Utility indices in patients with the obstructive sleep apnea syndrome

Schmidlin, M; Fritsch, K; Matthews, F; Thurnheer, R; Senn, O; Bloch, K E

Abstract: BACKGROUND: Utility indices are used in cost-effectiveness analyses as a measure of quality of life reflecting the patient’s preference for a given health state on a scale anchored at 0 (corresponding to death) to 1 (perfect health). It is uncertain which utility instruments are most suitable for application in patients with the obstructive sleep apnea syndrome (OSA). OBJECTIVES: To compare utility indices obtained in OSA patients by various instruments. Methods: In 66 untreated OSA patients (median Epworth score 12, apnea/hypopnea index, AHI, 57/h), five different utility instruments were employed. In 34 OSA patients, changes in utility after 4 months of continuous positive airway pressure (CPAP) were retrieved from published SF-36 data. RESULTS: In 66 OSA patients, median (quartiles) utility indices were: standard gamble 0.97 (0.89; 0.99); time trade-off 0.94 (0.81; 0.99); EuroQol questionnaire (EQ-5D) 0.92 (0.83; 1.00); Euro-thermometer visual analog scale 0.80 (0.70; 0.90); SF-36 questionnaire (SF-6D) 0.75 (0.69; 0.85; p < 0.05 SF-6D and Euro-thermometer utility vs. other indices). Different utility indices were poorly correlated among each other and with AHI and Epworth scores. SF-6D utility after 4 months of CPAP had changed by 0.04 (0.02; 0.12, p = 0.026). CONCLUSIONS: Utility indices measured by different instruments vary largely and some indices reflect the impaired quality of life in OSA poorly. Interpretation of cost-effectiveness analyses should account for the utility instrument used.

DOI: https://doi.org/10.1159/000222094

Posted at the Zurich Open Repository and Archive, University of Zurich
ZORAJURL: https://doi.org/10.5167/uzh-31358
Journal Article
Accepted Version

Originally published at:
DOI: https://doi.org/10.1159/000222094
Utility indices in patients with the obstructive sleep apnea syndrome

Martina Schmidlin¹, Karsten Fritsch¹, Felix Matthews¹,
Robert Thurnheer², Oliver Senn¹ and Konrad E. Bloch¹

¹Pulmonary Division, University Hospital of Zurich and
²Pulmonary Division, Cantonal Hospital Munsterlingen, Switzerland

Keywords: outcomes, quality of life, sleep apnea, symptoms, utility

Correspondence:
Konrad E. Bloch, MD
Pulmonary Division, University Hospital of Zurich
Ramistrasse 100, CH-8091 Zurich
Switzerland
Email: konrad.bloch@usz.ch
Abstract

Background: Utility indices are used in cost-effectiveness analyses as a measure of quality of life reflecting the patient’s preference for a given health state on a scale anchored at 0 (corresponding to death) to 1 (perfect health). It is uncertain which utility instruments are most suitable for application in patients with obstructive sleep apnea syndrome (OSA).

Objectives: To compare utility indices obtained in OSA patients by various instruments.

Methods: In 66 untreated OSA patients (median Epworth score 12, apnea/hypopnea index 57/h) 5 different utility instruments were employed. In 34 OSA patients changes in utility after 4 months of CPAP were derived from published SF-36 data.

Results: In 66 OSA patients median (quartiles) utility indices were: standard gamble 0.97 (0.89;0.99); time trade-off 0.94 (0.81;0.99); EuroQol questionnaire (EQ-5D) 0.92 (0.83;1.00); Euro-thermometer visual analog scale 0.80 (0.70;0.90); SF-36 questionnaire (SF-6D) 0.75 (0.69;0.85) (P<0.05 SF-6D and Euro-thermometer utility vs. other indices). Different utility indices were poorly correlated among each other and with apnea/hypopnea indices and Epworth scores. SF-6D utility after 4 months of CPAP had changed by 0.04 (0.02;0.12, P=0.026).

Conclusions: Utility indices measured by different instruments vary largely and some indices poorly reflect the impaired quality of life in OSA. Interpretation of cost-effectiveness analyses should account for the utility instrument used.
Background

Effectiveness of novel medical treatments is traditionally evaluated in terms of the objective effects on morbidity and mortality. In recent times, there is increasing emphasis on subjective outcomes such as quality of life assessed by generic and disease-specific questionnaires that provide profiles of subjective health perception in different domains [1-3]. For cost-effectiveness analysis, quality of life is expressed by a single index measure intended to convey the utility that a person derives from his or her health state [4]. The utility index is defined as the subjective preference of a patient for a given health state and rated on a scale anchored at 0, corresponding to death, and 1, corresponding to perfect health [5,6]. By multiplying the utility index by the years spent in a particular health state, quality-adjusted life years (QALY) are computed. The ratio of increased costs divided by the QALY gained by a medical intervention represents the cost-effectiveness ratio [4]. Decisions on allocation of financial resources for health care are increasingly guided by cost-effectiveness analyses. Since the utility index is a main component of such analyses its reliable measurement is essential. Various instruments have been used to obtain utility indices directly (i.e., the standard gamble and time trade-off methods [5], and the “Euro-thermometer” visual analog scale [7]), and indirectly from questionnaires such as the medical outcome health survey SF-36 [8] or the EuroQol questionnaire [7] that provide the SF-6D and the EQ-5D utility indices, respectively. The performance of different utility instruments in various settings is not well established. Utility indices may be affected by the age, gender, socio-economic status and cultural factors in addition to the individual health preference of a patient with a particular disease [9,10]. Therefore, utility instruments have to be validated in the specific setting where they are intended to be applied.

The obstructive sleep apnea syndrome (OSA) is a common disorder affecting at least 2 to 4 % of adults in the US population [11] and the prevalence is expected to increase due to
the epidemic of obesity. OSA patients are affected by daytime sleepiness, decreased concentration and irritability [12], and the disorder is an independent risk factor for cardiovascular diseases [13,14] and sleepiness related traffic and work accidents [15]. Since OSA has a considerable impact on health-economics [16] evaluating cost-effectiveness of various treatments such as nocturnal continuous positive airway pressure (CPAP), mandibular advancement devices and surgical interventions would be desirable. However, utility instruments have not been rigorously validated for application in OSA patients. Thus, the objective of this study is to compare utility indices obtained by different instruments in OSA patients and to correlate utility indices with other measures of quality of life, symptoms and the severity of sleep related breathing disturbances. The hypothesis was, that the performance of various utility instruments would vary. Furthermore, we evaluated whether one particular utility instrument, the SF-36 questionnaire-derived SF-6D utility index, reflects changes in quality of life achieved by CPAP therapy in OSA. For this purpose, we derived SF-6D utility indices from data collected in a previously published study in OSA patients at baseline and after 4 months of CPAP therapy [17].

**Methods**

**Patients and subjects**

Successive patients with OSA referred to the sleep disorders center of the Pulmonary Division, University Hospital of Zurich, were asked to participate in the study. OSA was diagnosed based on typical symptoms such as habitual snoring, excessive daytime sleepiness, an Epworth sleepiness scale score $\geq 8$ [18], and an apnea/hypopnea index $>10$/h during a cardio-respiratory sleep study. Patients with comorbidities that were thought to significantly affect their quality of life (in particular psychiatric, internal medical and neurologic disorders)
Utility assessment

Three instruments for direct utility assessments were employed:

**The standard gamble [5]:** This test was performed using a custom made interactive computer application. Patients were asked to choose between two theoretical alternatives presented on the computer screen (figure 1): either to continue their life in the current health state, or to accept an offered therapy. If they choose the therapy, this was associated with a certain chance (probability) of attaining perfect health, but this was also afflicted by a certain risk of immediate death (risk or probability of immediate death = 1-probability of perfect health). By systematically changing the probability of attaining perfect health and its connected risk of immediate death, the point of indifference was determined in an iterative procedure. The probability of perfect health at the point of indifference was taken as the utility of the individual’s current health state.

**The Time Trade-Off [5]:** This test was also performed using a custom made interactive computer application (figure 1). Patients were asked to choose between two theoretical alternatives: either live for 20 years in their current health state or live in perfect health but for a shorter time period. The number of years the patients were willing to trade off was varied systematically until a point of indifference was reached. The ratio of years at the point of indifference divided by 20 (i.e., the selected time horizon) corresponded to the utility index.
The Visual Analog Scale ("Euro thermometer") [7]: The Euro-thermometer is part of the EuroQol questionnaire EQ-5D. Patients had to mark their perceived current health state with a pencil on a piece of paper that contained a line with a scale from 0 (corresponding to worst imaginable health or death) to 100 (corresponding to best imaginable, perfect health). The value corresponding to the mark on the scale divided by 100 was taken as the utility index (figure 1).

In addition, 2 instruments for indirect utility assessments were employed. Utility was derived from answers to questions on various domains of quality of life. The responses were weighted and summed to obtain the utility index according to valuations obtained in reference populations as described elsewhere [19,20].

The Short Form 6 dimensions (SF-6D): The SF-6D is derived from the short form of the medical outcome questionnaire SF-36, a generic quality of life questionnaire [1,19]. Patients completed the SF-36 on paper. The answers from 11 of the 36 questions representing 6 dimensions were used to compute the utility index based on valuations in a British population [1,19]. The scores in the 8 domains of the SF-36 and the mental and physical component scores were also computed.

The EuroQol-5 dimensions (EQ-5D): The EQ-5D is a generic questionnaire for the evaluation of quality of life encompassing 5 dimensions. There is one question for each dimension which can be answered by three levels of impairment [2,20]. Patients completed the questionnaire on paper. The scores for the 5 domains were computed and the EQ-5D utility index derived according to valuations in a British population [10,21].
Protocol

Study participants were asked to perform utility assessment after receiving detailed information on the various tests. An investigator coached the participants performing the computer-based tests and questionnaires. If any participant did not understand how to handle the computer programs or did not understand the questions, the investigator gave additional explanations and, in some cases, the tests were restarted. The time to complete all utility assessments was measured.

To gather utility indices before and after 4 months of CPAP therapy SF-36 questionnaires from OSA patients who had participated in a previous study [17] were reanalyzed and the change in the SF-6D utility index with introduction of treatment was evaluated.

Data analysis and statistics

Results were summarized by medians (quartiles) or means (SD) for non-normally and normally distributed outcomes, respectively. Utility values obtained in the same participant by different instruments were compared by identity plots, by computing Spearman correlation coefficients and by Wilcoxon matched pairs test. Data from different groups were compared by the Mann-Whitney U test. Spearman correlations were computed between utility indices and the apnea/hypopnea index and the Epworth sleepiness score. A probability of P<0.05 was considered as statistically significant.
Results

Sixty-six OSA patients participated in the study (table 1). In some patients, utility indices could not be obtained by all 5 methods because of technical failures or incomplete questionnaire data and, in 1 patient, because he did not understand the principles of the standard gamble test. Therefore, the number of available utility indices collected by the different instruments varies between 56 to 66. OSA patients required a mean (±SD) time of 20 ±8 min to complete utility assessments by all 5 instruments. Most patients required detailed explanations before they were able to perform the standard gamble and time trade-off tests while they were generally able to complete the SF-36, the EQ-5D and the Euro-thermometer tests after brief instructions.

Patients and subjects characteristics are summarized in table 1 along with multidimensional quality of life assessed by the generic questionnaires SF-36 and EQ-5D. The OSA patients had moderate to severe sleep related breathing disturbances and moderate subjective daytime sleepiness. Compared to a US reference population of corresponding age and gender reported by Ware et al. [1], their SF-36 quality of life was reduced in several domains, whereas the medians of the EQ-5D domains had a value of 1 suggesting no impairment.

Results of utility assessments are summarized in table 2. Figure 2 shows histograms of utility indices and of the apnea/hypopnea index in the OSA patients. The median SF-6D utility index in OSA patients was significantly lower than the corresponding values by all other instruments with exception of the Euro-thermometer utility index that was similarly low (table 2). In contrast, the standard gamble and time trade-off utility indices were higher than those by all other instruments and their value was close to 1 suggesting a ceiling effect in these two indices (figure 2).
In table 3, Spearman rank order correlations of utility indices obtained by the 5 different instruments are presented.

The standard gamble and the time trade-off utility indices were correlated among themselves but not with any of the other utility indices. The EQ-5D and the Euro-thermometer VAS were correlated among themselves and with the SF-6D index. We further evaluated whether utility indices were correlated with selected measures of quality of life that were impaired in OSA patients (table 2). This analysis revealed that the SF-36 physical component summary was significantly correlated with utility indices from the EQ-5D, the Euro-thermometer visual analog scale and the SF-6D (table 3). The EQ-5D pain/discomfort domain was significantly correlated with utility indices from the EQ-5D, the Euro-thermometer and the SF-6D (table 3). With exception of a weak correlation between the Epworth sleepiness score and the standard gamble and time trade-off utility indices, none of the utility indices were correlated with measures of disease severity such as the Epworth sleepiness score or the apnea/hypopnea index (table 3).

In 34 patients participating in a our previous study [17], SF-36 data were re-analyzed to obtain SF-6D utility (table 4). The baseline SF-6D utility index was similar (median value of 0.74) to the corresponding value observed in the 66 patients in the current study (median value of 0.75, table 2). Computation of SF-6D utility indices after 4 months of CPAP therapy in patients from the previous study revealed a significant improvement by a median of 0.04 points to 0.79 (table 4). Over the same time period, the apnea/hypopnea index and the Epworth sleepiness score had also significantly improved (table 4).
Discussion

We evaluated the subjective health perception by several direct and indirect utility instruments in patients with the obstructive sleep apnea syndrome. We found that utility indices derived by the 5 different instruments differed significantly and were only weakly correlated among themselves and with other generic measures of quality of life and with measures of disease severity such as the Epworth sleepiness score and the apnea/hypopnea index. Utility indices obtained by the standard gamble and the time trade-off methods showed ceiling effects and seemed not to reflect the burden of disease in OSA patients. The Eurothermometer visual analog scale and the SF-6D utility indices revealed the lowest values in OSA patients and the SF-6D utility index improved significantly with CPAP therapy. Therefore, the SF-6D and the Euro-thermometer utility indices seem to be the most suitable among the 5 tested instruments to reflect the impaired quality of life in OSA patients.

Few previous studies have measured utility indices by various instruments in OSA patients. In a retrospective analysis of 19 OSA patients, Tousignant et al. [22] reported a mean standard gamble utility index of 0.63 before treatment and of 0.87 after several months of CPAP therapy. In a randomized trial Chakravorty et al. [23] recorded a mean standard gamble utility index in 32 OSA patients of 0.32 before and of 0.55 during CPAP therapy. The utility indices of untreated OSA patients in the 2 cited studies [22,23] are lower than the corresponding values of 0.97 and 0.94 obtained with the standard gamble and time trade-off methods in the current study (table 2). We have no definitive explanation for this discrepancy since disease severity assessed by the apnea/hypopnea index in our patients (median of 57/h, table 1) was similar to that of the patients in the cited studies (mean values of 67/h [22] and 55/h [23] before treatment), although socio-economic patient characteristics and aspects of the protocol and test application might have differed between the studies.
In 4 studies [23-26] comprising a total of 260 OSA patients, the mean EQ-5D utility indices before initiation of treatment were between 0.73 to 0.79, i.e. lower than the value of 0.92 observed in the current study (table 2). In only one of these studies [23] initiation of CPAP therapy was associated with a significant increase in the EQ-5D utility index of 0.04 while CPAP had no significant effect on the index in the other 3 studies [24-26]. Therefore, the authors concluded that the EQ-5D questionnaire might not capture the relevant quality of life domains affected in OSA patients [24,25]. Consistent with this interpretation we found that EQ-5D quality of life was normal in OSA patients with exception of a trend of a minor impairment in the pain/discomfort domain (table 1) and, accordingly, the EQ-5D utility indices were relatively high suggesting a ceiling effect as previously observed in other patient groups [27] (table 2).

In 2 of the cited studies [23,24] the Euro-thermometer visual analog scale has also been employed along with other utility instruments. In untreated OSA patients, the Euro-thermometer utility index was 0.67 [24] and 0.59 [23], and increased with CPAP therapy by 0.04 and 0.11, respectively. In the current study, the Euro-thermometer utility index was higher (median of 0.80, table 2) than the baseline value in the cited studies but lower than corresponding values derived in the same patients by the standard gamble, the time-trade-off and the EQ-5D questionnaire (table 2) suggesting that patients were able to better express their impaired quality of life by the Euro-thermometer visual analog scale.

Our study is the first to include SF-6D utility indices in quality of life assessment in OSA patients. The SF-6D indices were lower than those obtained by all other instruments (table 2) and there was a significant improvement in SF-6D utility of 0.04 with CPAP therapy (table 4). This value falls well within the range of minimally important differences of 0.011 to 0.097 computed for SF-6D utility in patients with various diseases other than OSA (i.e. COPD, back pain, among others) [28]. Since SF-6D utility indices in the current study were correlated with quality of life assessed by the physical component summary of the SF-36 and
with the pain/discomfort domain of the EQ-5D as well as with the EQ-5D utility index and the Euro-thermometer derived utility index, the SF-6D index seems promising as a sensitive generic instrument for evaluation of utility and its changes with treatment in OSA patients.

In line with divergent utilities obtained by the EQ-5D and other instruments in previous studies in OSA [22-26] and in other diseases [27,28] we found only weak or no correlation among utility indices obtained by different instruments (table 3). This was in part related to the ceiling effect observed in the standard gamble and time trade-off indices (figure 2). In our experience, the OSA patients in the current study did not perceive their disorder as directly life-threatening and were therefore reluctant to accept even a minor risk of immediate death in the standard gamble, or to give up a portion of their life-time in the time trade-off test. The weak or absent correlation between several utility indices and other measures of generic quality of life (i.e. SF-36 domains or the EQ-5D pain/discomfort domain) and with measures of OSA severity such as the Epworth sleepiness scale or the apnea/hypopnea index suggests that certain utility indices might not appropriately reflect the burden of disease in OSA. Similarly, generic quality of life was poorly correlated with sleep related breathing disturbances in OSA patients in previous studies [29]. Further prospective trials are required to evaluate which utility instruments are most suitable to track treatment effects in OSA.

In conclusion, we demonstrated that utility indices derived by different instruments in OSA patients vary largely and are poorly correlated among themselves. Therefore, the interpretation of cost-effectiveness analysis based on utility assessment in OSA has to carefully account for the instruments used. Instruments established in other settings such as the standard gamble and the time trade-off methods provided relatively high utility indices (between 0.9 to 1.0) even in moderate to severe OSA. These indices seem not to appropriately reflect the impaired quality of life domains of OSA patients and the improvement by treatment. Therefore, the SF-6D utility index and the Euro-thermometer visual analog scale that revealed lower values that were correlated with other measures of generic quality of life
seem better suited to capture the suffering of OSA patients, and to track changes with
treatment (by the SF-6D).

Acknowledgement

The study has been supported by the Swiss National Science Foundation and the Lung Ligue
of Zurich; ResMed Switzerland Inc. and the Respironics Foundation provided unconditional
grants.
References


28 Walters SJ, Brazier JE. Comparison of the minimally important difference for two health state utility measures: EQ-5D and SF-6D. Qual Life Res 2005; 14:1523-1532.

Figure legends

**Figure 1.** Utility indices were obtained by the 3 direct instruments displayed in panel A, B, and C in addition to the indirect utility indices derived from the SF-36 and the EuroQol questionnaires. Panel A: in the standard gamble test, patients had to select among 2 options displayed on the computer screen, i.e. accept a new therapy associated with perfect health but a certain risk of immediate death, vs. remain in their current health state. The utility index was determined as \((1 – \% \text{ risk of death/100})\) at the point of indifference. Panel B: in the time trade-off test, patients were asked whether they preferred to live in perfect health but trade-off a few years of their life-time (assumed time horizon of 20 years) vs. to stay in their current health state. The number of years traded off was varied to the point of indifference, and the utility index was taken as the ratio \((1 – [\text{years traded-off}/20])\). Panel C: in the Eurothermometer visual analog scale the patients positioned their current health state on a scale ranging from 0 (worst imaginable health or death) to 100 (best imaginable, perfect health). The value on the scale divided by 100 was taken as the utility index.

**Figure 2.** Distribution of the utility indices obtained by the various instruments and the apnea/hypopnea index in 66 OSA patients. There is a ceiling effect in the standard gamble and time trade-off utility indices.

**Figure 3.** Correlations among utility indices obtained by various instruments and the apnea/hypopnea index with the SF-6D utility index in 66 OSA patients. The Spearman rank order correlation coefficient \(R\) is indicated. The dashed lines represent identity.
Table 1. Patient characteristics and multidimensional, generic quality of life

<table>
<thead>
<tr>
<th></th>
<th>n (women)</th>
<th>66 (8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td></td>
<td>55 (47;61)</td>
</tr>
<tr>
<td>Apnea/hypopnea index, events/h</td>
<td></td>
<td>57 (38;72)</td>
</tr>
<tr>
<td>Epworth score</td>
<td></td>
<td>12 (10;15)</td>
</tr>
</tbody>
</table>

**SF-36 quality of life**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Norm §</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical function</td>
<td>85 (65;90)*</td>
<td>[90]</td>
</tr>
<tr>
<td>Role physical</td>
<td>75 (50;100)*</td>
<td>[96]</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>100 (62;100)</td>
<td>[78]</td>
</tr>
<tr>
<td>General health</td>
<td>72 (57;82)</td>
<td>[72]</td>
</tr>
<tr>
<td>Vitality</td>
<td>55 (35;70)*</td>
<td>[66]</td>
</tr>
<tr>
<td>Social function</td>
<td>100 (75;100)*</td>
<td>[99]</td>
</tr>
<tr>
<td>Role emotional</td>
<td>100 (67;100)*</td>
<td>[100]</td>
</tr>
<tr>
<td>Mental health</td>
<td>80 (64;88)</td>
<td>[80]</td>
</tr>
<tr>
<td>Physical component summary</td>
<td>49 (40;54)</td>
<td>[50]</td>
</tr>
<tr>
<td>Mental component summary</td>
<td>52 (45;56)</td>
<td>[50]</td>
</tr>
</tbody>
</table>

**EQ-5D quality of life**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>1 (1;1)</td>
</tr>
<tr>
<td>Self-care</td>
<td>1 (1;1)</td>
</tr>
<tr>
<td>Usual activities</td>
<td>1 (1;1)</td>
</tr>
<tr>
<td>Pain/discomfort</td>
<td>1 (1;2)</td>
</tr>
<tr>
<td>Anxiety/depression</td>
<td>1 (1;1)</td>
</tr>
</tbody>
</table>

Medians (lower quartile; upper quartile); Transposed SF-36 scores are presented with a range from 0 to 100, with higher values corresponding to better quality of life. EQ-5D domains are rated on a scale from 1, no impairment, to 3, maximal impairment.

* P<0.005 vs. Norm; § Norm: [median of the value observed in a US reference population of corresponding age and gender][1].
Table 2. Utility indices measured by different instruments in OSA patients

<table>
<thead>
<tr>
<th>Instrument</th>
<th>n</th>
<th>Utility Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard gamble utility index (SG)</td>
<td>65</td>
<td>0.97 (0.89;0.99)</td>
</tr>
<tr>
<td>Time trade-off utility index (TTO)</td>
<td>56</td>
<td>0.94 (0.81;0.99)</td>
</tr>
<tr>
<td>EQ-5D utility index</td>
<td>57</td>
<td>0.92 (0.83;1.00)</td>
</tr>
<tr>
<td>Euro-thermometer visual analog scale utility index (VAS)</td>
<td>65</td>
<td>0.80 (0.70;0.90)</td>
</tr>
<tr>
<td>SF-6D utility index</td>
<td>66</td>
<td>0.75 (0.69;0.85)</td>
</tr>
</tbody>
</table>

¶ P<0.001 for comparisons of SF-6D utility vs. TTO; SF-6D vs. SG; SF-6D vs. EQ-5D; VAS vs. TTO, VAS vs. SG; EQ-5D vs. SG;
§ P<0.05 for comparisons of VAS utility vs. EQ-5D; EQ-5D vs. TTO;
Table 3. Correlations between utility indices, generic quality of life, Epworth sleepiness score and apnea/hypopnea index in patients with the obstructive sleep apnea syndrome

<table>
<thead>
<tr>
<th>Standard gamble utility index</th>
<th>Time trade-off utility index</th>
<th>EQ-5D utility index</th>
<th>Euro-thermometer VAS utility index</th>
<th>SF-6D utility Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard gamble utility index</td>
<td>0.50¶</td>
<td>-0.09</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>Time trade-off Utility index</td>
<td>0.50¶</td>
<td>-0.01</td>
<td>0.21</td>
<td>0.07</td>
</tr>
<tr>
<td>EQ-5D utility index</td>
<td>-0.09</td>
<td>-0.01</td>
<td>0.50¶</td>
<td>0.55¶</td>
</tr>
<tr>
<td>Euro-thermometer VAS utility index</td>
<td>0.15</td>
<td>0.21</td>
<td>0.50¶</td>
<td>0.41¶</td>
</tr>
<tr>
<td>SF-6D utility index</td>
<td>0.12</td>
<td>0.07</td>
<td>0.55¶</td>
<td>0.41¶</td>
</tr>
</tbody>
</table>

| SF-36 physical function      | -0.03                        | 0.01               | 0.53¶                             | 0.43¶             | 0.48¶             |
| SF-36 Role physical          | 0.09                         | 0.12               | 0.32*                             | 0.37§             | 0.65¶             |
| SF-36 vitality               | 0.01                         | 0.12               | 0.35§                             | 0.30*             | 0.68¶             |
| EQ-5D pain/discomfort domain | 0.14                         | 0.02               | -0.88¶                            | -0.4§              | -0.49¶             |

| Epworth sleepiness score     | -0.28*                       | -0.31*             | 0.05                              | 0.00              | -0.17             |
| Apnea/hypopnea index         | -0.16                        | 0.01               | 0.13                              | 0.05              | -0.00             |

Values are Spearman rank order correlations (R). * P<0.05, § P<0.01, ¶ P<0.001; VAS=visual analog scale. Horizontal dashed lines separate direct from indirect utility indices and measures of disease severity, respectively.
Table 4. SF-6D utility indices in patients with the obstructive sleep apnea syndrome before and 4 months after initiating CPAP therapy#

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>4 months on CPAP</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epworth score</td>
<td>15.0 (11.0; 17.0)</td>
<td>7.0 (4.0; 9.5)</td>
<td>7.0 (5.0; 9.0)*</td>
</tr>
<tr>
<td>Apnea/hypopnea index (events/h)</td>
<td>49.8 (34.8; 59.4)</td>
<td>5.0 (3.1; 8.6)</td>
<td>37.8 (26.2; 54.7)*</td>
</tr>
<tr>
<td>SF-6D utility index</td>
<td>0.74 (0.66; 0.81)</td>
<td>0.79 (0.68; 0.85)</td>
<td>0.04 (-0.02; 0.12) ¶</td>
</tr>
</tbody>
</table>

#SF-6D utility was derived from data collected in a previous trial [17] in 33 obstructive sleep apnea patients; values are medians (quartiles).

* P<0.000001, ¶ P=0.026
A

Standard Gamble

The new therapy has a 80% chance of complete recovery, and a 20% risk of immediate death.

I choose the new therapy  I prefer my current health state  I cannot make up my mind

B

Time Trade-off

20 years

Alive: 16 years  Dead: 4 years
16 years in perfect health, then die.

Alive: 20 years  Dead: 8 years
20 years in current health, then die.

I choose the new therapy  I prefer my current health state  I cannot make up my mind

C

your current health

best

1.0

worst
![Histograms of utility indices](image_url)

- **A**: Time trade-off utility index
- **B**: Standard gamble utility index
- **C**: EQ-5D utility index
- **D**: Euro-thermometer utility index
- **E**: SF-6D utility index