

# Original Article

## Functional presbyopia in a rural Kenyan population: the unmet presbyopic need

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### ABSTRACT

**Background:** Presbyopia is the most common reason for requiring spectacles in low-income regions, although the unmet need for presbyopic spectacles in these regions is very high. The aim of this study was to estimate the prevalence of presbyopia, and the functional impairment and spectacle use among persons with presbyopia in a rural Kenyan population.

**Methods:** A cross-sectional study was carried out in the Rift Valley, Kenya. Clusters were selected through probability-proportionate to size sampling, and people aged  $\geq 50$  years within the clusters were identified through compact segment sampling. Within the context of this survey, 130 eligible participants were selected for interview and underwent near-vision testing. Functional presbyopia was defined as requiring at least +1.00 dioptre in order to read the N8 optotype at a distance of 40 cm in the participant's usual visual state. Participants were corrected to the nearest 0.25 dioptre in order to see N8. Unmet and met presbyopic need, and presbyopic correction coverage were calculated.

**Results:** Functional presbyopia was found in 111 participants (85.4%). Mean age was lower in those with presbyopia (64.1 years vs. 71.5 years,  $P=0.004$ ). Increasing degree of addition required to see N8 was significantly associated with increased difficulty with reading ( $P=0.04$ ), sewing ( $P=0.03$ ), recognizing small objects ( $P=0.02$ ) and harvesting grains ( $P=0.05$ ). Among participants with functional presbyopia, 5.4% wore reading glasses and 25.2% had prior contact with an eye care professional. The unmet presbyopic need was

80.0%, met presbyopic need was 5.4% and presbyopic correction coverage was 6.3%. Cost was cited as the main barrier to spectacle use in 62% of participants with presbyopia.

**Conclusion:** In low-income regions, there is a high prevalence of uncorrected presbyopia, which is associated with near-vision functional impairment. Provision of spectacles for near vision remains a priority in low-income regions.

**Key words:** Kenya, presbyopia, prevalence, rural, spectacle, Sub-Saharan Africa.

### INTRODUCTION

Presbyopia is the age-related loss of accommodation and is associated with difficulty with near vision.<sup>1</sup> In rural areas of low-income regions, presbyopia is a major cause of non-blinding visual impairment.<sup>2–4</sup> Yet, presbyopia is not targeted as a priority cause of visual impairment in the World Health Organization VISION 2020 'The Right to Sight' initiative, although refractive error is included.<sup>5</sup> Classically, presbyopia manifests with reading difficulties. However, recent population-based studies have demonstrated that even in areas of low-literacy presbyopia may exert a considerable impact on near-vision-associated functional impairment<sup>6</sup> and quality of life.<sup>7</sup> Such deficits may lead to loss of occupational productivity and psychological morbidity, acting as a further barrier to development.

Simple spectacles with a plus dioptre lens can fully correct presbyopia. The shift towards cataract surgery with intraocular lenses has led to a decrease in the requirement of aphakic spectacles in low-income regions.<sup>8</sup> Hence, the correction of

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presbyopia is the most common reason for requiring spectacles in low-income regions.<sup>9</sup> In order to quantify the burden of presbyopia on a population level, the unmet need for those with uncorrected or undercorrected presbyopia should be estimated.<sup>10</sup> This quantification of the requirement for near-vision correction will assist in the planning of subsequent intervention programmes.

The aim of this study was to estimate the prevalence of presbyopia, and the functional impairment and spectacle use among persons with presbyopia in a rural Kenyan population.

## METHODS

### Sample selection

This study was nested within the Nakuru District Blindness Study. Nakuru District is located north of the Kenyan capital Nairobi, and the predominantly rural population is strongly reliant on agriculture for economic and occupational means.

The Nakuru District Blindness Study selected clusters of people aged  $\geq 50$  years through probability proportionate to size, and individuals were selected within clusters through compact segment sampling. Participants from five rural clusters were included in the presbyopia study. Exclusion criteria for the presbyopia component of the study included being  $< 50$  years old and having a best corrected visual acuity of  $< 3/60$  in the better eye.

### Interview protocol

Two trained study personnel conducted the interviews for the presbyopia arm of the study. The interviewers for the presbyopia component were trained together for 1 week. To ensure agreement between interviewers, interviewers were closely supervised and monitored throughout the study and high inter-interviewer agreement was demonstrated before commencing. The interviews were conducted in English, Swahili or Kikuyu, as appropriate, and the answers were recorded in English on a separate form.

The presbyopia instrument was developed as a separate questionnaire to the primary questionnaire in the Rift Valley Blindness Study, and had not been used previously in clinical research. It was modelled on a questionnaire that was used in another rural African population,<sup>7</sup> and the Visual Function Questionnaire.<sup>11</sup> Questions included the impact of near vision on various activities, problems with near vision, spectacle use and prior experience with eye care professionals. Activities covered in the interview included writing, recognizing small objects, cooking, farming (harvesting of grains), reading, sewing (threading a needle), dialling a telephone and getting dressed. Participants were first asked if they regularly conducted the particular activity. If the answer was 'yes', participants were then asked to rate their difficulty that they experienced for their near-vision performance for each activity and these were recorded as (i) no difficulty, (ii) mild

difficulty, (iii) moderate difficulty, (iv) severe difficulty and (v) do not undertake the task (not applicable). Participants were instructed that this was a linear increase in severity, and other factors that did not relate to their near vision (e.g. mobility, distance vision) were not relevant for this question.

Questions about spectacle use included whether patients were presently using spectacles and the corresponding indication, the location at which the spectacles were purchased and if they wanted to own spectacles. Barriers to spectacle use were recorded as either cost, availability, cosmetic reasons or no felt need for spectacles. Participants were also asked about previous exposure to an eye care professional (ophthalmologist, ophthalmic clinic officer, ophthalmic nurse).

### Clinical examination

Near visual acuity was assessed by one examiner using a near-vision chart in English and locally spoken languages. Functional presbyopia was defined as requiring at least +1.00 dioptre in order to read the N8 optotype at a distance of 40 cm, in the participant's usual visual state.<sup>7</sup> If participants brought spectacles for near vision to the examination, they were tested both with and without near-vision correction. Among people with presbyopia, participants were corrected to the nearest 0.25 dioptre in order to see N8. The level of additional dioptre required in order to see N8 was categorized into three groups: no additional dioptre required, +1.00 to 1.75 D required and equal to or greater than +2.0 D required. Every participant in the Rift Valley Blindness Study was provided with a free pair of spectacles if they were presbyopic and indicated that they would like to own spectacles. These spectacles were made in India and cost price was between US\$1 and US\$2 per pair.

Visual acuity was measured using a tumbling 'E' chart at a distance of 6 m. Mean spherical equivalent was measured with an autorefractor. An ophthalmologist saw all patients for a comprehensive ophthalmic examination as part of the Nakuru District Blindness Study, including slit lamp biomicroscopy with gonioscopy, posterior segment photography and anterior segment ocular coherence tomography.

### Definitions

**Unmet or under-corrected presbyopic need (UPN):** Number unable to see N8 binocularly, with near-vision correction if used. If participants forgot to bring their spectacles for near-vision correction, they were included because we could not assume that the spectacles provided adequate near-vision correction.

$UPN \text{ in the sample } (\%) = 100 \times (\text{Number unable to see N8 binocularly, with near-vision correction if used}) / \text{Total sample population}$

**Met presbyopic need (MPN):** Measure of the distribution of spectacles for near vision in order to correct those with presbyopia to N8 or better binocularly.

MPN in the sample (%) =  $100 \times (\text{Number who see N8 or better binocularly with own near-vision spectacles}) / \text{Total sample population}$

**Presbyopic correction coverage (PCC):** Measure of presbyopia requiring correction with spectacles in order to see N8 or better binocularly.

$PCC (\%) = 100 \times MPN / (MPN + UPN)$

### Statistical analysis

Baseline characteristics including age, gender, reading and writing capability of participants with and without presbyopia were compared using chi-squared tests or an independent sample *t*-test based on the data types. One-way ANOVA and chi-squared techniques were used to compare the additional dioptre required by presbyopic participants by age groups and the linear term options were used to show the *P*-value for trend. A chi-squared test was performed to compare the participants based on difficulties with different activities and their corresponding power of the correction. Likelihood test for trend option was also used to show the trend on the additional required dioptre group. All analyses were performed in SPSS version 12.0.01 (SPSS Inc, Chicago, IL, USA) and the results were reported significant for  $P < 0.05$ .

### Ethical approval

Ethical clearance was obtained before the commencement of the study from the London School of Hygiene and Tropical Medicine and Kenya Medical Research Institute. The

research was conducted in accordance with the Declaration of Helsinki and subsequent revisions. The procedure for interview and examination was explained to the subjects before commencing, and all participants gave written informed consent. Participants requiring further treatment or testing were referred to the Eye Unit at Rift Valley Provincial General Hospital.

## RESULTS

### Sampling

Of the 144 people enumerated, 134 agreed to participate (93.1%). Of those not examined, six refused and four were unable to attend. Furthermore, four were excluded from the analysis because they did not see at least 3/60 distance vision (with distance correction) in either eye. The remaining 130 were included as part of the presbyopia study.

### Functional presbyopia

The mean age of participants was  $65.2 \pm 10.3$  years (median 62.0; range 50–87). The overall prevalence of functional presbyopia was 85.4% (Table 1). The mean prevalence was higher among women than men (87.0% vs. 83.0%,  $P = 0.06$ ). People with functional presbyopia were somewhat more likely to be able to read and write. Those with functional presbyopia were significantly younger (64.1 years) than those without (71.5 years,  $P = 0.004$ ) (Table 2). With increasing age, the prevalence of functional presbyopia significantly decreased ( $P = 0.02$ ), ranging from 93.3% among 50–59-year-olds to 72.2% in those aged 80 years or more

**Table 1.** Prevalence of functional presbyopia and additional required dioptre by age group of 111 participants with functional presbyopia

Age (years)	Functional presbyopia ( <i>n</i> = 111)	Prevalence (%)	Addition required to read N8	
			Mean <sup>†</sup>	SD
50–59	42	93.3	1.65	0.38
60–69	33	86.8	1.64	0.42
70–79	23	79.3	1.97	0.55
≥80	13	72.2	1.98	0.58
Total	111	85.4	1.77	0.46
<i>P</i> for trend		0.02		0.06

<sup>†</sup>Refers to mean dioptre required for addition among presbyopes only. SD, standard deviation.

**Table 2.** Demographic characteristics of 130 study participants

Characteristic	Functional presbyopia ( <i>n</i> = 111)	No functional presbyopia ( <i>n</i> = 19)	<i>P</i> *
Age (years)	64.1	71.5	0.004
Male gender (%)	39.6	47.4	0.53
Can read (%)	63.1	42.1	0.09
Can write (%)	54.1	35.8	0.07

\**P*-value based on independent sample *t*-test (for quantitative data) and chi-squared test (for categorical data).

(Table 1). In contrast, the addition required to read N8 increased with increasing age. Among people with functional presbyopia, 28 (25.2%) had had prior contact with an eye care professional.

### Functional impairment

Increasing degree of addition required to see N8 was significantly associated with increased difficulty with reading ( $P = 0.04$ ), sewing ( $P = 0.03$ ), harvesting grains ( $P = 0.05$ ), and recognizing small objects ( $P = 0.02$ ), following adjustment for age (Table 3).

Of persons with functional presbyopia, 88.3% had (mild, moderate or severe) difficulty with reading, 74.8% with near vision, 73.7% with sewing, 72.3% with writing, 66.4% with harvesting grains and 65.7% with dialling a telephone. The task incurring the greatest vision-related difficulty amongst presbyopes was sewing, with which 51.6% of presbyopes reported moderate-severe difficulty (Fig. 1). Females were more likely to sew than males (91.3% to 75.6%,  $P < 0.001$ ).

### Spectacle use

Seven (43.8%) participants had spectacles present at the time of examination, seven (43.8%) had discontinued spectacle usage and two (12.5%) had forgotten to bring them to the examination. Sixteen of the participants wore spectacles, of which seven (43.8%) were for near-vision correction and two (12.5%) were bifocals (distance and near). Two participants (22.2%) could still not see N8 with the addition of their regular near-vision correction spectacles. The remaining seven pairs (43.8%) were for distance correction. No participant owned more than one pair of glasses.

In terms of the origin of the spectacles, six pairs (37.8%) came from a hospital eye unit, four pairs (25.0%) from a local health care centre, three (18.8%) were purchased from a second-hand shop, and two (12.5%) were purchased from another shop. The mean time that a participant had owned their glasses was 4.7 years, with the longest duration 10 years. Of those wearing spectacles, four (25.0%) attended an eye care professional on a regular basis.

The principal barrier to spectacle use among persons with functional presbyopia was high cost accounting for 62.2% (Fig. 2). Excluding the seven persons with near-vision spectacles, 26 (25.0%) indicated that they did not want spectacles for near vision.

The UPN, MPN and PCC were calculated. The UPN was 80.0%, MPN 5.4% and PCC 6.3%.

### DISCUSSION

We found a very high prevalence of functional presbyopia in this rural population. This prevalence significantly decreased with increasing age. Increasing age was associated with increasing degree of addition required to see N8. Mean age was lower in those with presbyopia (64.1 years vs. 71.5 years,

Table 3. Difficulty with activities according to degree of functional presbyopia

Activity	Respondents		Difficulty with activity		Degree of addition (+D) required for near vision						P*	
	n <sup>†</sup>	%	n <sup>‡</sup>	%	0		1.0–1.75		≥2.0			
					Respondents	Difficulty with activity	Respondents	Difficulty with activity	Respondents	Difficulty with activity		
Harvesting grains	125	72.0	18	10	55.6	72	53	73.6	27	35	77.1	0.05
Reading	82	86.6	5	3	60.0	68	59	86.8	9	9	100.0	0.04
Telephone	73	63.0	6	2	33.3	51	34	66.7	10	16	62.5	0.13
Writing	68	70.6	3	1	33.3	47	32	68.1	15	18	83.3	0.14
Cooking	116	38.8	16	6	37.5	69	28	40.6	11	31	35.5	0.66
Sewing	111	72.1	16	10	62.5	67	47	70.1	23	28	82.1	0.03
Dressing	126	43.7	17	9	52.9	74	29	39.2	17	35	48.6	0.91
Recognizing small objects	125	64.0	15	7	46.7	75	50	66.7	23	35	65.7	0.02

\*Age-adjusted P-value. †Number undertaking the activity and responding to the question. ‡n is based on the number responding to the question and with difficulty (mild, moderate or severe) with the activity.

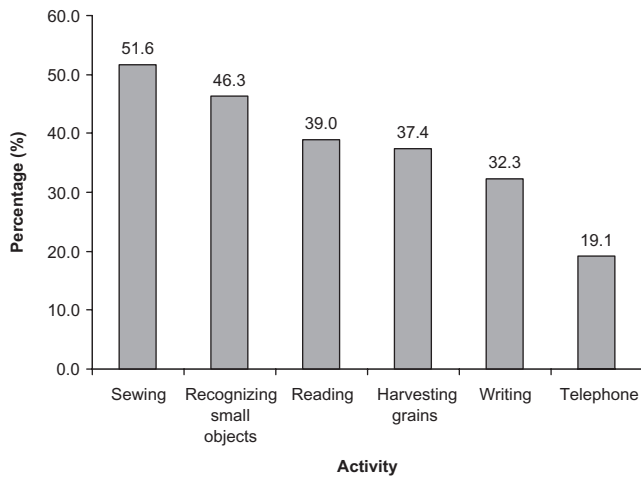


Figure 1. Moderate–Severe difficulty with activities among persons with functional presbyopia.

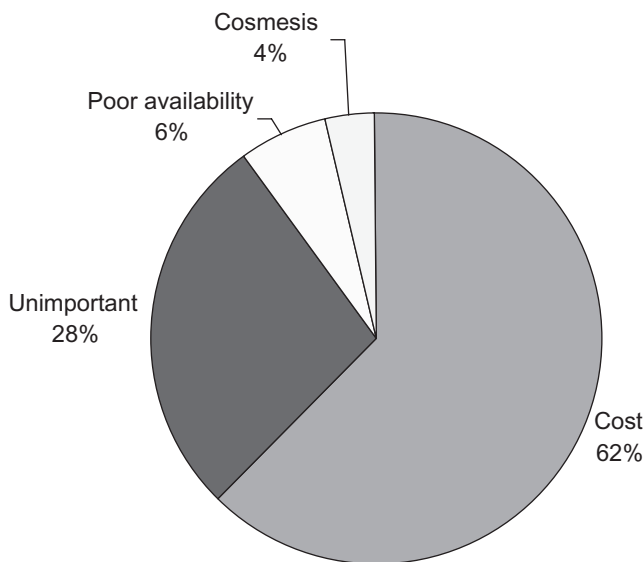


Figure 2. Principle barrier to spectacle use among persons with functional presbyopia (n = 111).

$P = 0.004$ ). Increasing degree of addition required to see N8 was significantly associated with increased difficulty with reading, sewing, recognizing small objects and harvesting grains. The UPN was very high, as 80% of people who needed presbyopic glasses did not have them, and cost was the major barrier to spectacle use.

The decreasing prevalence of presbyopia with age was also shown in Andhra Pradesh.<sup>6</sup> This reduction is most likely due to an age-related increase in nuclear sclerosis of the lens, with or without cataract, and associated myopia. In Nakuru district, cataract is the major cause of blindness and visual impairment, even though the cataract surgical coverage is high.<sup>12</sup> In the absence of ocular pathology, it is widely accepted that all persons will eventually become presbyopic. However, an investigation of lens pathology

and refractive error in our sample is beyond the scope of this paper.

This study took place in a rural population in Nakuru District where most of the sample population were involved in agricultural practices, and a high percentage of subsistence farming exists. By not investigating persons with objective presbyopia (those who are presbyopic only after distance correction), we wanted to evaluate near-vision-associated functional impairment impact in a participant’s usual environment. Patel *et al.* only used functional presbyopia to assess presbyopia-associated quality of life.<sup>7</sup> We have shown that increased severity of presbyopia is significantly associated with increasing impairment in the common agricultural activity, harvesting grains. Hence, our results demonstrate that presbyopia is associated with functional impairment even in areas of low literacy, rural regions. There are many tasks that are common to a subsistence farmer in addition to harvesting grains, such as weeding and planting seeds, and it is likely that near-vision impairment impacts on one’s ability to undertake these tasks to varying degrees. Older farmers may be less productive than younger counterparts because of uncorrected near-vision problems, and this may have wider implications for the community at large depending on the distribution of farming tasks among family members. Ramke *et al.* found an increased probability of having uncorrected presbyopia if residing in a rural domicile, being a subsistence farmer and being illiterate.<sup>10</sup> Residing in a rural setting may result in poorer access to spectacles and health-care services. Persons who are unable to read or write may be less able to communicate their symptoms, which may delay the diagnosis and consequent management of presbyopia. Increasing degree of addition required to see N8 was also significantly associated with increased near-vision-associated functional impairment in reading and recognition of small objects.

We found a higher prevalence of functional presbyopia among females. Although this was not statistically significant, this finding is consistent with other research that has shown that females require a greater degree of addition for presbyopia correction than age-matched males.<sup>13</sup> In another African population, female gender was associated with an increased prevalence of presbyopia in addition to an increased severity of presbyopia.<sup>2</sup> Female gender is also associated with decreased spectacle coverage.<sup>14</sup> In providing subsequent intervention programmes to assist with the management of presbyopia, it may be advantageous to target this risk factor. In this population, many women are involved in sewing not only to clothe their family, but also to generate income for the family. The importance of being able to sew is also of special worth in regions where mechanical sewing machines are less widely used.

We found a very high UPN. This was higher than a previous report from Timor-Leste where an UPN of 32.3% was recorded.<sup>10</sup> However, just because an individual is uncorrected or undercorrected for presbyopia, it should not automatically qualify them to be in ‘presbyopic need’. In this sense, it is important to realize that that is a physiological need in contrast to a physiological desire for spectacles. More than

25% of those with functional presbyopia did not want spectacles, yet they were included in the estimates for unmet need. If they are excluded, the UPN is reduced to 60%. Furthermore, if persons who normally wear spectacles for near vision forgot to bring them to the examination, we assumed that they were classified as being in presbyopic need if unable to read N8, which would overestimate the UPN if their spectacles provided adequate near-vision correction. There may be several reasons for not wanting spectacles, such as cultural reasons, and not thinking that their condition is important. Moreover, those with a greater degree of functional impairment may be more inclined to want to wear vision-correcting spectacles. Improved economic productivity as well as improvements in other activities and tasks, may result from the management of presbyopia. In low-income regions, these factors constitute an avertable hurdle to development. When presbyopia is corrected, it is associated with an increased scores vision-targeted quality of life.<sup>15</sup> Follow up of individuals following their receipt of free spectacles for near vision in of our study is required to evaluate any ensuing increase in vision-related quality of life and/or functionality.

In many areas of Sub-Saharan Africa, a service capable of diagnosing and correcting refractive error and presbyopia is lacking, and there are great challenges to improving the situation. The high prevalence of presbyopia and high unmet need for presbyopic glasses show that there is a need for widespread efforts to ensure that suitable near-vision spectacles are provided to those in need and who want them. In order to adequately supply those in need of spectacles, it is important to screen and test specific groups of individuals, such as older persons acquiring suitable and affordable spectacles, and dispense them to those in need.<sup>16</sup> In addition to finding previously undiscovered cases of presbyopia, regular testing would ensure that persons with presbyopia were not under corrected despite owning spectacles for near vision. Targeted training of auxiliary ophthalmic personnel in low-income regions is required to diagnose and correct presbyopia and refractive error, freeing the ophthalmologist to concentrate on more complex cases. In Nakuru District, these workers encompass refractionists, ophthalmic nurses and cataract surgeons. For the year 2010, the World Health Organization has established a target of one refractionist per 100 000 individuals in Sub-Saharan Africa,<sup>17</sup> but there is still a long way to go before this aim is achieved. Education also plays an important role in the management of presbyopia, informing people that presbyopia is a condition of ageing, and simple and effective management is available. It may also be of advantage to increase awareness in the community about the benefits of correcting refractive error and presbyopia,<sup>18</sup> and this may increase uptake of presbyopic spectacles. We found that approximately one-quarter of persons with presbyopia did not consider their condition to be important. Yet, this statistic encompassed all grades of presbyopia, and it is likely that this was seen especially in the less severe cases.

In a similar rural African population, it was reported that 94% of those with presbyopia aged  $\geq 40$  years did not own spectacles.<sup>7</sup> This statistic was mirrored in our study, and half

of the subjects cited cost as the main barrier. However, other studies have not found economic reasons to be the strongest barrier to spectacle use.<sup>6,19</sup> Our results may reflect a higher purchasing cost of purchasing spectacles in Sub-Saharan Africa, as well as poorer access to spectacles especially in rural regions.

There are some solutions, which are making the management of presbyopia more viable in low-income, rural regions. Low-cost spectacles, costing as little as US\$1, are now being produced in countries including India and China, which may limit the financial burden among those requiring them. We did not assess the willingness of participants with presbyopia to pay for spectacles. In Timor Leste, half the population were willing to pay US\$1 for spectacles and reduced to less than 20% for spectacles costing US\$3.<sup>10</sup> It is difficult to compare the socioeconomic status between the two countries, but based on these findings it would appear that in low-income regions payment for cheap spectacles at cost price (e.g. US\$1) would increase access to glasses among persons with presbyopia in Nakuru District. Further evaluation of cost and need is required to ensure that an ongoing supply of affordable spectacles is available in rural and low-income regions. Some non-governmental organizations collect used spectacles for use in low-income regions. Despite some advantages in this approach, the reliance on recycled spectacles alone are unsatisfactory in managing refractive error and presbyopia in low-income regions.<sup>19</sup> Off-the-shelf spectacles may also be a suitable approach to address the unmet need of presbyopes or those with refractive error, and could be provided by paramedical staff with training in subjective refraction and dispensing.<sup>14</sup>

There were several limitations in our study. Our sample size was considerably smaller than other published studies and may reduce the precision of our estimates. Furthermore, we did not use a validated instrument to assess functional impairment in our population.

The PCC is very low in our rural African population. Because the burden of presbyopia in low-income regions is starting to become elucidated, the issue now lies with ensuring that those who require and desire spectacles receive them in order to reduce the unmet need.

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