Is Utility-Based Quality of Life in Adults Affected by Glaucoma?

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Purpose. We evaluated the utility values (UVs), using the time trade off (TTO) technique, associated with primary glaucoma and varying degrees of visual field (VF) loss.

Methods. In this cross-sectional study, 198 adults (mean age, 59.8 years) with primary glaucoma were recruited from the glaucoma clinic of a tertiary center in Hyderabad, South India. Each patient underwent comprehensive glaucoma evaluation, and completed the utility (TTO) and Glaucoma Quality of Life-15 questionnaires (Rasch version, Glaucoma Activity Limitation [GAL]-10). Better mean deviation (MD, using Humphrey Field Analyzer program 24-2) between two eyes was used to classify participants into mild, moderate, and severe VF loss groups. Utilities (range, 0.0–1.0) derived by TTO technique (lifetime traded against perfect vision) and interval level Rasch scores of GAL-10 were used for analyses.

Results. Mean UV was 0.81 (95% confidence interval [CI], 0.78–0.84); that is, a decrease in quality of life (QoL) of 19%. Of the subjects, 59% were willing to trade lifetime in return of perfect vision; those willing to trade were significantly younger with poorer acuity in the worse-seeing eye. In univariate and multivariate analysis, severe VF loss in the worse eye was associated with lower UV ($\beta = -0.108$; 95% CI, −0.201 to −0.014; $P = 0.02$).

Conclusions. Our results show that primary glaucoma in adults causes substantial decrease in UVs (and QoL thereof), and is highly dependent on the severity of VF loss in the worse eye.

Keywords: utility values, glaucoma, quality of life, time trade off

Glaucoma is the second leading cause of irreversible blindness, affecting approximately 60 million people worldwide.[1] This prevalence has been projected to increase to 79.6 million by 2020.[2] It is estimated that Asians, including Indians, will represent 47% of the population with glaucoma.[2] Furthermore, it has been reported that the most detectable change in glaucoma worldwide will be its increase in India.[2] It is widely acknowledged that the risk of glaucoma increases exponentially with age (i.e., especially over 40 years),[3–6] and, given this, there are serious economic and public health concerns associated with this chronic disease.[7]

Glaucoma requires lifelong follow-up and treatment. More importantly, it carries a risk of vision impairment (VI) and, in some advanced cases, leads to blindness.[8,9] Therefore, it might be expected that decreased visual ability from glaucoma obviously impacts the quality of life (QoL). Regardless of the glaucoma type, there is a growing body of literature to show that QoL is reduced if patients have been diagnosed with glaucoma at all,[10,11] and that among patients with glaucoma, QoL decreases with the severity of visual field (VF) loss.[12–14] A number of technologies have been developed to measure the QoL associated with a health state.[15] Beside questionnaires (health- and vision-related), one important method is utility analysis to value different health states. Utility analysis is being adopted increasingly to obtain patient's preferences given the recognition that patient's preferences are key to decisions that affect their health care, and utility assessment is gaining popularity across health care, including ophthalmic conditions.[16,17]

Utility assessment provides the clinician and researcher with a single number representing the value or preference that a person attaches to a particular health state, for example, glaucoma. In practical terms, the utility values (UVs) associated with a specific health state indicate how patients feel about how well they are able to perform activities of daily life; thus, it is an indicator of QoL.[18] Utility values range from 0.0 to 1.0 and, by convention, a value of 0.0 represents death and 1.0 represents perfect health. The closer the value is to 1.0, the better is the perceived health-related QoL (HRQoL). In the ophthalmic field, utility values modified by Brown et al.[19] are used for measuring the HRQoL in patients with eye diseases, whereby the perfect health state is set at full visual function.[20] Standard gamble (SG) and the time trade-off (TTO) represent two common techniques of eliciting preferences in the utility assessment; TTO has been found to be easier to comprehend compared to SG and more satisfactory.[18,21,22] Using the TTO approach, a lower UV indicates that the patient is more willing to exchange a certain amount of life in return for perfect vision. For example, a UV of 0.35 for a patient with glaucoma means that a patient is willing to give up 65% of his/her remaining lifespan in return for perfect vision. A couple of reports regarding the UVs among glaucoma patients have emerged in India, albeit from a single tertiary eye care center in North

India.[23,24] Their values are lower when compared to that from Western populations. Given that India is a vastly diverse country with over a billion population, and there are cultural, linguistics, and lifestyle variations across regions (and subregions), the UVs of glaucoma patients from a single center in North India, may not be generalizable to those residing in other parts of the country, for example, in the Southern state of Andhra Pradesh. Therefore, our study aimed to determine the extent to which primary glaucoma with varying degree of VF loss affects utility-based QoL in adults in the Southern State of Andhra Pradesh, and to explore the factors that influence UVs in these patients.

Methods

The present study is part of a larger cross-sectional study to assess the impact of glaucoma on visual functioning in Indian adults at the L V Prasad Eye Institute (LVPEI), a tertiary eye care center in Hyderabad, the capital city of the South Indian state of Andhra Pradesh. Details of the study design, participant characteristics, and main outcome results can be found elsewhere,[25,26] and are presented here only briefly, when relevant.

Participants

Eligible participants were adults aged 18 years or older with an established diagnosis of primary glaucoma (primary open-angle glaucoma [POAG], primary angle closure glaucoma [PACG], juvenile open-angle glaucoma, or normal-tension glaucoma) who underwent ophthalmic examination in the past 6 months at the glaucoma clinic, LVPEI, Hyderabad, India, between November 2010 and January 2011, and had at least two consecutive reliable automated VFs (using Humphrey Automated Field analyzer [HFA], 24-2 Swedish Interactive Threshold Algorithm [SITA] – Standard; Carl Zeiss Meditec, Inc., Dublin, CA), one of which was performed in the past 6 months. Included participants spoke English or one of the two local languages (Hindi, Telugu) and were able to respond to questions in the corresponding language. Reliable VFs were defined as those with $<$20% fixation losses and $<$33% false-positive as well as false-negative response rates. Two reliable VFs were required so as to account for the learning effects and to obtain a robust estimation of amount of glaucoma damage. Given that age-related visually insignificant cataract (i.e., better eye visual acuity $>$ 20/40 and lack of self-reported difficulty in performing any of the daily tasks) has a relatively higher prevalence in patients with glaucoma, such patients also were eligible. Glaucoma patients with pseudophakia in one or both eyes were included. Patients with visually significant cataract (i.e., better eye visual acuity $\leq$ 20/40, self-reported difficulty in performing daily tasks, and/or were advised cataract surgery) were excluded. Other criteria for exclusion were the presence of other impairments (e.g., physical, cognitive) that could influence their responses, intraocular surgery within the past three months, had laser therapy within the previous two weeks, and presence of coexisting ocular morbidity, such as diabetic retinopathy and/or maculopathy of any etiology. Medical records of potentially eligible patients were screened a day before their appointment by the research assistants, and patients were invited to participate by either the research coordinator or the attending glaucoma specialist on the day of their appointment. Informed written consent was obtained from the patients after the nature of the study was explained. Ethics approval was granted by the LVPEI Ethics Committee for Human Research, and protocols adhered to the tenets of the Declaration of Helsinki.

Questionnaires

TTO Method. The TTO assessment employs a two-part question. The first is "How many years do you still expect to live?" followed by a second question "Assuming that there was a technology which restores your vision to full vision, what is the maximum number of remaining years of life you would be willing to give up if you could receive this technology and have normal vision in both eyes for the rest of your life?" The utility score then was calculated by subtracting the proportion (years traded/years to live) from 1.0. The Figure shows the method to calculate utility score with an example. The utility scores vary from the anchor of 1.00 (perfect vision) and 0.0 (blindness). This methodology has been described previously.[19,27,28] The TTO questions were administered face-to-face by a trained interviewer before any clinical examination so as to prevent respondent bias.

Glaucoma Quality of Life-15 (GQL-15) Questionnaire. The GQL-15 consists of 15 items that are rated using a five-category rating scale. A little over one-third (65%) of the participants self-administered the GQL-15, while trained interviewers administered it face-to-face to the remaining participants. Our previous Rasch analysis of the GQL-15 resulted in a 10-item reliable and valid questionnaire, the Glaucoma Activity Limitation (GAL-10). The specific Rasch methodology employed has been described in detail previously.[26] We used the Rasch-scaled scores of GAL-10 (expressed in log of the odds units, or logits). Higher negative scores indicated lower visual disability on the Rasch-scaled GAL-10.

Both questionnaires were administered in one of three languages (English, Telugu, and Hindi). Using standard forward-backward translation procedures, local language versions (Telugu and Hindi) were obtained. However, before use, the final translations into local languages were pilot tested in a representative sample of glaucoma patients to discuss the wording, comprehension, and cultural appropriateness of content. While this resulted in minor changes in the wording of some questions, no change in the overall content of the questionnaires was necessary.

Sociodemographic and Clinical Data

Baseline sociodemographic data and information about participants' general health were obtained by self report. These included age, highest completed level of education, marital status, employment status (if working), monthly family income, number of other medical conditions, and number of anti-glaucoma medications.

Information about participants' ocular health was obtained from the medical records. These included the type of glaucoma, duration of glaucoma since diagnosis, severity of VF loss, and previous surgical and laser treatment. Information regarding presenting and best-corrected visual acuity (VA, recorded monocularly using Snellen charts) was extracted from the medical records at the end of the detailed ocular examination on the day of visit to the clinic. Although VA was recorded using Snellen charts, it was later converted to logMAR for analysis. The severity of VF defects was graded based on the better mean deviation (MD) between the two eyes (better MD), in line with the Hodapp-Anderson-Parrish (HAP) grading scale.[29–32] Using this scale, patients were categorized into three groups: mild (MD of no worse than –6 dB), moderate (MD of 6–12 dB), and severe (MD worse than 12 dB). As indicated earlier, VF testing was performed using the HFA analyzer II with appropriate refractive correction. A VF was labeled glaucomatous by the glaucoma specialist based on two reliable threshold VF examination of the central 24^0 or 30^0 (SITA Standard 24-2 or 30-2), if the patient had a glaucoma

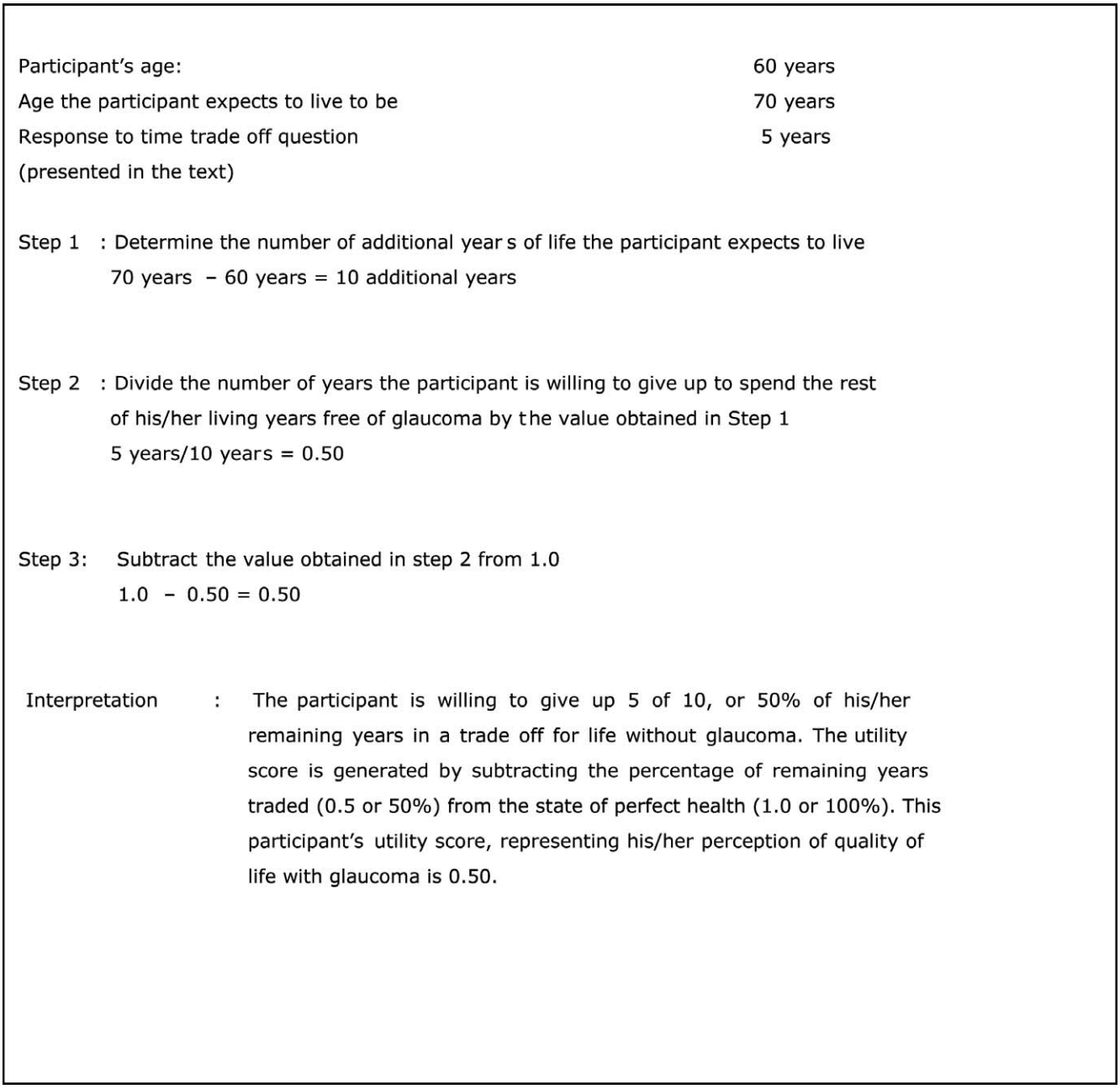

FIGURE. An example of calculation of a utility score.

hemifield test result that was outside the normal limits, or if the pattern standard deviation was flagged at $P < 0.05$ on at least two consecutive baseline VF tests.[3,33]

Statistical Analysis

Data analysis was performed with SPSS 16.0 for Windows (SPSS, Inc., Chicago, IL). The means and 95% confidence intervals (CIs) of the UVs (TTO scores) were calculated. Utility values also were assessed as dichotomous variables (willing to give up years of life versus not willing) and proportions across groups were compared using the χ^2 test. The UVs across different sociodemographic and clinical characteristics were compared between sample subgroups using 1-way ANOVA, independent sample *t*-test, or Mann-Whitney *U* test, as was appropriate. Correlations were calculated to examine the relationship between the UVs and the continuous variables of interest. For categorical variables, ANOVAs were conducted to examine group differences in the UV scores. Variables significantly related to the UVs then were included in multiple linear regression analyses to assess the impact of glaucoma on the UV score. All probabilities quoted were two-sided and were considered statistically significant at $P < 0.05$.

RESULTS

Sociodemographic and Clinical Characteristics

A total of 198 primary glaucoma adults was enrolled; the majority had either POAG (94, 48%) or PACG (82, 41%). The majority had obtained at least a secondary level of education (84%) and belonged to a higher socioeconomic status (SES)

Table 1. Sociodemographic and Clinical Characteristics of the Participants ($n = 198$)

Participant Characteristic	Result
Mean age, y ± SD	59.8 ± 12.34
Range, y	20–87
Sex, *n* (%)	
Male	132 (67)
Female	66 (33)
Mean duration of glaucoma, y ± SD	8.0 ± 6.8
Range, y	8 mo–58 y
Employment status, *n* (%)	
Working	66 (33)
Not working	132 (67)
Retired	77 (58)
Homemaker	49 (37)
Visual reasons	6 (5)
Socioeconomic status, *n* (%)*	
<5000	23 (12)
5000–10,000	33 (17)
>10,000	138 (71)
Type of primary glaucoma, *n* (%)	
Primary open-angle glaucoma	94 (48)
Primary angle closure glaucoma	82 (41)
Juvenile open-angle glaucoma	12 (6)
Normal tension glaucoma	10 (5)
Systemic co-morbidity, *n* (%)†	
Present	104 (53)
Presenting visual acuity in the better eye, mean ± SD	
LogMAR (Snellen)	0.15 ± 0.18 ($20/32^{+2}$)
Range	
LogMAR (Snellen)	0.0–0.9 (20/20–20/160)
Median logMAR (Snellen)	0.10 (20/25)
Presenting visual acuity in the worse eye, mean ± SD	
LogMAR (Snellen)	0.74 ± 0.86 ($20/125^{+3}$)
Range	
LogMAR (Snellen)	0.0–2.5 (20/20–no LP)
Median logMAR (Snellen)	0.30 (20/40)
Category of visual field loss, *n* (%)‡	
Mild	69 (35)
Moderate	52 (26)
Severe	77 (39)
Better mean deviation score, dB	
Mean ± SD	−12.03 ± 9.35
Range	0.38 to −32.44
Worse mean deviation score, dB	
Mean ± SD	−19.37 ± 8.30
Range	−6.11 to −33.02

LP, light perception.

* Socioeconomic status was self-reported by participants and was defined based on household monthly income in Indian Rupees: <5000 lower, 5000 to 10,000 middle, and >10,000 higher. Data on socioeconomic status were not available for four participants.

† Includes diabetes mellitus, hypertension, coronary artery disease, arthritis, asthma, and so forth.

‡ Based on better MD (using HFA program 24-2). See text for details.

category (71%). Sociodemographic and clinical characteristics of these participants are shown in Table 1.

While all the participants responded to the GAL-10 questionnaire (response rate, 100%), 181 responded to TTO (response rate, 91%). Of the 17 who did not respond, a common reason was inability to comprehend the TTO questions (cited by 9/17 patients). There were significant differences in the clinical characteristics between responders and nonresponders; while responders had significantly greater VA in the better-seeing eye, the nonresponders had significantly worse MD (Table 2).

Utility Values

The mean UV for the 181 participants who responded to the TTO questions was 0.81 ± 0.22 (95% CI, 0.78–0.84). The mean UV was not significantly different between the sample subgroups ($P = 0.45$).

Trading Behavior

A little over 50% of the entire cohort who responded to the TTO (105/181, 58%) was willing to trade some part of their estimated remaining life (14% willing to trade ≥50% of their life) in return for perfect vision. Results were similar across the sample subgroups ($P = 0.29$). Overall, participants who were willing to trade off life were significantly younger (mean difference, 8 years) and had poorer VA in the worse-seeing eye (Table 3).

Correlations Between Utility Values, VA, and Visual Disability

The utility score showed a statistically significant correlation, albeit only weak, with the VA in the worse-seeing eye (Table 4). By comparison, the self-reported visual disability assessed using the GAL-10 showed fair and statistically significant correlation with VA in the better as well as worse-seeing eye, and the MD (better and worse eye). There was a weak and statistically significant correlation between the UVs and the GAL-10 score ($r = -0.16$, $P = 0.03$) suggesting that both questionnaires provided different, yet related, information about patient's perspectives of his/her glaucoma.

Effect of Sociodemographic and Clinical Characteristics on Utility Values

Univariate analyses demonstrated that the UVs were not statistically significantly different across most of the sociodemographic characteristics, albeit with an exception (Table 5). The UVs were significantly lower for those with severe VF loss in the worse eye (MD of worse than 12 dB) compared to those with moderate VF loss (MD of 6–12 dB, 0.78 ± 0.22 vs. 0.90 ± 0.15, $P = 0.002$). In addition, there was a trend toward statistical significance in the UVs of older adults compared to younger adults (≥61 vs. <61 years, 0.84 ± 0.20 vs. 0.78 ± 0.23, $P = 0.05$). In the multivariate model, however, only severity of VF loss in the worse eye had a significant effect on the UV. Compared to patients with moderate VF loss, those with severe VF loss in the worse eye had lower UVs ($\beta = -0.108$; 95% CI, −0.201 to −0.014; see Supplementary Table S1 for results of multivariate analysis).

Discussion

The mean UVs of 0.81 (SD 0.22) for our sample as a whole, implied that the average adult in the South Indian state of

Table 2. Comparison of Sociodemographic and Clinical Characteristics Between TTO Responders and Nonresponders

Characteristic	Responders, $n = 181$	Nonresponders, $n = 17$	95% CI of Difference	P
Mean age, y ± SD	59.6 ± 12.5	62.6 ± 10.9	−9.19, 3.15	0.34
Male, %	68	53	−10.15, 41.03	0.32
Visual disability, GAL-10 score; mean ± SD	−1.34 ± 1.81	−0.75 ± 1.87	−1.49, 0.33	0.21
Better-seeing eye, VA, logMAR, mean ± SD	0.13 ± 0.17	0.29 ± 0.25	−0.24, −0.07	<0.001*
Worse-seeing eye, VA, logMAR, mean ± SD	0.74 ± 0.87	0.78 ± 0.75	−0.48, −0.39	0.83
Better mean deviation, dB, mean ± SD	−11.87 ± 9.34	−13.76 ± 9.48	−2.79, 6.57	0.43
Worse mean deviation, dB, mean ± SD	−18.80 ± 8.24	−25.78 ± 6.17	2.15, 11.80	0.005*

The TTO ranges from 0.0 to 1.0. GAL-10 scores are overall scores of the 10-item GAL questionnaire (Rasch analyzed version of GQL-15 questionnaire) and a higher negative GAL-10 score indicates lower visual disability, and is expressed in logits (log odds units). The logMAR is the log of minimum angle of resolution (lower scores indicate better VA).

* Values represent statistically significant P values (<0.05).

Andhra Pradesh with primary glaucoma, was willing to trade off a mean of 1.9 years out of every 10 years of his/her remaining life for return of perfect vision (i.e., eliminate visual disability from glaucoma). The mean UV of our population lay intermediate between those reported by Gupta et al.[23] from another tertiary center in North India on one end (0.64 ± 0.69; 95% CI, 0.51–0.77) and those reported by Jampel et al.[34] from a Caucasian population on the other (0.94 ± 0.83; 95% CI, 0.83–1.05). It should be pointed out that we applied the TTO technique that was similar to that used by Gupta et al.[23] However, Jampel et al.[34] used a slightly different approach in that they used a bracketing technique and presented the patient with two scenarios (i.e., one with current vision and another with ideal vision, but shorter remaining life, and the proportion of remaining life that the patient would sacrifice to have ideal vision during the remaining life was determined).[34,35] Consequently, Jampel et al.[34] have reported TTO score as percentage life remaining. Therefore, for purposes of comparison with that of our study, we calculated the mean UV from the report by Jampel et al.[34] As is evident, the calculated upper limit of the 95% CI of the mean UV from their study is marginally higher than the maximum possible value of 1.00. We believe that this occurred because of the large standard deviation.

As noted above, the mean UV in our study was much higher than that reported by Gupta et al.[23] (mean difference = 0.17; 95% CI of difference, 0.06–0.27; $t = 3.18$; $P = 0.002$). This is supported further by the nonoverlap of the CIs of the two mean UVs. Perhaps a relatively higher proportion of patients with advanced glaucoma in at least in one eye (59% with MD worse than 15 dB) in their study compared to ours (35% with MD worse than 12 dB) may have contributed to this difference. By comparison, Jampel et al.[34] reported a UV of 0.94 in a primarily Caucasian glaucoma sample (mean age = 70.6 years) using the TTO method. However, most of their patients had early glaucoma or were glaucoma suspects, which possibly may explain the higher UV in the Caucasian population compared to the present study. Although we found the 95% CIs of the mean UVs from the two studies to overlap marginally (mean = 0.81; 95% CI, 0.78–0.84 and mean = 0.94; 95% CI, 0.83–1.05), it, however, does not necessarily rule out statistically significant difference between the means.[36,37] Not surprisingly, we found the two mean UVs to be significantly different (mean difference = –0.13; 95% CI, –0.25 to –0.01; $t = -2.14$; $P < 0.0001$), indicating that the mean UV of our population actually was much lower than that reported by Jampel et al.[34] Some of the reasons for the higher UVs in the Caucasian population may be attributed to the relatively higher SES of patients in the developed countries, higher literacy levels (implying better compliance and understanding of the disease process), and the availability of social support networks compared to those in the developing countries, such as India.

An important aspect of our methodology relates to the use of the utility scale. We used the popular "vision scale" as has been used in several ophthalmic studies, and in this scale the UVs range from 0.0 for death to 1.0 for full visual function.[19,20] By comparison, the "policy scale" is used in other health care fields, and in this scale the UVs range from 0.0 for death to 1.0 for perfect health.[38,39] Given the difference in the anchor points, the results from studies using these two different scales are not comparable. More importantly, caution should be exercised when considering ophthalmic cost-effectiveness studies that have used perfect vision utilities, because these may not be interchangeable with those of the policy scale as both scales may be measuring different constructs and this may be more pronounced in cases of chronic ocular conditions, such as glaucoma.[40] It should be noted that using the policy scale, the researcher can compare the cost-utility of treatment for glaucoma to that for other systemic diseases, for example, cancer and diabetes mellitus, but this is not possible with the vision scale. In the vision scale, the researcher can at best

Table 3. Differences Between Those Willing to Trade and Unwilling to Trade a Part of Expected Remaining Life for Return of Perfect Vision

Characteristic	Willing to Trade, TTO Score <1.0, $n = 105$	Unwilling to Trade, TTO Score = 1.0, $n = 76$	95% CI of Difference	P
Mean age, y ± SD	56.3 ± 13.0	64.1 ± 10.1	−11.42, −4.36	<0.001*
Male (%)	71 (68)	52 (68)	13.82, 14.96	0.96
Visual disability, GAL-10 score, mean ± SD	−1.15 ± 1.82	−1.60 ± 1.78	−0.08, 1.00	0.09
Better-seeing eye, VA, logMAR, mean ± SD	0.13 ± 0.16	0.14 ± 0.18	−0.07, 0.03	0.51
Worse-seeing eye, VA, logMAR, mean ± SD	0.88 ± 0.94	0.54 ± 0.74	0.09, 0.60	0.01*
Better mean deviation, dB, mean ± SD	−13.0 ± 9.90	−10.29 ± 8.33	−5.47, 0.04	0.05
Worse mean deviation, dB, mean ± SD	−19.75 ± 8.30	−17.73 ± 8.10	−4.81, 0.77	0.15

* Values represent statistically significant P values (<0.05).

Table 4. Relationship Between the UVs and GAL-10 Questionnaire With Clinical Variables

	Visual Acuity		Perimetric Mean Deviation		
Questionnaires	Better Eye, r (P)	Worse Eye, r (P)	Better Eye, r (P)	Worse Eye, r (P)	GAL-10
TTO	0.06 (0.43)	−0.19 (0.01)	0.08 (0.29)	0.12 (0.16)	−0.16 (0.03)
GAL-10	0.31 (<0.001)	0.37 (<0.001)	−0.42 (<0.001)	−0.34 (0.001)	

compare the cost-utility of treatment of one ocular condition to another ocular condition only, for example, the cost-utility of treatment of glaucoma to that for age-related macular degeneration. In a study to elicit the utilities using the SG method, on a perfect health and perfect vision scale for five common eye diseases that included 99 patients with varying severity of glaucoma, Lee et al.[40] found lower UV (0.76) using the vision scale compared to 0.86 on the policy scale for one group; that is, patients with severe glaucoma with marked VF loss encroaching central 10^0 of vision. Perhaps, as suggested by Lee et al.,[40] the perfect vision scale is truncated when compared to the policy scale, which may account for the relatively lower UVs obtained using the vision scale compared to that of the policy scale. We obtained a UV of 0.78 for severe glaucoma in our study, which, although it is comparable to that reported by Lee et al.[40] (albeit using SG method), we cannot rule out the possibility that we may have obtained higher UVs for our sample if we had used the policy scale in light of the findings reported by Lee et al.[40]

There have been a few studies of UVs among glaucoma populations from other ethnic backgrounds, albeit consisting of specific types, such as POAG/PACG. For example, Saw et al.[41] reported the mean UVs of Singapore Chinese patients with PACG to be 0.90, but this is significantly higher than that of our PACG subgroup (mean difference = 0.10; 95% CI, 0.03–0.16; $t = 3.08$; $P = 0.002$). By comparison, there was a trend toward significant difference in the UVs for the POAG group between our sample (0.81) and that of Saw et al.[41] (0.87; mean difference = 0.06; 95% CI, −0.0005–0.12; $t = 1.95$; $P = 0.05$). In another study, Sun et al.[42] reported the mean UVs (using the TTO method) for Chinese patients with PACG to be 0.75, which is not significantly different from our PACG subgroup (0.80; mean difference = −0.05; 95% CI, −0.10–0.003; $t = -1.84$; $P = 0.07$). Nonetheless, attempts at comparing UVs across studies may be limited because of the inherent differences in the data collection and interview methods to assess UVs.

We found a weak and statistically significant relationship between the UV and GAL-10 score. This perhaps implies that one cannot expect an instrument, such as GAL-10, to offer a one-to-one mapping to a utility scale. Payakachat et al.[43,44] investigated the relationship between EuroQol-5 dimension, EQ-5D (multi-attribute health status classification system that generates a single index value as measure of health status), and the 25-item National Eye Institute Vision Functioning Questionnaire, and found that only a small portion of the two measures overlapped, indicating that both instruments measured different constructs. Given these results and those from the present study, it appears that if the intention is to perform a cost-utility analysis in glaucoma patients, then one always should elicit UVs directly from the patient using either the TTO or SG approach (preferable would be to use both), because the GAL-10 by itself will not provide enough information to address cost-utility issues.

Another important finding from our study was that the severity of VF loss in the worse eye affected the UVs. Those with severe VF loss in the worse eye were willing to trade off significantly more years than those with lesser severity of VF loss in the worse eye ($P = 0.002$). This may be explained partly by the fact that patients were concerned about their VF loss in the worse eye too, and that the worse eye (i.e., eye with worse MD) requires as much attention as that of the better eye in the decision-making process. More importantly, this may have implications for cost-effectiveness analyses, which often assume a differential impact of better or worse eye treatment on utilities.

The method used for utility assessment, TTO, in our study merits discussion. It has been reported to be influenced by biases, such as loss aversion (i.e., people are more sensitive to losses than to gains) and scale compatibility (in TTO, more attention is given to duration than to health status given that response scale is number of years in good health).[45,46] Given these biases, it can be expected that patients will be less willing to trade off life years, thereby resulting in higher UVs. Although methods have been proposed to correct TTO UVs of health states for utility curvature (discounting) for life duration using the certainty equivalent (CE), no such corrections are, however, known at present.[47] In a comprehensive study by van Osch et al.[45] using rheumatoid arthritis health state descriptions, the investigators compared the SG, TTO (corrected and uncorrected, albeit for utility curvature for life duration), and CE. They reported that correcting the TTO for utility curvature had only a minor effect given the utility of life years was nearly linear at the aggregate level.[45] It is plausible that the lack of correction for the biases associated with TTO may have resulted in higher UVs in our study. However, future research could be directed toward comparing the uncorrected and corrected UVs in our population so as to bring clarity to this issue.

We found a significant correlation between the UV and VA in the worse-seeing eye. This is in accordance with results of Nease et al.,[48] who speculated that perhaps the impaired VA in the worse-seeing eye contributes to a decrease in UV that is not completely related to visual disability. If patients are bothered by an interocular acuity difference (most of our patients reported this), and if visual functioning depends largely on VA in the better-seeing eye, VA of the worse eye might have a greater effect on utility for vision than on visual disability. Furthermore, there is a psychological impact of knowing that one eye has poor vision or is nearly blind that is very likely to reflect in patient's responses, regardless of whether the vision affects their daily activities.

Another interesting finding from our study is that 42% of the sample was unwilling to trade off life. We speculate that this behavior may be an indicator of perceived success of glaucoma treatment; however, we do not have any data to support this. By comparison, 58% of our sample was willing to trade off some time of their estimated remaining life (14% willing to trade ≥50% of their life) in return for perfect vision. This is at variance with studies among Chinese[42] and American[34] glaucoma patients, in which only one-third were willing to trade off life. This could be because approximately 60% of our patients had moderate to advanced glaucoma. In our study, participants who were willing to trade off life were significantly younger (mean difference 8 years), and had poorer VA in

Table 5. Univariate Analysis of UVs of Primary Glaucoma Patients Across Sociodemographic and Clinical Characteristics of TTO Responders ($n = 181$)

Variable	*n*	Utility Score, Mean ± SD, 95% CI	*P*
Total	181	0.81, 22	
Age, median			
<61 y	89	0.78 ± 0.23, 0.73–0.83	0.05
≥61 y	92	0.84 ± 0.20, 0.80 −0.88	
Sex			
Male	123	0.80 ± 0.23, 0.76 −0.84	0.41*
Female	58	0.82 ± 0.19, 0.78–0.88	
Education status			
No formal education/ primary education	28	0.75 ± 0.21, 0.67 −0.83	>0.05*
Secondary education	74	0.84 ± 0.21, 0.79–0.89	
Tertiary education	79	0.81 ± 0.22, 0.76–0.86	
Duration since glaucoma diagnosis, median†			
<7 y	89	0.81 ± 0.23, 0.76 −0.86	0.75*
≥7 y	88	0.80 ± 0.21, 0.76 −0.84	
Type of glaucoma			
POAG	87	0.81 ± 0.22, 0.76–0.86	>0.05*
PACG	73	0.80 ± 0.22, 0.75–0.85	
JOAG	12	0.79 ± 0.18, 0.69–0.89	
NTG	9	0.92 ± 0.17, 0.81–1.03‡	
Better-seeing eye, visual acuity, logMAR			
Better than 0.1	80	0.80 ± 0.23, 0.75 −0.85	>0.05*
0.1–0.3	77	0.83 ± 0.22, 0.78–0.88	
Worse than 0.3	24	0.81 ± 0.19, 0.73–0.89	
Worse-seeing eye, visual acuity, logMAR			
Better than 0.1	42	0.85 ± 0.18, 0.80–0.90	>0.05*
0.1–0.3	54	0.84 ± 0.22, 0.78–0.90	
Worse than 0.3	85	0.77 ± 0.23, 0.72–0.82	
Better mean deviation, dB			
Less than 6	65	0.82 ± 0.23, 0.76–0.88	>0.05*
6–12	47	0.83 ± 0.21, 0.77–0.89	
More than 12	69	0.78 ± 0.20, 0.73–0.83	
Worse mean deviation, dB			
Less than 6	0	-	
6–12	39	0.90 ± 0.15, 0.85–0.95	0.002§
More than 12	142	0.78 ± 0.22, 0.74–0.82	
Systemic comorbidity†			
Present	82	0.80 ± 0.22, 0.75–0.85	0.56†
Absent	98	0.81 ± 0.22, 0.77–0.85	

* Not statistically significant ($P > 0.05$).

† Data missing for some patients; systemic co-morbidity includes diabetes mellitus, hypertension, coronary artery disease, arthritis, and so forth.

‡ Upper CI exceeded maximum possible value of 1.00 because of very small sample size of normal tension glaucoma patients.

§ Significant $P < 0.05$.

the worse-seeing eye. While it is plausible that the glaucoma may have been uncontrolled in this group of patients, which may have led to their willingness to trade off life, we cannot substantiate this given that we did not collect the data regarding progression or stability of the disease in this study.

Strengths of our study included a large clinical sample of glaucoma with differing levels of VF loss and the inclusion of the GQL-15 questionnaire that provided a detailed profile of patient's visual disability from glaucoma. However, there also were some limitations in this study. Firstly, we did not perform a formal evaluation of the mental capability of the patients so as to ascertain whether that would have biased the data; we excluded patients only if they were on treatment for some form of mental ailment. Secondly, the study population consisted of those glaucoma patients who were followed up at one tertiary eye hospital from a rather limited geographical area of South India. Thirdly, patients from the lower (11%) and middle (16%) SES were underrepresented in our sample, and this may have impacted the way patients responded to the utility evaluation. Finally, although we used stringent inclusion/exclusion criteria to screen patients for our study, it is likely that we may have inadvertently included patients with visually insignificant cataract given the trend toward lower thresholds for cataract surgery. On the other hand, we may have excluded some patients who may have been eligible (such as those who may have refused or were deemed unfit for cataract surgery for various reasons, despite facing functional difficulties). The effects of any confounding bias from such inclusion or exclusion should be borne in mind while interpreting the results of our study.

Despite these potential detractors, our data strongly suggested that primary glaucoma in adults causes a substantial decrease in UVs and QoL thereof, and that appears to be highly dependent on the literacy level and severity of VF loss in the worse eye. Given the existence of a report of UVs from clinic-based glaucoma patients from Northern India, albeit with significantly lower UVs, the results of our study increased the validity of the TTO technique for utility valuation in glaucoma patients in India. Given this, the TTO technique offers the ophthalmologist (glaucoma specialist) an objective tool that can be used to gain valuable insights into how glaucoma affects a given patient's QoL. These findings are now extremely relevant in the field of glaucoma research, in which novel medical and surgical treatment therapies are emerging. Newer IOP-lowering medications will have to be compared with existing medications, in terms of clinical and patient-centered outcomes. Similarly, the cost-effectiveness of new treatments may have to be evaluated by policy planners using quality- and disability-adjusted life years (QALYs and DALYs), which are calculated from UVs. Therefore, a UV that can capture the impact of glaucoma and the changes after intervention will be invaluable. As noted above, our finding suggested that the TTO technique may well be suited in clinical trials in glaucoma patients evaluating newer medical or surgical treatments or for calculation of QALYs within cost-effectiveness studies.

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Investigative Ophthalmology & Visual Science

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