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Quantifying Quality of Life

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Contents:

0. Summary

1. What is quality of life - or what should it be?

2. Ordinal measurement

3. Ordinal measurement of quality of life

4. Cardinal scales and additivity

5. Adding pieces of the good life

6. QALYs

7. Can QoL be added over persons - and should it?

Summary

- The concept of quality of life (QoL) which is most relevant to medical and medico-political decisions is QoL as goodness of life, e.g., the value of a life for the person who lives it.
- Mainly because of the interdependence of values, components of an individual human life cannot be ordered in such a way as to permit a complete and context-free ordinal scale. However, local orderings (given a set of fixed conditions) can often be found.
- Similarly, although local ratio scaling of the desirability of life components using direct ratio estimation seems to be possible, the scales cannot be made complete.
- Ratio scale values assigned by an individual to the goodness of life components by estimation need not always be even locally additive, since there may not exist any principle of composition.
- By statistical means, representations of (something like) the value of life components have been derived, which are locally near-additive and which may be

useful on a population basis (the QUALY methodology). They are however not useful on an individual basis, nor outside the proven domain of additivity.

- The question whether the numbers representing the values of different lives can be added is wrongly put. There is no such thing as a composition of a supra-life from individual lives. The real question is whether the numbers should be added - whether the sum is the morally decisive arithmetical quantity to be calculated here. To this, utilitarianism answers Yes, while egalitarianism answers No.
- The measurement part of QUALY methodology must be kept conceptually apart from utilitarian ethics.

1. What is quality of life - or what should it be?

Few terms have been defined in so many different ways as “quality of life”, and it is futile to search for the one and only correct sense of the term. However, a look at the practical role which the concept is usually expected to play may help us to delimit a sense which is more suited than others for this role. The purpose of the concept is usually to assist in the evaluation of treatment effects and in medical and medico-political decisions, including the setting of priorities. One main aim of treatments and other medical interventions and medical programs is to make people’s lives better for them. Better lives is also one main kind of benefit expected from medico-political programs. So, in the most suitable sense, the concept of quality of life coincides with the value of the life for the person who is living it. High quality of life means having a good life, or a life worth living.

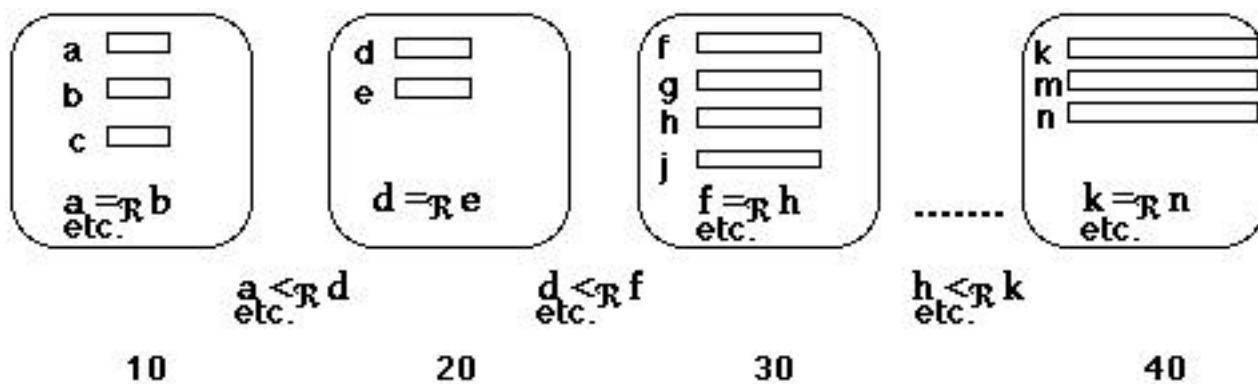
This concept excludes all interpretations of the term “quality of life” in which objective circumstances such as organ function, material standard of living and vocational status are included in the very concept of quality of life (QoL). Even if having a high material standard of living is positively correlated with QoL in a given society, there certainly are people in that society whose lives are better if they choose a lower standard of living. Hence such circumstances may be strongly correlated with goodness of life, and may therefore even be used as indirect measures or indicators of QoL, but they are not components of the goodness of life. Not seldom, certain indicators of quality of life (for example, income and physical functioning) can be measured on a high scale level. This does not entail, however, that QoL itself can be so measured.

When it comes to specifying more closely wherein the goodness of life consists, there are several theories. According to hedonism, the value of a person’s life is a function of how pleasant his experiences are. A second main theory is the desire-fulfilment

theory, which says that goodness of life is a matter of the satisfaction of preferences. For the sake of simplicity, I will here presuppose that one of these theories is the correct one.

2. Ordinal measurement

Suppose that the objects in a domain can be pairwise compared in a certain respect \leftarrow , e.g. their length, so that for all objects **a** and **b** it holds that **a** is less, greater or equal to **b** in this respect ($\mathbf{a} \leftarrow \mathbf{b}$, $\mathbf{a} \succ \mathbf{b}$ or $\mathbf{a} = \mathbf{b}$). (In the case of length, the actual method of comparison could involve putting the objects alongside each other.) Given that the relations \leftarrow etc. fulfil certain conditions, they will order the objects into a series of classes:



The ordering of the objects may now be represented (mirrored) by means of numbers. One possible assignment of numbers in our example is shown (10, 20, 30, 40). This basic kind of quantification is often called “ordinal scaling”. Any assignment of numbers which reflects the same ordering as the original assignment is equally valid. This can be expressed by saying that an ordinal scale allows for any strictly monotonous transformation. Yet another side of this is that the absolute size relations between the assigned numbers do not convey any further information about the domain over and above the ordering. Hence measures such as the arithmetical mean, which make use of absolute size relations, cannot be meaningfully used with ordinal scale data.

3. Ordinal measurement of quality of life

People can be asked to rank components of life with respect to their value for them. This can be done on different levels of analysis in the sense that life components of different complexity can be chosen as the objects of valuation. One might rank isolated components like ordinary goods, or complex chunks of life such as days of life fully specified in certain ways, or even whole lives.

On most choices of level, except the level of whole lives, the resulting rank structure will not be suitable for a complete and context-free ordinal scale. A main reason for this is that the valuation of any one item depends heavily on the presence or absence of other items. One well-known special case of this is known under the name of diminishing marginal value. This case is usually formulated with reference to cardinally quantifiable values, but it has an ordinal counterpart in a certain kind of context-dependency of preference orderings. Suppose that you rank losing (only) your left arm as worse than losing only one eye. Still, given that one eye has already been lost, you may rank losing the second eye as worse than losing the arm. There is then no order between “losing an eye” and “losing (only) the left arm”, which could be represented on an ordinal scale.

Hence the formal conditions for ordinal scaling of the value of life components are at most satisfied locally, with certain background conditions fixed. The prospects may be brighter if we move to higher levels of complexity. Maybe alternative whole lives can be ranked in a formally satisfying way? However, what we win in completeness will be lost in generalisability to other cases: even if a number of lives have been consistently ranked, there is no natural method to infer the ranking position of another life not belonging to the original set. The ranking of isolated items, on the other hand, opens the prospect of somehow calculating the value of the “new” life from the values of its components (which, hopefully, it shares with other lives). Therefore, ordinal scaling of the goodness of life components is a proper thing to attempt even if it can only be achieved locally.

4. Cardinal scales and additivity

Cardinal scales represent more aspects of the domain than the ordering. On a ratio scale, the ratio $v(\mathbf{a})/v(\mathbf{b})$ between the numbers assigned to the objects \mathbf{a} and \mathbf{b} represents some real relation between \mathbf{a} and \mathbf{b} . In one class of cases (e.g., length) this relation may be thought of as involving the aggregation of a number $v(\mathbf{a})$ of unit objects to form a complex object which is equal to \mathbf{a} with respect to \leftarrow , while another number $v(\mathbf{b})$ of units are required to form an object equal to \mathbf{b} . In other contexts the represented operation is intuitively more analogous to arithmetical division; it may for example be the immediately judged proportion or share of \mathbf{b} , with respect to \leftarrow , which is felt to be taken up by \mathbf{a} (“How intense is the pain \mathbf{a} , expressed as a share of the intensity of \mathbf{b} ?”).

The only transformations of a scale which preserve ratios are multiplications with a constant. Ratio scaling requires rather strict formal properties of the domain, which have however been shown to hold at least approximatively and locally for certain psychological estimates of the mentioned kind (“direct ratio estimates”).

In an additive scale, equalities and inequalities involving addition represent analogous relations in the domain. Hence additivity presupposes some kind of aggregation or composition of the objects. Length is additive with respect to a certain way of placing objects together: if **a** is placed in the required way together with **b**, then the length $v(\mathbf{a} \bullet \mathbf{b})$ of the composite object $\mathbf{a} \bullet \mathbf{b}$ is the sum $v(\mathbf{a}) + v(\mathbf{b})$ of the respective lengths of **a** and **b**. A scale may be additive with respect to one operation \bullet and non-additive with respect to another: if the objects are placed alongside each other, additivity of lengths does not hold.

All additive scales are ratio scales, but the opposite does not hold since ratio scaling does not presuppose any real composition operation in the domain. For example, there might be a direct estimation ratio scale for the intensity of headaches even if the idea of a headache which is composed of two headaches is without meaning.

5. Adding pieces of the good life

Using an extension of the argument from section 4, it can be shown that the goodness of parts of life, as measured for example by means of the mentioned direct ratio estimation procedure, is not generally additive with respect to conjunction. Even if losing either leg (but only one) is estimated to have exactly half the negative worth of losing (only) the left hand, it may still be the case that losing both the left leg and the right leg is regarded as worse than the loss of the hand. These relations cannot be represented by an additive assignment of values to the events “losing a leg” and “losing the left hand”.

There are other possible ways of arriving at additive measures of the goodness of parts of life, e.g. the so-called time-trade-off method. The subject is here asked to judge, concerning a certain kind of life, how big a share of a year of a really good life would be as desirable to him as one year of such a life. Since time is certainly measured on an additive scale, it is tempting to conclude that time-trade-off automatically delivers an additive scale for the goodness of a life - i.e., for quality of life.

The situation is not that simple, however. If there is an additivity, it must hold with respect to composition over time, and there are reasons to believe that composition of similar life segments over time involves decreasing marginal value and other non-orderly phenomena. It might be objected that what the person should be required to match with a share of a perfect year is not the specific contents of the present year, but this year with respect only to its quality. Changing marginal values may now seem to be excluded by the method. But let us again consider composition. Suppose

that a person has judged that the value of one year, having the quality of the next but last year and expressed in perfect-year equivalents, is $v(\mathbf{a})$, and that the corresponding value of the very last year is $v(\mathbf{b})$. It seems that he might still judge that the perfect-year equivalent of two years of life, having the respective qualities of the last two years, is not $v(\mathbf{a}) + v(\mathbf{b})$!

6. QUALYs

In the QWB-QUALY method as described by Kaplan (Kaplan, R M. *Using quality of life information to set priorities in health policy*. **Social Indicators Research** 33, 1994, 121-163), each of a number of symptoms complexes and each of a number of functional states (belonging to three different dimensions) is associated with a weight. The weights can be thought of as negative values. They were derived from the direct ratio estimates performed by a fairly large population sample. The subjects estimated the values of different days of life, characterised by different combinations of symptom complexes and functional states, in comparison with a day of perfect health. By means of statistical analysis using an assumption of additivity, hypothetical negative values of the individual symptom complexes and the individual functional states were then extracted, which could be shown to approximately explain the estimates of the population sample.

The method is meant to be used for calculating, in the following way, the value of a period in a person's life from his symptoms and functional states. For each day, the weights for his leading symptom complex and for his three functional states are added. The sum is subtracted from 1. The result is scaled with the length of the period and expressed as QUALYs, quality adjusted life-years. Typically, QUALYs are used to assess the cost-benefit ratio of a treatment by comparing its cost per patient with the mean gain in QUALYs.

The non-individual character of QUALY analysis is emphasised by the fact that the life of each individual involved in any application of it is assigned a value not on the basis of his judgment, but on the basis of the statistical data. Another limitation of QUALY analysis is that only the dominant symptom is taken account of. In populations with severe complex conditions, the analysis will therefore tend to overestimate quality of life. It is a complicated task to improve the model on the latter point, since additivity of the weights should not be expected to hold true for combinations of symptoms within a large range of complexity.

7. Can QoL be added over persons - and should it?

Since QoL, measured in either of a number of ways, is arguably locally (and approximatively) additive with respect to aggregation of goods or life segments in a

person's life, the question is sometimes raised whether QoL is additive over persons. This is however a pseudo-question, since additivity is relative to a real-world composition operation and no such composition operation exists for combining different lives.

Whether one should add the numbers representing the values of different lives is mainly an ethical question. If, for example, we want to maximise the sum total of these numbers, then we should of course add the numbers. If equal distribution of good is our ethical norm, or if we want to give priority to those worse-off, we should not use simple addition but give the lives of the worse-off a higher weight in the calculus. In this way, each ethical standpoint becomes associated with its own specific version of cost-benefit calculus.

One major problem of a theoretical and non-normative nature is involved here, namely, intersubjective comparability. Maximising the sum of the different "goodness numbers" maximises goodness only if goodness is measured in the same real units for all different lives. This is certainly not the case with the present QALY method which by fiat sets the value of any fully healthy life to 1. Proponents of egalitarianism and other ethical norms of course face the same issue.

Using an understatement, it is not an easy problem to solve how to guarantee intersubjective comparability. However, this and other remaining methodological questions associated with the QALY methodology could and should be discussed as separate from the ethical issue, how the lives of different persons should be weighted when a medical or medico-political decision is to be taken. A true QoL measure which is locally additive within lives is a good thing to have, and searching for such a measure need not entail a commitment to utilitarianism.

[Top of page](#)

[Back to Texts page](#)