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ORIGINAL ARTICLE

Prevalence of Refractive Error and Spectacle Coverage in Zoba Ma'ekel Eritrea: A Rapid Assessment of Refractive Error

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ABSTRACT

Purpose: To determine the prevalence of refractive error and spectacle coverage in Zoba Ma'ekel, Eritrea in order to assist in planning for refractive services and blindness prevention strategies.

Methods: A community-based cross-sectional study using multistage cluster sampling was conducted. A total of 3200 participants aged 15–50 years were enumerated and examined using the Rapid Assessment of Refractive Error (RARE) protocol.

Results: The response rate was 99.1%. The prevalence of refractive error was 6.4% (95% confidence interval [CI], 5.6–7.2%). Spectacle coverage for refractive error was 22.2% (95% CI 16.7–28.5%). It was higher among males than females (Fisher's exact test, $p = 0.028$), and highest in those who had completed secondary school (48.6%, 95% CI 31.9–65.6%) and those who resided in Asmara (Fisher's exact test, $p < 0.002$). The prevalence of presbyopia was 32.9% (95% CI 30.3–35.7%) with 94.9% correctable. Spectacle use for presbyopia was 9.9% (95% CI 7.2–13.4%), which was lowest in those with no formal schooling but highest in those who had completed secondary school (χ^2 test, $p < 0.001$) and those persons who resided in Asmara (Fisher's exact test, $p < 0.001$). Respondents expressed different barriers to uptake of services. A total of 128 subjects were aware of the problem but did not feel the need for consultation while 83 subjects stated they could not afford the cost of examination and spectacles.

Conclusion: The study provides helpful findings to assist with the development of appropriate refractive service planning in Zoba Ma'ekel. Uncorrected refractive error is of public health importance and prompt measures are needed to address the problem.

Keywords: Avoidable blindness, Eritrea, rapid assessment of refractive error, refractive error, spectacle coverage

INTRODUCTION

Uncorrected refractive error (URE) is the leading cause of visual impairment and a significant problem in most developed and developing countries.[1,2] This condition can be corrected by an eye examination and the provision of a pair of spectacles, contact lenses or refractive surgery.[3] The World Health Organization estimated that 153 million people are affected by visual impairment from treatable refractive error, excluding those who are presbyopic.[2] The need to deliver eye care services to overcome the problems of URE is obvious, as the interventions needed to treat refractive error can be cost-effective and can significantly improve a person's quality of life and economic opportunities.[4]

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Eritrea is a country on the north east coast of Africa, bordered by the Red Sea, Djibouti and Sudan with a total population of 3.6 million.[5] About 5000 cases of refractive error are reported in Eritrea annually.[6] Lack of access to spectacles is exacerbated as they are available only in private optical shops in urban areas.[6] In 2008, a rapid assessment of avoidable blindness (RAAB) study conducted in the population aged 50 years and older, found that 2.1% of a sample of 3163 people were blind due to URE.[7] While refractive error in Eritrea does not share the same prominence as cataract, few efforts have been undertaken to measure the prevalence of refractive error. As a result, intervention strategies cannot be justified, as there is little empirical evidence on which to base such efforts.

METHODS

Sampling

This study was a community-based cross-sectional study. The methodology was adopted from the rapid assessment of refractive error (RARE), which is a research methodology designed especially for gathering information on refractive error in a population.[8] The country is divided into six regions (zobas) and further subdivided into 50 subzones (subzobas).

The population of Zoba Ma'ekel, containing the capital, Asmara, was estimated to be 635,836.[9] Subjects were selected and gathered from the population aged 15–50 years old of Zoba Ma'ekel, using multistage cluster sampling.

Zoba Ma'ekel was divided into 'Asmara' (a total of 4 subzobas) and 'non-Asmara' (3 subzobas). These subzobas were further subdivided into smaller village administrative units (kebabi) and 17 kebabis were randomly selected and from these 25 villages (adi) were selected. Using systematic random sampling with probability to proportional to size, 40 clusters were allocated. The number of clusters allocated for each village was weighted according to the number of individuals in the village.

Since the prevalence of refractive error was unknown in Asmara, using literature reviews, the estimated prevalence was set at 5.5%. Assuming a binomial distribution of refractive error as a dichotomous variable, for a precision of 20% with a 95% confidence interval (CI), and allowing for a design effect of 1.75 and 10% non-responders, a sample size of 3200 was required.

Definitions

For the purpose of the study, URE was defined as presenting visual acuity (VA) <6/12 but could be corrected to >6/12 using pinhole. Presbyopia was defined as participants aged 35 years and older with binocular distance VA > 6/12, but binocular near VA < 6/12 at habitual working distance.

Spectacle coverage was calculated as: [met need/(met need + unmet need)] × 100%. "Met need" was defined as the number of subjects with spectacles having binocular unaided VA < 6/12, but improved to or were better than 6/12. "Unmet need" was defined as the number of subjects, without spectacles, whose near VA was <6/12, but improved to 6/12 or better with correction.

"Residing permanently at an address" implied staying in a household for at least the previous 6 months. "Non-Asmara" was a categorical variable which included Zobas Berik, Serejeqa and Gala Nefhi outside of Asmara.

Inclusion and Exclusion Criteria

All individuals between 15 and 50 years of age who had resided permanently at a particular address for at least the previous 6 months, were included. Individuals below the age of 15 and older than 50 years, visitors and people of any age not residing at the address concerned permanently for at least the previous 6 months, were excluded.

In the case of an unoccupied house, the enumerators checked with neighbors whether any eligible participants resided at the unoccupied house. If there were residents, enumerators returned to the house after making proper arrangements to revisit at a convenient time. If the inhabitants of the household were away after two return visits, that household was excluded.

Procedures

Field teams underwent three days of training to standardize activities on enumeration, clinical examination and recording of data. Inter-observer variability was conducted, to elicit a kappa value (level of agreement). A kappa value of 0.6 was considered acceptable. To identify operational challenges, a pilot study was conducted in a community which was not part of the larger study.

Clinical Examination

Monocular distance VA of participants was measured with a modified Snellen chart with tumbling "E" optotypes at 6 m under normal daylight illumination, both without and with (presenting vision) spectacles, if these were worn.

Respondents unable to see the 6/60 letter were then tested at 3 m and then 1 m. Participants were then

re-tested using a multiple pinhole occluder. Near vision was measured in all subjects over 35 years using a near Snellen chart with tumbling "E" optotypes at a standard 40 cm test distance. Respondents with near VA worse than 6/12 were reassessed with near addition lenses appropriate for their age. Those whose near vision improved to 6/12 or better, were provided with a pair of ready-made spectacles.

External ocular health was checked for any obvious pathology. Direct ophthalmology was performed in a darkened area to detect any retinal disease or pathologies. Participants were then referred to the nearest eye care facility for further investigation.

Ethical Considerations

Ethics clearance was obtained from the Ministry of Health and Ethics Committee of the Asmara College of Health Sciences. Written consent was sought from participants before examinations. All participants were given a unique study number to keep their identities anonymous and confidential. The research protocol adhered to the provisions of the Declaration of Helsinki governing research involving human subjects.

Data Management and Analyses

All data collected were captured daily onto a software program created especially for RARE methodology. A random sample of 10% of records was re-captured and analyzed for any inconsistencies. For categorical data, χ^2 and Fisher's exact test were used to analyze proportions. Multiple variable adjusted logistic regression on low vision and spectacle coverage for refractive error and presbyopia (odds ratio, OR, with 95% CI) for categories with $p < 0.25$ were determined. Age group, sex, education and occupation were used as explanatory variables for the initial model, and then followed by stepwise regression.

RESULTS

Basic Demographic Characteristics of Respondents

The response rate was 99.1% (3171). The median age of respondents was 30 years (inter-quartile range 20–40) with the highest proportion of persons being in the age cohort 35 years and above (37.7%), followed by those in the 15–19-year age group (24.1%). The lowest response rate was from those aged 25–29 years (11.4%). In terms of sex, more females (55.0%) than males were sampled, but the difference was parallel to the demographics of the larger population.[10] Some 37.7% of the examined sample population had not completed secondary school, while 20.5% had some form of secondary education or higher education. With respect to occupation, 31.4% of respondents were engaged in home duties, followed by 26.9% being students and 9.3% in the armed service (Table 1).

TABLE 1. Basic demography of participants, rapid assessment of avoidable blindness, Zoba Ma'ekel.

	Participants	
	n	%
Age group (years)		
15–19	763	24.1
20–24	455	14.3
25–29	362	11.4
30–34	394	12.4
35 and over	1197	37.7
Sex		
Male	1428	45.0
Female	1743	55.0
Spectacles use		
Yes	107	3.4
No	3064	96.6
Education		
No formal education	185	5.8
Primary school incomplete	505	15.9
Primary school complete	632	19.9
Secondary school incomplete	1196	37.7
Secondary school complete	649	20.5
Don't know	4	0.1
Occupation		
Professional	100	3.2
Teacher	76	2.4
Shopkeeper	38	1.2
Clerical	55	1.7
Laborer – construction work	60	1.9
Laborer – farm/agriculture	124	3.9
Home duties	996	31.4
Armed service	296	9.3
Student/trainee	852	26.9
Unemployed	264	8.3
Other	310	9.8
Total	3171	100.0

Refractive Error

The prevalence of refractive error was 6.4% (95% CI 5.6–7.2%). Differences in the proportion of people with refractive error were found to be statistically significant between the age groups ($\chi^2_{(4)} = 34.568$, $p < 0.001$). Some 56.7% of people with refractive error were 35 years and over, which was statistically significant ($\chi^2_{(1)} = 6.11$, $p = 0.013$). Figure 1 shows the number of people with refractive error in different age groups, stratified by sex. Statistically significant differences were also found in education ($\chi^2_{(5)} = 28.562$, $p < 0.001$). There were more people (30.5%) with refractive error from the incomplete secondary

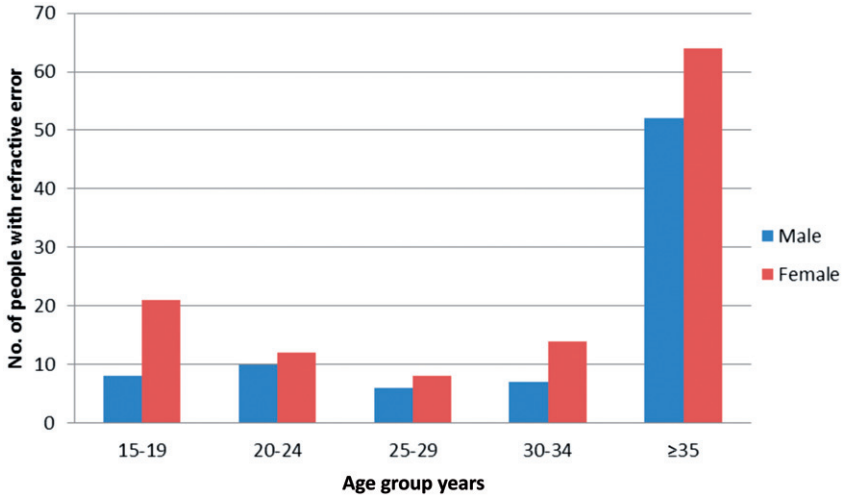

FIGURE 1. Refractive error by age group and sex.

TABLE 2. Spectacle coverage for refractive error.

	Refractive error			
	Met need, *n*	Unmet need, *n*	Total need, *n*	Spectacle coverage,% (95% CI)
Male	28	68	96	29.2 (20.3–39.3)
Female	17	90	107	15.9 (9.5–24.2)
Total	45	158	203	22.2 (16.7–28.5)

Met need, subjects with spectacles with binocular unaided visual acuity <6/12, which improved to 6/12 or better; Unmet need, subjects without spectacles with near visual acuity <6/12, which could be improved to 6/12 or better with correction; CI, confidence interval

TABLE 3. Spectacle coverage for presbyopia.

	Presbyopia			
	Met need, *n*	Unmet need, *n*	Total need, *n*	Spectacle coverage % (95% CI)
Male	12	119	131	9.2 (4.8–15.5)
Female	27	236	263	10.3 (6.9–14.6)
Total	39	355	394	9.9 (7.2–13.4)

Met need, subjects with spectacles with binocular unaided visual acuity <6/12, which improved to 6/12 or better; Unmet need, subjects without spectacles with near visual acuity <6/12, which could be improved to 6/12 or better with correction; CI, confidence interval

school category ($\chi^2_{(1)} = 4.75$, $p = 0.029$) compared to other education levels.

There were significant differences in the proportions of people with refractive error in different categories of occupations ($\chi^2_{(10)} = 19.893$, $p = 0.03$), the highest being home duties (31.0%) followed by students (21.2%), and the lowest being construction workers (0.5%).

After applying multivariable adjusted logistic regression, it was shown that those who were 35 years and over were 1.51 times (95% CI 1.67–3.77) more likely to have refractive error ($p < 0.001$; Table 4). In addition, the higher the education level, the less likely someone had refractive error ($p < 0.001$; Table 4).

Spectacle coverage was estimated at 22.2% (95% CI 16.7–28.5%). Spectacle coverage for males was 29.2% (95% CI 20.3–39.3%) and for females 15.9% (95%CI 9.5–24.2%; Table 2). Females were almost 2 times less likely to have had refractive error corrected (OR 0.46, 95% CI 0.23–0.91, $p = 0.025$; Table 2). The difference was found to be significant (Fisher's exact test, $p = 0.028$; Table 2). Excluding those who did not know their education level, the highest spectacle coverage was in those who had completed secondary school (48.6%, 95% CI 31.9–65.6%). In terms of locality, spectacle coverage was also significantly higher in Asmara (27.3%, 95% CI 20.4–35.2%) than in those from outside Asmara (8.9%, 95% CI 2.1–18.2%; Fisher's exact test, $p < 0.002$). Spectacle coverage showed borderline differences in different occupations ($\chi^2_{(10)} = 18.421$, $p = 0.048$). After applying multivariable adjusted logistic regression, differences between occupation and spectacle coverage became statistically insignificant ($p = 0.237$; Table 4).

Presbyopia

A total of 1197 people in the sample were aged 35 years and older. The prevalence of presbyopia was estimated to be 32.9% (95% CI 30.3–35.7%) with 433 subjects having VA <6/12 before correction, 94.9% of whom were correctable. There were more females (66.8%) than males (33.2%) with presbyopia, and this was found to be statistically significant (Fisher's exact test, $p = 0.023$).

TABLE 4. Odds ratios of explanatory variables with refractive error, spectacle coverage (for refractive error) and spectacle coverage (for presbyopia).

	Refractive error OR (95% CI)	Spectacle coverage (RE) OR (95% CI)	Spectacle coverage (presbyopia) OR (95% CI)
Age group (years)			
15–19	1	1	
20–24	1.43 (0.84–2.44)	0.59 (0.25–1.37)	Not applicable
25–29	0.95 (0.50–1.81)	0.65 (0.26–1.62)	
30–34	1.07 (0.58–1.95)	0.95 (0.35–2.58)	
35 and over	2.51 (1.67–3.77)	0.23 (0.12–0.44)	
Sex			
Male	1	1	1
Female	1.10 (0.83–1.47)	0.46 (0.23–0.91)	1.14 (0.56-2.32)
Education			
No formal education	1	1	1
Primary school incomplete	0.75 (0.43–1.29)	4.70 (0.48–46.12)	3E + 009
Primary school complete	0.49 (0.28–0.85)	11.06 (1.12–108.97)	3E + 009
Secondary school incomplete	0.43 (0.25–0.72)	12.06 (1.19–121.96)	3E + 008
Secondary school complete	0.47 (0.27–0.83)	12.97 (1.55–155.52)	2E + 009
Occupation			
Professional	1	1	1
Teacher	0.78 (0.18–3.37)	3.00 (0.15–59.89)	0.35 (0.05–2.55)
Shopkeeper	0.51 (0.06–4.54)	0	2E + 008
Clerical	0.72 (0.13–3.82)	1.5 (0.06–40.63)	0.07 (0.01–0.45)
Construction work	0.32 (0.04–2.83)	2E + 009	2E + 008
Farm/agriculture	1.85 (0.62–5.51)	15.00 (0.98–228.89)	2E + 008
Home duties	1.28 (0.50–3.27)	14.25 (1.97–102.91)	1.67 (0.44–6.33)
Armed service	2.14 (0.81–5.68)	4.93 (0.68–35.67)	0.44 (0.10–1.97)
Student/trainee	1.01 (0.39–2.61)	3.88 (0.57–26.15)	2E + 008
Unemployed	2.00 (0.74–5.34)	3.19 (0.44–23.01)	3.35 (0.33–34.20)
Others	1.24 (0.45–3.41)	4.20 (0.54–32.96)	0.53 (0.13–2.10)
Locality			
Asmara	1	1	1
Not Asmara	0.92 (0.66–1.27)	4.61 (1.56–13.58)	3E + 008

OR, odds ratio; CI, confidence interval; RE, refractive error.

Spectacle coverage for presbyopia was estimated to be 9.9% (95% CI 7.2–13.4%); 9.2% (95% CI 4.8–15.5%) for males and 10.3% (95% CI 6.9–14.6%) for females, without significant statistical difference (Fisher's exact test, $p = 0.858$; Table 3).

Spectacle coverage was lowest among subjects who had not received any formal schooling (0%, 95% CI 0–5.4%) and highest in subjects who had not completed secondary school (21.2%, 95% CI 11.4–33.9%; $p = 0.007$). In regards to occupations and spectacle coverage, there was also a significant difference ($\chi^2_{(10)} = 43.836$, $p < 0.001$), whereby those with clerical jobs were 0.07 times (95% CI 0.01–0.45) less likely to have their presbyopia corrected ($p = 0.009$; Table 4). Furthermore, spectacle coverage was significantly higher in those who were living in Asmara (15.1%, 95% CI 11.0–20.1%) than those from elsewhere (Fisher's exact test, $p < 0.001$).

Spectacle Use

In the sample, 107 (3.37%) people currently wore spectacles, of whom 58 (54.2%) used single vision distance spectacles, 46 (43%) wore single vision near spectacles, and 3 (2.8%) used bifocals. Differences were statistically significant based on where the community accessed dispensing services ($\chi^2_{(4)} = 39.673$, $p < 0.001$). A total of 72% of current spectacles users sought dispensing services from private opticians, followed by hospitals (14%) and from abroad (9.3%).

Barriers

One of the objectives of the study was to identify the reasons people with refractive error or presbyopia, despite the availability of services, did not wear spectacles. Figure 2 depicts the different barriers identified during the research. The highest number of people (128) responded that they were aware of the problem but did not feel the need for consultation. This was followed by 83 people expressing concern that the costs of spectacles were too high. There were 64 subjects who were unaware of the problem and 60 people felt that the services were too far away and the perceived cost of examination was more than they could afford.

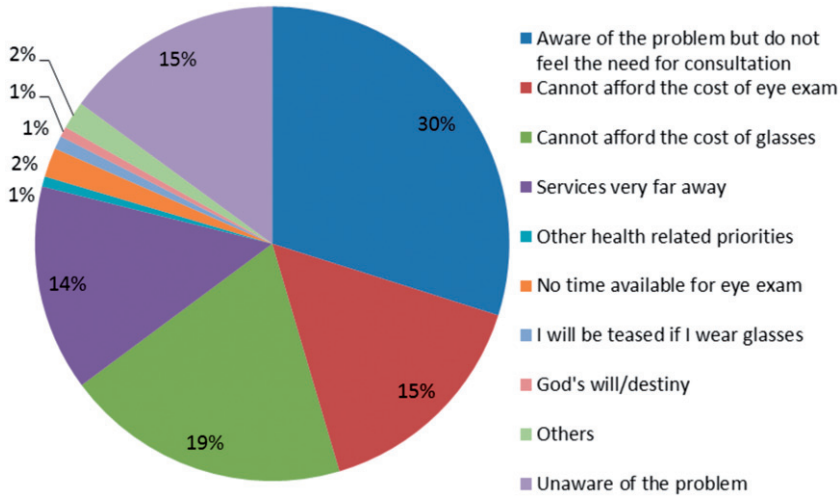

FIGURE 2. Barriers to uptake of services.

DISCUSSION

Eye care services are currently provided within the comprehensive integrated eye care delivery system of Eritrea. The National Plan for Prevention of Blindness targets disease-specific control, human resources and infrastructure development.[10]

In this study, people aged 15–50 years old were targeted because individuals in this age category could be considered academically and economically active, and reliant on good vision for execution of their daily tasks. Furthermore, a RAAB was carried out in 2007 for the population 50 years and older in Eritrea, thus, repetition of a survey for this age group was avoided.

The prevalence of refractive error was 6.4% (95% CI 5.6–7.2%). Extrapolated to the population aged 15–50 years in Zoba Ma'ekel, the number of people with refractive error ranges from 17,030 to 21,895. This suggests that there is an urgent need to attend to the problem of URE which can greatly hinder a person's ability to carry out daily activities effectively.[3] In Uganda and Tanzania, similar RARE studies in people over the age of 15 years, found a refractive error prevalence of 8.6% (95% CI 7.7–9.6%; N Nsubuga, personal communication, 2011) and 10.4% (95% CI 9.4–11.4%; E Mashayo, personal communication, 2010), respectively.

Refractive error was found to be higher in those 35 years and over (56.7%) with 30% of respondents from outside Asmara stating that they were aware of the problem but did not feel the need for consultation. These findings are similar to Marmamula, in rural South India, where a lack of "felt need" was found to be the main barrier to uncorrected presbyopia in a similar RARE study.[11]

Palagyi, in a rapid assessment of cataract surgical services in people over the age of 40 years, cited that respondents were "feeling there was no need" to seek treatment of a reported vision or eye problem.[12] Health promotion activities regarding health-seeking behavior for refractive services and appropriate interventions targeting these activities should be investigated.

The low uptake of refractive services was reflected in the low spectacle coverage for refractive error (22%, 95% CI 16.7–28.5%). In Andhra Pradesh, it was reported that spectacle coverage was 29%,[11] and a similar finding (25.2%) was reported in a Bangladesh study that included people over 30 years old.[13] Currently, refractive services in Eritrea are provided in limited eye care facilities where ophthalmologists, optometric technicians or refractionists are present. Like many developing countries, Eritrea has a limited number of eye care personnel. Refractive services are provided in well-populated areas or where eye health centers are situated. This suggests that efforts should be made to provide better access, availability and affordability of refractive services in Zoba Ma'ekel and underserved areas. This is also the case in many African and Asian countries.[14]

People in Asmara (urban) were also more likely to have their refractive error corrected (27.3%, 95% CI 2.1–18.2%) as they were nearer to eye care facilities and to private opticians, who are the main dispensing service providers. In Eritrea, eyes need to be examined in a governmental eye facility before spectacles can be dispensed from private opticians, as there are no in-house dispensing services in the eye care facilities. Private opticians are mostly located in Asmara.

The prevalence of presbyopia was 32.9% (95% CI 30.3–35.7%). Higher prevalences of presbyopia were reported from Andhra Pradesh[8] (63.7%), rural Tanzania[15] (61.7%) and Zanzibar[16] (89.2%). However, spectacle coverage for presbyopia was only 9.9% (95% CI 7.2–13.4%) in Ma'ekel; this can be explained by low awareness of the condition, and high cost of spectacles, that resulted in an unfelt need for correction of presbyopia. In Kenya, spectacle coverage for

presbyopia was found to be 6.3%, in a study in people over the age of 50 years, with cost as the main barrier to spectacle use.[17]

Most (95%) uncorrected presbyopic participants could be assisted with near correction. In Zanzibar, spectacle coverage was higher (17.6%) and the stated reason for not owning a pair of near reading spectacles was that it was not a priority.[16] It is worth noting that those who resided outside of Asmara had 0% (95% CI 0–2.7%) spectacle coverage. This could be attributed to lack or inaccessibility of services. Those who had not received any formal schooling had only 0–5.4% spectacle coverage. This suggests that this group of people is less sensitized to eye health and their near visual requirement could also be lower.

Both males and females showed similar spectacle coverage for presbyopia. Presbyopia affects near vision and most people older than 35 years engage in near work, irrespective of sex. The difficulties in performing near tasks may have encouraged both sexes to seek near correction.

Due to the definition of refractive error as those who had vision <6/12 which can be corrected to better than 6/12 with pinhole, people with small refractive errors and hyperopia might have been missed. However, an assumption was made that people with vision better than 6/12 face minimal difficulties in their daily chores, and hence eye care services may not be a priority for them.

Regarding presbyopia, the cut-off was set at binocular uncorrected near vision worse than 6/12 and with correction to 6/12 or better with near reading addition. The prevalence of a functional near vision problem in Ma'ekel may have been underestimated, as most daily chores there (especially those of females engaged in home duties) require vision better than 6/12. These chores include sorting stones from grains and sewing.

The number of males aged 30–40 years was disproportionately distributed, which might have also influenced the results of the present study. This may be due to the fact that many of them were involved in national military service and thus might have been under-represented.

The RARE provided helpful findings to mount appropriate refractive services in Zoba Ma'ekel. It also provided baseline information for monitoring and evaluating future eye care intervention strategies. URE is of public health importance and immediate measures are needed to overcome the problem.

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DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

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