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Change in function and spectacle-use 2 months after providing presbyopic spectacles in rural Tanzania

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Abstract

Aims—To examine near vision spectacle retention and use, and changes in self-reported and performance-based near vision, 2 months after the provision of near vision spectacles.

Methods—We conducted a 2-month follow-up of a population-based cohort of persons in rural Tanzania with near vision impairment who had received spectacles. Previously, residents age 40 years were examined for distance and near vision acuity. Those with presbyopia and hyperopia ('functional presbyopia') were given near vision spectacles. At baseline, subjects were asked to thread a needle; they were also asked questions on the perception of their near vision, ability to be independent and general health. At 2 months, subjects were again queried. Questions on the perceived affordability of replacement spectacles were also asked.

Results—Of the 866 people provided with spectacles, 89% were seen at 2 months. Ninety-two per cent were still using the spectacles. Users were more likely to have any education (51.8%) than non-users (28.3%) ($p < 0.001$). Only 31% had successfully threaded a needle at baseline, increasing to 91% at follow-up ($p < 0.001$). Spectacle-users showed a significant improvement in satisfaction with near vision and ability to be independent, but no change in perception of general health, from baseline to follow-up. Men were more likely than women to be able to afford spectacles and to know where to get them.

Conclusions—Our cohort maintained their spectacles and reported tangible improvements associated with their use. The value of simple reading spectacles for those with near vision impairment suggests that a greater emphasis on near vision is needed in the Vision 2020 agenda.

INTRODUCTION

Refractive error is a leading cause of visual impairment in the developing world,^{1–9} and is part of the Vision 2020 agenda. In addition, recent work has estimated the huge prevalence of presbyopia globally.¹⁰ Strides are being taken to implement spectacle distribution programmes worldwide, including a non-governmental organisation dedicated to creating a workforce for the provision of reading spectacles.^{11,12} However, little is known about the value of providing spectacles to the wearer. Outcomes after supplying spectacles for

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presbyopia are needed to document improvement in function and justify expenditures for spectacle-provision programmes.

A small study in a spectacle-corrected sample of presbyopic patients in the USA showed a nominal decrease in quality of life with presbyopia using time trade-off utility analyses.¹³ This is contradicted by a large study in the USA, using the National Eye Institute Refractive Error Quality of Life Scale, which found that persons with presbyopia scored significantly lower in seven of the 13 sub-scales.¹⁴ In rural Tanzania, we have demonstrated that good near vision appears to be important for independent function and daily tasks appropriate to that setting among populations without access to spectacles who may not use near vision for reading and writing.¹⁵ A subsequent study in Kenya had similar findings.¹⁶ Such studies suggest potential benefits from near vision correction within these populations.

In the context of our previous study on the prevalence and impact of presbyopia,⁵¹⁷ we provided spectacles to persons who needed them following assessment. In this follow-up study, we examined the effect of spectacles on change in self-report of function, on performance of a near vision task, and on reported ability to pay for reading spectacles 2 months after the provision of free spectacles.

METHODS

Study population

A complete census of three villages and four neighbourhood sectors of rural Kongwa town, Tanzania, was carried out. A total of 1709 (83%) adults aged 40 years were screened for presbyopia using a near vision E chart placed at 40 cm from the eye in ambient outdoor illumination after distance correction. Persons were excluded if they had best corrected distance visual acuity less than 20/63 and no improvement with assessment using a pinhole. The study, sample and methods are described in detail elsewhere.¹⁵¹⁷

We defined persons with presbyopia as those who, after best spherical distance correction, were unable to read the N8 optotype and demonstrated improvement in near vision by one line or more with at least +1.0 D of 'add'. This endpoint corresponded to newsprint and was felt to be a reasonable, functional target. The positive binocular addition of least magnitude that improved near visual acuity at 40 cm according to the participant was recorded as the subject's 'add' and quantified their degree of presbyopia.

The majority of subjects with vision impairment did not have correction. Therefore, those with near vision impairment included, in addition to persons with presbyopia, persons with hyperopia, even though they may have some accommodative ability (n=44). Conversely, those without near vision impairment may include persons with myopia with adequate near vision despite having presbyopia, as well as those without presbyopia. From the perspective of providing near vision correction, such persons with myopia would not need spectacles. Hence, we defined 'functional' presbyopia as those subjects who needed plus lenses of at least +1.0 D to improve near vision in his/her usual visual state. A total of 866 persons were given near vision spectacles based on this definition.

The power of near vision spectacles was calculated and for subjects requiring net plus lenses for near vision; spectacles of +1.0, +1.5, +2.0 or +2.5 D were provided at no cost. Those subjects requiring +0.5 D were given +1.0 D and subjects requiring greater than +2.5 D were given +2.5 D. Prescriptions and referrals were given to all subjects requiring minus lenses for distance correction.

Follow-up

Two months after the survey, 866 persons were re-assessed using the same questions from baseline on satisfaction with near vision, reported limitations in function, perceptions about visions and general health, as well as other questions on affordability.

Outcome measures

We asked a series of questions on spectacles use. These included: (1) whether the subject had retained the spectacles; (2) whether the spectacles were being used; and (3) a global question on subjective impression of whether there had been improvements in the subject's life as a result of having better near vision. If a subject reported using spectacles, we asked the frequency of use. We also examined the spectacles to make an assessment of their condition and asked questions about ability to afford spectacles, where to get spectacles and having the means to get there.

We asked subjects to thread a needle at baseline and follow-up. At follow-up, subjects were asked to wear their spectacles if they had them. We used the same needles and thread in both rounds and the test was carried out in a shaded outdoor setting. Subjects were shown the needle and thread and given instructions to thread the needle. The observers made sure the subjects understood the instructions before being allowed to attempt the task. Subjects were allowed three passes at threading the needle. A success was scored as the ability to thread the needle and pull the thread through.

At baseline and follow-up we included questions on the perception of difficulty with near vision (yes/no), perceived role limitation due to near vision limitation (yes/no), perceptions of functional dependency due to near vision limitation (yes/no) and general health.

Statistical analysis

Chi-square tests were used to assess differences between participants and non-participants at follow-up. Frequency distributions for the responses to the 'Experience with spectacles' questionnaire items were tabulated. Chi-square tests were used to assess differences in demographic variables and questionnaire responses between subjects who used spectacles and non-users. McNemar's test was used to assess before—after associations. Threading the needle, our performance-based test, had three outcomes (able, unable or refused). Fifty-nine subjects refused to thread a needle at baseline and/or follow-up, and we excluded them in calculating McNemar's test statistic. Stata (ver. 7.0; Stata Corporation, College Station, Texas, USA) and SAS (version 9; SAS Inc., Cary, North Carolina, USA) were used to carry out the analyses.

RESULTS

Of the 866 eligible subjects, 771 (89%) participated. The reasons for non-participation were temporarily travelling during the time of the follow-up survey ($n=59$, 6.8%), refusal ($n=13$, 1.5%), illness ($n=1$, 0.1%) and permanent move out of the district ($n=22$, 2.5%). Non-participants were more likely to be town-dwellers and have secondary education (table 1). There were no differences by participation status in ability to thread a needle at baseline or the mean power of spectacles prescribed. The mean power of spectacles provided was +1.53 D.

Most participants had near vision impairment greater than +1.0 D, with 48.4% at +1.0 D (table 2). Of the 771 participants, 97% had retained their spectacles (table 3). Among the 23 (3%) subjects who reported not having their spectacles, 12 (1.6%) had lost them, six (0.8%) had broken spectacles, three (0.4%) had them stolen and two (0.3%) were missing for other

reasons. Most spectacles (91%) were in good condition. Sixty (8%) subjects reported not using the spectacles, including nine persons of the 23 who no longer had their spectacles. The rest of the 23 would have used them if they had had them.

Persons used their spectacles frequently: 49% used them a few times a week with another 18% using them daily (table 3). Women were just as likely to be using the spectacles as men (table 4) and there was no difference in use of spectacles by residence in town or rural village. Subjects using the spectacles were more likely to have some education (51.8%) than those who reported not using their spectacles (28.3%) ($p<0.001$). Only 3% of those not using their spectacles reported improvement in their life due to better near vision, compared with 92% among the spectacles-users (table 4). There was no difference in mean power of spectacles prescribed to the users and non-users. Adjusting for age, sex and town-dwelling, education was still a significant predictor of spectacles use (data not shown).

Significant improvement in performance of the near vision task, threading the needle, was observed. At baseline, only 215 of the 654 who attempted to thread a needle (32.9%) were successful (table 5). Of those who were unsuccessful at baseline, 88.4% were able to complete the task at follow-up. Fifty-seven people had refused to perform the task at baseline; at follow-up, all but two of these subjects attempted the task and 81% of them completed it successfully.

The spectacles-users reported significant change from being dissatisfied with their near vision to satisfaction, and improvement from feeling limited in their function and needing help from family members to feeling independent (table 6). More than one-half changed their responses dealing with near vision dissatisfaction, role limitation and functional dependency, to becoming satisfied and independent. About one-third of subjects for each question reported no change, almost all because they had no dissatisfaction or dependency at baseline to begin with. A very small percentage, between 0.4% and 2.9% (depending on the question), changed from being satisfied or independent at baseline to being dissatisfied or dependent at follow-up. We also asked participants to rate their general health at baseline and at 2 months and observed no significant change, suggesting that respondents were not simply responding so as to improve in all items. About 8–9% remained dissatisfied with their near vision and their ability to do near work before and after acquiring spectacles.

We estimated the cost of procuring and providing the spectacles at US\$2. When asked about affordability at this level, men were more likely than women to report being able to afford spectacles (76% of men versus 52% of women) (table 7). A further 5% of men and 9% of women said there would be someone else who could cover the cost of spectacles for them. In total, 69% of subjects reported being able to afford spectacles directly or with someone's help at follow-up, with pronounced sex differences. A higher proportion of men (78%) than women (58%) reported that if necessary, they would get replacement spectacles (table 7). This response was correlated with the response to the affordability question ($r=0.77$). However, only 26.6% of men and 17.6% of women reported knowing where to obtain spectacles, with one-half of them stating spectacles were available at the local hospital, which was not true. Women were less likely to report knowing where to get spectacles.

DISCUSSION

Spectacles-use following provision to persons with functional presbyopia was high (92% at 2 months), with almost one-half reporting use at least a few times per week. Thus, adequate near vision in rural areas of Africa appears to be important for residents, even if not used primarily for reading and writing tasks. There have been previous studies on spectacle-use, but they have been primarily in children, showing lower rates of spectacles use. In a

Mexican study, 43% of children had spectacles within 18 months of receiving them.¹⁸ A self-report of spectacles use in Chinese children revealed only 26% of those who bought spectacles used them.¹⁹ Dandona *et al*'s cross-sectional study of spectacles use for distance correction in Southern India found current spectacles use was 34% among subjects with distance refractive error of ± 3.0 D or worse, and 12% had stopped wearing the spectacles they had.²⁰

We had expected higher rates of usage of spectacles among men and among town-dwellers because of higher reported rates of performing reading and writing tasks in these sub-groups.¹⁵ However, women were as equally likely as men to report using spectacles, a result similar to that found in the Indian study. We also found no significant difference between town-dwellers and villagers in use of spectacles, suggesting the importance of near vision for a variety of tasks beyond reading and writing.

More than one-half the sample changed from reported dissatisfaction with their near vision, having role limitations and dependency on family members at baseline, to being satisfied and independent at 2 months, a finding which further supports the benefit of the spectacles. Even the 26% of spectacles-users who at baseline reported satisfaction with ability to do near work were all using their spectacles at follow-up. Spectacles clearly improved the wearer's function, as measured by our simple, objective, performance-based test of near vision—threading a needle. The test was sensitive to change in performance, and all but two persons were able to attempt it (ie, they did not refuse to try threading a needle) at follow-up. Such a simple test of performance could be used in other settings where the population has low literacy rates.

A high proportion of persons with presbyopia indicated ability to pay US\$2 for their spectacles. In this area, roughly one-half the population subsists on less than US\$0.65 per day, so this price represents a significant expenditure.²¹ The percentage in men (78%) was similar to the reported 77% of rural Cambodians who were willing to pay at least US\$0.38 for spectacles, although no sex differences were described in the latter study.²² In a study in Timor-Leste, Ramke *et al* found that 50% of subjects were unwilling to pay even US\$1 for spectacles, with women less willing than men.²³

The finding that women were less able to pay for spectacles than men, even though both sexes were equally likely to use the spectacles, suggests a problem of gender disparity that will raise additional challenges for refractive error correction programmes.

There are some limitations to this study. First, the possibility that subjects may have given more favourable responses or exaggerated their satisfaction to please interviewers cannot be ruled out. However, this is unlikely as those who were not using the spectacles reported little improvement in the functional items queried, and certainly performance on the needle-threading task provided additional evidence of improvement. In addition, follow-up at 2 months may be insufficient time to gauge spectacles retention.

In conclusion, there are some significant challenges to providing adequate near vision at the population level, especially in less developed countries and particularly among women, who may have higher rates of presbyopia and are often less likely to be able to afford correction. Further, ancillary costs like transportation to optical services represent an additional economic burden to patients, and such costs need to be factored into spectacle programmes. The support and establishment of local entrepreneurs in the area is one way to reduce lack of access. This study provides further evidence that a greater emphasis on near vision in the WHO's Vision 2020 refraction agenda would be beneficial.

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Ethics approval This study was conducted with the approval of the Johns Hopkins University Institutional Review Board and Tanzania National Institute for Medical Research.

REFERENCES

1. Dandona R, Dandona L. Review of findings of the Andhra Pradesh Eye Disease Study: policy implications for eye-care services. *Indian J Ophthalmol*. 2001; 49:215–234. [PubMed: 12930114]
2. Dineen BP, Bourne RR, Ali SM, et al. Prevalence and causes of blindness and visual impairment in Bangladeshi adults: results of the National Blindness and Low Vision Survey of Bangladesh. *Br J Ophthalmol*. 2003; 87:820–828.
3. Mbulaiteye SM, Reeves BC, Mulwanyi F, et al. Incidence of visual loss in rural southwest Uganda. *Br J Ophthalmol*. 2003; 87:829–833. [PubMed: 12812876]
4. Abdu L. Prevalence and causes of blindness and low vision in Dambatta local government area, Kano State, Nigeria. *Niger J Med*. 2002; 11:108–112. [PubMed: 12221951]
5. Dandona R, Dandona L. Refractive error blindness. *Bull World Health Organ*. 2001; 79:237–243. [PubMed: 11285669]
6. Rosman M, Wong TV, Tay WT, et al. Prevalence and risk factors of undercorrected refractive errors among Singaporean Malay adults: the Singapore Malay Eye Study. *Invest Ophthalmol Vis Sci*. 2009; 50:3621–3628.
7. Saw SM, Foster PJ, Gazzard G, et al. Undercorrected refractive error in Singaporean Chinese adults: the Tanjong Pagar Survey. *Ophthalmology*. 2004; 111:2168–2174. [PubMed: 15582070]
8. Thiagalingam S, Cumming RG, Mitchell P. Factors associated with undercorrected refractive errors in an older population: the Blub Mountains Eye Study. *Bt J Ophthalmol*. 2002; 86:1041–1045.
9. Muñoz B, West SK, Rodriguez J, et al. Blindness, visual impairment and the problem of uncorrected refractive error in a Mexican-American population: Proyecto VER. *Invest Ophthalmol Vis Sci*. 2002; 43:608–614. [PubMed: 11867574]
10. Hofden BA, Fricke TR, Ho SM, et al. Global vision impairment due to uncorrected presbyopia. *Arch Ophthalmol*. 2008; 126:1731–1739. [PubMed: 19064856]
11. Anon. Report. Elimination of avoidable visual disability due to refractive errors. http://whqlibdoc.who.int/hq/2000/WHO_PBL_00.79.pdf.
12. Elimination of avoidable visual disability due to refractive error. [WHO_PBL_00.79](http://www.who.int/hq/2000/WHO_PBL_00.79.pdf).
13. Luo BP, Brown GC, Luo SC, et al. The quality of life associated with presbyopia. *Am J Ophthalmol*. 2008; 145:618–622. [PubMed: 18243152]
14. McDonnell PJ, Lee P, Spritzer K, et al. Associations of presbyopia with vision-targeted health-related quality of life. *Arch Ophthalmol*. 2003; 121:1577–1581. [PubMed: 14609914]
15. Patel I, Munoz B, Burke AG, et al. Impact of presbyopia on quality of life in a rural African setting. *Ophthalmology*. 2006; 113:728–734. [PubMed: 16650665]
16. Sherwin JC, Keeffe JE, Kuper H, et al. Functional presbyopia in a rural Kenyan population: the unmet presbyopic need. *Clin Experiment Ophthalmol*. 2008; 36:245–251. [PubMed: 18412593]
17. Burke AG, Patel I, Munoz B, et al. Population-based study of presbyopia in rural Tanzania. *Ophthalmology*. 2006; 113:723–727. [PubMed: 16650664]
18. Castanon HAM, Congdon N, Patel N, et al. Factors associated with spectacle wear compliance in school-aged Mexican children. *Invest Ophthalmol Vis Sci*. 2006; 47:925–928. [PubMed: 16505025]
19. Li L, Song Y, Liu X, et al. Spectacle acceptance among secondary school students in rural China: the Xichang Pediatric Refractive Error Study (X-PHES) - report 5. *Invest Ophthalmol Vis Sci*. 2003; 49:2895–2902.

20. Dandona R, Dandona L, Kovai V, et al. Population-based study of spectacles use in southern India. *Indian J Ophthalmol*. 2002; 50:145–155. [PubMed: 12194576]
21. Anon. USAID Budget. Tanzania. <http://www.usaid.gov/policy/budget/cbj2006/afr/tz.html>.
22. Ramke J, Palagyi A, duToit R, et al. Using assessment of willingness to pay to improve a Cambodian spectacle service. *Br J Ophthalmol*. 2008; 92:170–174. [PubMed: 18211947]
23. Ramke J, du Toit R, Palagyi A, et al. Correction of refractive error and presbyopia in Timor-Leste. *Br J Ophthalmol*. 2007; 91:860–868. [PubMed: 17576709]

Table 1

Characteristics of the 866 persons with functional presbyopia who were provided with spectacles by participation at 2-month follow-up

Characteristic	Participants (%) n = 771	Non-participants (%) n = 95	Total (%) n = 866	p Value
Age (years)				
40–44	15.3	22.1	16.1	0.14
45–49	18.6	14.7	18.1	
50–54	21.3	28.4	22.1	
55–59	11.2	12.6	11.3	
60–64	13.6	10.5	13.3	
65	20.1	11.6	19.2	
Sex (% female)	60.4	52.1	59.6	0.08 [‡]
Residency (% town-dwellers)	60.6	75.5	62.3	0.01 [‡]
Education *				
None	50.0	45.7	49.5	0.03 [‡]
Some primary	40.1	35.1	39.6	
Some secondary	9.9	19.2	10.9	
Able to thread needle at baseline				
No	60.9	51.6	59.9	
Yes	31.3	37.9	31.9	0.34 [‡]
Refused	7.8	10.5	8.2	
Mean power of spectacles (D)	+ 1.53	+ 1.51	+ 1.52	0.61 [‡]

* Four subjects had missing education data.

[‡] Age-adjusted.

Table 2

Degree of near vision impairment in 771 participants in 2-month follow-up study

Degree of near vision impairment (D)*	n	%
+1	373	48.4
> +1.0 to +2.0	302	39.2
> +2.0 to +3.0	70	9.1
> +3.0	25	3.2

* One person who received spectacles had missing data on degree of near vision impairment.

Table 3

Retention and use of spectacles at follow-up in 771 participants

Item	n (%)
Subject has retained spectacles	
No	23 (3.0)
Yes	748 (97.0)
Subject has been using spectacles in past 2 months	
No	60 [*] (7.8)
Yes	711 (92.2)
Frequency of spectacles use	
Daily	129 (18.1)
Few times a week	346 (48.7)
Once a week	79 (11.1)
Few times a month	62 (8.7)
Once a month or less	95 (13.4)

^{*} Includes nine of 23 persons who lost the spectacles.

Table 4

Comparison of the sample of spectacles users and non-users

Characteristic	Using spectacles (%) n = 711	Not using spectacles (%) [*] n = 60	Total n = 771	p Value
Age (years)				
40–44	15.8	10.0	15.3	0.39
45–49	19.0	13.3	18.6	
50–54	21.1	25.0	21.3	
55–59	11.1	11.7	11.2	
60–64	13.9	11.7	13.6	
65	19.1	28.3	20.1	
Sex (% female)	59.9	66.7	60.4	0.24 [‡]
Residency (% town-dwellers)	61.5	50.0	60.6	0.11 [‡]
Education [‡]				
None	48.2	71.7	50.0	<0.001 [‡]
Some primary	41.1	28.3	40.1	
Some secondary	10.7	0.0	9.9	
Satisfaction with doing near work at baseline				
Yes	26.4	35.0	27.1	0.11 [‡]
No	73.6	65.0	72.9	
Better near vision has improved life (% saying yes)	92.1	2.9	87.8	<0.001 [‡]
Mean power of spectacles (D)	1.54	1.52	1.53	0.55 [‡]

^{*} Includes nine subjects who reported no longer having spectacles.

[‡] Four subjects had missing education data.

[‡] Age-adjusted.

Table 5

Ability to thread a needle without spectacles at baseline compared with follow-up where spectacles were used (n=711)

Able to thread needle at follow-up				
	No (n (%))	Yes (n (%))	Refused (n (%))	Total
Able to thread				
No (n (%))	49 (11.2)	388 (88.4)	2 (0.4)	439 (100)
needle at baseline				
Yes (n (%))	8 (3.7)	207 (96.3)	0 (0.0)	215 (100)
Refused (n (%))	9 (15.8)	46 (80.7)	2 (3.5)	57 (100)

McNemar's test, $p < 0.001$.

Changes from baseline to follow-up in items on satisfaction with vision, functional dependency and limitations, and general health for participants using spectacles (n=711)

Table 6

Item	Change from baseline to follow-up (% of total)				p Value*
	No change				
	No at baseline/yes at follow-up	No at baseline/no at follow-up	Yes at baseline/yes at follow-up	Yes at baseline/no at follow-up	
Near vision					
Dissatisfaction with seeing up close	2.1	27.4	8.6	61.8	<0.001
Dissatisfaction with doing near work	1.8	24.8	9.2	64.2	<0.001
Reported being limited in things can do	1.4	38.8	4.0	55.9	<0.001
Reported functional dependency:					
Need help from family for tasks	1.3	32.2	5.8	60.7	<0.001
Perceptions about vision					
Vision an annoyance	2.9	27.1	11.2	60.9	<0.001
Frustrated by vision	0.4	56.8	0.7	42.0	<0.001
General health					
Satisfaction with general health	3.5	7.2	83.7	2.5	0.88

* Age-adjusted.

Table 7

Sex differences in responses to questions on spectacles affordability and replacement

	Male	Female	p Value *
Per cent who said they had the means to get spectacles if they cost TZS2000 (US \$2)	76.4	52.4	< 0.001
Per cent who said there is some other person who is able to pay for spectacles for them	4.9	8.6	< 0.001
Per cent who said they would replace their current spectacles if needed	78.0	58.0	< 0.001
Per cent who knew where to get spectacles (regardless if correct)	26.6	17.6	0.046

* Age-adjusted.