Utility for Uncorrected Refractive Errors in Adolescent Schoolchildren in Kakamega County, Kenya

Emmanuel E. Okenwa-Vincent, PhD,[1,2]* Jyoti Naidoo, PhD,[3] and Peter C. Clarke-Farr, PhD[4]

SIGNIFICANCE: Uncorrected refractive errors (UREs) present an enormous lifetime burden in children. Despite this, there is a dearth of knowledge on URE-related preference-based quality of life (QoL) in East Africa. This study demonstrates the positive impact of interventions on UREs; hence, it provides an empirical justification for advocacy to improve the QoL of children with URE.

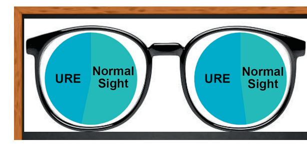
PURPOSE: This study investigated the preference-based QoL (utility) for URE in school-going adolescents of Kakamega County, in Kenya.

METHODS: An observational cross-sectional study with multistage sampling was conducted on randomly selected secondary school adolescents. School-going adolescents in Forms 1 to 4 were clinically examined for the presence of URE and classified according to their URE types. Pre-screened students who met the selection criteria were classified into two groups: URE and normal sight. Participants in the normal-sight group were randomly selected from among screened students without URE. Selected participants were administered a previously validated adolescent-specific utility weighting instrument—Assessment of Quality of Life—Six Dimensions.

RESULTS: A total of 330 participants aged 17.32 ± 1.60 years (URE, 17.50 ± 1.58 years; normal-sight, 17.15 ± 1.61 years) were included in the study. The mean utility score, as elicited by the Assessment of Quality of Life—Six Dimensions scoring algorithm, was better in the normal-sight group (URE, 0.496 ± 0.22; normal sight, 0.567 ± 0.25) at baseline, whereas the reverse was true at follow-up (URE, 0.655 ± 0.20; normal sight, 0.603 ± 0.25). In all cases, the differences were significant ($P < .05$); however, there was no significantly better ($P > .05$) utility elicited by any URE subtype at any given time point. Nonetheless, the URE group showed significantly better utility ($P < .05$) after spectacle correction.

CONCLUSIONS: Uncorrected refractive errors are associated with reduced utility in school-going adolescents, regardless of URE subtype. Spectacle correction resulted in a significantly improved utility for those with URE. Thus, this study recommends early public health strategies and spectacle interventions in schools for adolescents with URE.

Optom Vis Sci 2023;100:631–637. doi:10.1097/OPX.0000000000002054



Author Affiliations:
[1]Department of Optometry and Vision Sciences, Kaimosi Friends University, Kaimosi, Kenya
[2]Department of Optometry and Vision Sciences, Masinde Muliro University of Science and Technology, Kakamega, Kenya
[3]African Vision Research Institute, Department of Optometry, School of Health Sciences, University of KwaZulu-Natal, Durban, South Africa
[4]Department of Ophthalmic Sciences, Faculty of Health and Wellness Sciences, Cape Peninsula University of Technology, Cape Town, South Africa
*eokenwa@kafu.ac.ke

The use of economic evaluation for decision-making involving health care resource allocation is increasing globally. Key outcome measures within the evaluations are quality-adjusted life-years and hence utility measures.[1] Cost-utility analysis being a type of economic appraisal technique that incorporates the computation of quality-adjusted life-years, as its main outcome measure, enables analysts to compare between one health intervention and another. It enables between- and within-subject effect analyses of health states by applying weighted outcomes that combine quality and length of life within a common measure.[2] Generally, utility is an economic term representing choices-based decisions or "preferences" an individual would have to make to consume some desired items.[3] In terms of health intervention, it refers to a value an individual or a society (as a whole) places on a particular "health state," which is measured against an index that is determined by the affected entity's personal choices.[4] Utility weightings provide objective and quantitative means to measure quality of life related to health states and improvement in quality of life or changes in treatment interventions.[5] Utility weights are scored on a scale of 0.0 to 1.0, with a utility score of 1.0 representing perfect or full health and a utility score of 0.0 representing death or the worst state of health. A utility score tending toward 0.0 indicates a poorer quality of life for a health state, and the reverse is true as the utility value rises toward 1.0. Generally, a lower utility score indicates a less than normal health state, tending to death and, in the case of eye health, to blindness.[6,7]

Continuous utility represents preferences and rational choice. The concept of utility is a type of "theory of rational choices,"[2] which tends to assume that individuals have preferences among available alternatives that allow them to make rational decisions on the option they prefer.[8] However, an individual's benefits, satisfaction enjoyed, or even happiness received from a specific commodity or intervention is in their nature abstract and difficult to derive a direct measure from; hence, utility is represented and measured in terms of measurable economic choices.[9] Utility as an economic concept is often used while deriving paradigms such as the "indifference curve."[3] The curve is a plot of a mix of goods or services that a person or group(s), if accepted, will maintain a certain level of consistent satisfaction.[3] There have been few published studies on preference-based quality of life (utility) for persons with uncorrected refractive errors and presbyopia,[5,10] and more so in children.[11–13] However, these studies have applied adult-specific methodologies in measuring preferences for their health states. Furthermore, many of these studies focused on either a broader sense of uncorrected refractive error health states in the general population or presbyopia.[5,14,15]

In Kenya, the prevalence of refractive errors in adolescents has been reported to range between 5.2%[16] and 17.2%,[17] accounting for more than two-thirds of all causes of vision impairment in children.[18] Like most developing countries, uncorrected refractive errors in Kenya heavily impact academic performance[19] and expose affected children to a lifetime of poverty and other socioeconomic challenges.[20] Globally, severe vision impairment associated with uncorrected refractive errors is known to hinder children in terms of their opportunities for education, personality development, and future career potential. In addition, it further indirectly places immense economic strain on societies at large.[21] However, in Kenya, there is poor information on quality of life and the impact of uncorrected refractive errors on affected persons. Therefore, this study investigated the impact of vision impairment resulting from uncorrected refractive errors on school-going adolescents' utility in health interventions. This study presents empirical baseline information for policymaking and advocacy for child-eye health in the National Plan, which, before this study, was not considered.[22]

METHODS

Ethical Considerations

This research was reviewed and approved by independent ethical review boards: the Biomedical Research Ethics Committee of the University of KwaZulu-Natal in South Africa (reference no. BE359/15) and Institutional Ethics Review Committee of the Masinde Muliro University of Science and Technology (MMUST) in Kenya (MMU/COR:403009 [volume 1]). In addition, a mandatory research permit to conduct the study in Kenya was obtained from the National Commission for Science, Technology, and Innovation (permit no. NACOSTI/P/17/33921/18996). This study conforms to the principles and guidelines for the protection of human subjects in biomedical research, including adherence to respondents' right to refuse participation in the study and the right to withdraw participation at any point in the study. This study strictly adhered to all ethical provisions of the Declaration of Helsinki, including its subsequent revisions, for research involving human subjects.

Research Design and Methods

This study used an observational descriptive design involving cross-sectional sampling methodologies to elicit the utilities associated with uncorrected refractive errors in school-going adolescents. Two phases of the research were used. In the first phase, clinical examinations of all the selected participants were conducted to determine their uncorrected refractive errors status, the result of which has been previously published elsewhere.[23] This clinical component comprises one aspect of the quantitative component of the investigation. The second phase elicited utility (preference-based quality of life) for uncorrected refractive errors. For this purpose, a structured instrument, previously validated elsewhere,[24] was used. The structured questionnaire was designed to quantitatively elicit participants' utility responses, in line with the study objectives.

Sampling Procedure

The study sample was selected from a population of secondary school-going students aged 13 to 25 years. All learners (Forms 1 to 4) who met all pre-defined criteria for this study were identified and included. A multistage technique was used to select the study sample. One-third (4 subcounties) of the 12 subcounties of Kakamega County were randomly selected as four clusters[25] using a computer-generated random system.[26] The four subcounties had 138 secondary schools and comprised a total of 40,577-student population.

Schools with both day scholars and boarding facilities, as well as a gender mix, were identified for this study. This ensured that homogeneity was maintained for each selected school. Only 19 schools met these criteria, of which 7 schools were randomly selected by simple balloting. All students who provided consent were included as participants, and 2821 students were screened, of whom 244 were identified as having any form of uncorrected refractive error in any eye. From the pre-determined power analysis, a minimum of 300 samples (150 students with uncorrected refractive errors and another 150 students with normal sight) were required to detect a 10% difference in mean utility.

Description of the Techniques

All students who met the selection criteria—including giving assent to participate in the study through their legal caregivers—were included in this study. Each student was given a consent note/information document, through their respective school head, 1 week before the study. They were to return with it, signed by their legal caregiver, again through their school head on the first day of the researchers' visit to collect data. Detailed eye examinations were conducted on students screened for uncorrected refractive errors.

Eye examinations included ocular and medical history taking, assessment of the presenting aided and unaided distance and near visual acuities, direct ophthalmoscopy, and biomicroscopy. All visual acuities were measured at 4 and 0.4 m using high-contrast Bailey-Lovie logMAR charts. Finally, detailed objective and subjective refraction tests were performed. After refraction, 165 students with uncorrected refractive errors were issued appropriate corrective glasses for their respective refractive errors within a day or two, depending on the nature and dioptric power of their spectacle prescriptions.

Before the eye examinations, the utility questionnaire—the Australian adolescent-specific "Assessment of Quality of Life—Six Dimensions (AQOL-6D)" scoring algorithm—previously tested for construct and face validity, reliability, and psychometric fitness elsewhere,[27] was administered to all participants who met the selection criteria (pre-test) by research assistants who were all optometrists. This procedure for questionnaire administration took approximately 5 to 8 minutes per participant. The principal investigator (EEO-V) supervised the questionnaire administration, which was read out to the participants in English Language by the pre-trained research assistants. All participants (uncorrected refractive error and normal-sight groups alike) were requested to return the following day or after 2 days for repeat administration of the same study questionnaire (post-test) and scoring of the tools to elicit utility after the clinical assessment of the participants in the uncorrected refractive error group. Scoring of both the pre- and post-test findings formed the baseline utility scores for uncorrected refractive error. These findings were later compared with the utility scores elicited after 3 weeks of follow-up in both groups to readminister the same utility tool. These differences indicated a change in utility for the uncorrected refractive error group, possibly induced by the consistent use of spectacle corrections.

To enable utility scoring, responses to the AQOL-6D questionnaire were converted to "adolescent-specific health state"—uncorrected refractive error—scores by using the updated "adolescent-specific scoring algorithm" originally developed by Moodie et al.[27]

TABLE 1. Sociodemographic distribution of participants in the study

Variables	Distribution (n = 330) URE group (n = 165), Freq. (% share)	Normal-sight group (n = 165), Freq. (% share)	*P*
Age*			.20
<18 y	88 (53.3)	94 (57.0)	
≥18 y	77 (46.7)	71 (43.0)	
Sex			.03
Male	94 (57.0)	74 (44.8)	
Female	71 (43.0)	91 (55.2)	
Domiciliation			.86
Rural	146 (88.5)	147 (89.1)	
Urban	19 (11.5)	18 (10.9)	

χ^2; $\alpha = 0.05$. *Population: mean age, 17.32 ± 1.60 years; URE group: mean age, 17.50 ± 1.58 years; normal-sight group: mean age, 17.15 ± 1.61 years. Freq. = frequency; n = number of participants; URE = uncorrected refractive errors.

The approach and sequences to eliciting and scoring for utility were the same for both the uncorrected refractive error and the normal-sight groups, following the procedure described in the AQOL-6D scoring manual[28] and transcribed into uncorrected refractive error utility values for both the uncorrected refractive error and normal-sight groups. The detailed step-by-step process that converts the responses elicited using the adolescent-specific AQOL-6D questionnaire and uploading into an SPSS syntax file, which is then run to generate appropriate utility scores, is available online.[28]

Data Analysis

The collected data were exported to the Statistical Package for the Social Sciences (version 25; IBM Corp, Armonk, NY) for statistical analysis. The results comprised descriptive statistics including means, standard deviations, and percentages. Normality was assumed, and parametric inferential statistics were used to explore the data structures in this study. Specifically, the within-group interaction of participants' sociodemographic variables was compared using the Pearson χ^2 test, whereas the utilities for different uncorrected refractive errors health states at different time points were compared using a one-way analysis of variance.

In addition, the relationship between utility and different refractive error health states at different time points was explored using a simple linear regression model. Furthermore, differences in participants' utility at different time points were explored using a general linear model (repeated-measures analysis of variance). When a significant difference was found, multiple comparisons using the Bonferroni post hoc test were applied to locate the point of significant difference. Finally, the difference in utility between the two independent homogenous groups (uncorrected refractive error group vs. normal-sight group) was compared using an unpaired independent *t* test. All inferential analyses were conducted at $\alpha = 0.05$, with a 95% confidence interval (CI), and the results are presented in the form of tables, plots, charts, and descriptive formats.

RESULTS

Social Demographic and Refractive Error Subtype Distributions of Study Participants

A total of 330 participants who met the selection criteria were included in this study. This consisted of 165 adolescents with uncorrected refractive errors and 165 normal-sight adolescents. Efforts to follow-up, through the support of the schools' heads, were put in place to mitigate against loss of participants due to attrition. Table 1 shows the sociodemographic distribution of all the 330 study participants with a population mean age of 17.32 ± 1.60 years, distributed according to those younger than 18 years and those 18 years and older. In both study groups, we found slightly more participants younger than 18 years (uncorrected refractive errors, 53%; normal-sight, 57%), but this was not significant ($P = .20$), regardless of whether they had uncorrected refractive error or were normal-sighted. More so, the mean

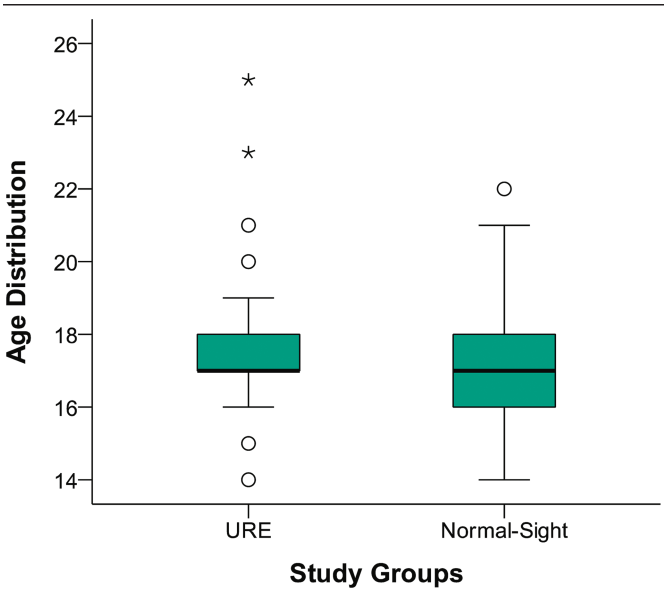


FIGURE 1. Boxplot comparison of age distribution in the uncorrected refractive error and normal-sight groups (n = 330). Interquartile range of age distribution and age outliers mostly occurring in the uncorrected refractive error group.

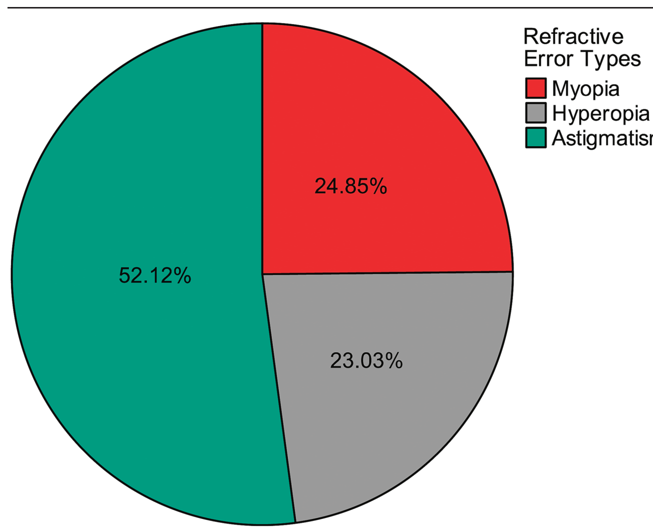


FIGURE 2. Chart showing the distribution of participants' uncorrected refractive error types (n = 165), with most of the participants having astigmatism.

TABLE 2. Utility scores in both study groups measured with the AQOL-6D utility algorithm at different time points

Measurement intervals	Distribution (n = 330)		
	URE group (n = 165), mean ± SD	Normal-sight group (n = 165), mean ± SD	*P**
Pre-test	0.496 ± 0.22	0.567 ± 0.25	.01
Post-test	0.596 ± 0.21	0.587 ± 0.25	.73
Test-retest	0.655 ± 0.20	0.603 ± 0.25	.04

*Unpaired *t* test; $\alpha = 0.05$. AQOL-6D = Assessment of Quality of Life—Six Dimensions; n = number of participants; SD = standard deviation; URE = uncorrected refractive errors.

age for the uncorrected refractive error group was slightly higher (17.50 ± 1.58 years) as compared with that of the normal-sight group at 17.15 ± 1.61 years (Fig. 1), whereas the interquartile range of age distribution was closer together for the uncorrected refractive error groups, with most of them being around 17 and 20 years of age. However, unlike the normal-sight group, a few age outliers occurred in the uncorrected refractive error group, which were as low as 13 years and as high as 25 years (Fig. 1). In general, as shown in the various variables that defined the sociodemographic distribution of participants in this study (Table 1), the study found similar demographic distributions in both the uncorrected refractive error and normal-sight groups. However, this was with the exception of sex, where the male and female distributions in both groups were significantly different ($P = .03$). Regarding the uncorrected refractive error subtype distribution, classified into myopia, hyperopia, and astigmatism (Fig. 2), this study found that more than half of all participants (52%) with uncorrected refractive errors had astigmatism. Also, the details of the sociodemographic distribution and characteristics of the uncorrected refractive error participants included in this current article are presented in a separate publication, elsewhere.[23] The purpose of mention in this current article is to provide baseline for comparison of the quality-of-life preferences of participants with uncorrected refractive error for their health states, with those of their normal-sight counterparts.

Utility Scores of Study Participants

The mean utility scores for both the uncorrected refractive error and normal-sight groups at different time points are listed in Table 2. As shown, the lower the utility score, tending toward zero, the lower the utility value for both independent health states, indicating a poorer health state and increasing quality-of-life burden on the affected individuals. The results showed higher mean utility scores in both groups after up to 3 weeks of follow-up compared with baseline scores. The finding further shows that the normal-sight group had a significantly better ($P = .01$) mean utility score than the uncorrected refractive error group in the pre-test. Nonetheless, this trend changed at the test-retest time point—approximately 3 weeks after spectacle intervention for the uncorrected refractive error group was introduced—with the uncorrected refractive error group having a significantly better ($P = .04$) mean utility score than the normal-sight group.

A comparative assessment of the mean utility scores for the three uncorrected refractive error subtypes at three different time points is presented in Table 3. The study found no specific trend for one uncorrected refractive error subtype consistently having the best mean utility at different time points. Although myopia was best at baseline (pre-test) and weeks after spectacle intervention (test-retest), hyperopia was best at the utility measurement immediately after spectacle intervention (post-test). However, the within-group comparison at all time points showed no significant difference ($P > .05$, 95% CI) in the mean utility scores for the three different uncorrected refractive error subtypes in school-going adolescents.

Furthermore, an assessment of the relationship between the mean utility scores and uncorrected refractive error dioptric values showed negative β values, indicating a negative linear relationship at all three time points (Table 4). These findings show that mean utility scores tend to decrease with increasing magnitude of uncorrected refractive error dioptric values, regardless of the type. This was consistent at all three time points; however, the linear relationships, as demonstrated by the negative β scores at all three time points, were not statistically significant ($P > .05$), as shown in Table 4. Therefore, the results indicate that the relationships could not be sufficiently explained by the linear regression model for uncorrected refractive error health states adopted in this study.

Utility Score Differences between Adolescents with Uncorrected Refractive Error and Those with Normal Sight

A pairwise comparison of the mean utility scores in both the uncorrected refractive error and normal-sight groups showed that the intergroup and within-group effects differed significantly ($P < .05$, 95% CI) in the mean utility scores from baseline to follow-up

TABLE 3. Comparative assessment of utility of different URE subtypes as measured using the AQOL-6D utility algorithm at different time points

Measurement intervals	Distribution (n = 165)			
	Myopia, mean ± SD (CI)	Hyperopia, mean ± SD (CI)	Astigmatism, mean ± SD (CI)	*P**
Pre-test	0.540 ± 0.21 (0.47–0.61)	0.472 ± 0.23 (0.40–0.55)	0.485 ± 0.22 (0.44–0.53)	.33
Post-test	0.599 ± 0.21 (0.53–0.67)	0.604 ± 0.24 (0.52–0.68)	0.591 ± 0.20 (0.55–0.63)	.95
Test-retest	0.670 ± 0.21 (0.60–0.74)	0.648 ± 0.22 (0.58–0.72)	0.650 ± 0.20 (0.61–0.69)	.86

*Analysis of variance at $\alpha = 0.05$. AQOL-6D = Assessment of Quality of Life—Six Dimensions; CI = 95% confidence interval; n = number of participants; SD = standard deviation; URE = uncorrected refractive errors.

TABLE 4. Assessment of relationship between utility and URE dioptric values at three different time points as measured using the AQOL-6D instrument

	Utility vs. dioptric values of URE health states at different time points					
	Unstandardized coefficient					
Measurement intervals	Mean ± SD	R^2	*β* Coef.	SE	*t*	*P**
Pre-test	0.526 ± 0.50	0.008	–0.024	0.021	–1.138	.26
Post-test	0.596 ± 0.01	0.000	–0.005	0.020	–0.239	.81
Test-retest	0.655 ± 0.01	0.001	–0.009	0.019	–0.449	.65

*Linear regression model at $\alpha = 0.05$. AQOL-6D = Assessment of Quality of Life—Six Dimensions; Coef. = coefficient; SD = standard deviation; SE = standard error; URE = uncorrected refractive errors.

(Table 5). As shown, the mean utility scores significantly improved in both groups, a few weeks after spectacle uptake (by the participants with uncorrected refractive error), with the uncorrected refractive error group showing better utility scores than the normal-sight group at follow-up (Table 5). The post hoc analyses of the utility scores elicited from both the uncorrected refractive error and normal-sight groups at different time points showed that significant differences ($P < .001$) occurred between each pair compared with the uncorrected refractive error group alone (Table 6). However, for the normal-sight group, the significant difference in the group's comparison occurred only in the pairwise interaction between the pre-test and test-retest utility measurements (Table 6).

In essence, for the normal-sight group, the difference between the utility measures at points before (pre-test) and immediately after the issuance of spectacles to the uncorrected refractive error group participants (post-test) was not significant ($P = .29$). In addition, the difference between the utility measures taken at points just after issuing the spectacles to participants in the uncorrected refractive error group (post-test) and after 3 weeks of continuous use of the same (test-retest) was not significant ($P = .41$). This was not surprising, as no spectacle was given to the normal-sight group (no intervention). However, the difference between baseline (pre-test) measures and utility measured approximately 3 weeks after (test-retest) was significant ($P = .003$). Therefore, the foregone analyses further justify the hypothesis of a significant difference in mean utility scores between school-going adolescents with uncorrected refractive error and their normal-sight counterparts, as shown in Table 2 and Fig. 3.

DISCUSSION

Our research reveals that corrective spectacle use markedly improves utility scores among adolescents with uncorrected refractive errors. Notably, after 3 weeks of spectacle use, these participants exhibited the highest utility values. Interestingly, an uptick in utility scores was also observed in the normal-sight group, which could be ascribed to recall bias. However, upon scrutinizing the mean utility scores across all three measurement points, it became evident that recall bias was not a significant factor. In fact, as our finding showed, at baseline the normal-sight group had notably better utility scores compared with their counterparts with vision impairment, a trend that progressively changed after issuance of spectacles to the latter group, with this group using corrective spectacles demonstrating significantly better mean score weeks later (Table 2). This finding thus demonstrates that the factor influencing positive utility shift must have been more of the spectacle uptake than of the influence of recall bias. More so, a comparative analysis of the mean utility scores for both groups—those with uncorrected refractive errors and those with normal sight—demonstrates significant differences ($P < .05$) in both intergroup and intragroup effects from baseline to follow-up scores (Table 5). Therefore, these findings imply that, although uncorrected refractive errors may be associated with lower utility values, the uptake of spectacle intervention significantly improves utility values and hence the quality of life for adolescent learners with uncorrected refractive errors. These findings resonate with an Australian study[5] that similarly observed an uptick in quality of life after spectacle correction in a presbyopic population with uncorrected refractive errors, thus underscoring the significant effect of poor distance-and-near vision on the quality of life.

With regard to the refractive error types, the results of the pairwise comparison conducted (Table 3) show that the type of refractive error did not seem to significantly affect the utility scores, suggesting that the reduced quality of life is primarily a result of uncorrected refractive errors rather than the specific type of refractive error. Furthermore, the uncorrected refractive error group displayed significant differences ($P < .05$) in the mean utility score at all three stages of pairwise comparison. This was not the case for the normal-sight group, where the significant difference ($P < .05$) was observed only between the initial and final utility scores (Table 6). These findings underscore the transformative power of spectacle correction on utility valuation and, by extension, the quality of life of adolescent learners with refractive errors. Despite the normal-sight group's familiarity with

TABLE 5. Comparison of utility at three different time points of data collection as measured using the AQOL-6D instrument

	Time point variables*			
Measurement intervals	Pre-test, mean ± SD (CI)	Post-test, mean ± SD (CI)	Test-retest, mean ± SD (CI)	*P*†
URE group	0.496 ± 0.22 (0.46–0.53)	0.596 ± 0.21 (0.56–0.63)	0.655 ± 0.20 (0.62–0.69)	<.001
Normal-sight group	0.567 ± 0.25 (0.53–0.61)	0.587 ± 0.25 (0.55–0.63)	0.603 ± 0.25 (0.55–0.63)	<.001

*General linear model at 95% CI. †*P* value for pairwise comparison at $\alpha = 0.05$. AQOL-6D = Assessment of Quality of Life—Six Dimensions; CI = 95% confidence interval; SD = standard deviation; URE = uncorrected refractive errors.

TABLE 6. Post hoc test for differences in utility at three different time points of data collection as measured using the AQOL-6D instrument for participants in both groups

	Pairwise comparison*			
Measurement intervals	**AQOL6D_Time**	**AQOL6D_Time**	**Mean difference (95% CI)**	***P*†**
URE group	Pre-test	Post-test	–010 (–0.13 to –0.07)	<.001
		Test-retest	–0.16 (–0.20 to –0.12)	<.001
	Post-test	Post-test	0.10 (0.07 to 0.13)	<.001
		Test-retest	–0.06 (–0.09 to –0.03)	<.001
	Test-retest	Post-test	0.16 (0.12 to 0.20)	<.001
		Test-retest	0.06 (0.03 to 0.09)	<.001
Normal-sight group	Pre-test	Post-test	–0.02 (–0.05 to 0.01)	.29
		Test-retest	–0.04 (–0.06 to –0.01)	.003
	Post-test	Post-test	0.02 (–0.01 to 0.05)	.29
		Test-retest	–0.02 (–0.04 to 0.01)	.41
	Test-retest	Post-test	0.04 (0.01 to 0.06)	.003
		Test-retest	0.02 (–0.01 to 0.04)	.41

*Adjustment for multiple comparisons: Bonferroni at 95% CI. †*P* value for pairwise comparison at $\alpha = 0.05$. AQOL-6D = Assessment of Quality of Life—Six Dimensions; CI = 95% confidence interval; URE = uncorrected refractive errors.

the same assessment tool over time, they consistently recorded lower mean utility scores compared with their counterparts, thus supporting our position in this study that uptake and consistent use of spectacle correction have a significant positive impact on the quality of life of school-going adolescents with uncorrected refractive errors. This position is further justified by evidence in the literature on the impact of spectacle correction of refractive errors, including presbyopia, on utility.[5,10,12–14,29]

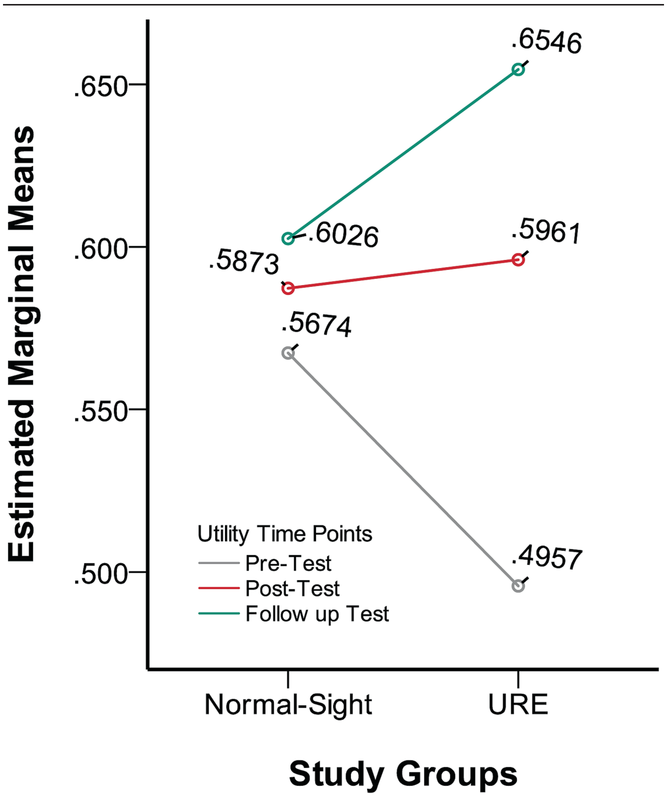


FIGURE 3. Group comparison of mean utility scores, as elicited by the Assessment of Quality of Life (AQOL) scoring algorithm, in both the uncorrected refractive error and normal-sight groups at three different time points (n = 330). Although participants in the normal-sight group have a higher mean utility score at pre-test, those in the uncorrected refractive error group have a higher mean utility score post-intervention with spectacle correction.

Furthermore, in terms of the severity of refractive errors, our study found a negative correlation between the magnitude of dioptric values and utility scores (Table 4). This implies that, as the severity of refractive errors and/or visual disability resulting from their uncorrected refractive error health states increased, the quality of life of the participants decreased. However, this trend was not statistically significant ($P > .05$) and therefore could not be accurately interpreted using a linear regression model, even as our present study agrees with previous studies.[5,11–13]

Our study firmly established that spectacle intervention significantly boosts the quality of life among school-going adolescents with uncorrected refractive errors, leading to improved utility scores compared with their normal-sight counterparts after 3 weeks of continuous spectacle use. These observations align with findings from other nonocular health-related studies.[7,30,31] In all cases, they found utility scores to be lower in all their study participants with health states considered less than full health compared with that of their control subjects with better health. In addition, the findings of this study agree with those of other ocular studies that investigated utilities associated with diabetic retinopathy, cataract, and age-related macular degeneration, among other common ophthalmic diseases,[15] and open-angle glaucoma,[32] where the studies consistently found reduced quality-of-life valuations for the varying conditions under study. Finally, it is also important to note that past studies have variously reported utility scores for refractive error health states, including presbyopia, in various identified adult population groups. However, these studies applied different adult and generic utility instruments, including the Time Trade-off instrument,[11,29] the EuroQol-5 Dimension,[33] and the UK adult general population Standard Gamble technique.[5,10,12–15,29] Despite this, a consistent trend of reduced utility scores for refractive error health states has been reported, bolstering the findings of our current study.

CONCLUSIONS

The findings of this study show that, at baseline, participants with normal sight had significantly better mean utility scores (hence, better quality of life) than their counterparts with uncorrected refractive errors. Conversely, at follow-up, after uptake and consistent use of corrective spectacles, participants with uncorrected refractive errors had significantly better utility for their health states. These findings demonstrate that preference-based quality of life in school-going adolescents is affected by uncorrected refractive error health status; however, their utility scores improved significantly after spectacle correction. The utility improvement after spectacle correction was true regardless of uncorrected refractive error subtype and even improved with consistent use over time (Fig. 3). Based on the results presented in this article, this study recommends an increase in public health strategies, including early spectacle uptake, as well as the correct and consistent use of public health strategies and early spectacle uptake among adolescent learners with uncorrected refractive error in Kakamega County, Kenya.

ARTICLE INFORMATION

Submitted: March 14, 2023

Accepted: June 24, 2023

Funding/Support: None of the authors have reported funding/support.

Conflict of Interest Disclosure: None of the authors have reported a financial conflict of interest.

Author Contributions and Acknowledgments: Conceptualization: EEO-V, JN, PCC-F; Data Curation: EEO-V, PCC-F; Formal Analysis: EEO-V, JN; Funding Acquisition: EEO-V, JN; Investigation: EEO-V, JN, PCC-F; Methodology: EEO-V, JN, PCC-F; Project Administration: EEO-V, JN, PCC-F; Resources: EEO-V, JN, PCC-F; Software: EEO-V, JN, PCC-F; Supervision: EEO-V, JN, PCC-F; Validation: EEO-V, JN, PCC-F; Visualization: EEO-V, JN, PCC-F; Writing – Original Draft: EEO-V, JN, PCC-F; Writing – Review & Editing: EEO-V, JN, PCC-F.

The authors hereby acknowledge the support received from optometrists who assisted in the data collection for this study. Furthermore, they acknowledge the supports received from the trained teachers and schools' heads, Masinde Muliro University's Institutional Ethics Review Committee, the African Vision Research Institute, the Brien Holden Vision Institution, and the National Commission for Science, Technology, and Innovation.

REFERENCES

1. Hirth RA, Chernew ME, Miller E, et al. Willingness to Pay for a Quality-adjusted Life Year. Med Decis Making 2000;20:332–42.

2. Drummond M. Cost-effectiveness Guidelines for Reimbursement of Pharmaceuticals: Is Economic Evaluation Ready for Its Enhanced Status? Health Econ 1992;1:85–92.

3. Gilboa I. Theory of Decision under Uncertainty. Cambridge, United Kingdom: Cambridge University Press; 2009.

4. Drummond M, Sculpher MJ, Claxton K, et al. Principles of Economic Evaluation. In: Drummond MF, Sculpher MJ, Claxton K, et al, eds. Methods for the Economic Evaluation of Health Care Programmes. 4th ed. Oxford, United Kingdom: Oxford University Press, Inc; 2015:77–122.

5. Tahhan N, Papas E, Fricke TR, et al. Utility and Uncorrected Refractive Error. Ophthalmology 2013;120:1736–44.

6. Seyedifar M, Dorkoosh FA, Hamidieh AA, et al. Health-related Quality of Life and Health Utility Values in Beta Thalassemia Major Patients Receiving Different Types of Iron Chelators in Iran. Int J Hematol Oncol Stem Cell Res 2016;10:224–31.

7. Prigent A, Auraaen A, Kamendje-Tchokobou B, et al. Health-related Quality of Life and Utility Scores in People with Mental Disorders: A Comparison with the Non-mentally Ill General Population. Int J Environ Res Public Health 2014;11:2804–17.

8. Ostrom E. A Behavioral Approach to the Rational Choice Theory of Collective Action: Presidential Address, American Political Science Association, 1997. Am Polit Sci Rev 1998;92:1–22.

9. Kapteyn A. Utility and Economics. Economist (Leiden) 1985;133:1–20.

10. McDonnell PJ, Lee P, Spritzer K, et al. Associations of Presbyopia with Vision-targeted Health-related Quality of Life. Arch Ophthalmol 2003;121:1577–81.

11. Saw SM, Gazzard G, Au Eong KG, et al. Utility Values and Myopia in Teenage School Students. Br J Ophthalmol 2003;87:341–5.

12. Lim WY, Saw SM, Singh MK, et al. Utility Values and Myopia in Medical Students in Singapore. Clin Exp Ophthalmol 2005;33:598–603.

13. Li S, Wang G, Xu Y, et al. Utility Values among Myopic Patients in Mainland China. Optom Vis Sci 2014;91:723–9.

14. Lu Q, Congdon N, He X, et al. Quality of Life and Near Vision Impairment Due to Functional Presbyopia among Rural Chinese Adults. Invest Ophthalmol Vis Sci 2011;52:4118–23.

15. Lee BS, Kymes SM, Nease RF, et al. The Impact of Anchor Point on Utilities for 5 Common Ophthalmic Diseases. Ophthalmology 2008;115:898–903.e4.

16. Muma MK, Kimani K, Wanyoike MK, et al. Prevalence of Refractive Errors among Primary School Pupils in Kilungu Division of Makueni District, Kenya. Med J Zambia 2009;36:165–70.

17. Nyamai LA. Prevalence, Knowledge, Attitude and Practice on Refractive Error among Students Attending Public High Schools in Nairobi County [master's thesis]. Nairobi, Kenya: University of Nairobi; 2016.

18. Njuguna M, Msukwa G, Shilio B, et al. Causes of Severe Visual Impairment and Blindness in Children in Schools for the Blind in Eastern Africa: Changes in the Last 14 Years. Ophthalmic Epidemiol 2009;16:151–5.

19. Resnikoff S, Pascolini D, Mariotti SP, et al. Global Magnitude of Visual Impairment Caused by Uncorrected Refractive Errors in 2004. Bull World Health Organ 2008;86:63–70.

20. Naidoo K. Poverty and Blindness in Africa. Clin Exp Optom 2007;90:415–21.

21. Naidoo KS, Leasher J, Bourne RR, et al. Global Vision Impairment and Blindness Due to Uncorrected Refractive Error, 1990–2010. Optom Vis Sci 2016;93:227–34.

22. Republic of Kenya, Ministry of Health. Transforming Health: Accelerating Attainment of Universal Health Coverage: Kenya Health Sector Strategic and Investment Plan (KHSSPI) July 2013–June 2017; 2013. Available at: http://guidelines.health.go.ke:8000/media/Kenya_Health_Sector_Strategic_Investment_Plan_2013_to_2017.pdf. Accessed June 16, 2023.

23. Okenwa-Vincent EE, Naidoo J, Clarke-Farr P. Factors Associated with Uncorrected Refractive Errors in School-going Adolescents in Kakamega County, Kenya. Ophthalmol J 2022;7:152–62.

24. Stevens K, Ratcliffe J. Measuring and Valuing Health Benefits for Economic Evaluation in Adolescence: An Assessment of the Practicality and Validity of the Child Health Utility 9D in the Australian Adolescent Population. Value Health 2012;15:1092–9.

25. St. Olaf College. Sample Size—Institutional Effectiveness and Assessment. Available at: https://wp.stolaf.edu/iea/sample-size/. https://wp.stolaf.edu/iea/sample-size/. Accessed August 3, 2023.

26. Random.org. Random Integer Generator. Available at: https://www.random.org/integers/?mode=advanced. Accessed March 2, 2018.

27. Moodie M, Richardson J, Rankin B, et al. Predicting Time Trade-off Health State Valuations of Adolescents in Four Pacific Countries Using the Assessment of Quality-of-Life (AQoL-6D) Instrument. Value Health 2010;13:1014–27.

28. Assessment ot Quality of Life (AQOL). AQoL-6D Adolescent Algorithm SPSS. Available at: http://www.aqol.com.au/index.php/scoring-algorithms?id=201. Accessed March 20, 2018.

29. Luo BP, Brown GC, Luo SC, et al. The Quality of Life Associated with Presbyopia. Am J Ophthalmol 2008;145:618–22.

30. Fann CY, Huang PC, Yen AM, et al. Patient Utility Measurement for Managing Ureteral Stones: A Modified Standard Gamble Approach. Value Health Reg Issues 2012;1:87–92.

31. Tarride JE, Burke N, Bischof M, et al. A Review of Health Utilities across Conditions Common in Paediatric and Adult Populations. Health Qual Life Outcomes 2010;8:12.

32. Hernández R, Rabindranath K, Fraser C, et al. Screening for Open Angle Glaucoma: Systematic Review of Cost-effectiveness Studies. J Glaucoma 2008;17:159–68.

33. Lin JC, Yu JH. Assessment of Quality of Life among Taiwanese Patients with Visual Impairment. J Formos Med Assoc 2012;111:572–9.