comparison groups capable of modelling the impact of interventions. For example, in order to measure the impact of curing a particular disease on subjective wellbeing, it is necessary to gather data for patients and healthy counterparts. To ensure the appropriateness of the comparison groups, background sociodemographic information should also be collected including (at least) age, gender, income, employment, and marital status. This way, the potential increase in subjective wellbeing from a particular intervention can be isolated and estimated by controlling all other relevant differences between both groups.[2]

However, collecting huge data samples is often quite very costly. With limited resources, making use of existing datasets is advised. Examples of widely used sources offering data on subjective wellbeing are:

- **Survey of Health, Aging, and Retirement in Europe**
- **English Longitudinal Study of Ageing**
- **German Socio-Economic Panel**
- **United States General Social Survey**
- **US Behavioural Risk Factor Surveillance System**
- **World Values Survey**
- **Gallup World Poll**
- **British Household Panel Survey**
- **Household, Income and Labour Dynamics in Australia**

Utilising existing databases can be useful to determine the expected wellbeing impact of potential interventions as long as they capture the population in question. For instance, as SHARE and ELSA only survey European citizens over the age of 45, it is important not to use these datasets to model changes in subjective wellbeing for younger cohorts.[3]

9.1.3 Additional measures of wellbeing

While obtaining life evaluations is paramount, it may also be worthwhile to incorporate additional measures pertaining to other aspects of wellbeing. In this report, we identified a number of key contributors to differences in subjective wellbeing across patient populations: loneliness, depression, optimism, engagement, vitality, and self-sufficiency (Chapter 6).[4]

- ***How much of the time do you feel lonely?***
- ***How often do you feel left out of things?***
- ***In the last month, have you felt sad or depressed?***
- ***What are your hopes for the future?***
- ***What have you enjoyed doing recently?***
- ***In the last month, have you had too little energy to do the things you wanted to do?***

Recent recommendations have also proposed using measures that capture so called eudaimonic and affective dimensions of subjective wellbeing.[5]

- ***Overall, to what extent do you feel the things you do in your life are worthwhile?***
- ***Overall, how happy did you feel yesterday?***
- ***Overall, how anxious did you feel yesterday?***

While we have presented a model of Wellbeing Adjusted Life Years rooted primarily in life evaluations in this report, understanding changes in these key contributors may help produce a clearer and more nuanced picture of subjective wellbeing in a given population of interest.

9.2 Discovery

For investors or policymakers seeking to track, target, and improve subjective wellbeing, understanding where to direct energy and investment is half the battle. Before experimental methods can be implemented, it is crucial to have a basic understanding of the key determinants of happiness and misery. In this report, we have sought to evaluate differences in wellbeing pertaining to health and pollution. These efforts can be characterised as discovery and rely primarily on regression techniques using existing data sources.

9.2.1 Regression analysis

Assuming that the data being analysed is representative of the target population, linear regressions can be used to estimate the influence of particular conditions on individual subjective wellbeing. This approach can be used to isolate key differences between or within groups while controlling for background conditions and circumstances. In this case, the relevant wellbeing indicator (e.g. life satisfaction) should be used as the dependent variable and regressed on an independent variable of interest using relevant sociodemographic controls (Chapter 3). However, it is important to note that this procedure may not necessarily reveal causal dynamics. The suitability of causal interpretations will always depend on the study design and relevant context.

9.2.2 Converting to WALYs

Finally, once wellbeing differences have been estimated using the methods mentioned above, they can then be converted into WALYs as representations of actual and potential wellbeing. *Actual* wellbeing is considered in terms of the average level of wellbeing currently experienced by the target population, while *potential* wellbeing is calculated by adding the relevant beta coefficient. Formally, this can be understood in terms of the following equation where a is actual wellbeing experienced and p is potential wellbeing: $a = p \pm \beta$.

WALYs can then be calculated by dividing actual wellbeing by potential wellbeing to arrive at average WALYs experienced (3.1) or lost (3.2) per person in a given year. These estimates can then further be multiplied by population sizes to get societal estimates. Additional details and examples are provided in Chapter 3.

$$\text{(3.1)} \quad \text{WALYs}_{\text{experienced}} = \frac{\text{actual wellbeing}}{\text{potential wellbeing}}$$

$$\text{(3.2)} \quad \text{WALYs}_{\text{lost}} = 1 - \frac{\text{actual wellbeing}}{\text{potential wellbeing}}$$

9.3 Evaluation

Claims about the (cost) effectiveness of a technology or intervention to improve wellbeing should whenever possible be supported WALY evaluations. An evaluation of this kind involves the collection of original data to analyse the real impacts of a particular intervention. These are active investigations in which wellbeing is tracked over time in response to or in the context of particular changes in key variables of interest. WALY evaluations can be used to further qualify and inform public decision-making and private investment decisions by enabling fair comparisons of cost-effectiveness between different technologies and interventions. In these contexts, a number of related considerations are called for: what to measure, hypothesis and transparency, and choice of method.

9.3.1 Experimental studies

Preferably, wellbeing data used in WALY evaluations should be collected as part of a randomised controlled trial (RCT). RCTs are scientific experiments that aim to establish causality and identify the effectiveness of an intervention. Participants are randomly assigned to at least two groups: an experimental group exposed to the intervention and a control group exposed to a neutral intervention (i.e. placebo) or no intervention at all. The efficacy of the intervention can then be determined by comparing the wellbeing of both groups before and after the intervention took place.

When using WALYs to evaluate medical technologies technologies, we recommend readers follow guidelines provided by the European Medicines Agency on the use of Patient Reported Outcome Measures (PROMs) and Health Related Quality of Life measures (HRQOL).[6] HRQOL measures can be substituted or complemented by questions on subjective wellbeing and associated domains to evaluate (cost) effectiveness in terms of WALYs.

What to measure

Once again, WALY evaluations should ideally be rooted in measures that capture at least evaluative dimensions of subjective wellbeing such as life satisfaction. Sociodemographic control variables should also be obtained to control for omitted variables and group differences. It may also be appropriate to include additional variables capturing related wellbeing domains including loneliness or self-sufficiency in some contexts as life satisfaction alone may be insensitive to small but relevant changes and differences.[7]

Hypothesis and transparency

In general, WALY evaluations should be driven by preformulated hypotheses, preferably based on previous discovery efforts. Researchers conducting WALY evaluations should also be completely transparent about expected and unexpected effects. This could include relevant changes in associated symptoms including social wellbeing, mental health, and physical functioning. Such an approach ensures that outcomes deviating significantly from expectations can be thoroughly investigated to not only provide insight into the effects of a given intervention, but also to better understand the opportunities and limitations of the Wellbeing Adjusted Life Year as a metric.

Choice of method

When evaluating the effects of an intervention or technology, experimental or observational methods can be used. WALY evaluations could even be based on a synthesis of both. In both contexts, regression methods should be employed whenever possible to uncover wellbeing differences as they adjust for initial differences in baseline values between treatment and control groups. However, for smaller samples or RCT designs, it could be more appropriate to measure the 'Area Under the Curve' (AUC) or 'Change From Baseline' (CFB). In the case of AUC, WALY values could be simply expressed as the difference in average wellbeing levels between experimental and control groups. For CFB, WALY values could be expressed as the average of all wellbeing changes recorded throughout the duration of the study relative to the initial starting point.[8]

9.3.2 Observational studies

Although RCTs are largely considered to be the gold standard of scientific research due to their high degree of internal validity, they may not always be suitable for practical and ethical reasons. These could include interventions targeting adverse conditions that cannot easily be manipulated (e.g. pollution) or those in which the outcome variable of interest (e.g. mortality rate) cannot be captured within a limited trial period. In these situations, observational studies may be appropriate substitutes or supplements to capturing the wellbeing impacts of an intervention. Although in this case there would be no random assignment of study participants into treatment or control groups, wellbeing changes could for instance be evaluated in response to given environmental changes over time in a longitudinal study.

9.4 Next steps

Widespread dissatisfaction with current economic and financial indicators has also already spurred significant interest in developing new ways to measure progress. In this report, we have sought to lay the theoretical and empirical groundwork for a new metric capable of measuring and modelling outcomes in public and private decision-making: Wellbeing Adjusted Life Years. Encouragingly, much of the subjective wellbeing data needed to create the WALY impact assessments is already available at national and international levels.

However, a successful transition to measuring progress in terms of wellbeing requires a number of additional steps. First, further research should seek to contribute domain specific insights in areas that have not been covered in this report. These could include WALY assessments of crop health, city infrastructure, or local community support. Second, it is vital that existing insights from the subjective wellbeing literature are harmonised across domains to enable reliable comparisons. Following recent recommendations provided by Frijters, Clark, Krekel, and Layard (2019), a Database of Happiness Coefficients could be assembled to represent differences in subjective wellbeing due to any number of interventions and used to conduct reliable WALY estimations of past and future potential interventions.[9] Thirdly, and perhaps most importantly, it is crucial that WALY estimates and underlying methodologies undergo continuous evaluation and revaluation from scientific experts and practitioners to ensure ongoing qualification, refinement, and improvement.

All of these steps can be initiated and implemented by investors, policymakers, statistical agencies and scientific experts at public or private institutions. Leaps by Bayer and The Happiness Research Institute are dedicated to bringing together stakeholders committed to improving and supporting wellbeing by offering WALY as a common currency for public and private decision-making. There is every hope that by making WALYs a success, we can foster more impactful investing, better policymaking, and ensure sustainable improvements in subjective wellbeing for all.

Notes

1 This is also in line with recent recommendations by numerous experts across a wide variety of disciplines related to wellbeing. See: VanderWeele et al. (2020).

2 For more detailed information on best practices for measuring subjective wellbeing, see: OECD (2013); VanderWeele et al. (2020).

3 For additional datasets and relevant sources, see Powdthavee (2015).

4 These contributors also align with positive psychology theories of wellbeing and related findings. See: Seligman (2018); Kong & You (2011).

5 VanderWeele et al. (2020).

6 Committee for Medicinal Products for Human Use. (2005).

7 Brazier et al. (2004); Bryan & Longworth (2005); Davis & Wailoo (2013).

8 For additional details regarding impact evaluations, see Impact Evaluation in Practice (IEP) provided by the World Bank. Freely downloadable at: http://www.worldbank.org/en/programs/sief-trust-fund/publication/impact-evaluation-in-practice

9 Frijters et al. (2019).

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