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## Time Trade-Off and Ranking Exercises Are Sensitive to Different Dimensions of EQ-5D Health States

Kim Rand-Hendriksen, Cand.Psychol, MSc<sup>1,2,\*</sup>, Liv Ariane Augestad, MD<sup>1,2</sup>

<sup>1</sup>Department of Health Management and Health Economics, University of Oslo, Oslo, Norway; <sup>2</sup>Health Services Research Centre, Akershus University Hospital, Lørenskog, Norway

### ABSTRACT

**Background:** One method suggested for creating preference-based tariffs for the new five-level EuroQol five-dimensional (EQ-5D) questionnaire is combining time trade-off (TTO) and discrete choice exercises. Rank values from previous valuation studies can be used as proxies for discrete choice exercises. This study examined rank and TTO data to determine whether the methods differ in sensitivity to the EQ-5D questionnaire dimensions. **Methods:** We used rank and TTO data for 42 EQ-5D questionnaire health states from the US and UK three-level EQ-5D questionnaire valuation studies, extracting overall ranks of mean TTO and mean rank values, ranging from 1 (best) to 42 (worst). We identified pairs of health states with reversed overall ranks between TTO and rank data and regressed overall rank differences (TTO – ranking) on dummy variables representing impairments on EQ-5D questionnaire dimensions. **Results:** Forty-three (US) and 41 (UK)

health state pairs displayed reversed rank order. Both US and UK regression models on rank differences indicated that respondents rated impairments involving pain/discomfort and anxiety/depression as relatively worse in TTO than in the ranking task. **Discussion:** Different dimension sensitivity between TTO and ranking methods suggests that combining them could lead to inconsistent tariffs. Differences could be caused by respondents focusing on the first presented dimensions when ranking states or could be related to the longest endurable time for health states involving pain/discomfort or anxiety/depression. The observed differences call into question which method best represents the preferences of the population.

**Keywords:** EQ-5D, QALY, ranking, TTO, utility, valuation.

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### Background

The EuroQol five-dimensional (EQ-5D) questionnaire is a health-related quality-of-life instrument that is used extensively to estimate quality-adjusted life-years in health economic evaluations [1,2]. It uses five dimensions of health: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Up until recently, these dimensions could be rated at three levels, corresponding to “no problems,” “some problems,” and “extreme problems.” The EuroQol group, however, has released official versions of the new five-level EQ-5D questionnaire, an expansion of the previous three-level EQ-5D questionnaire, in which each of the instrument’s five dimensions can be rated at five levels. This expansion has increased the number of combination health states from 243 to 3125.

Value sets for the three-level EQ-5D (EQ-5D-3L) questionnaire have typically been made by using mean preference values from the general population, elicited by using the time trade-off (TTO) method, in which health states are valued in relation to perfect health and death. As TTO interviews are costly and time-consuming, EQ-5D-3L questionnaire valuation studies have typically elicited TTO values for subsets (17–46) of the 243 possible health states, and values for all 243 states have been estimated by using regression modeling. Differences in the number of health states directly valued have been determined to contribute to observed differences between na-

tional EQ-5D questionnaire value sets [3], and two recent valuation studies directly valuing greater numbers of health states have revealed more complex interactions than those identified by previous valuation studies [4,5]. The increase in the number of possible health states that accompany the new five-level EQ-5D questionnaire makes the conventional method economically unfeasible and has led to a renewed focus on alternative valuation methods. One suggested method for creating value sets for the five-level EQ-5D questionnaire is combining TTO values for a limited set of health states with discrete choice exercise (DCE) data for a larger sample of health states [6]. In DCE, respondents are asked to state which of two alternative health states they think is best, a simpler and less costly method than TTO valuation. Combining TTO and DCE data in this manner requires that the two methods measure the same construct in similar manners. Preliminary analyses of results from a set of experimental valuation exercises performed in Norway, however, led us to wonder whether ranking and TTO exercises may make respondents sensitive to different EQ-5D questionnaire dimensions; we observed unexpected and stable mean rank transpositions between TTO and ranking of health state pairs involving impairments on different EQ-5D questionnaire dimensions. Both in our valuation experiments and in previous TTO-based EQ-5D-3L questionnaire valuation studies, respondents have been familiarized with health state valuation before TTO elicitation by having them rank the presented

\* Address correspondence to: Kim Rand-Hendriksen, Department of Health Management and Health Economics, University of Oslo, Pb. 1089 Blindern, 0318 Oslo, Norway.

E-mail: [kim.rand-hendriksen@medisin.uio.no](mailto:kim.rand-hendriksen@medisin.uio.no).

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health states from subjective best to worst and then value the ranked states on a visual analogue scale (VAS). Lacking a gold standard for comparison, several researchers have proposed the use of ranking as a benchmark for comparison when considering the validity of other valuation methods such as TTO [7,8]. Furthermore, the ranking task can be considered as an ordered set of discrete choices. As such, existing rank data may be used as imperfect proxies for DCE data. Since ranking tasks were used in previous TTO-based EQ-5D questionnaire valuation studies, an abundance of data is available that enables comparison of ranking and TTO values.

*The aim of this study was to examine data from previous valuation studies to determine whether respondents were sensitive to different dimensions of health state impairment when performing ranking of health states to when performing TTO valuation.*

## Methods

### Data

We used data from the UK (measuring and valuing health) [9] and US [10] TTO-based EQ-5D questionnaire valuation studies, both of which asked respondents from the general population to value the same 42 EQ-5D questionnaire health states by using a ranking task, VAS, and TTO. Performed in 1993, the UK valuation study was the first large-scale national EQ-5D questionnaire valuation study using TTO interviews, and it has become the model upon which most subsequent valuation studies have been built. After exclusions, 2997 respondents were included in the valuation sample. The US valuation study was performed in 2001 by using an interview protocol that was nearly identical to the UK protocol. The sampling techniques used were more advanced than in the UK study, as were the statistical methods used to ensure population representativeness. With 3773 respondents after exclusions, the US valuation study has partially supplanted the UK study as the valuation study of reference.

We were interested in two variables from these studies: rank order and TTO values for the measured EQ-5D questionnaire health states.

### Rank order

In both studies, respondents were familiarized with the EQ-5D questionnaire and valuation of hypothetical health states prior to TTO valuation. First, they were asked to describe their own current health by using the EQ-5D questionnaire descriptive system. They were then asked to rank from subjective best to worst a set of 15 cards, each describing a health state. The cards included the states "death," "unconscious," EQ-5D questionnaire state 11111 (no health problems), and 12 other EQ-5D questionnaire states selected from the pool of 42 EQ-5D questionnaire states that were valued in the study. We were interested in the rank order of the 12 health states from the pool of 42, and therefore discarded the ranks of "death," "unconscious," and state 11111. The remaining 12 states then had ranks from 1 (best) to 12 (worst). We extracted the mean rank values of all 42 measured EQ-5D questionnaire health states from the UK and US data sets.

### TTO values

The states "death" and 11111 were used as anchors in the TTO interview, with values of 0 and 1, respectively. In the TTO interview, respondents valued the 12 EQ-5D questionnaire health states they had previously ranked, one by one in random order. The objective of the TTO task was to identify the respondent's point of preferential indifference between 10 years in the impaired health state in question (the target state) and a shorter life in state 11111. The point of indifference was identified through a sequence of choice tasks in which the length of life in state 11111 was ma-

nipulated. When equilibrium was found, the TTO value of the target state was calculated as time in the target state divided by time in perfect health (10 years). We extracted the mean TTO values for each of the 42 measured health states from the UK and US data sets.

In the calculation of mean rank and TTO values, we used the same methods and exclusion criteria employed in the respective valuation studies. There were two primary differences between the UK and US valuation studies that merit mention here: The US valuation study intentionally oversampled certain ethnic groups. To achieve population representativeness, respondent survey weights were used. The other difference pertains to health states considered worse than death. In both studies, TTO values elicited when respondents considered the presented health states to be worse than death were transformed before health state means were calculated. However, the UK valuation study was performed by using a transformation suggested by Patrick et al. [9,11], while the US study was performed by using a method suggested by Torrance [10,12]. The worse-than-death valuation procedure and subsequent transformations have been extensively discussed and criticized for being atheoretical [3,13-16], and the differences between the two methods used have been found to contribute substantially to observed differences between the published US and UK EQ-5D questionnaire tariffs [16]. Nevertheless, worse-than-death transformation has been considered a necessary evil and has been used in the calculation of all published mean-based TTO tariffs for the EQ-5D questionnaire, with the Torrance transformation used only in the US valuation study and the Patrick transformation used in the remaining 14 valuation studies (UK, Spain, Germany, Japan, Denmark, Zimbabwe, Netherlands, Argentine, South Korea, Thailand, Poland, France, Chile, and Australia). We consider discussion of the appropriateness of the valuation studies' exclusion criteria, sampling methods, and worse-than-death transformation methods to be outside the scope of this article. Because of previous observations of the substantial impact that the choice of the transformation method makes, however, we performed sensitivity analyses substituting transformation methods.

### Overall rank orders

Mean TTO values and mean rank orders are not directly comparable. To enable a crude comparison using a common scale, we chose to perform analyses on the overall rank orders of the mean TTO values and the mean rank values: In each data set, the best mean TTO value was assigned an overall rank value of 1 and the worst was assigned a rank value of 42. Similarly, the state with the best mean rank order (close to 1) was assigned an overall mean rank value of 1 and the worst (close to 12) was assigned a value of 42. In this procedure, we disregard the relative distances between mean TTO values and between mean ranks. For simplicity, we will refer to the overall mean TTO rank orders as *mean TTO ranks* and the overall mean ranking task rank orders as *mean rankings*.

For each of the two data sets, we then subtracted the mean rankings from the mean TTO ranks, rendering a measure of difference between the two valuation methods' relative ordering of the 42 EQ-5D questionnaire health states. We refer to these values as mean rank differences. A positive mean rank difference reflected states that were ranked as worse in the TTO valuation than in the ranking task, and a negative mean rank difference reflected states ranked as worse in the ranking task than in the TTO.

### Analyses

First, we analyzed the mean TTO ranks and the mean rankings to identify pairs of health states for which the rank orders were reversed between mean TTO rank and mean rankings, that is, in which one of the health states was considered to be better than the

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