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Central European Economic Journal

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Value of Life Year and Cost-Effectiveness Thresholds: The Case of Poland

Abstract

Objective: The objective of this article is to examine how people value two different attributes of Value of Life Year (VOLY): life expectancy and the quality of life. The results of the first VOLY estimations conducted in Poland are discussed and compared with Polish cost-effectiveness thresholds for medical treatments in the period 2008–2020.

Methodology: The Discrete Choice Experiment (DCE) method was used to value two attributes of VOLY: increase in life expectancy and improvement in the quality of life.

Main findings: The VOLY research was conducted in two populations: general and dialysis. Depending on their current health status, people value increased life expectancy and improvement in health quality differently. In light of these results, the VOLY should be differentiated. Also in the Quality Adjusted Life Year (QALY) indicator, the weights of the attributes of length and quality of life should be varied according to different states of health.

A uniform cost-effectiveness threshold is not justified from the perspective of stated preferences. Cost-effectiveness thresholds based on demand-side values should be differentiated.

Current Polish cost-effectiveness thresholds are overestimated compared to valuations based on stated preferences.

Contributions: The article presents the first estimations of two attributes of VOLY: life expectancy and the quality of life, carried out in Poland.

Keywords

Cost-Effectiveness Threshold | Discrete Choice Experiment (DCE) | Quality Adjusted Life Year (QALY) | Value of Life Year (VOLY) | Value of Statistical Life (VSL)

JEL Codes

Q51; I18; D12

1. Introduction

'How much is a human life worth?' 'Is it possible to estimate this?' 'If so, how and on what basis?' These questions are not only asked by students of philosophy. Many would like the answer to be: human life is priceless. However, this answer is of no use to anyone and is not in line with reality: 'While some declare life priceless, and many assert that all lives should be equally valued, we live in a world that constantly assumes the opposite' (Friedman, 2021, p. 175). Human life is constantly assigned a value in many everyday situations: in courts, by automotive specialists, pharmaceutical and insurance companies, and finally by the executive and legislative authorities at various levels. This is why the valuation of life is a recurring subject of discussion and controversy among economists and non-economists.

Attempts to assign a monetary value to health and life are much more controversial than estimating the value of other non-market goods such as: clean air, virgin forests or unpolluted water. Those opposed to the monetary valuation of health and life, who in the main are not professional economists, emphasise the priceless value of health and life. On the other hand, defenders of life valuation argue that its abandonment is not tantamount to treating life as a supreme value, primarily because the idea of saving life at all costs is in practice confronted with a budget that is limited for this purpose, just as for all others.

Differences of opinion on this subject are often the result of lack of knowledge about the meaning of the Value of Statistical Life (VSL) or the Value of Life Year (VOLY) gained, as well as a lack of understanding of the purposes for which scientific research is carried out, and what its practical applications are. Although an

increasing number of scientific and popular-science articles concerning life valuation are being published, this has not led to any subsiding of the debate between supporters and opponents. In the health care sector, the problem of a reliable valuation of VOLY arises in the context of polemics over the validity of the cost-effectiveness thresholds for particularly expensive and rare therapies. In such situations, it is worth assessing the value of a life year gained in order to compare it with the thresholds.

The findings of the first VOLY studies conducted in Poland in 2006 and 2008 provide the basis for a number of general conclusions to be drawn. One of these is that people value life expectancy and quality of life differently depending on their health status. This justifies the recommendation that cost-effectiveness thresholds based on demand-side values should be differentiated. Furthermore, the VOLY should be differentiated according to varying states of health. The implementation of a uniform cost-effectiveness threshold is not justified from the perspective of stated preferences. In the light of these factors, the Quality Adjusted Life Year (QALY) indicator turned out to be a significant simplification. The weights of the attributes of length and quality of life should be also differentiated in this measure. Additionally, the current Polish cost-effectiveness thresholds are overestimated compared to valuations based on stated preferences. This is another important conclusion presented in this article.

This article argues for the implementation of stated preference methods in the valuation of human health and life as an important part of demand-side empirical research. The focus of discussion in what follows is the health care sector and a comparison between VOLY values and the cost-effectiveness thresholds used in Poland in 2008–2020. The subject discussed here is also important in the context of new challenges arising from the Covid-19 pandemic. A crucial objective should be increasing social awareness that the valuation of health and life is in the best interest of all parties in society.

2. VOLY Based on Stated Preference Methods

'Money is not an embarrassing addition to an objective economic analysis which shows real social preferences in relation to the decisions we make every day. On the contrary, 'money is a key instrument without which we cannot answer the question of what people really want' (Żylicz, 2014, p. 68). Economists undertake statistical health and life valuation to facilitate informed economic evaluation. Value expressed in monetary terms is essential to cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA). It enables the cost-effectiveness of projects to be calculated and compared, so that the most effective option can be selected.

The results of such analyses are crucial for the decision-making process. In the following sections, two examples are given from the first VOLY valuations carried out in Poland: one in the context of air pollution reduction (2006) and the other in the context of health care (2008).

The VOLY measure allows us to assess the cost-effectiveness of health care programmes and to verify the suitability of the cost-effectiveness thresholds used in Poland. In 2008, the threshold amounted to 60,000 PLN[1], calculated as the cost of 1 year of dialysis therapy, while in 2012 it amounted to nearly 100,000 PLN, calculated as three times per capita GDP. In 2016, the figure thus calculated was approximately 150,000 PLN, and currently, according to the data for 2020, it is over 173,000 PLN. There is no scientific explanation as to why three times GDP should be the optimal threshold in Poland; so, it is reasonable to compare this level with the VOLY obtained from studies based on stated preferences.

Valuation methods depend on the context, the purpose of the valuation and the scenario adopted. A person who assigns a value to their life, for example in the context of their sudden death and the need to provide for their family, will value their life in a different way than the government, which estimates the price of life in the context of various kinds of disasters. Thus, there are many methods of calculating the value of a statistical human life. This value is not always determined arbitrarily by experts or government officials. Sometimes, people are asked about the value of life directly in surveys. For example, respondents are asked how much they would need to be paid (Willingness To Accept, WTA) to do a very risky job that endangers their lives, or how much they would be willing to pay (Willingness To Pay, WTP) to reduce the probability of dying prematurely of cancer by 1/10,000, or, more generally, to gain a certain increase in life expectancy. Questions such as these

1 In 2021, 1 PLN ≈ 0.22 EUR ≈ 0.26 USD.

form the basis of stated preference valuation methods, which were used in the Polish studies described in this article.

In the valuation of a statistical life based on the Contingent Valuation Method (CVM), two approaches are distinguished according to the adopted scenario. The first is based on the VSL, the second on the VOLY directly. VSL is useful when the programme effect is expressed directly by a change in the mortality rate of a given population. Appropriate interpretation techniques applied to the VSL index allow the value of additional life years gained to be assessed. The VSL reflects only a person's WTP to reduce the risk of death and it does not take into account their life expectancy.

There are two approaches to measuring the remaining years of life using stated preferences methods. One of them, as just mentioned, is derived from VSL and requires no additional research. The VOLY = VSL/A, where A is the discounting factor for the remaining years. The alternative approach based on the direct VOLY concept is a method that determines WTP for an increase in life expectancy. One of the first such studies using the CVM method was conducted in Sweden (Johannesson &Johansson, 1996). A similar study was carried out in Poland in the context of reducing air pollution in 2006 (the New Energy Externalities Developments for Sustainability (NEEDS) Project). In a subsequent study in 2008, in the context of health care programmes, the Discrete Choice Experiment (DCE) method was used to estimate two attributes of the VOLY indicator. Sometimes, the concept of CVM is used as a synonym for an entire class of methods of this type, including DCE (Carson, 2012).

The VOLY concept can be also used for QALY valuation. QALY is a measure of disease burden, embracing both the quality and quantity of life. It is a standard unit which is calculated by multiplying life years by a factor which reflects health preferences (Drummond et al., 2015). This ratio ranges between 0 (death) and 1 (perfect health).

Recognising the main advantage of the QALY coefficient, namely that it allows a total assessment of the quality of life expectancy, environmental and health economists have made attempts to use it for research into health effects in their respective fields. A study which could constitute a further step in the valuation of health effects would be to test the validity of the assumptions behind the QALY and assign qualitative and quantitative attributes, differentiated on the basis of social preferences instead of merely assigning equal weighting. Such conclusions about the differentiation of weights are derived from the Polish study on VOLY valuation in the context of health programmes.

3. VOLY in the Context of Air Pollution

The first Polish VOLY valuations were carried out in the context of air pollution reduction programmes (NEEDS, 6th Framework Programme of the EU, http://www.needs-project.org/) using a CVM. The main study was conducted in 2006 on a sample of 150 Warsaw residents. The hypothetical scenario envisaged an increase in average life expectancy (for the population as a whole) as a result of specific air quality improvement programmes. A key element of the survey was the question concerning the amount of money the respondent would be willing to pay to achieve a given increase in the expected (population average) life expectancy. The declared amounts of WTP were the basis for calculating the VOLY value.

The results obtained were approximately 32,000–43,745 PLN and 49,000–70,370 PLN, depending on the calculation formula used. Despite the relatively small sample, it was suggested that the results could be used in cost-benefit analyses (CBA) in the fields of environmental and health protection (Desaigues et al., 2011). The values obtained were compared with the cost-effectiveness threshold which, as explained above, was then approximately 60,000 PLN per year. The stated-preference based VOLY figures were in most cases below this threshold.

In the report summarising the NEEDS results, a simplifying assumption was made that the VOLY figures obtained were a QALY valuation (1 VOLY = 1 QALY), which in the later Polish studies was shown to be an oversimplification. QALY is used by economists to assess the value of medical interventions. One QALY can be equated with one year in perfect health. QALY scores range from 1 (perfect health) to 0 (dead). QALY can be used to inform health insurance coverage determinations and treatment decisions, to evaluate programmes and to set priorities for future programmes.

The main research problem that emerged in the study turned out to be the disproportion between the research goal – to assign a value to increases in life expectancy on the basis of responses to the survey questionnaire – and the valuations given by the respondents, which took account of such factors as: life expectancy, its quality, the value to future generations of their own and other people's lives (the problem of altruism) and the value of clean air and its importance for future generations. These methodological difficulties confirmed the complexity of the concept of value and prompted the search for more reliable scenarios and methods of valuation. Owing to these important findings, a new research approach was applied in the next study, which forms part of the subsequent section that uses the DCE method allowing the separate valuation of two attributes: quantitative – life expectancy and qualitative – health status.

4. VOLY in the Context of Health Care: (1) General Population

The questionnaire for this study was developed in light of the observation made in the first Polish VOLY study that, when declaring WTP, respondents took into account not only increased life expectancy but also other attributes, including improvement in health quality. For the evaluation of several attributes, the most appropriate method is the DCE. A hypothetical scenario for counteracting major diseases of civilisation was presented to two groups of respondent populations: general and dialysis (Markiewicz, 2008).

The study questionnaire was the same for both groups and consisted of six parts. The key for research purposes was the fourth part, which proposed a range of hypothetical 'Programmes for better prevention and treatment of major diseases of civilisation' ('Programmes') within the population as a whole. Each Programme was described using three attributes: increase in life expectancy, improvement in health and cost in the form of a permanent monthly increase in income tax per capita. The attribute levels adopted are presented in Table 1.

For all possible attribute levels, 48 Programme variants were obtained. Next, 20 Programme pairs were randomly selected and grouped into five sets of choice cards. Each set consisted of four cards, with three Programme alternatives presented in tabular form on each card. For each card, the respondent was asked to select a preferred alternative, one of which was always the status quo, meaning no changes in the length and quality of life, and thus no additional costs. The second and third Programmes, labelled A and B respectively, presented options entailing additional costs. The sample choice card is presented in Table 2.

Table 1. Attribute levels

Attribute	Levels
Increase in life expectancy	0 years; 6 months; 1 year; 2 years
Improvement in health on a 10-point scale	0 point; 1 point; 2 points
Monthly cost in the form of higher tax	10 PLN; 20 PLN; 50 PLN; 100 PLN

Source: Questionnaire for general and dialysis population (2008).

Table 2. Sample choice card

Health effects and programme cost	Programme 0	Programme A	Programme B
Increase in life expectancy	0 years	1 year	1 year
Improvement in health on a 10-point scale	0 point	0 point	1 point
Monthly cost in the form of higher tax	0 PLN	20 PLN	50 PLN
Your choice	☐	☐	☐

☐ I don't want to pay anything

Source: Questionnaire for general and dialysis population (2008).

The study was conducted on a representative group of 150 adult residents of Warsaw in April and May 2008 by specialised pollsters from the Centre for Public Opinion Research (CBOS). In total, 600 observations of choice were collected. In response to the question about the respondent's own health status on a simplified scale from 1 (critical state) to 10 (perfect health), the mean for the group was 7.3, with a standard deviation of 1.9. Out of the 600 observations of choice, 299 were identified as coming from protesters (Meyerhoff & Liebe, 2006), and the vast majority of these responses were related to the option 'I don't want to pay anything'. Responses considered to be from protesters were removed from the sample.

Table 3. Estimation results of the multinomial logit model for the general population

```
+--------------------------------------------+
| Discrete choice (multinomial logit) model  |
| Maximum Likelihood Estimates               |
| Model estimated: Jul 01, 2008 at 00:04:29PM.|
| Dependent variable              Choice     |
| Weighting variable                None     |
| Number of observations             301     |
| Iterations completed                 5     |
| Log likelihood function       -310.9589    |
| Number of parameters                 4     |
| Info. Criterion: AIC =          2.09275    |
|   Finite Sample: AIC =          2.09320    |
| Info. Criterion: BIC =          2.14201    |
| Info. Criterion:HQIC =          2.11246    |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
| Constants only    -324.8237  .04268  .03628 |
| Response data are given as ind. choice.    |
| Number of obs.=   301, skipped   0 bad obs. |
+--------------------------------------------+
+--------+--------------+----------------+--------+--------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]|
+--------+--------------+----------------+--------+--------+
 SQ      |     .70586159       .24725451     2.855   .0043
 D       |     .62529092       .15008808     4.166   .0000
 J       |     .62879090       .13006984     4.834   .0000
 MU      |    -.00614504       .00324460    -1.894   .0582
```

Source: Calculations made with the use of the Limdep 4.0 statistical package.

A multinomial logit model (McFadden, 1974) was used to estimate the monetary value of the attribute levels. Using the approach suggested by Hanemann (1984), the average respondent's WTP was estimated for each attribute level in relation to the status quo associated with no additional cost. The estimated results are presented in Table 3. Estimated monthly WTP values amounted to 102 PLN for a 1-year increase in life expectancy, and for a 1-point improvement in health status on a 10-point scale, the monthly WTP was also 102 PLN.

The DCE approach allowed increased life expectancy and improvement in health to be valued separately, and the selected Programme to be valued as a whole. The results showed that respondents from the general population of Warsaw were willing to pay, on average, about 204 PLN per month for the Programme, which offered them a total improvement in health status of 1-point and a 1-year increase in life expectancy. These results are difficult to relate to other valuations carried out using this method, because in the area of human health valuation, the only study conducted so far in Poland was a VSL valuation carried out by Giergiczny (2006) on a sample of students.

The main conclusion from this part of the study was that in the general population, respondents assigned the same value to an increase in life

expectancy of 1 year and an improvement in health of 1 point, thus giving each attribute equal weight. Based on the results of the study, the VOLY gained were estimated according to the formula:

$$VOLY_D = \overline{WTP}_D \times 12 \times LE$$

where $VOLY_D$ denotes the valuation of an additional life year calculated based on the average monthly $\overline{WTP}_D$ for an increase in life expectancy of 1 year, amounting to 102 PLN for the general population; and LE denotes the remaining life expectancy of the general population (the difference between the life expectancy statistically experienced by a person at a given age and their current age), which was 32 years. The $VOLY_D$ calculated on this basis was:

$VOLY_D$= 39,127 PLN

A formula taking into account a simultaneous increase in life expectancy of 1 year and improvement in health status of 1 point was used to estimate VOLY:

$$VOLY_{D+J} = WTP_{D+J} \times 12 \times LE$$

$VOLY_{D+J}$ = 78,254 PLN

$VOLY_{D+J}$ calculated for the total WTP, taking into account the WTP for both attributes (204 PLN), amounted to 78,254 PLN. This value can be interpreted as the total (lifetime) payment for the implementation of a programme offering an increase in life expectancy of 1 year and an improvement in health of 1 point.

The VOLY values calculated with the use of the two formulas are presented in Table 4.

A formula based on individual WTPs was not used to estimate the VOLY value. Attempts were made to introduce respondent heterogeneity into the model, but this turned out to be of dubious merit – most of the variables were irrelevant and it could be presumed that these variables were not random at all, but relatively constant. This means that the respondents were fairly 'uniform' and had approximately the same parameters in utility functions, regardless of the socio-demographic variables (income, age, gender, household size, number of children and education). The parameters which could have influenced the utility functions (and hence the WTP) did not affect it and therefore the estimation of individuals' WTP was discontinued.

Table 4. VOLY values for the general population

$VOLY_D$	39,127 PLN
$VOLY_{D+J}$	78,254 PLN

Source: Calculations based on the WTP results for the general population.

Another aspect that was considered when estimating the VOLY value was the discounting of the obtained values over time. By adopting a simplifying assumption that the benefit in the form of extended life expectancy and/or improved health quality is not a 'bonus' received at the end of life, but is rather a cumulative benefit that we would receive from the implementation of the Programme until the end of life, discounting was abandoned.

5. VOLY in the Context of Health Care: (2) Dialysis Population

The study was conducted in May 2008 in the form of individual interviews at the Dialysis Centre of Warsaw's Central Clinical Hospital, on a sample of 40 Warsaw residents diagnosed with chronic renal failure.

The mean self-defined health status for the dialysis respondent group as a whole was 5.1 points, with a standard deviation of 1.8. The question 'How many points on the 10-point health status scale would you assign to an average person of your age?', received an average answer of 7.4 points, with a standard deviation of 1.5 (a result comparable to the general population). The vast majority of respondents in the dialysis group (75%) assessed their health status as well below average. A total of 60% said that their health could improve (by an average of 2.8 points, with a standard deviation of 1.4) with appropriate medical treatment.

Out of 160 observations, the opt-out option was selected 67 times. On the basis of analogous procedures which were used earlier for the general population, responses from protesters were rejected. These constituted nearly 42% of the responses. As in the case of the general population, a multinomial logit

Table 5. Estimation results of the multinomial logit model with an error component for the dialysis population

```
+--------------------------------------------+
| Error Components (Random Effects) model    |
| Maximum Likelihood Estimates               |
| Model estimated: Jul 01, 2008 at 00:07:17PM.|
| Dependent variable                  ANS    |
| Weighting variable                 None    |
| Number of observations               93    |
| Iterations completed                  6    |
| Log likelihood function       -96.54986    |
| Number of parameters                  4    |
| Info. Criterion: AIC =          2.16236    |
|   Finite Sample: AIC =          2.16725    |
| Info. Criterion: BIC =          2.27129    |
| Info. Criterion:HQIC =          2.20635    |
| Restricted log likelihood     -102.1709    |
| McFadden Pseudo R-squared      .0550164    |
| Chi squared                   11.24216    |
| Degrees of freedom                   4    |
| Prob[ChiSqd > value] =         .2397316E-01 |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
| No coefficients   -102.1709  .05502  .03425 |
| Constants only     -99.4722  .02938  .00805 |
| At start values    -96.5792  .00030 -.02167 |
| Response data are given as ind. choice.    |
+--------------------------------------------+
+--------+--------------+----------------+--------+--------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]|
+--------+--------------+----------------+--------+--------+
---------+Nonrandom parameters in utility functions
 D       |     .62018123       .23555333     2.633   .0085
 J       |     .43664541       .22826505     1.913   .0558
 MU      |    -.01085952       .00666461    -1.629   .1032
---------+Standard deviations of latent random effects
 SigmaE01|     .33227837       .00573395    57.949   .0000
```

Source: Calculations made with the use of the Limdep 4.0 statistical package

model was used for testing/verification. The ordinary MNL model did not pass the Hausman test (IIA); so, a logit model with an error component was used, which is a certain way of relaxing these assumptions. The estimation results are presented in Table 5.

On the basis of the results obtained, it was concluded that in this group of respondents, WTP for a 1-year increase in life expectancy was higher than WTP for a 1-point improvement in health. Dialysis patients value longer life more than improved health (which they can achieve only through a transplant, and only a minority have a chance of this). As in the general population, the values of the average respondent's WTP for each of the attribute levels were estimated on the basis of the model parameters obtained for the variables D, J and MU (while the status quo was, unsurprisingly, not significantly attractive to the dialysis population).

Estimated values of WTP amounted to 57 PLN for extending life expectancy by 1 year and 40 PLN for improving the quality of health by 1 point on a 10-point scale. Increase in life expectancy by 1 year was therefore worth 1.4 times more to dialysis respondents than a 1-point improvement in health. The VOLY values were calculated using the same formulas as for the general population. The results are presented in Table 6.

In the questionnaire prepared for dialysis patients, an additional group of questions was included to facilitate the estimation of private costs related to dialysis therapy. Average per-person private expenditure by patients to supplement the cost of their treatment for chronic renal failure amounted to 308 PLN per month, or 3,700 PLN per year. Additionally, average per-person lost earnings for the dialysis population as a whole amounted to 749 PLN per month, or 8,985 PLN per year. This was the highest component of private costs. Despite the provision and financing of patient transport to the Dialysis Centre by the National Health Fund, 23 out of the 40 respondents used public or private transport. The average per-person annual cost of this transport was 348.20 PLN.

Table 6. VOLY values for the dialysis population

$VOLY_D$	14,655 PLN
$VOLY_{D+J}$	24,939 PLN

Source: Calculations based on WTP results for the dialysis population.

The total average private costs per year per person for the dialysis patients came to 13,034 PLN, which constituted a significant expense in the respondents' budget. In this group, the average individual monthly income was 1,242 PLN, and household income was 2,378 PLN.[2] Private costs directly related to medical expenses accounted for as much as 26.5% of personal income. This significantly impacted disposable income reserved for other purposes. Therefore, in considering the amount of VOLY calculated on the basis of the declared WTP in the population of dialysis patients, it can be stated that in addition to the overall lower level of income in this group, the value of the increase in life expectancy was also negatively affected by the structure of private expenditure and costs related to dialysis therapy.

6. Conclusions from the First Polish VOLY Studies

The first estimates of VOLY in Poland carried out in the general population of Warsaw in the context of air pollution reduction gave results in the range of 32,000–70,370 PLN. The valuable qualitative conclusions from this study showed that a significant number of respondents had taken into account those attributes into their WTP values that were in addition to increased life expectancy (the attribute covered by the study). For this reason, the concept for the next stage of the research was developed so as to include the valuation of two attributes together: life expectancy and quality of health. It was decided to implement a method based on DCEs in the context of health care.

Respondents in the general population assigned equal monetary value to a 1-year increase in life expectancy and a 1-point improvement in health with an average WTP of approximately 102 PLN for each. At this point, it is worth recalling the fact that the QALY, the numerical indicator of health which combines increase in life expectancy and health quality improvement, also gave the same (numerical) weights to the quality and life expectancy attributes. On this basis, it can be deduced that the construction of the QALY, although based on highly simplified assumptions, was consistent with the preferences of the general population (i.e. those with average health).

The results of VOLY in the dialysis patient group were lower than in the general population. On the basis of the WTP, for a 1-year extension of life, VOLY was calculated at approximately 14,700 PLN, while the attributes of a 1-year increase in life expectancy and a 1-point improvement in the quality of health valued together gave a result of approximately 25,000 PLN. This stage of the research led to another important conclusion. Dialysis patients valued increase in life expectancy more than improvement in health quality by assigning them different weights. Therefore, QALY is not a good quantitative indicator for this narrow population.

7. 2008 VOLY Indicators in 2020 Values

It is worth relating the estimated values to the Polish health system's cost-effectiveness thresholds, which changed significantly in 2008–2020. To compare the VOLY calculated in the 2008 research with the current threshold requires the expression of WTP and VOLY in 2020 values.

The expression of the 2008 WTP and VOLY in 2020 values involved taking into account the inflation rate in 2008–2020 and the increase in real gross wages in the national economy according to Central Statistical Office (GUS) data. Remaining factors were deemed to have remained unchanged. On this basis, hypothetical WTP_{2020} and $VOLY_{2020}$ values were obtained as shown in Table 7 below.

In estimating the hypothetical values for WTP_{2020} and $VOLY_{2020}$, the following assumptions were made: there had been no changes in socio-economic characteristics in the population; the respondents had remained unchanged in their preferences; and the WTP amounts represented the same proportion of personal income as in 2008. It would be interesting to conduct the 2008 surveys in the reality of 2020. The

2 For the general population sample, the average individual monthly income was 2,122 PLN and household income was 3,393 PLN.

Table 7. WTP and VOLY in 2008 and 2020 values (PLN)

Sample	WTP_{2008}	$VOLY_{2008}$	WTP_{2020}	$VOLY_{2020}$
General population 1-year increase in life expectancy	102	39,127	144	55,106
General population 1-year increase in life expectancy and 1-point improvement in health quality	204	78,254	287	110,212
Dialysis population 1-year increase in life expectancy	57	14,655	80	20,640
Dialysis population 1-year increase in life expectancy and 1-point improvement in health quality	97	24,939	137	35,124

Source: Calculations based on the WTP results from the 2008 questionnaire; 2020 values were calculated on the basis of annual macroeconomic indicators from GUS (2008–2020).

results would assess factors which were not included in the original study but had changed over time and influenced preferences. Such factors could, for example, be one or more of the following: a change in social awareness of the value of health and statistical life; and a change in trust in health care institutions, as well as economic and emotional factors related to the COVID-19 pandemic in 2020, which could have significantly changed the preferences. In the absence of such studies, and also with the significantly limited possibility of conducting them due to the safety procedures connected with COVID-19, a simplified approach was adopted to calculate the hypothetical value of WTP_{2020} and $VOLY_{2020}$ based on the results of the research from 2008. Expressing VOLY in 2008 and 2020 values is important for comparing these values with the cost-effectiveness thresholds in 2008–2020. In 2012, there was a significant change in the basis for calculating the threshold used in Poland, which is discussed in the next section.

8. VOLY and Polish Cost-effectiveness Thresholds in 2008–2020

A review of the literature in the field of cost-effectiveness thresholds indicates that there are no uniform criteria commonly used on an international scale. Additionally, Thokala et al. (2018) claim that there have been many new developments in this area; however, there is still a lack of understanding among many people concerning the question of what cost-effectiveness thresholds mean. Additionally, Thokala et al. (2018) stress that the cost-effectiveness thresholds that are being used across the world might be considered overestimates and have no empirical foundation, since they are based on historical estimates, heuristics and judgements.

Effectiveness is generally measured using a generic measure of health, typically QALY or Disability Adjusted Life Year (DALY). The costs per QALY/DALY are then compared to a cost-effectiveness threshold to identify whether the new intervention is good value for money. Whether a given intervention is or is not cost-effective depends upon how much health it would generate and whether that amount is greater than the health that could have been obtained if the money required to fund it had been spent on something else, which is a measure of opportunity cost. Using such a cost effectiveness threshold to reflect this perspective has come to be known as the 'supply-side' approach (Culyer, 2016; Bertram et al., 2016; Woods et al., 2016; Vallejo-Torres et al., 2016). When some assessment of the equivalent consumption value of health is required, demand-side empirical research is conducted (Vallejo-Torres et al., 2016). Such approaches aim to represent social WTP for additional health gains, i.e. what individuals are willing to forego in non-health care/private consumption for gains in health care.

In the initial practice, relative rather than absolute assessments were used more often in the cost-effectiveness analysis of certain medical procedures. The method of comparing medical interventions in health care is to express the effect in the costs of

an additional QALY, i.e. based on cost-effectiveness analysis, the so-called 'league table' approach. Such rankings were published by Williams (1985) in the UK, while in North America, medical procedure league tables were proposed by Torrance & Zipursky (1984) and Schulman et al. (1991). The development of league tables allows us to compare the results obtained for a particular medical procedure and evaluate them against other procedures.

Many countries use a threshold value based on various other methods, rather than thresholds consistent with QALY maximisation. For example, in line with previous WHO-CHOICE guidance (Bertram et al., 2016), some lower middle-income countries employ a heuristic of one to three times GDP per capita (Hutubessy et al., 2003). The UK and US use thresholds broadly based on historical estimates (McCabe et al., 2008; O'Mahony & Coughlan, 2016). Many countries (including Canada, Brazil, Australia and Sweden) do not specify an explicit threshold at all, or a differentiated multi-step scale is used.

In another approach, the cost of annual dialysis therapy is used as a cost-effectiveness threshold. The precursor of such solutions was the United States Congress which, in the 1970s, established a law requiring the costs of dialysis to be covered by Medicare, the US Government health insurance programme. This law inspired researchers to create a certain normative system for comparing the results of cost-effectiveness analyses: society should reimburse health programmes with a dialysis-like, or lower, cost factor per unit of effect. When this method of determining the cost-effectiveness of treatment was introduced into Poland in 2003, it was assumed that it amounted to approximately 60,000 PLN per year (Orlewska, 2000, 2003). Such an approach was used in Poland until 2012.

In 2012, for its decisions on reimbursing the costs of new pharmaceuticals, Poland legislated a new cost-effectiveness threshold of three times per capita gross GDP per QALY gained (Jakubiak-Lasocka & Jakubczyk, 2014). In 2012, this amounted to nearly 100,000 PLN, in 2016 the threshold was approximately 150,000 PLN and in 2020 it was over 173,000 PLN. Manufacturers who submit applications for the reimbursement of the costs of new products are required to provide fully functional models that allow the evaluation of all the input parameters. Although the full impact of the change in the basis of the threshold is not yet clear, the prices paid in Poland for certain products and procedures appear to be higher than the mean values for the European Union (Gallacher et al., 2013).

The VOLY indicators obtained in 2008 allowed for the verification of the research hypothesis which claimed that the 60,000 PLN cost-effectiveness threshold value applicable in Poland at that time was overstated in relation to the value that was based on stated preferences (Markiewicz, 2008). The values of VOLY, calculated on the basis of the valuation of only the attribute of increase in life expectancy, by both the general population and the dialysis patient population, amounting to 39,000 PLN and 15,000 PLN respectively, turned out to be lower than the cost-effectiveness threshold in use. The situation was different when the respondents assessed the total value of two attributes: a 1-year increase in life expectancy and a 1-point health improvement. The VOLY indicators obtained for the general population amounted to 78,254 PLN, i.e. above the cost-effectiveness threshold. However, in this case, it is a comparison of two different goods.

The cost-effectiveness threshold reflected only the life expectancy attribute, but the adjusted $VOLY_{D+J}$ index also took into account the health quality assessment. Therefore, these indicators are not comparable. The adjusted VOLY index may be interpreted differently, as a QALY valuation. Second, people on dialysis valued an increase in life expectancy more than improved health, giving them different weights; so, QALY is not a good quantitative indicator for this narrow group. Third, a comparison of the results obtained for the general population and a narrow population of people affected by a given disease allows for the conclusion that the use of uniform cost-effectiveness indicators is not justified in the light of stated preferences research.

The comparison of VOLY expressed in 2020 values with the cost-effectiveness threshold applicable in 2020 led to conclusions similar to those for 2008. However, in all the cases analysed, the obtained VOLY values were below the cost-effectiveness threshold, which confirmed the hypothesis that the threshold model currently used in Poland is overestimated compared to values obtained in the study of stated preferences.

9. Conclusions

The article presents the first valuations of VOLY conducted in Poland using stated preference methods.

An important general conclusion from this research was that people evaluate the attributes of life expectancy and quality of life differently depending on their state of health. In light of this, the QALY indicator turned out to be a significant simplification. In addition, the weights of the attributes of length and quality of life should be differentiated.

The cost-effectiveness thresholds used in Poland in 2008–2020 can be considered overestimated and there is no empirical basis to consider that the three times GDP per capita threshold in use since 2012 is the most suitable. Empirical estimates provide a more appropriate value for the threshold than heuristic ones. The question is whether supply-side (GDP-based) or demand-side thresholds (WTP estimates which reflect the value that society places on the QALY and VOLY) should be used. The results of the studies presented in this article suggest that WTP varies substantially according to a person's health status. This justifies the recommendation that demand-side–based cost-effectiveness thresholds should be differentiated. The implementation of a uniform cost-effectiveness threshold is not justified from the perspective of stated preferences.

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References

Bertram, M. Y., Lauer, J. A., De Joncheere, K., Edejer, T., Hutubessy, R., Kieny, M.-P., & Hill, S. R. (2016). Cost–effectiveness thresholds: Pros and cons. *Bulletin of the World Health Organization*, *94*(12), 925–930. https://doi.org/10.2471/blt.15.164418

Carson, R. (2012). *Contingent valuation: A comprehensive bibliography and history*. Edward Elgar Publishing.

Culyer, A. J. (2016). Cost-effectiveness thresholds in health care: A bookshelf guide to their meaning and use. *Health Economics, Policy and Law*, *11*(4), 415–432. https://doi.org/10.1017/s1744133116000049

Desaigues, B., Ami, D., Bartczak, A., Braun-Kohlová, M., Chilton, S., Czajkowski, M., et al. (2011). Economic valuation of air pollution mortality: A 9-country contingent valuation survey of value of a life year (VOLY). *Ecological Indicators*, *11*(3), 902–910. https://doi.org/10.1016/j.ecolind.2010.12.006

Drummond, M. F., Sculpher, M. J., Claxton, K., Stoddart, G. L., & Torrance, G. W. (2015). *Methods for the economic evaluation of health care programmes*. Oxford university press.

Friedman, H. S. (2021). *Ultimate price: The value we place on life*. University of California Press.

Gallacher, K., Morrison, D., Jani, B., Macdonald, S., May, C. R., Montori, V. M., et al. (2013). Uncovering treatment burden as a key concept for stroke care: A systematic review of qualitative research. *PLoS Med*,*10*(6), e1001473 https://doi.org/10.1371/journal.pmed.1001473.

Giergiczny, M. (2006). Wycena wartości statystycznego życia ludzkiego przy wykorzystaniu metody wyborów z eksperymentami. *Ekonomia i Środowisko*, 2, 42–56.

Hanemann, W. M. (1984). Welfare evaluation in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics*, *66*(3), 332–341. https://doi.org/10.2307/1240800

Hutubessy, R., Chisholm, D., & Edejer, T. T. T. (2003). Generalized cost-effectiveness analysis for national-level priority-setting in the health sector. *Cost Effectiveness and Resource Allocation*, *1*(1), 1–13.

Jakubiak-Lasocka, J., & Jakubczyk, M. (2014). Cost-effectiveness versus cost-utility analyses: What are the motives behind using each and how do their results differ?—A Polish example. *Value in Health Regional Issues*, *4*, 66–74. https://doi.org/10.1016/j.vhri.2014.06.008

Johannesson, M., & Johansson, P. O. (1996). To be, or not to be, that is the question: An empirical study of the WTP for an increased life expectancy at an advanced age. *Journal of Risk and Uncertainty*, *13*(2), 163–174. https://doi.org/10.1007/bf00057866

Markiewicz, O. (2008). Analiza opłacalności programów ochrony zdrowia na podstawie wyceny statystycznego życia i wyceny dodatkowego roku przeżycia w Polsce. Praca doktorska przygotowana pod kierunkiem prof. dr hab.Tomasza Żylicza, Uniwersytet Warszawski, Wydział Nauk Ekonomicznych, Warszawa.

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. *Frontiers in Econometrics, New York Academic Press*, 105–142.

McCabe, C., Claxton, K., & Culyer, A. J. (2008). The NICE cost-effectiveness threshold. *Pharmacoeconomics*, 26(9), 733–744.

Meyerhoff, J., & Liebe, U. (2006). Protest beliefs in contingent valuation: Explaining their motivation. *Ecological Economics, 57*(4), 583–594. https://doi.org/10.1016/j.ecolecon.2005.04.021

O'Mahony, J. F., & Coughlan, D. (2016). The Irish cost-effectiveness threshold: Does it support rational rationing or might it lead to unintended harm to Ireland's health system?. *Pharmacoeconomics*, *34*(1), 5–11. https://doi.org/10.1007/s40273-015-0336-1

Orlewska, E., & Mierzejewski, P. (2000). Polskie wytyczne przeprowadzania badań farmakoekonomicznych (projekt). *Farmakoekonomika*, 4(supl 1), 2–11.

Orlewska, E., & Mierzejewski, P. (2003). Project of polish guidelines for conducting pharmacoeconomic evaluations in comparison to international health economic guidelines. *The European Journal of Health Economics, formerly: HEPAC*, *4*(4), 296–303. https://doi.org/10.1007/s10198-003-0185-2

Schulman, K. A. (1991). Cost Effectiveness of Low-Dose Zidovudine Therapy for Asymptomatic Patients with Human Immunodeficiency Virus (HIV) Infection. *Annals of Internal Medicine*, *114*(9), 798–802. https://doi.org/10.7326/0003-4819-114-9-798

Thokala, P., Ochalek, J., Leech, A. A., & Tong, T. (2018). Cost-Effectiveness Thresholds: the Past, the Present and the Future. *PharmacoEconomics*, *36*(5), 509–522. https://doi.org/10.1007/s40273-017-0606-1

Torrance, G. W., & Feeny, D. (1989). Utilities and Quality-Adjusted Life Years. *International Journal of Technology Assessment in Health Care*, *5*(4), 559–575. https://doi.org/10.1017/s0266462300008461

Torrance, G. W., & Zipursky, A. (1984). Cost-Effectiveness of Antepartum Prevention of Rh Immunization. *Clinics in Perinatology*, *11*(2), 267–281. https://doi.org/10.1016/s0095-5108(18)30920-5

Vallejo-Torres, L., García-Lorenzo, B., Castilla, I., Valcárcel-Nazco, C., García-Pérez, L., Linertová, R.,et al. (2016). On the estimation of the cost-effectiveness threshold: Why, what, how?. *Value in Health*, *19*(5), 558–566. https://doi.org/10.1016/j.jval.2016.02.020

Williams, A. (1985). Economics of coronary artery bypass grafting. *British Medical Journal (Clin Res Ed)*, *291*(6491), 326–329. https://doi.org/10.1136/bmj.291.6491.326 291(6491), 326–329.

Woods, B., Revill, P., Sculpher, M., & Claxton, K. (2016). Country-level cost-effectiveness thresholds: Initial estimates and the need for further research. *Value in Health*, *19*(8), 929–935. https://doi.org/10.1016/j.jval.2016.02.017

Żylicz, T. (2014). *Cena przyrody*. Wydawnictwo Ekonomia i Środowisko.