




The impact of uncorrected refractive error and visual impairment on the quality of life amongst school-going children in Sekhukhune district (Limpopo), South Africa



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Background: Uncorrected refractive error (URE) and subsequent visual impairment (VI) is expected to have an impact on the quality of life (QoL) amongst schoolchildren.

Aim: This study aimed to determine the impact of URE and VI on the QoL amongst school-going children aged 14–18 years.

Settings: The study was performed at Sekhukhune district in the Limpopo province, South Africa.

Methods: The tool used to assess the QoL was the National Eye Institute Quality of Life Questionnaire (NEI-VFQ-25). A modified refractive error study in children (RESC) protocol was employed to determine the value of URE and VI. The tests performed included Logarithm of the Minimum Angle of Resolution (LogMAR) visual acuity, cycloplegic autorefraction, binocular motor function tests, media and fundus examination.

Results: A total of 154 learners, aged 14–18 years completed the NEI-VFQ-25, which was offered in an interview format. A total of 56 learners (36.3%, 95% confidence interval [CI]: 14.9–27.9%) had URE and VI. Children with URE and VI scored low on the NEI-VFQ-25 as compared with those without URE and VI.

Conclusion: Uncorrected refractive error has an impact on the QoL of learners in the greater Sekhukhune district. This calls for policymakers and other relevant stakeholders in basic education to prioritise programmes that seek to address the visual health of scholars in rural schools.

Keywords: uncorrected refractive error; visual impairment; quality of life; school-going children; learner eye health; National Eye Institute Quality of Life Questionnaire.

Introduction

Refractive error (RE) can be defined as a defect in the focusing of light on the retina leading to blurred vision.¹ Visual impairment (VI) is defined as RE that cannot be corrected by spectacles or contact lenses, medication or surgery, leaving a person with poor distance vision categorised as worse than 0.3 Logarithm of the Minimum Angle of Resolution (LogMAR).^{2,3} Uncorrected refractive error (URE) has been established as the leading cause of VI globally and a contributory factor to childhood blindness.³

Globally, the prevalence rate of URE amongst school-going children is estimated to be approximately 11.7%,⁴ with the Asian population having the highest prevalence (36.9%)⁵ and the African population, the lowest (9.7%).⁶ In contrast, other studies have reported a relatively low prevalence of 4.5% in an Asian population^{7,8,9} as opposed to 24.0% in some parts of the African continent.^{10,11} The prevalence of URE in South Africa has been reported to be 7.0%.¹² Myopia was found to be the leading type of URE in most studies, followed by astigmatism and hypermetropia.^{5,11,13} Furthermore, 19 million children have VI worldwide, of which 1.4 million are blind and 17.5 million have low vision, with 90.0% of these children living within the African continent.¹⁴

Relative to cataract and glaucoma that are regarded as the other major contributors to global blindness, URE and subsequent VI has its onset much earlier in life thus affecting individuals for many years and on many levels including socially, psychologically and financially.^{15,16} In the United States, the medical expenditure of a person with RE and VI was estimated at around

\$4000.00 per annum, excluding the cost of loss of productivity, anxiety and distress.^{17,18} Not surprisingly, therefore, the World Health Organization (WHO) has prioritised URE and VI in its campaigns such as 'VISION 2020: Right to Sight'.¹⁹

It is known that VI is associated with depression, anxiety and frustration.^{18,20} Moreover, people with VI worry that the condition might worsen, and they could become blind,¹⁸ which may impact their quality of life (QoL). According to the WHO, QoL can be defined as a personal perception of one's position in life in the context of culture and value systems, in which he lives and in relation with his goals, expectations, standards and concerns.²¹ Therefore, vision-related QoL can be defined in the context of VI²² and is an important aspect to review particularly amongst children¹⁵ as RE and VI can affect the learning ability of children²³ with a ripple effect on their lives. Most children with RE and VI complain of having difficulties copying what is written on the blackboard at school.²² Furthermore, they cannot participate in most sporting codes that require good vision. Myopia was found to be a factor resulting in poorer vision-related QoL for both distance and near vision, whilst hyperopia had no association with near nor distance difficulties.²³ Pan et al.²⁴ reported that children with poor vision often score very low on health-related QoL (HRQoL). In addition, children with worse VI are reported to experience more difficulties in life when compared with those with average VI,²⁵ and children with VI in one eye could still score better on the QoL assessment than those with bilateral VI.²³

There is a little information on the burden these two conditions have on children's QoL.¹⁵ To the best of the researchers' knowledge, the impact of RE and VI on the QoL of school-going children from the Sekhukhune district in the Limpopo province has not been investigated. The outcome of this study has the potential to guide policymakers in channelling resources to alleviate the burden children experience because of these conditions.²⁶

Materials and methods

Participants

A cross-sectional, quantitative research design was used to determine the impact of URE and VI on the QoL of a sample of schoolchildren. The study was conducted in 10 randomly selected schools in the Greater Sekhukhune, the smallest district making up 11% of the geographical area of the Limpopo province, South Africa. From the estimated population of 1 169 762,^{27,28} a total of 155 learners, aged 14–18 years were recruited, by convenience sampling, to participate in an interview using the validated National Eye Institute Visual Function Questionnaire-25 (NEI-VFQ-25) version 2000²⁹ and thereafter an eye examination was performed. Learners were only excluded from the study if they failed to return the signed consent and assent forms.

Quality of Life Questionnaire

The validated NEI-VFQ-25 consisted of 23 compulsory questions and was administered in a structured interview format.²⁹ A trained research assistant read out each question or statement about vision problems or difficulty and each child responded with reference to his or her vision condition. After each question or statement, the research assistant read the list of possible answers, and the child was requested to choose the response that best described his or her situation. The questions were categorised into various subscales, including global vision rating ($n = 1$), difficulty with near-vision activities ($n = 3$), difficulty with distance vision activities ($n = 3$), limitation in social functioning because of vision ($n = 2$), dependency on others as a result of vision ($n = 4$), limitation with peripheral visual field ($n = 1$) and ocular pain ($n = 2$). The maximum score was 100, with a low score reflecting a low QoL. The questionnaire was presented in English, with the research assistant being proficient in both English and each child's indigenous language (Sepedi), thus further enabling him or her to translate to the respondent in case of confusion.

Eye examination

After the completion of NEI-VFQ-25 interview, learners were sent for an eye examination in another classroom as allocated by the school. A modified Refractive Error Study in Children (RESC)³ protocol was employed to determine the prevalence rates of URE and VI. The tests included unaided visual acuity (VA) determined with the LogMAR chart using the Tumbling E optotype, binocular motor function assessment using Hirschberg and cover uncover test, pupil dilation was performed with one drop of 0.5% Novesine and 2–3 drops of 1% cyclopentolate eye drops. Novesine was used to anaesthetise the cornea so that the cyclopentolate did not sting too much and allow for better absorption of the cyclopentolate, hence, cycloplegia was achieved faster. Refraction using Topcon (Grand Seiko, RM-800B), Tokio) autorefractor, media and fundus examination using a WelchAllyn direct ophthalmoscope and aided VA following autorefraction (Topcon RM-800B) results.

Refractive error was classified according to the RESC protocol where myopia was defined as an autorefractor value of -0.50 dioptre (D) or more in one or both eyes, a value of $+2.00$ D or more in one or both eyes as hypermetropia and a value -0.75 or more cylindrical refraction in one or both eyes as astigmatism. Furthermore, any child who scored between 0.0 M (minimum angle of resolution) and < 0.2 M in both eyes, through the autorefractor findings, on the LogMAR chart was considered to have good vision, a score of 0.2 M or worse in one or both eyes was considered as URE, whilst a score of 0.3 or worse in one or both eyes was considered as VI.³

Data captured were entered into Microsoft Excel and analysed using the Social Package for Social Sciences (SPSS), version 25 in consultation with a statistician. Correlations

were made to assess the strengths of the relationship between QoL scores. Independent sample *t*-test or analysis of variance was used to compare the mean QoL scores between the different categories of RE. All the tests were two tailed, and statistical significance was set at $\alpha = 5\%$.

Ethical considerations

Ethical clearance to conduct this study was obtained from the Biomedical Research Ethics Committee at the University of KwaZulu-Natal (number: BE080/19).

This study adhered to the tenets of the Declaration of Helsinki. Further approval was obtained from the Limpopo Department of Education and the principals of the concerned schools. Signed consent and assent forms were obtained from parents and children before the children could be allowed to participate in this study.

Results

A total of 155 learners participated in the interview; however, one record went missing, thus the responses of only 154 learners were analysed.

Demographics

Gender and age demographics of the sample are shown in Table 1. Participants were aged between 14 and 18 years, with most (61%) being older than 17 years of age. The mean age of the sample was 16.59 ± 1.42 (standard deviation [s.d.]) years with the median age 17 years. There were slightly more female than male participants, and 70.8% of participants were from Grades 10 to 12.

TABLE 1: Demographics of the participants.

Variables	Males		Females		Total	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
Age (years)						
14–16	27	17.5	33	21.4	60	39.0
17+	46	29.9	48	31.2	94	61.0
Total	73	47.4	81	52.6	154	100.0
Grades						
6–7	7	4.5	4	2.6	11	7.1
8–9	18	11.7	16	10.4	34	22.1
10–12	48	31.2	61	39.6	109	70.8
Total	73	47.4	81	52.6	154	100.0

TABLE 2: Participants with and without refractive error (RE) and visual impairment (VI) based on age and gender.

Variables	Learners without RE and VI		Types of RE						Learners with RE and VI	
			Myopia		Hypermetropia		Astigmatism			
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Gender										
Males	46	63.0	18	24.7	1	1.4	8	11.0	27	37.1
Females	52	64.2	15	18.5	2	2.5	12	14.8	29	35.8
Total	98	63.6	33	21.4	3	1.9	20	13.0	56	36.3
Age (years)										
14–16	36	60.0	13	21.7	2	3.3	9	15.0	24	40.0
17+	62	66.0	20	21.3	1	1.0	11	11.7	32	34.0
Total	98	63.6	33	21.4	3	1.9	20	13.0	56	36.3

Refractive error and visual impairment

In the eyes with successful cycloplegia, refraction was performed with an autorefractor. A minimum of five readings with valid confidence rankings as per the manufacturer's instructions were obtained for each eye.

Of the 154 participants, 56 learners (36.3%, 95% CI: 14.9–27.9) presented with URE and VI as determined with cycloplegic autorefraction (Table 2). The prevalence rate of myopia in the total sample was 21.4% (95% CI: 14.9–27.9) and was higher in male participants and older children (Table 2). In three learners, vision could not be improved to better than 0.30 (20/40). The prevalence rate of VI in this study was therefore 1.9% (95% CI: 0.00–4.10).

Quality of life

Table 3 shows the mean and s.d. subscores of the 11 subscales (including the composite score) on the NEI-VFQ-25 for learners with and without RE and VI. The subscores have been determined by averaging the score for the items under each subscale. The *p*-value from the independent *t*-test run for each subscore reflected in Table 3 is also provided for comparison between learners with RE and VI and those without RE and VI. A lower score represents poorer functioning.

TABLE 3: Comparison of the mean and standard deviation (s.d.) between the learners with refractive error (RE) or visual impairment (VI) and those without, based on the subscores of the items of the National Eye Institute Quality of Life Questionnaire-12.

Scale name	Subscore				Independent <i>t</i> -test (<i>p</i> -value)
	Learners without RE and VI		Learners with RE and VI		
	Mean	s.d.	Mean	s.d.	
Composite scores	80.56	10.36	65.21	17.65	0.000*
General health	59.43	26.50	60.71	24.24	0.768
General vision	76.12	17.85	67.41	23.08	0.010*
Ocular pain	76.19	18.74	61.38	22.64	0.000*
Near activities	83.41	12.58	70.16	21.21	0.000*
Distance activities	86.30	12.21	69.79	20.26	0.000*
Social functioning	88.05	13.30	72.76	21.46	0.000*
Mental health	79.75	15.79	52.56	26.82	0.000*
Role difficulties	79.33	19.08	58.24	27.34	0.000*
Dependency	83.58	16.68	56.84	30.00	0.000*
Colour vision	88.52	16.51	77.41	23.90	0.001*
Peripheral vision	85.45	14.76	70.00	23.55	0.000*

*, indicates that the mean difference is significant at $\alpha = 5\%$.

Excluding general health, for all items the mean subscores of those learners with RE and VI were statistically significantly lower than for those without RE and VI (p -values < 0.05). However, as the difference in the number of participants in the two groups was 42, a minimum of 20-point difference in the subscores would indicate a difference between the groups and was observed only for the subscales ocular pain, mental health, role difficulties, dependency and colour vision.

TABLE 4: The mean and standard deviation of subscores of the items on the National Eye Institute Quality of Life Questionnaire-25 for participants with refractive error and visual impairment based on age groups.

Scale name	Subscore				Independent t -test (p -value)
	14–16 years		17+ years		
	Mean	s.d.	Mean	s.d.	
Composite scores	68.27	21.12	62.92	14.47	0.753
General health	64.58	23.21	57.81	24.95	0.753
General vision	69.37	23.04	65.93	23.36	0.990
Ocular pain	64.06	27.16	59.37	18.78	0.112
Near activities	71.52	26.00	69.13	17.16	0.003*
Distance activities	71.87	23.54	68.22	17.64	0.021*
Social functions	71.35	22.56	73.82	20.90	0.392
Mental health	60.41	30.10	46.67	22.83	0.039
Role difficulties	67.70	31.25	51.14	21.91	0.031*
Dependency	65.96	29.89	49.99	28.63	0.703
Colour vision	73.33	29.32	80.46	18.77	0.034*
Peripheral vision	70.83	25.18	69.53	22.66	0.586

s.d., standard deviation.

*, indicates that the mean difference is significant at $\alpha = 5\%$.

TABLE 5: The mean and standard deviation (s.d.) of subscores of the items on the National Eye Institute Quality of Life Questionnaire-25 for participants with refractive error and visual impairment based on gender.

Scale name	Subscore				Independent t -test (p -value)
	Male		Female		
	Mean	s.d.	Mean	s.d.	
Composite scores	63.31	18.01	66.98	17.45	0.476
General health	55.55	26.25	65.51	21.56	0.311
General vision	66.48	24.01	68.27	22.57	0.651
Ocular pain	59.25	22.35	63.36	23.13	0.857
Near activities	68.67	22.63	71.55	20.10	0.381
Distance activities	70.05	20.58	69.54	20.32	0.931
Social functions	68.06	22.56	77.16	19.78	0.195
Mental health	50.92	26.27	54.09	27.71	0.815
Role difficulties	55.01	28.27	61.25	26.59	0.715
Dependency	53.39	30.42	60.05	29.74	0.545
Colour vision	79.63	20.84	75.34	26.62	0.621
Peripheral vision	69.44	26.25	70.69	21.20	0.148

TABLE 6: The mean and standard deviation (s.d.) of subscores of the items on the National Eye Institute Quality of Life Questionnaire-25 according to refractive status.

Scale name	Emmetropia		Myopia		Hyperopia		Astigmatism	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Composite scores	80.56	10.36	62.09	19.02	60.98	00.68	71.00	15.03
General health	59.43	26.50	57.57	23.78	75.00	0.00	63.75	26.25
General vision	76.12	17.85	64.24	24.53	80.00	00.00	70.75	21.78
Ocular pain	76.19	18.74	62.87	25.09	54.16	7.21	60.00	20.11
Near activities	83.41	12.57	65.02	23.15	74.99	22.04	77.91	15.36
Distance activities	86.30	12.21	66.41	20.88	66.66	8.33	75.83	19.66
Social function	88.05	13.30	68.18	21.89	75.00	12.50	80.00	20.43
Mental health	79.75	15.79	50.56	28.00	50.00	6.25	56.25	27.12
Role difficulties	79.33	19.08	57.98	30.27	41.66	14.43	61.15	23.37
Dependency	83.58	16.68	49.99	30.76	49.99	36.32	69.16	24.94
Colour vision	88.52	16.51	75.75	22.95	45.00	32.78	85.00	20.51
Peripheral vision	85.45	14.76	64.39	24.23	58.33	14.43	81.25	19.65

There was no significant difference observed in the composite scores when extrapolated according to age groups as per Table 4; however, significant differences were found for the subscores of near and distance activities, role difficulties and colour vision.

Neither the mean and standard deviation composite score or any of the subscores of the items on the VFQ-25 was influenced by gender as shown in Table 5.

When further analysed according to the refractive status, learners with myopia scored low in all the items of NEI-VFQ-25 as compared with those with hyperopia and astigmatism (Table 6).

Further analysis was conducted to determine if there were any correlations between the scorings for each of the subscales using Pearson's correlations. It was observed that all subscales were significantly correlated at a 95% confidence level ($p < 0.05$) with all other subscales excluding general health, which was correlated only with general vision, ocular pain, near activities, distance activities and dependence.

Discussion

This study was performed to understand the impact of URE and VI on the QoL amongst children in greater Sekhukhune, Limpopo, South Africa (SA). A total of 154 schoolchildren aged 14–18 years completed the NEI-VFQ-25 and underwent a vision assessment. The sample had an almost equal distribution of males and females, which is important considering the findings of other studies where the prevalence rate of RE differs according to the gender.^{30,31} A total of 56 learners (36.3% [95% CI: 28.8–44.0]) had URE, with 3 (1.9% [95% CI: 0.00–4.10]) also presenting with VI. This prevalence rate of 36.3% was closer to 36.9% found amongst Chinese children,⁵ but much higher than the 15% prevalence rates reported amongst South African children.¹² The difference might be related to the latter study being performed in a different location, which is KwaZulu-Natal province, whilst the current one was performed in the Limpopo province.

Myopia was the leading type of RE and was associated with older age and the male gender. Similar findings were found

amongst Nigerian children.⁶ In South Africa (Wajuhiian & Hansraj)¹² did not find any association between demographics (age and gender) and RE. The prevalence rate of 1.9% of VI was similar to the value of 1.8% found amongst Ethiopian children³² but lower than 2.74% in South Africa.³³

The NEI-VFQ-25 is a validated tool²³ that has been used to assess health domains, including mental and social well-being, and in particular self-ratings of functioning in specific vision-related tasks in many studies involving ocular pathology.^{34,35} This study has largely focussed on the functioning of schoolchildren with RE and VI. The first statement in the questionnaire required a rating of general health, and this study found almost identical ratings of general health by the schoolchildren irrespective of whether they had RE and VI. In addition, ratings of general health were found only to be correlated to 5 of the other 10 vision-targeted subscales. This could imply that schoolchildren do not perceive a direct influence of their general health on vision functioning. This corresponds to results found by Parrish et al.³⁵ after administering the NEI-VFQ on glaucoma patients, where general health scores were found to be the same for patients with glaucoma and those without.

For all vision-targeted subscales, statistically significant differences were observed in the rating scores of schoolchildren with RE and VI and those without, with the trend being a lower score obtained for the group with RE and VI. This implies that this grouping of schoolchildren perceived their visual functioning to be of lower quality compared with that of their counterparts. The tasks that schoolchildren are involved in is largely dependent on vision, this score means learners with RE or VI have difficulty with doing their schoolwork. Kumaran et al.²² further reported that most learners with URE admit that their academic performance is always average to low depending on the magnitude of their vision problems.

Whilst statistically significantly lower ratings for all vision targeted subscales were obtained from the schoolchildren with RE and VI, this difference must be interpreted with caution considering the relatively small number of subjects in this grouping. As per the NEI-VFQ-25 manual, for the sample size ($n = 56$) in this group, a difference of at least 20 points is required to indicate a difference in rating compared with the schoolchildren without RE and VI. This difference of 20 points or more was observed for the subscales of ocular pain, mental health symptoms, role limitations, dependency on others because of vision and colour vision.

Difficulty with distance vision may be experienced more than with tasks involving near vision in this group as most schoolchildren presented with myopia rather than hyperopia. Furthermore, because of good accommodative ability in this age group a reduction in near vision can be overcome with accommodation. Hsieh et al.²³ also found the same results after administering the same questionnaire on Taiwanese junior high school students.

The subscales of mental health symptoms, role limitations and dependency on others because of vision all relate to mental and social well-being and appear to be significantly affected as rated by the children with RE and VI in this study. Similar findings have been established by other studies.^{15,16} This may be related to this group of learners who are not at liberty to participate in most sports or games at school or home because of the poor vision. Moreover, it has been found that people with vision problems find it difficult to make friends.³⁴ Therefore, their social skills are negatively affected considering they spend most of their time alone, with subsequent psychological affects also reported.^{36,37} The results also show that learners with RE and VI scored relatively lower on mental health. This implies that this group of learners possibly experience tremendous frustration as a result of poor vision. Furthermore, studies have indicated that people with VI are often depressed, frustrated and anxious, because they are worried that their condition might get worse.^{34,38}

Learners with RE and VI are limited in performing duties they were supposed to perform reflected in the significantly lower rating score for dependency on others because of vision in this study. They probably often rely on others for help and unfortunately if they cannot get help on time, they are unable to complete the task. This can result in learners often being mistaken as those with difficulties or some form of dyslexia, if this vision problem is not solved early.²²

Concerning ocular pain, even though the rating scores of the learners with RE and VI were found to be statistically significantly different from the other group, the difference was not found to be more than 20 points, indicating a minimal difference in rating for this aspect. One may have expected those with RE and VI to report more discomfort; however, Kumaran et al.²² found that people with better functional vision experience more pain and discomfort than those with poor functional vision. This may be because of frequent rubbing of eyes in attempting to focus clearly, and this eye strain and discomfort were seen mostly in children with astigmatism.²²

Overall, this study supports the assertions that VI, either from RE or ocular pathology, has an impact on QoL as reflected in the global vision rating score. Pan et al.²⁴ used a HRQoL questionnaire on Chinese adolescents and found that those with reduced VA reported lower HRQoL scores in comparison to those with normal VA. Similar findings were reported by Elsmann et al.³⁹ who employed the low vision QoL questionnaire on young adults aged 18–25 years at a Dutch low vision rehabilitation centre, as well as by Parrish et al.³⁵ after administering NEI-VFQ amongst glaucoma patients attending a glaucoma clinic at the University of Miami. This is of particular concern as Frick et al.¹⁷ indicated that children with VI find it difficult to progress satisfactorily in life.

The findings of this study must be interpreted with caution as the number of schoolchildren who completed the NEI-VFQ-25 was relatively small ($N = 154$), only 47% of the total

sample of a larger study.⁴⁰ However, this was to ensure that the child was old enough to complete the questionnaire satisfactorily. Furthermore, only 56 (approximately 36%) of the 154 participants had RE and VI, and a study with a larger sample of children with RE and VI would be useful to corroborate the findings of this study. The NEI-VFQ-25 was not translated into the learners' indigenous language, which is Sepedi, which may have brought into question the validity of their responses; however, the research assistant who administered the questionnaire was proficient in both English and Sepedi. Although it is recommended that the NEI-VFQ-25 be translated into the 11 official languages for future use at South African schools. The strength of this study is that it is one of a few studies globally and possibly the only one in Africa that attempted to investigate the QoL amongst schoolchildren, a population who will carry any current RE and VI for many years in their lives. The validity of NEI-VFQ-25 in the paediatric population remains unclear because there appears to be no previous evaluation of this on RE and VI in this population.

Conclusion

Refractive error and VI have a significant impact on the QoL of learners in the greater Sekhukhune district, Limpopo, SA. This calls for greater attention from the government and all stakeholders responsible for eye care to devise strategies in order to address these conditions, particularly in this vulnerable group.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

T.S.S.M., R.H. and Z.N.Q.X.-K. conceptualised the project and designed methodology. T.S.S.M. collected data and drafted initial manuscript. R.H. and Z.N.Q.X.-K. supervised the project and reviewed drafts up to the final publication.

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Data availability

Derived data supporting the findings of this study are available from the corresponding author, T.S.S.M., on request.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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