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# Health utility values associated with vision impairment among the elderly in Hong Kong: a community-based study using EQ-5D-5 L and time trade-off

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## Abstract

**Background** To estimate health utility decrements associated with correctable and uncorrectable vision impairment (VI) in community-dwelling older adults in Hong Kong using the EQ-5D-5 L and time trade-off (TTO), and to compare the sensitivity of these utility instruments in detecting VI's quality-of-life impacts.

**Methods** A random sample of 999 older adults, previously screened in a community-based eye care programme between 2015 and 2017 and not referred for eye specialist care, completed follow-up eye examinations and questionnaire surveys between 2022 and 2024. Distance VI was defined as presenting visual acuity worse than 6/12 in the better-seeing eye, and categorized as correctable (due to uncorrected refractive error, URE) or uncorrectable (due to pathology), based on best-corrected visual acuity. Health utility was measured using the EQ-5D-5 L questionnaire and the TTO method. Associations between VI type and utility scores were analyzed using multivariable linear regression.

**Results** The prevalence of VI was 19.1%, with 15.4% correctable and 3.7% uncorrectable. Mean EQ-5D-5L utility scores were 0.91 (standard deviation [SD] = 0.15) for those without VI, 0.90 (SD = 0.12) for correctable VI, and 0.85 (SD = 0.22) for uncorrectable VI ($p < 0.05$). Mean TTO scores followed a similar pattern: 0.95 (SD = 0.14), 0.94 (SD = 0.15), and 0.89 (SD = 0.22), respectively. In adjusted models, uncorrectable VI was significantly associated with a 0.052 decrease in TTO utility (95% confidence interval: −0.103 to −0.002; $p < 0.05$), while correctable VI showed no significant utility loss in either measure.

**Conclusions** There were generally lower utility values for community dwelling elders with VI compared to no VI, with significant reductions of uncorrectable VI due to eye diseases in health utility among older adults living in the community. In contrast, correctable VI due to URE did not significantly affect utility values, suggesting that generic instruments like EQ-5D-5 L and TTO may lack sensitivity to detect the burden of milder, reversible vision loss. These

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findings provide essential data for evaluating the cost-effectiveness of community eye care programs and highlight the need for more targeted quality-of-life measures in vision research.

**Keywords** Utility values, Vision impairment, Health-related quality of life, EQ-5D-5L, TTO, Refractive error

## Background

Vision impairment (VI) is a common and growing public health problem, especially among older adults. It can lead to loss of independence, reduced quality of life, increased risk of falls and injuries, and greater healthcare costs [1–5]. As the global population continues to age, the number of people affected by VI is expected to rise from 1.1 billion in 2020 to about 1.8 billion by 2050 [6, 7]. To plan effective healthcare services and policies, it is important to understand how VI affects people's daily lives and well-being.

One way to measure this is by looking at health-related quality of life (HRQoL) using health utility values. These values range from 0 (representing death) to 1 (representing full health), and they are used to calculate quality-adjusted life years (QALYs), which help compare the value of different health conditions and treatments [8]. Health utility can be measured using either direct methods, such as the time trade-off (TTO), or indirect methods, such as the European Quality of Life-5 Dimensions (EQ-5D), which asks people to rate their own health in several areas. Both methods are commonly used in studies on vision [9–12], but results have been mixed on how well they capture changes in vision-related quality of life [13–16].

VI can be broadly categorized into two types: correctable VI, which is primarily due to uncorrected refractive error (URE) and can be corrected with appropriate vision correction (e.g., glasses or contact lenses); and uncorrectable VI, which results from underlying eye diseases (e.g., macular degeneration, glaucoma) and is not fully reversible with standard correction. This distinction is clinically important because correctable VI represents an easily addressable burden through primary eye care, while uncorrectable VI typically requires ongoing medical management and has greater impact on visual function.

Most research on the impact of VI on health utility has looked at people with specific eye diseases, such as cataract, age-related macular degeneration, diabetic retinopathy or glaucoma [17–19]. These studies have mostly involved patients from hospitals or eye clinics [17–21], which means their findings may not apply to the wider population. This is a concern because the most common cause of VI is not eye disease, but URE—a condition that can usually be corrected with glasses or contact lenses.

Although some population-based studies have explored the relationship between VI and HRQoL using tools like the EQ-5D [22–25], few have focused on the effects of URE, and even fewer have compared how well different tools measure the impact of VI on utility values.

In Hong Kong, VI is also a major issue among older adults. Around 17 out of every 100 people aged 60 and above have some level of VI, and about three-quarters of these cases are due to URE, with the rest caused by eye diseases [26]. Despite the high prevalence of VI in older adults in Hong Kong, utility values specific to this population are lacking.

This study addresses these gaps by providing the local utility estimates for correctable and uncorrectable VI, offering data necessary for cost-effectiveness evaluations of primary eye care services. The specific objectives were: (1) to estimate utility decrements associated with correctable VI and uncorrectable VI in a community-dwelling older adults using the EQ-5D-5L and TTO instruments; and (2) to compare the sensitivity of these utility instruments in detecting impact of correctable and uncorrectable VI on HRQoL.

## Methods

### Subjects and study design

Participants in this study were drawn from the "Kwai Tsing Signature Project Scheme" (KT programme), a community-based initiative that provided subsidized comprehensive vision care to over 10,000 residents aged 50 years or older in the Kwai Tsing district of Hong Kong between 2015 and 2019. Details of the programme's design and major findings have been reported previously [26].

To be eligible for inclusion in this prospective cohort study, participants had to meet the following criteria: (1) received a comprehensive eye examination through the KT programme between 2015 and 2017; (2) were not referred to an eye specialist based on the results of that examination; and (3) were not under routine follow-up at an ophthalmology clinic within the Hospital Authority at the time they participated in the KT programme. From the pool of eligible individuals, participants were randomly selected using an age- and sex-stratified sampling strategy to form the study cohort.

These selected individuals were invited to undergo a follow-up comprehensive eye examination between October 2022 and July 2024. During their follow-up visit, participants completed a face-to-face questionnaire survey. The survey collected information on socioeconomic status (including education and income levels), self-reported doctor-diagnosed chronic conditions (such as hypertension and diabetes), and responses to HRQoL instruments: the EQ-5D-5L (the five-level version of the European Quality of Life-5 Dimensions) and the TTO measure.

### Definition and measurement of vision impairment (VI)

Comprehensive eye examinations were conducted by qualified optometrists at either the Integrative Community Health Centre or the Optometry Clinic of The Hong Kong Polytechnic University, following a standardized clinical protocol. The examination included assessments of both presenting visual acuity (PVA) and best-corrected visual acuity (BCVA) for each eye. Distance visual acuity (VA) was measured using the Thomson Test Chart (Thomson Software Solutions, UK), displayed on a monitor at a simulated 6-meter distance using a mirror setup.

For each eye, VA was defined as the smallest line on the chart that the participant could correctly identify while the other eye was occluded. If participants could not read any optotypes, their VA was assessed using alternative methods, such as counting fingers, detecting hand movements, light perception, or no light perception.

PVA was recorded using the participant's habitual refractive correction if they brought their eyeglasses or contact lenses to the appointment; otherwise, unaided VA was documented as their presenting vision. BCVA was determined by first performing objective refraction, followed by refinement through subjective refraction. Final BCVA was measured with the participant wearing the prescribed correction. All VA results were recorded in Snellen notation.

Distance VI was defined according to the International Classification of Diseases, 11th Revision (ICD-11), as a PVA worse than 6/12 [27]. Distance VI was further categorized based on the potential for correction:

- **Correctable VI (due to URE)** was defined as PVA worse than 6/12 that improved to 6/12 or better with best correction (BCVA).
- **Uncorrectable VI (due to pathological causes)** was defined as both PVA and BCVA worse than 6/12.

Classification was based on the PVA and BCVA of the better-seeing eye, reflecting the standard clinical assumption that overall visual function is primarily determined by the eye with better vision. If VA data were missing or ungradable for one eye, the VA of the fellow eye was used for classification. Suspected ocular disorders were classified into anterior disorders (e.g., pterygium, corneal lesions, etc.) and posterior disorders (e.g., macular degeneration, glaucoma, retinal lesions, etc.).

### Health-related quality of life (HRQoL) measure

Health-related quality of life was assessed using two commonly used approaches through face-to-face interviews: the EQ-5D-5L questionnaire, a generic preference-based tool, and the TTO method, a direct utility elicitation technique.

The EQ-5D-5L is a standardized instrument that has been validated for use in the Hong Kong population [28]. It includes five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension is rated on five levels of severity, ranging from "no problems" to "extreme problems." The combination of responses defines a specific health state, which can be converted into a utility score using a population-based value set. In this study, EQ-5D-5L utility scores were calculated using the Hong Kong-specific value set, which yields scores ranging from −0.86 (worst possible health state) to 1.0 (full health) [29].

The TTO method was adapted to focus on visual health, following its conventional use in vision-related studies [12]. Structured interview-assisted questions were used to conduct the TTO interviews, and visual aids were presented to participants to help them understand the trade-off questions intuitively. These were translated into Chinese. Comprehension checks were administered verbally, with questions being re-explained using plain language with the help of visual aids if a lack of comprehension was identified. The protocol was piloted with five participants to assess comprehensibility and feasibility and no modifications were required. The reasons for non-response were documented.

Participants were asked to consider two hypothetical scenarios:

1. Living 10 more years in their current health and vision condition, or
2. Living fewer years (less than 10) but with guaranteed perfect vision in both eyes for the rest of their life.

If participants preferred the second option, they were asked how many years they would be willing to give up in exchange for perfect vision. The TTO utility score was then calculated using the formula: **TTO utility = 1.0 − (years traded/10)**. By convention, scores range from 0.0 (equivalent to death) to 1.0 (perfect binocular vision), providing a numeric value that reflects the participant's preference for visual health.

All interviewers completed two rounds of training conducted by a senior team member (CS) and the principal investigator (JXL), covering research procedures and simulated questionnaire interviews. Proficiency checks were required before fieldwork commenced. During the initial stages of each interviewer's fieldwork, a senior team member (MKY, CS, or JXL) was onsite to monitor adherence, and ensure consistency and interview quality.

## Statistical analysis

Descriptive statistics were used to summarize the demographic and clinical characteristics of the participants, as well as their EQ-5D-5L and TTO scores.

The prevalence of VI was compared across subgroups based on sex, education level, income, and self-reported chronic conditions (hypertension or diabetes) using chi-squared tests. Differences in age across the three VI groups were assessed using one-way analysis of variance (ANOVA).

To compare HRQoL across the VI categories (no VI, correctable VI, and uncorrectable VI), chi-squared tests were used to examine differences in the proportion of participants reporting problems in each of the five EQ-5D-5L dimensions and those expressing a willingness to trade time for perfect vision. The number of years participants were willing to trade (as measured by the TTO method) was compared across VI groups using one-way ANOVA. As utility scores from both the EQ-5D-5L and TTO instruments were not normally distributed (based on the Shapiro-Wilk test, $p < 0.05$), the Kruskal–Wallis test was used to test for differences in utility scores across VI groups.

To assess the association between VI and health utility scores measured by the EQ-5D-5L and TTO instruments, multivariate linear regression models were used. These models adjusted for potential confounding variables, including age, sex, socioeconomic status, and the presence of chronic health conditions.

**Table 1** Characteristics of the participants (*N* = 999)

| Characteristics | Number | Percent (%) |
|---|---|---|
| Age (Mean, SD), years | 73.1 (5.3) | |
| Sex | | |
| Male | 474 | 47.4 |
| Female | 525 | 52.6 |
| Education level | | |
| No schooling, primary or below | 513 | 51.4 |
| Secondary or above | 486 | 48.6 |
| Monthly personal income level | | |
| Less than HK$5,000 | 624 | 62.5 |
| HK$5,001 or above | 368 | 36.8 |
| Refused to answer | 7 | 0.7 |
| Any self-reported hypertension or diabetes | | |
| No | 437 | 43.7 |
| Yes | 562 | 56.3 |
| Presenting VA level | | |
| No VI (VA 6/12 or better) | 808 | 80.9 |
| VI (VA worse than 6/12) | 191 | 19.1 |
| -Correctable VI due to URE | 154 | 15.4 |
| -Uncorrectable VI due to pathology | 37 | 3.7 |

SD = standard deviation; VA = visual acuity; VI = vision impairment; URE = uncorrected refractive error

Data are presented as no. and percent, unless otherwise indicated

Ordinary least squares (OLS) model was selected rather than alternative models like generalized linear model (GLM) or Tobit, because it produces asymptotically unbiased estimates of regression coefficients in large samples, even when the distribution of the outcome variable does not fully meet normality assumptions [30]; and it is applicable to the utility data with range from negative values to 1. When the assumption of constant variance (homoscedasticity) was violated, robust standard errors were applied to ensure accurate estimation of confidence intervals. All statistical analyses were performed using R software (version 4.3.2), with a significance level set at 0.05.

## Results

A total of 1114 individuals agreed to participate in the follow-up study. Of these, 999 completed both the comprehensive eye examination and the questionnaire survey between 2022 and 2024. Table 1 summarizes the sociodemographic and health characteristics of the participants. The average age was 73.1 years old (standard deviation [SD] = 5.3), 47.4% were male, and 56.3% reported having been diagnosed with either hypertension or diabetes.

The overall prevalence of VI was 19.1% (191/999, 95% confidence interval [CI]: 16.7% to 21.7%). A proportion of 15.4% (154/999, 95% CI: 13.3% to 17.8%) had correctable VI due to uncorrected refractive error, while 3.7% (37/999, 95% CI: 2.7% to 5.1%) had uncorrectable VI due to underlying pathological conditions. Out of these 37 subjects, 26 (70.3%) were grouped under anterior disorders, 2 (5.4%) under posterior disorders and 9 (24.3%) under both anterior and posterior disorders. As shown in Table 2, the prevalence of VI was significantly higher among participants of older age, with lower education levels, and lower income level.

The comparison of EQ-5D-5L among different VI statuses is presented in Table 3. The proportion of full health (reporting no problems across the five EQ-5D-5L domains) was significantly different across the groups ($p = 0.039$), with 35.1%, 40.3%, and 49.3% respectively for the groups with uncorrectable VI, correctable VI and no VI. There were significantly higher proportions of reporting 'Mobility' (29.7% vs 26.6% vs 16.6%, $p = 0.003$) and 'Self-care' (13.5% vs 3.2% vs 2.4%, $p$=0.004) domain problems in the uncorrectable and correctable VI groups, compared to no VI group. However, there was no significant difference in the proportion of the domains as 'Usual activities', 'Pain/discomfort' and 'Anxiety/depression'. Moreover, there were significant differences in EQ-5D-5L utility scores across VI groups ($p < 0.05$), with highest utility scores of 0.91 ± 0.15 for those without VI, followed by 0.90 ± 0.12 for those with correctable VI and the lowest utility scores of 0.85 ± 0.22 for those with uncorrectable VI.

**Table 2** Comparison of characteristics among participants with different vision impairment (VI) status

| Characteristics | No VI (*n* = 808) | Correctable VI (*n* = 154) | Uncorrectable VI (*n* = 37) | *P* value |
|---|---|---|---|---|
| Mean age (SD), years | 72.5 (5.0) | 74.9 (5.8) | 77.3 (7.0) | < 0.001[a] |
| Sex | | | | 0.785[b] |
| Male | 385 (81.2) | 70 (14.8) | 19 (4.0) | |
| Female | 423 (80.6) | 84 (16.0) | 18 (3.4) | |
| Education | | | | < 0.001[b] |
| No schooling, primary or below | 389 (75.8) | 97 (18.9) | 27 (5.3) | |
| Secondary or above | 419 (86.2) | 57 (11.7) | 10 (2.1) | |
| Monthly personal income | | | | 0.006[b] |
| Less than HK$5,000 | 491 (78.7) | 101 (16.2) | 32 (5.1) | |
| HK$5,001 or above | 310 (84.2) | 53 (14.4) | 5 (1.4) | |
| Refused to answer[c] | 7 | 0 | 0 | |
| Any self-reported hypertension or diabetes | | | | 0.208[b] |
| No | 363 (83.1) | 62 (14.2) | 12 (2.7) | |
| Yes | 445 (79.2) | 92 (16.4) | 25 (4.4) | |

SD = standard deviation; VI = vision impairment

Data are presented as no. (% as row percentage), unless otherwise indicated

[a] Analysis of variance

[b] Chi-square test

[c] Refuse to answer not included in chi-square test

**Table 3** Comparison of EQ-5D-5L among different vision impairment (VI) status

| | No VI (n = 808) | Correctable VI (n = 154) | Uncorrectable VI (n = 37) | *P*value |
|---|---|---|---|---|
| **Full health (%)** | 398 (49.3) | 62 (40.3) | 13 (35.1) | 0.039[a] |
| **With EQ-5D-5L health problems (%)** | | | | |
| Mobility | 134 (16.6) | 41 (26.6) | 11 (29.7) | 0.003[a] |
| Self-care | 19 (2.4) | 5 (3.2) | 5 (13.5) | 0.004[a] |
| Usual activities | 52 (6.4) | 13 (8.4) | 5 (13.5) | 0.172[a] |
| Pain/discomfort | 313 (38.7) | 70 (45.5) | 18 (48.6) | 0.166[a] |
| Anxiety/depression | 140 (17.3) | 20 (13.0) | 4 (10.8) | 0.265[a] |
| **Mean EQ-5D-5L utility scores (SD)** | 0.91 (0.15) | 0.90 (0.12) | 0.85 (0.22) | 0.042[b] |

VI = vision impairment; EQ-5D-5L = Five-level version of European Quality of Life-5 Dimensions; SD = standard deviation

The EQ-5D-5L health state of "11111" represents full health, with participants rating themselves as having no problems in any of the five domains

[a]Chi-square test

[b]Kruskal- Wallis test

**Table 4** Comparison of time-trade-off among different vision impairment (VI) status

| | No VI (n = 808) | Correctable VI (n = 154) | Uncorrectable VI (n = 37) | *P*value |
|---|---|---|---|---|
| **Willing to trade (%)** | | | | 0.209[a] |
| No | 685 (85.5%) | 126 (82.9%) | 28 (75.7%) | |
| Yes | 116 (14.5%) | 26 (17.1%) | 9 (24.3%) | |
| Refuse to answer[b] | 7 | 2 | 0 | |
| **Mean No. of years to trade (SD)** | 3.41 (2.12) | 3.31 (2.00) | 4.33 (2.45) | 0.425[c] |
| **Mean TTO utility scores (SD)** | 0.95 (0.14) | 0.94 (0.15) | 0.89 (0.22) | 0.159[d] |

VI = vision impairment; TTO = time-trade-off; SD = standard deviation

[a]Chi-square test

[b] Refuse to answer not included in calculation of percentage and chi-square test

[c]Analysis of variance

[d]Kruskal- Wallis test

Regarding the TTO questions, nine participants did not provide a response, with 2 citing difficulty understanding the questions and 7 declining to answer. Among those who responded, a high proportion of participants were not willing to trade off for perfect vision, with 75.7%, 82.9%, 85.5% respectively for the groups with uncorrectable VI, correctable VI and no VI. There was no statistically significant difference in proportion of willing to trade off, duration of years to trade off for perfect vision and utility values measured by TTO. The mean TTO utility scores were $0.95 \pm 0.14$, $0.94 \pm 0.15$ and $0.89 \pm 0.22$ for participants with no VI, correctable VI and uncorrectable VI due to pathology, respectively (Table 4).

The association of VI on the utility scores was analyzed using OLS regression for EQ-5D-5L and TTO respectively. To ensure the validity of the results, we tested for heteroskedasticity in the residuals of both models, and the White test revealed that both models met the assumption of homoscedasticity ($p > 0.05$ for both). We therefore reported the OLS estimators without coupling with the robust standard error (Table 5). Compared to subjects without VI, subjects with uncorrectable VI tended to have lower utility scores after controlling for multiple covariates. This association was statistically significant for TTO utility scores, with a decrease of 0.052 (95% CI −0.103, −0.002; $p < 0.05$), whereas the association was not significant for EQ-5D-5L utility scores ($p = 0.055$). In addition, there was no significant difference in utility scores for subjects with correctable VI, compared to those without VI.

**Table 5** Association of different vision impairment (VI) status with health utility score

| Variable | EQ-5D-5L (*n* = 999) | | TTO (*n* = 990) | |
|---|---|---|---|---|
| | Mean utility change (95% CI) | *P*value | Mean utility change (95% CI) | *P*value |
| **VI** | | | | |
| No VI | Reference | | Reference | |
| Correctable VI | −0.003 (−0.028, 0.022) | 0.804 | −0.004 (−0.031, 0.022) | 0.748 |
| Uncorrectable VI | −0.047 (−0.096, 0.000) | 0.055 | −0.052 (−0.103, −0.002) | 0.041 |
| **Age** | −0.002 (−0.004, 0.000) | 0.038 | −0.001 (−0.003, 0.001) | 0.344 |
| **Sex** | | | | |
| Male | Reference | | Reference | |
| Female | −0.055 (−0.073, −0.036) | < 0.001 | −0.024 (−0.043, −0.005) | 0.014 |
| **Education level** | | | | |
| No Schooling, primary or below | Reference | | Reference | |
| Secondary or above | −0.005 (−0.024, 0.013) | 0.581 | 0.000 (−0.020, 0.019) | 0.978 |
| **Monthly personal income** | | | | |
| Less than HK$5000 | Reference | | Reference | |
| HK$5,001 or above | 0.018 (−0.000, 0.037) | 0.062 | 0.000 (−0.020, 0.020) | 0.995 |
| **Any self-reported hypertension or diabetes** | | | | |
| No | Reference | | Reference | |
| Yes | −0.020 (−0.039, −0.002) | 0.032 | 0.000 (−0.019, 0.019) | 0.993 |

VI = vision impairment; EQ-5D-5L = Five-level version of European Quality of Life-5 Dimensions; TTO = time trade off; CI = confidence interval

## Discussion

This study examined health utility values associated with different statuses of VI in a community-based sample of older adults in Hong Kong. About 80% of VI cases were due to URE, while the remaining 20% were linked to underlying eye diseases. These findings are consistent with previous research, which has also identified URE as the leading cause of VI among older adults in Hong Kong [26, 31].

We found that uncorrectable VI—caused by pathological conditions—was associated with a significant reduction in health utility, as measured by the TTO instrument (disutility of 0.052, $p = 0.041$), and a borderline significant reduction when measured by the EQ-5D-5L (disutility of 0.047, $p = 0.055$), after adjustment for socio-demographic factors and chronic disease history. These values fall within the range reported in a recent meta-analysis, which estimated pooled disutility values between 0.04 and 0.06 for age-related macular degeneration, diabetic retinopathy, and glaucoma [19].

It is important to note that participants in this study were eligible for routine eye care in the community. Those who had previously been referred for specialist care or were already under the management of an ophthalmologist within Hospital Authority were not included. As a result, this sample had a lower proportion of individuals with moderate VI (defined as VA < 6/18 and ≥ 6/60)—8.9% in this study compared to 16.6% in the general older population—and none with severe VI at presentation, compared to 0.7% reported elsewhere [26]. This may have led to an underestimation of disutility associated with uncorrectable VI in this sample because of missing out the utility measurement on more severe uncorrected VI due to underlying eye diseases. Nonetheless, our findings may reflect the typical burden of vision loss experienced by older adults eligible for community-based eye care services.

In contrast, correctable VI due to URE did not show a significant reduction in utility scores when compared to those without VI, using either EQ-5D-5L or TTO. The disutility was modest—around 0.01 before adjustment and between 0.003 and 0.004 after controlling for other factors. Few studies have directly assessed the utility loss associated with refractive error [32–35], and most of those used the TTO method rather than EQ-5D-5L. However, differences in study design—such as population type (hospital-based vs. community-based), age of participants, definitions of refractive error (e.g. spherical equivalent vs.VA), and classification methods (e.g. based on unaided VA vs. based on PVA and BCVA)—make direct comparisons difficult.

The small and non-significant impact of correctable VI observed in this study may reflect the limited effect of URE on quality of life, which is understandable given that patients with URE may adjust habitual distance to facilitate the seeing and reading, or correct refractive errors with glasses or contact lenses. In contrast, eye diseases may impair additional aspects of vision, such as contrast sensitivity and visual fields, which are harder to restore. This result is consistent with findings by Tahhan et al. [32], who also found that the impact of URE on quality of life was smaller than that of eye diseases.

Alternatively, it is possible that the tools used in this study—EQ-5D-5L and TTO—were not sensitive enough to detect the full impact of correctable VI. Vision-specific instruments, such as the National Eye Institute Visual Functioning Questionnaire (NEI-VFQ), have shown stronger associations between URE and reduced HRQoL in other studies [36–38].

The performance of the EQ-5D-5L in capturing the impact of VI has been mixed across studies [39], particularly in cases of mild to moderate VI [23, 40, 41]. More than 35% participants reported the full health in EQ-5D-5L, indicating the ceiling effect of using this instrument to measure the utility value associated with VI. Although our study employed the EQ-5D-5L version which showed a reduced ceiling effect compared with the 3 L version [42], the ceiling effects remained substantial in our sample (49.3% in the no VI group, 40.3% and 35.1% in the correctable and uncorrectable VI group). This may lead to a loss of sensitivity and make it difficult to differentiate between groups. Moreover, the EQ-5D-5L is a generic instrument, and some of its dimensions—such as "pain"—are less likely to be affected by changes in vision. As a result, EQ-5D-5L utility scores may only decline when VI is severe enough to interfere with broader aspects of daily functioning [43]. Some researchers have suggested adding vision-specific "bolt-on" items to the EQ-5D to improve its ability to reflect the impact of vision loss [39, 44].

The TTO method has also been criticized for its limited sensitivity to mild health conditions [45]. This is often attributed to participants' reluctance to trade years of life for improvements in conditions they perceive as relatively minor. At least 75% participants even in the group with uncorrectable VI, were not willing to trade off life years for perfect vision leading to the maximum utility in TTO, indicating the ceiling effect that reduces its ability to distinguish between levels of impairment. Sociocultural factors may further influence TTO responses. For example, cultural views on the importance of vision, as well as individual preferences around risk and longevity, can shape willingness to trade lifespan. In this study, participants reported higher TTO utility scores than those typically observed in Western populations [32, 35], consistent with findings from a Singaporean study [16]. These patterns suggest that older adults in Asian populations may be more conservative in their responses to TTO-based questions compared to their Western counterparts. The feasibility for elderly people to complete TTO questions was also challenging in terms of understanding the TTO tasks [46, 47].

One strength of this study is its focus on community-dwelling older adults who were not under specialist eye care. This population is a key target for public health and primary care interventions, yet utility values for VI in this group—and in the broader older population of Hong Kong—have not been previously reported. To our knowledge, this is the first study to estimate utility values for VI in this context. These estimates enable quantification of the health burden of correctable and uncorrectable VI at the population level. By multiplying the prevalence with corresponding disutility values, annual QALY losses for correctable and uncorrectable VI can be calculated, providing evidence to understand the magnitude of the health burden and the need for resource allocation. Moreover, utilities associated with VI can be incorporated into cost-utility analyses of community eye-care interventions for older adults, such as regular eye examinations and refractive-error correction, to derive cost-effectiveness ratio in terms of cost per QALY gained which can be benchmarked against willingness-to-pay thresholds to inform the cost-effectiveness and make comparison across programmes.

We also compared the performance of two widely used instruments for utility measurement in vision research—EQ-5D-5L and TTO—and found that both were limited in their ability to detect the impact of VI, particularly in its milder forms. This suggests that alternative or vision-specific tools may be needed to more accurately capture the effects of VI on quality of life in similar populations.

However, several limitations should be considered. First, our assessment of VI was based solely on distance visual acuity. As a result, the derived utility values may not reflect impairments in other important aspects of vision, such as near vision, contrast sensitivity or visual field. Although there is currently limited evidence among the elderly population in Hong Kong, studies elsewhere indicate that impairments in these domains adversely affect quality of life [48–50]. More detailed studies will be helpful to assess their impacts on health utility in the future. Second, the study population had a relatively mild profile of VI, which may have led to an underestimation of disutility values. Third, we were not able to analyze the impact of uncorrectable VI by specific cause.

## Conclusions

Among community-dwelling older adults, those with VI had lower health utility values compared to those without impairment, but this difference reached statistical significance only for uncorrectable VI due to underlying eye disease. The two utility measurement tools used in this study—EQ-5D-5L and TTO—showed limited ability to distinguish between correctable VI and normal vision, suggesting they may not be sensitive enough to detect the burden of milder or reversible forms of impairment.

The utility values derived from this study provide valuable data for assessing the cost-effectiveness of public health interventions aimed at preventing or managing VI in aging populations. These findings provide useful utility estimates that can inform future evaluations of the cost-effectiveness of primary eye care interventions for older adults.

**Abbreviations**

| | |
|---|---|
| VI | Vision impairment |
| HRQoL | Health-related quality of life |
| QALYs | Quality-adjusted life years |
| EQ-5D | European Quality of Life-5 Dimensions |
| URE | Uncorrected refractive error |
| KT programme | Kwai Tsing Signature Project Scheme |
| EQ-5D-5 L | Five-level version of the European Quality of Life-5 Dimensions |
| PVA | Presenting visual acuity |
| BCVA | Best-corrected visual acuity |

| | |
|---|---|
| VA | Visual acuity |
| ICD-11 | International Classification of Diseases, 11th Revision |
| ANOVA | One-way analysis of variance |
| OLS | Ordinary least squares |
| SD | Standard deviation |
| CI | Confidence interval |
| NEI-VFQ | National Eye Institute Visual Functioning Questionnaire |

**Author contributions**
MKY contributed to the acquisition, analysis, interpretation of data and draft the work. JXL contributed to the award of the research grant, design of the study, analysis and interpretation of data, and revised the work critically for important intellectual content. CS contributed to the interpretation of data, and critically revised the work for important intellectual content; SMM contributed to the award of the research grant, design of the study, interpretation of data and critically revised the work for important intellectual content; RWMS contributed to the acquisition of the data and revise the paper critically for important intellectual content; MKHY contributed to the conception and design of the study, interpretation of the data, and revised the work critically for important intellectual content. All authors read and approved the final manuscript.

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**Data availability**
The dataset analyzed for during the current study is not publicly available as the service recipients' data is protected by the Personal Data (Privacy) Ordinance and ethical approval on the use of the data was restricted to the approved research proposal only. Please contact the corresponding author if there are any queries regarding the dataset.

## Declarations

**Ethics approval and consent to participate**
This study was conducted in accordance with the principles outlined in the Declaration of Helsinki and received ethics approval from the Human Subjects Ethics Subcommittee of The Hong Kong Polytechnic University (Ref ID: HSEARS20210712002). Written informed consent was obtained from all participants prior to their eye examination and questionnaire interview.

**Consent for publication**
Not applicable

**Competing interests**
The authors declare no competing interests.

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