MONETARY VALUE PER QUALITY- ADJUSTED LIFE- YEAR (QALY) GAINED.

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ABSTRACT

A model that links cost-utility analysis to cost-benefit analysis is proposed. We estimate the monetary value of a health gain obtained for avoiding a slight health problem, defined in terms of quality and quantity of life. After that, from a variant of Standard Gamble (SG) method, we obtain the utility of that health gain. Based on the developed model, we infer the monetary value per Quality-Adjusted Life-Year (QALY) gained. Mean for a QALY gained was estimated range from $US 7,938 to $US 30,367 depending on method used to link the individual utility of the worst health state to death ($US 2001 values).

JEL classification: I10, D61

Keywords: Quality-Adjusted Life-Years, willingness to pay, utility theory, cost-utility analysis, cost benefit analysis.

1 Introduction.

Quality-Adjusted Life-Years (QALYs) or any other effectiveness measure, allow comparing the effects on health of treatment options or health technologies and selecting that one maximizing the health gain. However, it cannot derive conclusions related to how much cost every effectiveness unit gained. Although quite a few studies have been carried out at health care programmes there are still a relatively small number of research to determine the willingness to pay for a gain at QALYs. Most studies focus on the WTP for a treatment or health technology or, alternatively, in their effectiveness. Some of them have also inferred the monetary value of a health gain from one estimation to other. However, these studies do not include, in general, the analysis of the correlation between utility measures and monetary units excepting at O'Brien and Viramontes (1994) and Blumenschein and Johannesson (1998).

Important studies, focus on the monetary value of a statistical life, are those carried out by Jones-Lee (1976 and 1989), Jones-Lee et al. (1985 and 1993), Viscusi (1993) and Johansson (1995). The statistical life value is identified as the exchange relation between monetary incomes and fatal accident risk. There are some important conclusions derived from these studies. Their results evidence that individual valuation are not always sensitive to the heath problem seriousness and practically never proportional to the size of the risk reduction for such problems.

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An alternative line of investigation is the one developed when taking decisions in a context of certainty. One of the first works in application of contingent valuation methodology to the evaluation of small health problems in a certainty context is that of Berger et al (1987). Authors estimated willingness to pay for avoiding small but inconvenient symptoms. Later investigations conclude that for small health gains, monetary value to avoid a health problem can be approximated through willingness to pay to get such gains (Jones-Lee, 1985). Carthy et al. (1999) quantified the willingness to pay for a recuperation of lesions provoked by an accident car, inferring the exchange relation that individuals perform between monetary incomes and health gains from such willingness to pay. Authors estimated that WTP to avoid a small health problem and also the required compensation –willingness to accept (WTA)– for the risk of that problem. The Standard Gamble (SG) is defined in terms of two treatments whose consequences on the health states imply the assumption of a death risk.

Finally, there are four recent papers by Zweifel and Breyer (1997), Garber and Phelps (1997), Meltzer (1997) and Bleichrodt and Quiggin (1999) analyzed the allocation of health resources where both health states and consumption are arguments of the utility function. Bleichrodt and Quiggin (1999) show that under certain assumptions one can derive an expression for the WTP for a QALYs gain. This is the only alternative study here proposed, that we know that derives the conditions under which cost- effectiveness analysis is consistent with cost- benefit analysis.

The aim of this research is to link a health gain measure in QALYs with its monetary value. Which means to develop a model that allows us to link results of cost utility analysis (CUA) with cost-benefit analysis (CBA). Monetary value per QALY gained allows evaluating the allocation efficiency for whatever option of treatment and assigns resources to those alternatives maximizing the most net benefit. In this sense, the monetary value of a health gain constitutes an important tool for taking decisions (Johannesson 1995, Kartman, Anderson and Johannesson 1996, Blumenschein and Johannesson 1996).

From a literature review Hirth et al (2000) infer the monetary value for a QALY taking into account the results obtained from the main methodologies used when estimating the monetary value of a statistical life. Median for QALY values per type of studies range from $US 24,777 according to the human capital method, to $US 93,402 in the case of revealed preferences studies and amounting to $US 161,305 according to estimations of the contingent valuation methodology. As these authors point it, estimations of monetary value for a statistical life are really high and consequently, they determine an equally high value for QALY, (Hirth et al. 2000).[2] Due to the arbitrariness of the definitions used at the cost-effectiveness analysis Johannesson y Meltzer (1998) point the necessity of obtaining more information on the willingness to pay per QALY gained.

2 The Model.

Let us consider the individual's health profile as the sequence of health states where q_t stands for health state in time period t. A change from a health state to a minor one implies a welfare losing. This is the reason why the health state improving is a desirable characteristic for the health care services, (Zweifel and Breyer 1997, Sculpher and O´Brien, 2000). Let us consider the individual's utility function whose arguments are the consumer goods X from the area of goods R^2_+ and the health goods (non-consumer goods) Q:

$$U = u(X,Q) \qquad (1)$$

Similarly, $((x_1, q_1), \ldots,(x_t, q_t), \ldots,(x_T, q_T))$ denotes the sequence of pairs of consumer goods and health states, where (x_t, q_t) denotes consumption level and health state in period of time t. The succession of health states q_t from the set Q of health states through individual's life defines his health profile.

$$U(x\,q) = \underset{t=1}{\overset{T}{U}} \left((x_1, q_1),\ldots,(x_t, q_t),\ldots,(x_T, q_T)\right) = \sum_{t=1}^{T} U(x_t, q_t) : q \in Q \qquad (2)$$

where Q denotes the set of temporal health states, T is the total of life years –i.e. life expectancy- and x represent consumer goods for each period t.

Let us assume that the individual's health profile is reduced to two consecutive periods defined every one for a temporal health state. For simplicity, let us assume that health state at every period is either a perfect health state q^* or a slight health problem q_i. The addition of both periods is equivalent to life expectancy for the individual T. Let us next assume that the individual's preferences for consumer goods are stable and independent from the health state along the whole periods. So that, the utility of consumer goods do not vary among periods. The utility of sequence $(q_1,\ldots,q_t,\ldots,q_T)$ is equal to: $U(x\,q) = \sum_{t=1}^{T} U(x_t, q_t) = \sum_{t=1}^{T} U(x, q_t) = \sum_{t=1}^{T} U(q_t)$. And according to the conditions commonly used to characterize QALYs, the utility function holds additive independence, (Pliskin, Shepard and Weinstein 1980).

[2] Hirt et al., (2000) transform estimations on the monetary value of an statistical life at QALYs using the updated

The utility of the health profile is defined as follows:

$$\sum_{t=1}^{T} U(q \;\; t) = \underset{t=1}{\overset{t}{U}} \, (q_i \;\; t) + \underset{t=t}{\overset{T}{U}} \, (q^* \; T\text{-}t) : q_i,\, q^* \in Q,\;\; t < T. \tag{3}$$

The indirect utility function $V\,(\;,)^3$ defined in terms of monetary income w is:

$$V = \;\; v\,(w) \tag{4}$$

Viscusi and Evans (1990) found evidence that the utility of monetary income depended on the state of health. More precisely, the marginal utility of monetary income decreased with decreases in health state. This result rejects the assumption of an overall utility function in which all attributes are mutual utility independent. This assumption means rejecting the additive specification of the multilinear utility function. However, there are also clear evidences that for little changes at the health state, the marginal utility of income remains constant, (Jones-Lee 1989, Evans and Viscusi 1990, Johansson 1995).

We can specify the indirect utility function given a health state as:

$$\underset{t=1}{\overset{T}{V}} (w)|_{q\,*\,T} \tag{5}$$

where $V\;(,\;)$ is the utility of the monetary income w given a perfect health state q^* from a set of health states Q during the total of life years of an individual T. Similarly, the utility of the monetary income when a slight health problem $q_i \hat{I}\;\; Q$ during a period of time t after that the individual recover the perfect health state q^* during the rest of his life $(T\text{-}t)$ is defined as follows:

$$\underset{t=1}{\overset{t}{V}} (w)|_{q_i\, t} \;\; + \underset{t=t}{\overset{T}{V}} (w)|_{q^*\, T\text{-}t} \tag{6}$$

The difference between the utility function defined by vN-M and the utility function given a health state will depends on the variation of the utility and the marginal utility of monetary income when health state changing. Let us assume that the utility function is continuous, increasing and concave: $\partial V\,(\mathrm{w}\;)_{\mathrm{qit}}\,/\partial \mathrm{w} > 0$,

value formula, supposing a 3% discount rate.

[3] The indirect utility function is increasing at income w, not increasing at prices p and homogeneous with zero rank at prices and incomes, (Varian 1992). At indirect utility function it is not specified prices vector for consumption goods X as they have been deleted from the analysis as they do not affect this. We suppose health as a good not from market. However, if there would be some cost sharing for patients the differences in prices of medical care do make an effect.

$\partial^2 V(w)_{qi\ t}/\partial w^2 < 0$ whenever q_i t and w; monotonic with respect to health state, if health state q* is preferred to health state q_i for a given level of income w, then q^* is preferred to q_i for all income levels: $V(w)_{q^*t} > V(w)_{qit}$ " w, $t<T$, q_i, $q^* \hat{I} Q$ / $U(q^*t) > U(q_it)$; monotonic with respect to income, higher income levels are strictly preferred to lower levels; and for little changes at the health state, the marginal utility of monetary income remains constant:

$$\partial \sum_{t=1}^{T} V(w)|_{q^*T} \Big/ \partial w = \left[\partial \sum_{t=1}^{t} V(w)|_{qi\ T} + \partial \sum_{t=t}^{T} V(w)|_{q^*\ T\text{-}t}\right] \Big/ \partial w \quad .$$

Let us now consider that with probability (1-¶) the individual's health state could be a slight health problem q_i during a period of time t after which he recovers the perfect health state q^* during the remaining life years *(T-t)*. And with probability ¶ the individual's health state could be a perfect health state q^* during the total T life years. We suppose that such problem does not imply a reduction at the monetary income of the individual, either it does not affect to his capacity to work and due to this getting an income or because this income is totally ensured. The expected utility is written as:

$$ue = ð \sum_{t=1}^{T} V(w)|_{q^*\ T} + (1-p)\left[\sum_{t=1}^{t} V(w)|_{qit} + \sum_{t=t}^{T} V(w)|_{q^*\ T\text{-}t}\right] \tag{7}$$

Let us next suppose that it is possible to reduce the occurrence probability of the health problem q_i. Differentiating at equation (Eq.) (7) we obtain the marginal rates of substitution (MRS) between monetary income and the risk of the health problem:

$$MRS(w,p) = \frac{\left[\sum_{t=1}^{T} V(w)|_{q^*\ T} - \left(\sum_{t=1}^{t} V(w)|_{qi\ t} + \sum_{t=t}^{T} V(w)|_{q^*\ T\text{-}t}\right)\right]}{ð \dfrac{\partial \sum_{t=1}^{T} V(w)|_{q^*T}}{\partial w} + (1-ð)\left[\dfrac{\partial \sum_{t=1}^{t} V(w)|_{qi\ t} + \partial \sum_{t=t}^{T} V(w)|_{q^*\ T\text{-}t}}{\partial w}\right]} \tag{8}$$

The marginal rate of substitution indicates the quantity that an individual would be willing to pay for a reduction at occurrence probability for a health problem. This willingness to pay mq_i is function of w, (1-¶) and the size of the risk reduction. Accepted that the marginal utility of income remains constant for a little health state changes, we can express the Eq. (8) as the rate of the utility of a health gain and the marginal utility of the monetary income.

$$m_{q_i} = \frac{\left[\mathop{V}_{t=1}^{T} (w)|_{q^*\, T} - \left[\mathop{V}_{t=1}^{t} (w)|_{qi\, t} + \mathop{V}_{t=t}^{T} (w)|_{q^*\, T\text{-}t} \right] \right]}{\partial \mathop{V}_{t=1}^{T} (w)|_{q^*\, T} \Big/ \partial V(w)} \qquad (9)$$

where m_{qi} refers to the willingness to pay for a reduction at occurrence risk; the utility of the health gain is $[\ V_{t=1}^{T}(\ w)\ |_{q^*T} - [V_{t=1}^{t}(w)|_{qit} + V_{t=t}^{T}(w)\ |_{q^*T\text{-}t}]\ ]$ and the marginal utility of the monetary income is $[\ \ V_{t=1}^{T}(\ w)|_{q^*T}/\ \ V(w)]$. Eq. (9) can be interpreted as the exchange relation between monetary income and occurrence risk for a health problem in terms of the utility of the health gain obtained from a reduction at risk and the marginal utility of the monetary income.

Let us now consider the temporal health state q_j during a period of time t, from the set of health states Q, after recovering a perfect health state during the remaining life years. Additionally, let us suppose that q_j is a more serious health problem than q_i. Assume that it is offered to the individual to take a drug which with a probability (¶) would be effective, therefore he would recover his perfect health state, but with a probability (1-¶) his health state would be an state such as q_j. We can obtain the probability ¶ for which both alternative choices would be indifferent for the individual as:

$$ð\ \mathop{V}_{t=1}^{T}(w)|_{q^*\, T} + (1-p)\left[\mathop{V}_{t=1}^{t}(w)|_{qj\, t} + \mathop{V}_{t=t}^{T}(w)|_{q^*\, T\text{-}t}\right] = \left[\mathop{V}_{t=1}^{t}(w)|_{qi\, t} + \mathop{V}_{t=t}^{T}(w)|_{q^*\, T\text{-}t}\right] \qquad (10)$$

The relation between the utility of the health gain for avoiding a health problem q_i and a more serious health state q_j and the occurrence probability of this last one can be derived by solving in Eq. (10).

$$\frac{\left[\mathop{V}_{t=1}^{T}(w)|_{q^*\, T} - \left(\mathop{V}_{t=1}^{t}(w)|_{qjt} + \mathop{V}_{t=t}^{T}(w)|_{q^*\, T\text{-}t}\right)\right]}{\left[\mathop{V}_{t=1}^{T}(w)|_{q^*\, T} - \left(\mathop{V}_{t=1}^{t}(w)|_{qit} + \mathop{V}_{t=t}^{T}(w)\ |_{q^*\, T\text{-}t}\right)\right]} = \frac{1}{(1\text{-}ð\ )} \qquad (11)$$

Then, Eq. (12) can be written as the relation between the willingness to pay and the utility of a health gain.

$$\frac{m_{qj}}{m_{qi}} = \frac{\left[\overset{T}{\underset{t=1}{V}}(w)\,|_{q^*T} - \left(\overset{t}{\underset{t=1}{V}}(w)|_{qjt} + \overset{T}{\underset{t=t}{V}}(w)\,|_{q^*T\text{-}t} \right) \right]}{\left[\overset{T}{\underset{t=1}{V}}(w)\,|_{q^*T} - \left(\overset{t}{\underset{t=1}{V}}(w)|_{qit} + \overset{T}{\underset{t=t}{V}}(w)|_{q^*T\text{-}t} \right) \right]} \qquad (12)$$

next let us equalizing Eq. (11) and Eq. (12) yields the relation between the willingness to pay and the risk for each health problem.

$$\frac{m_{qj}}{m_{qi}} = \frac{1}{(1-p)} \qquad (13)$$

From Eq.(13) is possible to obtain the monetary value m_{qi} of the utility of a health gain as follows:

$$m_{qi} = m_{qj} \frac{\left[\overset{T}{\underset{t=1}{V}}(w)|_{q^*T} - \left(\overset{t}{\underset{t=1}{V}}(w)|_{qit} + \overset{T}{\underset{t=t}{V}}(w)|_{q^*T\text{-}t} \right) \right]}{\left[\overset{T}{\underset{t=1}{V}}(w)|_{q^*T} - \left(\overset{t}{\underset{t=1}{V}}(w)|_{qjt} + \overset{T}{\underset{t=t}{V}}(w)|_{q^*T\text{-}t} \right) \right]} \qquad (14)$$

Where, the utility of the health gain obtained for avoiding the slight health problem q_j with probability (1-¶) is $[U_{t=1}^{T}(w)|_{q^*T} - (U_{t=1}^{t}(w)|_{qjt} + U_{t=t}^{T}(w)|_{q^*T\text{-}t})]$; the willingness to pay for that gain is m_{qj}; and the monetary value of a health gain obtained for avoiding the health problem q_i is m_{qi}.

3 The Survey.

Through a structured questionnaire 110 individuals valuate the health gains obtained for avoiding a different slight health problems. Interviews (face to face) were performed at Barcelona in July 1999.[4] It is designed a hypothetical setting where the individual, who does not feel well, goes to see the doctor. The doctor explains him that he suffers from a slight health problem which could be solved taking a drug. Such drug is effective and the individual would recover his perfect health state. In case of not taking the drug, he would be with that problem for a given period of time (specified for every case) after that, he would recover his perfect health state during the rest of his life. The remaining life years are expressed in function of the life expectancy according to the age of the individual. Every contingent scenario are design in such way that the inquired feels once at life with the slight health problem, so the payment (WTP) he would do for a drug that allows him to recover his perfect health state is unique. Due to this, we suppose that the effect on the total monetary income to avoid every slight health problems specified is really small.

To not overweight with questions to individuals, the sample was randomly divided in two groups (I and II) with approximately the same number of people. Every of these groups evaluated the health problems q_A, q_E, q_C and q_D, q_B, q_F, respectively. Study's design is performed in such way that it is possible to define different consistency measures in order to evaluate coherence and validate, according to the economic theory, the answers obtained.

Quality life for health states is defined following the EuroQol health system. At states definition it is specified the time the individual would find each health problem.

Table 1. Health states.[5]

	11121	22222	33333
3 days	q_A	q_B	q_C
15 days	q_D	q_E	q_F

3.1 Health States ordering.

First task (TASK I) the individuals performed was to put in order cards, identified from A to F, according to state seriousness in their opinion. From the ordering of health states we obtain the first consistency measure. For the total sample, Table 2 shows percentages of answers whose ordering corresponds to the objective relation of preferences that must be complied, according to the health states definition. Taking into account the relation of preferences, we can conclude that individuals clearly identified extremes of the rank, -states q_A and q_F- and the ordering was clearly consistent with the definition of states.

Table 2. Health states and preference relation.

Relation of preferences.	% Answers
q_A must be preferred to any other health states	100
q_F must be set at last position of preferences relation	100
q_B must be preferred to q_E.	91.8
q_B must be preferred to q_C.	87.27
q_D must be preferred to q_E.	99.09

[4] Drug prices at Spanish National Health System shows a 100% covering for elder than 65 years. These individuals and also those persons that for any other reason receive free drugs do not constitute part of the sample.

[5] For a description of different dimensions and levels, see Annex.

3.2 Willingness to pay for a health gain.

Through the design of a Payment Card it was presented to the individual a bid vector defined between 0 and more than 100,000 Ptas where the individual signed the quantity he was willing to pay (once at life) to avoid every health problem described. The possible answers were defined in terms of "Surely he would pay, probably he would pay, doubt, surely he would not pay". And, it was included at the questionnaire the possibility that the own individual indicated the maximum quantity of money he would certainly pay if it was a higher quantity than those specified at vector prices.

According to economic theory predictions, WTP for avoiding a health state must be so higher as more serious the individual considers such problem. In such manner that if the individual considers the q_i state more serious than q_j, he should pay more for avoiding q_i. So that, according to health state definition we can conclude that the WTP obtained are clearly consistent. Individuals, from each group, are willing to pay less for avoiding health problems which they have previously qualified as less serious which means that, WTP is coherent to the relation of preferences per health state. Analysis of consistency between WTP and relation of preferences is summarized at Tables 3 and 4.

Table 3: Willingness to pay and relation of preferences (Group I).

Relation of preferences ($q_I > q_J$)	Number of individuals (n)	WTP (q_I) < WTP (q_J)	WTP (q_I) = WTP(q_J)	WTP (q_I) > WTP(q_J)
$q_A > q_E$	61	61	0	0
$q_A > q_C$	61	60	1	0
$q_C > q_E$	27	18	5	4
$q_E > q_C$	34	24	5	5

Note: At WTP 22 and 1 individuals said not to be willing to pay anything to respectively avoid health problem q_A and q_c.

Which means that from 61 individuals preferring state q_A to state q_E 100 per cent were willing to pay a minor quantity for avoiding the health problem q_A than the quantity he would pay to avoid the problem q_E.

Table 4. Willingness to pay and relation of preferences (Group II).

Relation of preferences ($q_I > q_J$)	Number of individuals (n)	WTP (q_I) < WTP (q_J)	WTP (q_I) = WTP(q_J)	WTP (q_I) > WTP(q_J)
$q_D > q_B$	43	41	2	0
$q_B > q_D$	6	3	0	3
$q_D > q_F$	49	49	0	0
$q_B > q_F$	49	49	0	0

Obtained WTP are again clearly consistent in relation to the expressed preferences. Out of 43 individuals who preferred state q_D to q_B, 41 expressed a minor WTP for avoiding the health problem q_D than for avoiding q_B. Only two individuals expressed they would pay the same for avoiding such states.

Whenever WTP answer obtained were negative, it was requested to the individual the reason of it, in order to identify protest answers like: “No, I would not pay anything as drugs must be free”, “No, it is the national health system who must pay drugs”, etc. In our study, these kinds of protest answers have not been detected. The given reasons were that “as it deals with temporal and slight health problems, they would not take any drug and so that, they would not pay anything for it”. In case of state q_A and q_D, 22 and 5 individuals, respectively, expressed that they were not willing to pay anything to avoid such problems. With regard to state q_C and q_B an individual, in each case, told not to be willing to pay anything to avoid it. This negative WTP was, for any case, consistent with health state ordering performed at TASK I. In such manner that it has not been considered as inconsistent answer that individuals preferred state q_A to state q_E -state q_D to state q_B- and were not willing to pay anything to avoid q_A, -q_D-.[6]

WTP to avoid every health state is also consistent with the definition of such state. This consistency is kept for every group and also between the two groups the sample was divided. Table 5 summarizes the WTP main statistic descriptive.

Table 5. Willingness to pay (PTAs. 1999).

Health State.	Mean	95% CONFIDENCE INTERVAL		Median	Mode	Standard Deviation
		Lower Limit	Upper Limit			
q_A	1,899	1,341	2,456	1,000	1,000	1,697
q_B	12,032	9,455	14,609	10,000	20,000	8,776
q_C	15,100	11,476	18,744	10,000	10,000	13,944
q_D	4,098	3,141	5,054	3,000	3,000	3,029
q_E	12,181	9,502	14,860	9,000	5,000	10,188
q_F	35,711	29,115	42,307	40,000	50,000	21,955

3.3 Utility of a health gain at QALYs.

Utility of a health gain at QALYs was obtained from a sequential exercise in two phases. First individuals assess, from a modified version of SG, every of six health states in relation to the most serious one. In this way, we obtained the relative health gains among states. Later, and from three different questionnaire versions, they assess the most serious health state in relation to death. We asked the individual equivalent of durations of 15 days in the health state (q_F) as exchange of a minor occurrence probability for this state -less risk-. These equivalents allow to link the utility for the worst health state, from the specified states, with death.

Gain at QALYs it is summarized at Table 6 for every of the methods used -q_{F1}, q_{F2} y q_{F3}-. Methods q_{F2} and q_{F3} essentially follow the same logic. In both cases, and with difference of q_{F1}, we suppose a very small initial death risk (1%). To avoid such risk, individuals can accept inferior durations of health problem q_F with certainty, -method q_{F2}- or a given risk of occurrence for such state, -method q_{F3}-. In such way at method q_{F2} to avoid a 1% death risk, we ask in successive questions how much time the individual would be willing to accept at state (q_F) till get a near time to 15 days. Method q_{F3} is similar to a q_{F2} where, instead of asking the individual time that he would be willing to accept, we ask the occurrence probability of the state (q_F) that he would accept to avoid an initial death risk of 1%.

[6] It has been considered as inconsistent that if individuals preferred q_A to q_C, after they were not willing to pay anything for avoiding neither q_A nor q_C, (1 individual).

Table 6. Gain at QALYs.

	q_{F1}	q_{F2}	q_{F3}
Mean	0,0032	0,037	0,069
Median	0,00018	0,035	0,061
Standard Deviation	0,0084	0,0102	0,03910

From the estimations obtained, it is emphasized differences in the gain at QALYs to avoid the same health problem depending on the method used. The overweight of death risk, methods q_{F2} and q_{F3}, conditioning the gain at QALYs is really higher to the one obtained with the first method q_{F1}. And, as it will be shown later, this difference will be determining at the estimation of monetary value per QALY gained.

In other way, the valuation of the same health state (q_F) when it is directly compared to death is different to successive valuation of health state progressively more serious till including death as possible result. With method q_{F1} we required the individual's equivalent of higher durations to 15 days at state (q_F), when changing a minor risk and related them to death. Duration at state (q_F) we obtained to be low and due to this, then there existed more difficulties to link such durations at state (q_F) with death.[7] Therefore, the success probabilities expressed later, where success is perfect health and dead is a failure, were really high –loss aversion effect, Kahneman and Tversky 1979- This could be the reason why the gain at QALYs is so low and substantially different to that obtained with methods (q_{F2}) and (q_{F3}).

Finally, at two first methods lotteries are defined in terms of the choice between a definite health state and a gamble. As the individuals are generally risk averse, they tend to attach a higher value to the definite health state than to the possibility of enjoying full health. This could be conditioning the difference in the gain at QALYs obtained to avoid the heath problem in case of method (q_{F2}) and substantially different to the method (q_{F1}), respectively, in relation to method (q_{F3}) where both alternative choices require the assumption of a risk -certainty effect, Tversky, (1969)-. In other words, individuals are opposed to assume health risks no matter how small the probability is.

Although we can not clearly conclude what from these three methods used results in a cognitive way more appropriated -theoretically they are identical-, it is true that they are more difficult to assume the differences in QALYs gained when the estimation method is the first one.

[7] In relation to q_{F1} the result we obtained was that t_0 was equivalent to 2,51 months and t_1 was equivalent to 5,25 months. Which means that individuals were opposed to increase the duration expected at q_F in exchange obtaining a perfect health state, with a 90% probability.

The gain at QALYs -differentiating between methods used- is a significant variable in the Analysis of Variance (ANOVA). Since the sample was randomly selected, it could be expected that the mean variability would not be higher than the variability inside the groups. This would mean that the gain at QALYs varies for all individuals regardless of the method used. Then, the differences in the utility could be explained by the different characteristics of the individuals in the sample. Nonetheless, we saw that intergroup variability is wider than intragroup variability, thus the variable "method used" (to link the utility of the worst health state to death) would explain the difference in the gain at QALYs.

Analysis of Variance, (ANOVA). "Gain at QALYs" and "Method used".

	SUM OF SQUARES	df	QUADRATIC MEAN	f	sig.
Inter-groups	1,865E+18	2	9,325E+17	42,70	,001
Intra-groups	4,607E+18	211	2,183E+16		
Total	6,472E+18	213			

We reject the hypothesis of equal means. The variable "Method used" -factor- is significant to explain the variable "Gain at QALYs".

Differences in gain at QALYs are going to condition the utility of a health gained for avoiding every health state (q_A-q_E), and, as is obtained in relation to the most serious state, the monetary value of a gain at QALYs.

3.4 Utility of a health gain among health states.

Through a modified version of the SG -Eq. (7) of the model- we estimated the utility of the health gain obtained to avoid every health state. As consistency measure, we test that the utility of the health states is corresponds to the ordering of preferences performed by individuals -Tables 7 and 8-. In such way that, if an individual preferred state q_j to state q_i, then $U(q_j)$ must be higher than $U(q_i)$.

Table 7. Utility of the health state and relation of preferences (Group I).

Relation of preferences ($q_I > q_J$)	Number of individuals (n)	$U(_{QJ}) > U(_{QI})$	$U(_{QJ}) = U(_{QI})$	$U(_{QJ}) < U(_{QI})$
$q_A > q_E$	61	27	9	2
$q_A > q_C$	61	28	9	1
$q_C > q_E$	27	11	9	6
$q_E > q_C$	34	13	16	3

Note: Addition of comparisons among utilities is not equivalent to number of individuals, as in case of preference $q_A > q_E$ and $q_A > q_C$, 23; $q_C > q_E$, 1; and, $q_E > q_C$, 2 individuals were not willing to accept any risk of suffering states q_F in order to avoid state q_A, q_C and q_E, respectively.

Table 8. Utility of the health state and relation of preferences (Group II).

Relation of preferences ($Q_J > Q_I$)	Number of individuals (n).	$U(Q_J) > U(Q_I)$	$U(Q_J) = U(Q_I)$	$U(Q_J) < U(Q_I)$
$q_D > q_B$	43	15	9	0
$q_B > q_D$	6	2	3	0

Note: The addition of comparisons among utilities is not equivalent to the number of individuals in case of preference $q_D > q_B$ and $q_B > q_D$ as 20 and 1 individuals respectively, were not wiling to accept any risk to suffer the state q_F for avoiding the state q_D. From those individuals who preferred $q_D > q_B$ and $q_B > q_D$, 12 and 1 respectively, were not willing to accept any risk to suffer the state q_F for avoiding the state q_B.

The utility of the health gain obtained through SG is consistent with the relation of preferences in both groups. For example, out of 61 individuals who preferred state q_A to q_E, 27 obtain a higher utility for the first state than the second one, which means, that the utility of the health gain to avoid state q_A in relation to q_F is lower than the obtained to avoid the state q_E in relation to q_F.

As additional measure of consistency, according to the Eq. (13) for the model proposed we test if the relation of proportionality that must be done between the utility of the health gain obtained through the SG and the willingness to pay for the same health gain comply. The results obtained are summarized at the following Table 9.

Table 9. The utility of a health gain according to the Standard Gamble and the Willingness to pay.

Health state $q_{i/i=A,\dots,E}$	$1/(1-p)$		Mq_F/Mq_I [8]	
	MEAN	MEDIAN	MEAN	MEDIAN
q_A	11,96	20	18,80	40
q_B	24,01	8,33	4,73	3,00
q_C	4,14	5	2,36	4
q_D	20,46	6,67	10,33	7,50
q_E	4,98	6,66	2,93	4,44

We have already pointed that health states are slight. This generates some resistances, by individuals, to relate the most serious state to death, and also to accept any risk (although it be a small one), of suffering

[8] The outliers were not included.

the health state (q_F) for avoiding a slight state.[9] This would be the reason why 23, 2 and 3 individuals were not willing to accept any risk to suffer the most serious health state (q_F) to avoid health state (q_A), (q_C) and (q_E), respectively. At the same time, 21 and 13 individuals were not willing to accept any risk if health state gets worse as (q_F) for avoiding state (q_D) and (q_B), respectively. So that, individuals that in the SG were not willing to accept any risk for avoiding the health state, were not taken into account at the utility analysis. This is the main reason why the monetary value per QALY gained will be different according to the method followed to link the worst health state with death and the technique used to valuate the health state -SG and WTP-.

The analysis of the relationship between the health gain for avoiding a health problem and the willingness to pay shows that clearly the correlations are in the expected direction. Furthermore, the utility of the health gain is consistent with the WTP for each state, except in the case of health state q_E. Individuals are willing to pay more (less) and obtain a higher (lower) health gain for avoiding the most serious (slightest) effect.

Table 10. Spearman's correlation coefficients between the utility of a health gain and the willingness to pay.

		Health Gain Utility: Standard Gamble Method				
		A	**E**	**C**	**D**	**B**
WTP	**A**	0,528**				
Payment	**E**		-0,273*			
Card	**C**			0,336*		
Technique	**D**				0,377*	
	B					0,289

Pearson Correlations. The correlations were significant at the *5% and ** 1% level.

3.5 Monetary value of a gain at QALYs.

From the Eq. (11) and Eq. (12) we can infer the monetary value per QALY gained from the health gain that supposes to avoid a health problem and the WTP for obtaining such gain. To get this we 1) normalized the perfect health state q^* during the remaining life years of an individual T; 2) obtained the utility of a slight health problem q_i; 3) estimated the WTP for avoiding that health state; and 4) supposed that there were a health problem that when avoiding it, the health gain an individual obtains were a QALY.

[9] If the individual are not willing to accept any risk, at the Eq. (11) the probability of success (ð) will be 1. Which in terms of Eq. (13) supposes that $(m_{qF}) / (m_{qi})_{/i = A,E,C,D,B} =$.

The monetary value per QALY gained, were obtained depending on health state and the method used to link the worst health state with death.[10] The differences at monetary value are due, mainly, to the reasons exposed at the previous paragraph.

Table 11. Monetary value per QALY gained. (PTAs 1999).

		VALUE AVAC½$_{F1}$ (N=79)	VALUE AVAC½$_{F2}$ (N=72)	VALUE AVAC½$_{F3}$ (N=63)
Mean		196,341,676	4,445,728	1,162,159
(Standard Error)		(27,325,541)	(1,009,664)	(387,050)
95% CI	**Lower Limit**	141,940,703	2,435,515	388,457
	Upper Limit	250,742,649	6,458,940	1,935,860
Median		108,675,964	1,732,994	351,584
Standard Deviation		242,874,720	8,567,282	3,072,114

[10] We are not reporting here the estimations by health states. For more details ask authors.

The Table here below summarizes the characteristics of the sample.

Table 12.

Sample descriptives (number of observations 110).	
VARIABLE	**% (NUMBER)**
AGE	
20-35	45,4
36-45	25,0
46-55	18,5
56-65	11,1
Missing	(2)
SEX	
MEN	51,8 (57)
WOMEN	45,45 (50)
Missing	2,72 (3)
EDUCATION	
He/She does not know either reading or speaking	--------------
He/She has not get primary school degree (although he knows reading and writing)	3,6 (4)
Elementary school	1,8 (2)
EGB or similar	7,3 (8)
FP or similar	21,8 (24)
High school or similar	15,5 (17)
COU	17,3 (19)
Higher studies	30,9 (34)
Missing	1,8 (2)
LABOUR SITUATION	
Working	87,3 (96)
Unemployed	4,5 (5)
Housewife	5,5 (6)
Student	0,9 (1)
Other (specify)	- -
Missing	1,8 (2)
HOUSEHOLD INCOME (Pesetas/month)	
Income ≤150.000	23,63 (26)
150.000< Income ≤250.000	24,54 (27)
250.000< Income ≤350.000	19,09 (21)
350.000< Income ≤500.000	11,81 (13)
Income >500.000	8,18 (9)
Missing	12,72 (14)

4 Concluding remark.

This paper has derived the monetary value of a health gain at QALYs that can be estimated empirically. From different consistency measures we can conclude that there is a clear consistence among obtained estimations through the utility of a health gain at QALYs and the willingness to pay for that gain. According to the estimations obtained, from the most conservative point of view, the median of the monetary value per QALY gained, range from $US 2,402 to $US 11,838 ($US 2001 values).

Despite the evidenced consistency, estimations obtained must be understood in a preventive way for different reasons. As health states object of evaluation are slight, death is not initially included as possible results of defined Standard Gamble to valuate every one. The inclusion of death at evaluation setting would rest credibility and coherence to the states definition and also the analysis of consequence of these on health. However, it is concise to link the utility of the worst health state in relating to death, in order to gain quality of life be comparable to gain quantity of life. We have found evidence that when death is included as possible result of the Standard Gamble the individuals overweight health gains obtained for avoiding such state. Due to this, the utility of the health gain at QALYs depends on the method used to link the same health problem with death.

In other way, the monetary value per QALY gained it is obtained from the utility of the health gain and the corresponding willingness to pay. So that, the health state -a high number of individuals were not willing to pay anything to avoid a slight state as those specified- and the utility of the health gain obtained as function of the most serious health state is really going to determine the difference at monetary value per QALY gained from the different health problems. Future research should test if using the same method to link the most serious health state to death the monetary value of a health gain is the same independently from the health state from which it has been obtained.

In spite of difficulties in the empirical estimation of assessment changes in health states, we consider that interpreted carefully the estimations obtained may be helpful for orientation to the monetary value of a health gain at QALY. Such estimations allow us to compare the different health care options, according to the monetary value per QALY gained for every one. And then, we can derive conclusions on the allocation of health care resources comparing such QALY value to their cost.

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5 ANNEX.

HEALTH STATES USED IN THE SURVEY

State A

Duration: 3 days
Quality of life:
- No problems walking
- No problem with self-care
- No problems with performing usual activities
- Moderate pain or discomfort
- Not anxious or depressed

State B

Duration: 3 days
Quality of life:
- Some problem walking about
- Some problem washing or dressing self
- Some problems with performing usual activities
- Moderate pain or discomfort
- Moderately anxious or depressed

State C

Duration: 3 days
Quality of life:
- Confined to bed
- Unable to wash or dress self
- Unable to perform usual activities
- Extreme pain or discomfort
- Extremely anxious or depressed

State D

Duration: 15 days
Quality of life:
- No problems walking
- No problem with self-care
- No problems with performing usual activities
- Moderate pain or discomfort
- Not anxious or depressed

State E

Duration: 15 days
Quality of life:
Some problem walking about
Some problem washing or dressing self
Some problems with performing usual activities
Moderate pain or discomfort
Moderately anxious or depressed

State F

Duration: 15 days
Quality of life:
- Confined to bed
- Unable to wash or dress self
- Unable to perform usual activities
- Extreme pain or discomfort
- Extremely anxious or depressed