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THE UTILITY OF HEALTH AT DIFFERENT STAGES IN LIFE: A QUANTITATIVE APPROACH

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Abstract—Thirty students and thirty-five elderly people compared the quality of life of imaginary patients of different ages suffering from end-stage renal disease. By manipulating the time the imaginary patients had to be on a transplantation waiting list, the utility of health at different periods of life could be compared. Except for the very young, respondents found health in the early periods of life to be twice as important as in the last decade of life. Health at age 35 had an utility somewhere between these two extremes. The responses of the elderly people showed remarkable resemblance to the students' responses, suggesting that the results reflect a general ethical standard. The values found were tested by means of a factorial design and found to fulfill the qualifications of an interval scale.

Key words—utility measurement, quality of life, QALY's, age

INTRODUCTION

In a Quality Adjusted Life Years analysis (QALY analysis) the number of life years gained by a health care program is multiplied by the utility of quality of life. This index for the quality of life can have a value between one for the best health state and zero, or even a negative value, for the worst health state. By calculating the cost per QALY, it is possible to compare different health care programs in terms of efficiency. Some authors, like Harris [1] and Donaldson *et al.* [2], claim that allocation decisions in health care based on QALY analyses provide results unfavorable for the care of the elderly. Harris has the following train of thought. Older patients have fewer years to live, thus their cost-per-life year gained by health improvement activities is higher than for younger patients. As a result, it is more efficient to invest in health care programs for the young than in health care programs for the elderly. Harris is concerned about the distributional consequences of this utilitarian way of thinking. Harris proclaims that it is more ethical to apply an egalitarian distribution system in which every patient gets his or her share, irrespective of the age of the patient.

In the debate about the distributional consequences of the QALY approach, many authors have argued that the QALY model has utilitarian roots but also egalitarian characteristics [3–6]. The QALY model values health on an equal basis for all people, without considering that health may have different utilities for different people. In other words, every QALY is equal, irrespective of the characteristics of the patient. For instance, a QALY gained by an elderly patient is equal to a QALY gained by a young patient. In this sense the QALY model is not utilitarian but rather egalitarian; it ignores differences in preference that may exist in the general public. Without questioning the ethical implications, it is relevant to discover whether this egalitarian aspect of the QALY model represents real preferences of the general public. From Wright's investigation in 1986 [7], one can conclude that these differences in preference for health at different ages may exist in the general public. Wright asked his respondents to indicate which period of life would be the most important period for people to be healthy. Two periods of life stood out, namely 'infancy' and 'the period of raising children'. From this finding one can conclude that health in different periods of life has a different utility and thus the egalitarian aspect of the QALY model is not a representation of real preferences in society.

A remarkable finding from Wright's study was that older people did not assign a higher utility to the later stages of life. One might expect that older subjects would select later stages of life as the most important because of egocentrism or self-interest [6]. In Wright's inquiry there was some evidence that such a relationship exists, but the nonparametric correlation coefficient showed that it was very weak ($\rho = 0.08$, $P = 0.055$).

A shortcoming in Wright's investigation was that he did not quantify the differences found in the utilities. The investigation described in this article tries to quantify the ratio between these differences in utility. A starting point in our investigation was that respondents had to be aware that they were dealing with a situation of scarcity. This was thought to be of utmost importance because QALY analyses are used in a context of scarcity rather than in situations in which there are enough resources. In order to create an experimental situation of scarcity, scarcity was not defined in terms of money, but in terms of donor kidneys. This had the advantage that the imposed scarcity could not be eliminated by allocating resources from other public services. Moreover, the scarcity was easy to manipulate by varying conceptual factors such as blood groups and waiting lists. Also, because of the public discussion in The Netherlands about the scarcity of donor organs, people are familiar with this form of scarcity in health care, which makes choosing between patients realistic.

Froberg and Kane [8] advocated to test whether the responses of the subjects can be scaled on an interval level, or that the subjects can only give ordinal responses by a method called 'parallelism'. The basic idea of parallelism is that if one moves the reference point on the scale, all values on the scale should move in the same direction and with the same proportion.

The following hypotheses were formulated: (1) There is a negative relation between the utility of health and age. (2) Preference of respondents is independent of the respondent's age. (3) The responses given by the subject, under the condition of different reference points, are sufficiently parallel to assume responses on an interval level.

METHODS

The interview

The hypotheses were tested by means of an interview with students and elderly people. The interview began with a description of the problems of patients with renal failure. Respondents were then asked to imagine that they were a hospital director. In this imaginary function, they were asked to advise a doctor in the following situation. Two patients with renal failure have an identical medical condition, have been ill for the same period of time and will both reach the same age. The patients differed only in age; one was 35 years old, the other 60 years old. If the patients would be transplanted, both patients would return to a normal health state. Respondents were told that scarcity of donor organs limited the possibilities to operate on only one patient. Therefore, one of the two patients would have to wait for the next opportunity. Because both patients had the same rare blood group, this opportunity for a transplant would be 2 years later. Respondents were also told that the operation would not influence the life span of the patient. Both patients would reach the same age independent of the time of transplantation. In this way the respondents had to choose between a quality of life improvement for the young patient and a quality of life improvement for the older patient. This choice is made visible in Fig. 1.

After each respondent had chosen between the two patients, the imaginary situation was changed. The respondent was told that the patient who had been chosen to be operated on first, had a less rare blood-group. Therefore, this patient had to wait for only 1 year for a new chance, if he/she was not operated on immediately. On the other hand, the patient who initially had to wait, still had to wait for 2 years. So the respondent had to make a trade-off between the utility of 2 years of illness for one patient and 1 year of illness for the other. In order to facilitate the interview, the choices were visualized on cards. Decreasing the period of illness of the preferred patient did continue (using continuously halving), until the respondent changed his/her preference. Like time trade-off, this 'switch point' indicates the ratio between the utility for a 'decrease' in health at the age 35 (U_{35}) and the age 60 (U_{60}). In order to arrive at the ratio of the utility of health at different ages two assumptions were made. The first assumption is that the ratio of the utility for a decrease of health is the same as the ratio for the utility of health itself. The second assumption is that the real switch point or point of indifference is located somewhere between the two different responses. The point of indifference, which served as the raw data for the analyses, was defined as the switch-point minus one half. So if the respondent changed preference after 3 times of halving, the point of indifference was located at 2.5 halvings. Appendix A shows that this is a good approximation independent of the assumption that utility is constant over age. Respondents had to indicate the ratio's of:

U_{35} and U_5
U_{35} and U_{10}
U_{35} and U_{60}
U_{35} and U_{70}

U_{60} and U_5
U_{60} and U_{10}
U_{60} and U_{35}
U_{60} and U_{70}

It can be seen that the subjects performed the task two times. One time they used the age of 35 as a reference point and the other time the subject used the age of 60 as a reference point. This was done in order to get the 'parallel measurement' which tests if the scale satisfies the criteria of an interval scale.

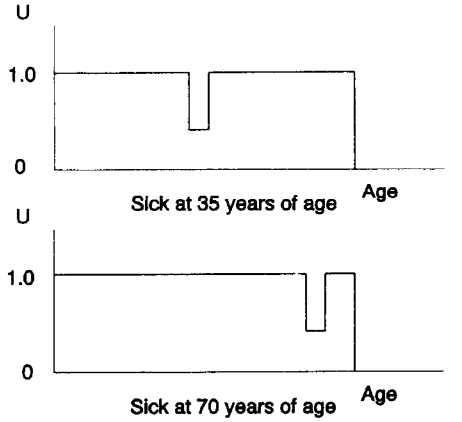

Fig. 1. Comparing the utility of being sick at age 35 with the utility of being sick at age 70.

When respondents needed more than four halvings, the response was judged to be an 'absolute choice'. This was because four halvings would already mean a ratio of 1 to 0.0625 and one could easily doubt if the respondent still made a trade-off in time between the patients. If the respondent made such an absolute choice, then the subject probably did not understand the task and then the response must be judged as invalid. Another reason for an absolute response might be that the respondent applied a very simple allocation model, in which the younger patient always has priority over the older one (or the other way around). Absolute responses made on the basis of this simple model of age do not fit in the QALY model and are, therefore, excluded from the analyses.

Respondents

To test the hypothesis that the preferences are independent of the age of the respondents, two different populations were interviewed; students and elderly people. The students were recruited by posters at the university and were paid 10 Dutch guilders (about $6.00) as payment. The older respondents were selected from four institutions for the elderly. The staff of the institutions were asked to make a list of residents with good mental capabilities and who were still socially active. This selection was made in order to match the elderly with the students in terms of cognitive functioning, and to assure that the answers of the elderly would not be a reflection of resignation. The elderly were approached in three different ways: by means of a poster in the corridor of the institution, by means of a personal letter, or by being asked personally by the staff. The elderly were given a bouquet of flowers, a traditional gift of appreciation in The Netherlands, to thank them for their cooperation.

RESULTS

Respondents

Thirty students (mean age 23.6, SD 2.7) and 47 elderly (mean age 79.0, SD 8.3) were questioned. There were no problems recruiting the students. The cooperation of the elderly depended on the way they were approached. The more personal the initial approach, the more inclined the elderly were to participate. When the visit of the researcher was announced by a poster in the corridor, 19 (46%) of the 41 elderly were willing to cooperate. Of the 23 elderly who received a personal letter, 18 (78.3%) reacted positively. None of the 8 elderly who were asked by the staff refused to participate.

Number of valid responses

Of the total 240 responses given by the students, there was only one response that had to be classified as an absolute choice, which means that the trade-off needed more than four halvings. The elderly had more problems with the interview. Seven elderly could not understand the interview, three elderly only made absolute choices and two elderly refused to accept the hypothetical situations suggested by the investigator, but could clearly understand the questions. These twelve respondents (25.5%) were excluded from the analyses. Five of the elderly, in addition to their valid responses, also gave a total of 14 absolute choices. Of this group the absolute choices were excluded from the analyses. After these exclusions, 35 elderly were included in the analyses, with a total of 266 responses.

Table 1. ^{2}Log of the ratios of utility of health at different ages*

	Students			Elderly		
Ratio	$(\Sigma\,^2\log)/n$	SD	N	$(\Sigma^2\log)/n$	SD	N
U_5/U_{60}	0.67	1.17	29	0.74	1.03	33
U_{10}/U_{60}	1.07	1.07	30	0.92	0.94	33
U_{35}/U_{60}	0.37	1.11	30	0.59	0.83	34
U_{70}/U_{60}	−0.13	1.10	30	−0.13	0.92	34
U_5/U_{35}	0.53	1.33	30	0.03	1.13	34
U_{10}/U_{35}	0.90	1.00	30	0.37	0.88	34
U_{60}/U_{35}	−0.40	1.12	30	−0.62	0.96	33
U_{70}/U_{35}	−0.50	1.41	30	−0.56	1.26	31

*The ratios are presented as ^{2}log, because the raw data were halvings.

Data analysis

The mean ratios between the utility of health at different ages are presented in Figs 2–5. The Y-axis represents values on a ^{2}Log-scale. An increase of 1, therefore, means a doubling and a decrease of 1 a halving. Through the log transformation, the Y-axis has more similarity with the responses which were doublings and halvings. The ratio of health at the age of 60 years in Fig. 2, and for the age of 35 years in Fig. 3 are theoretical values because a trade-off between the utility of health of a person of 35 years of age and another person 35 years of age is one by definition. The standard deviation and the number of valid observations are given in Table 1.

In Fig. 2 the utility of being in good health at 5, 10,

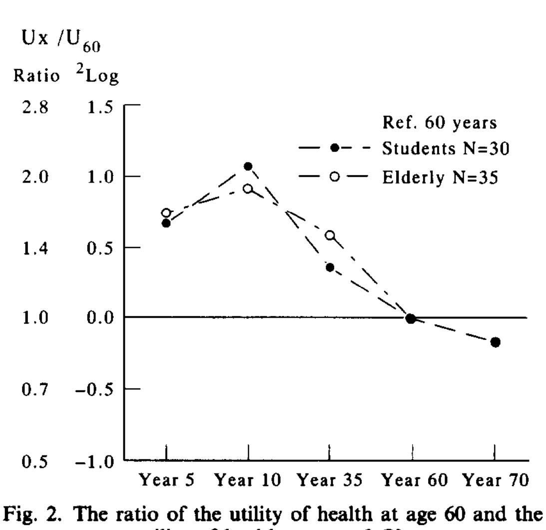

Fig. 2. The ratio of the utility of health at age 60 and the utility of health at ages 5–70.

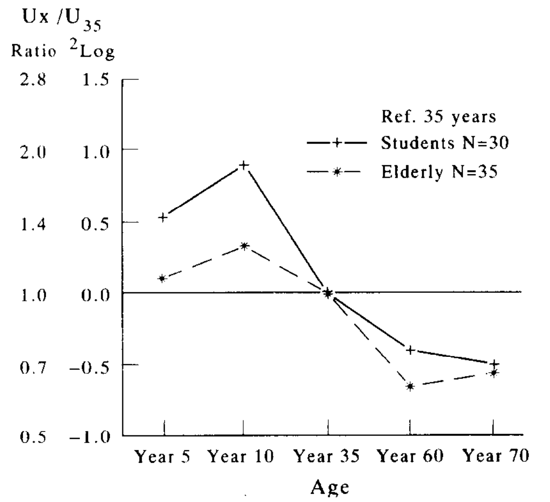

Fig. 3. The ratio of the utility of health at age 35 and the utility of health at ages 5–70.

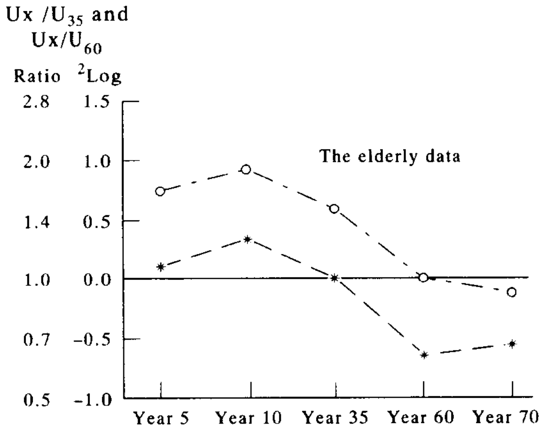

Fig. 4. Testing parallelism; the two utility ratios with different reference points.

35 and 70 years of age is compared with being in a good health at 60 years of age. The utility of health at the age of 10 is valued twice as high ($^2\log 2 = 1$) as being in a good health at the age of 60. The utility of health at higher ages decreases relatively, and finally the utility drops below the value of health at 60 years of age. This pattern emerged from both the responses of the students as well as from the responses of the elderly. In both cases the pattern differences from the straight line $U_x/U_y = 1$ ($P < 0.000$). Such a straight line would mean that there would be no differences between the utility of health at a different age. The same pattern can be seen in Fig. 3 where the utility of health at different ages is compared with the utility of being in good health at 35 years of age.

The close resemblance of the responses of the elderly and the students is remarkable, particularly in Fig. 2. There were no significant multivariate differences between the elderly and the students ($P > 0.20$) in either figure. When tested univariately, only one difference between the responses of students and elderly was significant (U_{10}/U_{35} Fig. 3, $P = 0.029$, two-tailed).

Another remarkable aspect of the figures is the declining utility of health at 5 years of age compared to the utility of health at 10 years. Differences between these two utilities were significant ($P < 0.05$) for the student population in Figs 2 and 3. The effect is not significant in the population of the elderly.

According to the methodology called parallelism [8] respondents make judgements on an interval level, if the choice of the reference year does not make any difference, apart from a constant effect. In Figs 4 and 5 the results of the parallel measurements are presented split up by the population of respondents. At first sight, the lines appear almost parallel. A MANOVA on the difference scores (the mean difference score for students was 0.3239 and 0.5463 for the elderly) shows no significant multivariate life period effect for both populations ($P > 0.20$). This indicates that the difference is constant over the life span and that there is no interaction between the two lines. Therefore, the assumption of an interval scale cannot be rejected.

DISCUSSION

The different utility of health at different ages could have several explanations. First, it might be possible that health at a younger age has a higher utility because it has influences on the development of the patient. Therefore, disease at a younger age had not only immediate consequences, but has also consequences for the future. A second reason might be that at mid-life, one has more responsibility for others, e.g. children. A third reason might be that younger people are seen as more valuable for society, because the benefits for society of the young are higher than the benefits of the elderly.

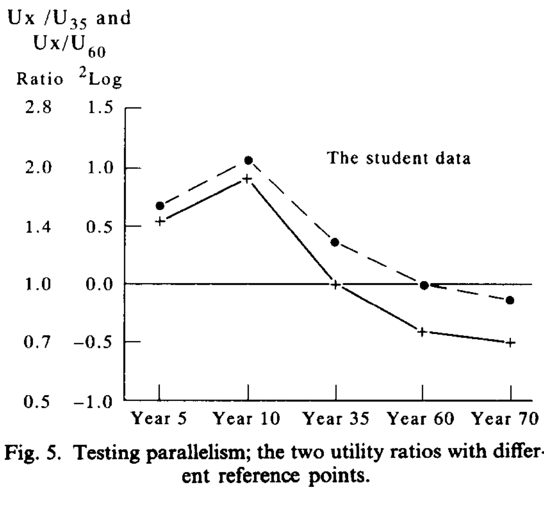

Fig. 5. Testing parallelism; the two utility ratios with different reference points.

The students indicated that health at the age of 5 is less important than health at the age of 10. During the interview, some subjects gave the following explanations. They believed that younger children suffer less from their diseases than older children, because younger children would be less aware of their abnormality. Also they believed that at the age of 5, it would be easier to make up school absences, than at the age of 10.

The hypothetical scarcity situation was created by suggesting that donor organs were rare. At the onset it was thought that this situation might be too repulsive for the subject to work with. However, in practice it was not difficult to persuade the subjects to accept the conditions of the forced choices. Most difficulties seemed to arise from cognitive limitation of the elderly.

The inclusion of the absolute choices in the analyses would mean that it is no longer possible to work with parametric statistics, because some absolute responses have an infinite value. In the student population the impact of the exclusion of the absolute choices is rather low because only one out of 240 responses could be classified as an absolute response. Absolute responses were more numerous in the elderly population. Three elderly gave only absolute responses (a total of 24 responses) and 5 elderly gave, besides valid responses, a total of 14 absolute responses. Of the total 38 absolute responses, 32 favored the young patient. This means that the direction of the absolute responses was in agreement with the results mentioned above. Absolute responses could be interpreted as representing the grey area between understanding and non-understanding because they simplify the trade-off.

The use of halvings to formalize the trade-off has two important advantages. The first advantage is that the interview is more standardized than when the interview is done without a formalized trade-off like most investigations using time trade-off and standard gamble. The higher the standardization, the higher the reproducibility of the experiment. The second advantage is that the point of indifference is not indicated directly by the respondent, but is derived from the switch points. This speeds up the interview because near the point of indifference, a respondent typically is in doubt. Working with formalized trade-off might provide opportunity for mass administrations with the aid of computers.

A conservative estimate would be that being healthy during childhood is about twice as important as being healthy during the last period of life. The utility of health at the age of 35 is likely to be located somewhere halfway between these two extremes. The utilities according to the student population resemble closely to the utilities given by the disadvantaged population, namely the elderly. This is a strong indication that the utilities for health found in this investigation belong to a value system that exists throughout the whole population. It is important to realize that this is not the only value system for health that can influence decisions in health care. Policy makers have also the responsibility to guarantee rights which are derived from other value systems such as the equal access to health care. In this investigation these other value systems were put aside, in order to create an experimental situation in which the influence of age on the utility of health could be measured.

The results of this study show that respondents judged the utility of health to be dependent on the age of the patient and this might have consequences for the QALY analysis. People value health to be twice as important for a 10 year old than for a 60 year old person, yet the health utility index in a QALY analysis is the same. This is what Culyer called 'QALY egalitarism' [3]. The QALY analysis creates differences among people on the basis of effectiveness to cure, but on the other hand, the QALY analysis forces an equality between other qualities of people, such as the time of life people are confronted with disease. Without an age correction, the QALY analysis is, according to our findings, more egalitarian than judgments of the general public imply.

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APPENDIX A

Estimating the Age-Specific Utility Loss Ratio

Let—for a given person—$D(a)$ be the utility loss perceived between being healthy at age a and having the disease at age a.

The accumulated utility loss $L(a, T)$ in a period T starting at age a and therefore ending at age $a + T$ can, strictly speaking, be computed as the integral over time of $D(t)$ for t ranging from a to $a + T$. A good approximation (if the decrease of utility as a function of age is not too wildly varying, which is a very sensible assumption when T is not too large) is, however, given by

$$L(a, T) = D(a) * T. \quad (1)$$

We have to determine the age specific utility loss ratio for ages a_1 and a_2

$$R(a_1, a_2) = D(a_1)/D(a_2) \quad (2)$$

which is performed by asking people to compare the accumulated utility losses for both ages, by the method of successive halving the period considered. That is, if the respondent rates $L(a_1, T)$ to be larger than $L(a_2, T)$, he is asked to compare the accumulated losses when for a_1 the period considered is halved, i.e. to compare $L(a_1, T/2)$ with $L(a_2, T)$, and so on for a series of continuously halved periods $T(x)$, where

$$T(x) = T * 2^{-x}, \quad x = 0, 1, \ldots . \quad (3)$$

Let m be the smallest number such that it simultaneously holds that

$$L(a_1, T(m)) > L(a_2, T) \quad (4a)$$

$$L(a_1, T(m + 1)) < L(a_2, T). \quad (4b)$$

We infer that at some point between m and $m + 1$ there is an indifference point i such that

$$L(a_1, T(i)) = L(a_2, T). \quad (5)$$

Substituting equations (1) and (3) into (5) we get

$$D(a_1) * T * 2^{-i} = D(a_2) * T. \quad (6)$$

Using equation (2) we see that equation (6) implies

$$R(a_1, a_2) = 2^i. \quad (7)$$

Now a good approximation of i should be $m + \frac{1}{2}$, so we finish with the result

$$R(a_1, a_2) = 2^{m+1/2}. \quad (8)$$

Notice that the method is not depending on an assumption that the utility of health is constant over age.