Community Eye Care

Population-based Study of Spectacles Use in Southern India

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This study assessed the use of spectacles and its demographic associations in a sample representative of the population of the Indian state of Andhra Pradesh. A total of 11,786 subjects of all ages were sampled from 94 clusters in one urban and three rural study areas of Andhra Pradesh using stratified, random, cluster, systematic sampling. The eligible subjects underwent detailed interview and eye examination including dilated examination of the posterior segment. The data on the use of spectacles were analysed for subjects >15 years of age. A total of 7,432 subjects >15 years of age participated in the study of whom 1,030 (13.8%) had a refractive error of spherical equivalent ±3.00 Diopter or worse. The prevalence of current use of spectacles in those with spherical equivalent ±3.00 Diopter or worse, who were likely to be visually impaired without refractive correction, was 34.2% (95% confidence interval 30.3-38%) and of previous use of spectacles was 12.3% (95% confidence interval 10.3-14.3%). The odds of using spectacles currently were significantly higher for those with any level of education, those living in the urban area, and for those with aphakia or psuedophakia as compared with natural refractive error. Among those who had used spectacles previously, 43.8% had discontinued because they felt that either the prescription was incorrect or that the spectacles were uncomfortable, suggesting poor quality of refractive services, and another 19.6% had lost the pair and could not afford to buy another pair. These data suggest that the use of spectacles in this population by those with refractive error was not optimal. Two-thirds of those with spherical equivalent ±3.00 Diopter or worse were not using spectacles. Of those who had discontinued the use of spectacles, a significant proportion did so for reasons related to poor quality of refractive services. Strategies such as vision screening programmes and eye health promotion need to be implemented, the quality of refractive services monitored and the cost of spectacles regulated, if the substantial burden of visual impairment due to refractive error in this population is to be reduced.

Key Words: India, Andhra Pradesh, refractive error, spectacles, visual impairment

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We have previously reported data on blindness and moderate visual impairment from the population–based Andhra Pradesh Eye Disease Study (APEDS) conducted in the southern Indian state of Andhra Pradesh.[1,2] Refractive error was the leading cause of moderate visual impairment and the second major cause of blindness in this population.[1,2] An estimated 3.7% of this population has moderate visual impairment and 0.3% are blind due to refractive error.[1,2]

For the most part, refractive error can be easily corrected with spectacles. In the background of a significant burden of blindness and moderate visual impairment due to refractive error, we assessed the use of spectacles in this population and its demographic associations. These data could help identify those groups in the population who are likely to be not using spectacles for refractive error correction. This will also help formulating effective strategies to reach out to these groups.

Materials and Methods

In order to achieve a study sample representative of the urban-rural and socioeconomic distribution of the population of the Indian state of Andhra Pradesh, a sample of 11,786 subjects

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was selected using a multistage sampling procedure from 24 urban clusters and 70 rural clusters from one urban and three rural areas of the state.[1-7] These four areas were located in Hyderabad (urban), West Godavari district (well-off rural), and Adilabad and Mahabubnagar districts (poor rural). The APEDS was conducted from October 1996 to February 2000.

Various aspects of the study design of APEDS have been described previously.[1-7] In brief, the major difference between the urban and rural sampling was that the former was selected from blocks stratified by socioeconomic status and religion, whereas the latter were selected from villages stratified by caste as described previously.[1-7] Eligible subjects were interviewed by trained field investigators which included information about demographics. The subjects were then invited for detailed eye examination at a local site specially setup for the study. All subjects were asked to bring their spectacles to the clinic. Written informed consent was obtained from subjects who could read or write; for those subjects who could not read or write, the consent form was read aloud at the examination site in the presence of all subjects of the day of the examination. The thumb impression of these subjects served as consent.

The clinical examination performed in APEDS has been described in detail elsewhere.[1-7] The procedures related to assessment of refractive error are described here.[6,7] For those more than 15 years of age, refraction was attempted on all those who presented with distance and/or near visual acuity worse than 6/6 in either eye. Objective refraction was followed by subjective refraction. The current spectacles correction was considered as the refractive error so long as this gave visual acuity of 6/6, N6. Subjects who had distance and near visual acuity of 6/6 or better without any refractive correction were considered as not having refractive error. APEDS was approved by the Ethics Committee of the L.V. Prasad Eye Institute, Hyderabad, India.

Use of spectacles

Subjects above 15 years of age responded to a structured questionnaire on the use of spectacles administered by trained field investigators. Subjects were asked whether they were using or had used spectacles or contact lenses to improve their vision. Previous users were asked the reason(s) for discontinuing the use of spectacles and this was documented in a pre-coded data form that had a list of possible responses. If a subject gave more than one reason for not using spectacles currently, all the reasons were documented and the subject was asked to decide the most important reason, which was noted. If a subject gave a reason that was not listed on the form, the response was documented in full.

Statistical analyses

Data were analysed to assess the use of spectacles, and the reasons for not using spectacles currently by those who had used them previously. The analyses were done using SPSS software (SPSS for Windows, rel.10.0.5. 1999. Chicago; SPSS Inc.). Univariate analyses were done followed by multiple logistic regression. The effect of each category of a multi-categorical variable was assessed by keeping the first or the last category as the reference. All variables were introduced in the model simultaneously and none of the variables were optimised. The estimates were adjusted for the age, gender, and urban-rural distribution of the population of India for the year 2000.[8,9] Based on the rates in each cluster, the design effect of the sampling strategy was calculated for the prevalence estimates,[10] and the 95% confidence intervals (CI) adjusted accordingly. Poisson distribution[11] was assumed for prevalence less than 1%, and normal approximation of binomial distribution for prevalence 1% or more. The data were analysed for the following three groups.

In the population

The use of spectacles was first assessed in the population irrespective of the refractive need to wear spectacles. This was assessed to understand the demographic associations of the use of spectacles in the population at large. The demographic associations of the use of spectacles currently were assessed with age, gender, education, socioeconomic status, and urban-rural residence. All the subjects who were currently using spectacles or had used spectacles in past were considered for this analysis irrespective of the type of refractive error.

In those with refractive error

The use of spectacles was assessed in those with refractive error (myopia, hyprеropia, aphakia, and pseudophakia) in the population. The subjects on whom data for refractive error were not available were excluded from this analysis. Spherical equivalent for the worse eye (eye with higher refractive error) was used to quantify the magnitude of refractive error. It was calculated by adding half of the cylindrical value to the spherical value of the refractive error. Presbyopia was not considered in this analysis. Those with aphakia/pseudophakia in both eyes were categorized under the category of aphakia/psuedophakia. The refractive error of the phakic eye was considered in those with aphakia/pseudophakia in one eye.

The use of spectacles was assessed for those with spherical equivalent of $\pm$1.00, $\pm$3.00, and $\pm$5.00 Diopter or worse. The demographic associations of the use of spectacles currently were assessed with age, gender, education, socioeconomic status, urban-rural residence, and type of refractive error. Likely interactions between age and type of refractive error, between urban-rural residence and type of refractive error, and between urban-rural residence and education were assessed in a separate multiple logistic model simultaneously with all the variables.

In those with refractive error as cause of visual impairment

The use of spectacles was then assessed for subjects who had refractive error as cause of visual impairment.[1,2] Visual impairment was defined as presenting distance visual acuity less than 6/18 in the better eye.[1-5] The assigning of cause of visual impairment has been described in detail elsewhere.[1,2,3-5] The demographic associations of the use of spectacles currently in those with visual impairment due to refractive error were assessed with age, gender, education, socioeconomic status, urban-rural residence, type of

refractive error, and level of visual impairment. Presbyopia was not considered in this analysis. Likely interactions between age and type of refractive error, between urban-rural residence and type of refractive error, and between urban-rural residence and education were assessed in a separate multiple logistic model simultaneously with all the variables.

Reasons for not using spectacles currently

The reasons for not using spectacles were analysed for the population, in those with refractive error, and in those with refractive error as cause of visual impairment. Further categorisation of the reasons for not using spectacles was done based on the type of error for those with refractive error, and those with refractive error as cause of visual impairment.

Results

Of the 11,786 subjects sampled for APEDS, 10,293 (87.3%) participated in the study. The participation rate was 85.4% in the urban area , and 84.6%, 91.6%, and 87.7% in West Godavari, Adilabad, and Mahaboobnagar districts, respectively. Of those examined, 7,432 (72.2 %) were >15 years of age, 5,439 (52.8%) were females, and 7,741 (75.5%) were living in the three rural areas. On comparing subjects >15 years of age, who participated in the study with those who did not participate, the following groups were less likely to participate: those 16-29 years of age ($p=0.023$; chi square test), illiterate ($p<0.0001$; chi square test), and those belonging to the upper socioeconomic stratum ($p<0.0001$; chi square test).

Use of spectacles in the population

Table 1 shows the prevalence of current and previous use of spectacles for the four study areas. Considering all the study areas together, the prevalence of current spectacles use was 17.4% (95% CI 14.5-20.3%; design effect 11.5) and of previous spectacles use was 9.2% (95% CI 8.2-10.2%; design effect 2.4), after adjusting for the age, gender, and urban–rural distribution of the population of India in the year 2000. The prevalence of current use of spectacles was the highest in Hyderabad, the urban study area, as compared with the rural study areas.

The distribution of those currently using spectacles in the population >15 years of age is shown in Table 2. On applying multiple logistic regression, the odds of using spectacles currently increased with the increasing age and increasing socioeconomic status, and were significantly higher for females, those with any level of education, and those living in the urban study area (Table 2).

Use of spectacles in those with refractive error

Spherical equivalent ±1.00 Diopter or worse

Of the 7,432 subjects >15 years of age, 2,220 (29.9%) subjects had spherical equivalent ±1.00 Diopter or worse (Table 3). Considering all the study areas together, among those with spherical equivalent ±1.00 Diopter or worse the prevalence of current spectacles use was 35% (95% CI 29.9-40.1%; design effect 6.6), and of previous spectacles use was 11.2% (95% CI 9.8-12.7%; design effect 1.2) after adjusting for the age, gender, and urban–rural distribution of the population of India in the year 2000 (Table 1). On applying multiple logistic regression (Table 4), the odds of using spectacles currently increased with increasing socioeconomic status. The odds of using spectacles currently were higher for those aged 50 or more (odds ratio 1.96; 95% CI 1.57-2.47), females, for those with any level of education, those living in urban study area (odds ratio 3.89; 95% CI 3.09-4.89), and for those with aphakia/pseudophakia in both eyes (odds ratio 14.10; 95% CI 6.97-28.43). There was a statistically significant interaction between urban-rural residence and education (odds ratio 1.29; 95% CI 1.15-1.43).

Table 1. Prevalence of current and previous use of spectacles for subjects >15 years of age

	Prevalence of current use* (95% confidence interval)	Prevalence of previous use* (95% confidence interval)
In the population		
Hyderabad	32.0% (25.8-38.2%)	7.7% (6.4-8.9%)
West Godavari	17.1% (14.0-20.3%)	12.6% (11.1-14.1%)
Adilabad	12.2% (9.6-14.8%)	9.9% (7.5-12.2%)
Mahabubnagar	8.2% (5.7-10.7%)	6.5% (4.9-8.2%)
In those with refractive error		
Spherical equivalent ± 1.00 Diopter or worse		
Hyderabad	55.0% (46.3-63.8%)	7.0% (4.5-9.6%)
West Godavari	24.6% (18.8-30.4%)	11.5% (9.0-14.1%)
Adilabad	21.9% (16.9-27.0%)	10.9% (8.1-13.8%)
Mahabubnagar	10.2% (6.4-14.0%)	6.4% (4.2-8.7%)
Spherical equivalent ± 3.00 Diopter or worse		
Hyderabad	56.8% (48.7-64.8%)	7.8% (4.0-11.5%)
West Godavari	24.8% (18.5-31.2%)	11.6% (7.8-15.5%)
Adilabad	24.8% (18.5-31.1%)	12.7% (8.3-17.0%)
Mahabubnagar	10.1% (6.4-13.8%)	6.1% (3.3-8.8%)
Spherical equivalent ± 5.00 Diopter or worse		
Hyderabad	54.1% (44.2-64.0%)	12.4% (5.8-19.0%)
West Godavari	27.0% (19.5-34.4%)	9.2% (4.5-13.9%)
Adilabad	27.9% (19.3-36.6%)	13.8% (7.9-19.7%)
Mahabubnagar	16.0% (8.0-24.0%)	5.8% (0.8-10.8%)
In those with refractive error as cause of visual impairment		
Hyderabad	15.2% (7.7-22.7%)	18.2% (10.2-26.3%)
West Godavari	15.8% (10.6-21.0%)	15.5% (10.2-20.7%)
Adilabad	14.2% (7.0-21.4%)	11.3% (4.4-18.2%)
Mahabubnagar	8.3% (4.1-12.5%)	8.9% (4.8-12.9%)

**Prevalence adjusted for the estimated age and gender distribution of the population of India in the year 2000,[8] and also for the design effects.*

Table 2. Association of using spectacles currently with age, gender, education, socioeconomic status, and urban-rural residence for subjects >15 years of age

	Total n=7,432	Using spectacles currently (%)	Odds ratio for using spectacles currently with multiple logistic regression
Age group (years)*			
16-29	1,845	148 (8.0)	1.00
30-39	1,863	211 (11.3)	1.68 (1.33–2.13)
40-49	1,424	373 (26.2)	5.24 (4.20-6.54)
50-59	1,047	335 (32.0)	8.54 (6.76-10.79)
60-69	900	307 (34.1)	11.26 (8.83-14.35)
≥70	353	160 (45.3)	19.16 (14.12-26.00)
Gender*			
Male	3,397	655 (19.3)	1.00
Female	4,035	879 (21.8)	1.73 (1.51–1.98)
Education*†			
No education	3,875	552 (14.2)	1.00
With any education	3,549	981 (27.6)	2.84 (2.43–3.31)
Socioeconomic status*‡			
Extreme lower	904	114 (12.6)	1.00
Lower	3,636	588 (16.2)	1.29 (1.02-1.63)
Middle	2,478	672 (27.1)	1.82 (1.43-2.31)
Upper	290	131 (45.2)	2.79 (1.98-3.94)
Residence*§			
Hyderabad	1,859	690 (37.1)	1.00
West Godavari	1,881	393 (20.9)	0.45 (0.38-0.53)
Adilabad	1,845	261 (14.1)	0.43 (0.36-0.52)
Mahabubnagar	1,847	190 (10.3)	0.21 (0.17–0.26)

**p<0.0001, univariate chi-square test; † Data on education not available for 8 subjects; ‡ Socioeconomic status defined according to monthly per capita income in rupees: extreme lower ≤200 (US $4.5), lower 201-500, middle 501-2000, and upper >2000; Data on socioeconomic status not available for 124 subjects; § Hyderabad is the urban study area, and West Godavari, Adilabad and Mahabubnagar are rural study areas.*

Spherical equivalent ± 3.00 Diopter or worse

Of the 7,432 subjects >15 years of age, 1,030 (13.8%) subjects had spherical equivalent ± 3.00 Diopter or worse (Table 3). Considering all the study areas together, among those with spherical equivalent ± 3.00 Diopter or worse the prevalence of current spectacles use was 34.2% (95% CI 30.3-38%; design effect 1.8), and of previous spectacles use was 12.3 % (95% CI 10.3-14.3%; design effect 1.0) after adjusting for the age, gender, and urban–rural distribution of the population of India in the year 2000 (Table 1). On applying multiple logistic regression (Table 4), the odds of using spectacles currently were higher for those with any level of education, those living in urban study area (odds ratio 3.15; 95% CI 2.13-4.64), and for those with aphakia/pseudophakia in both eyes (odds ratio 22.30; 95% CI 9.33-53.32). There were no significant interactions in this model.

Spherical equivalent ± 5.00 Diopter or worse

Of the 7,432 subjects >15 years of age, 525 (7.1%) subjects had spherical equivalent ±5.00 Diopter or worse (Table 3). Considering all the study areas together, among those with spherical equivalent ±5.00 Diopter or worse the prevalence of current spectacles use was 38.9% (95% CI 34.1-43.6%; design effect 1.3), and of previous spectacles use was 13.2% (95% CI 10.2-16.3%; design effect 1.1) after adjusting for the age, gender, and urban–rural distribution of the population of India in the year 2000 (Table 1). On applying multiple logistic regression (Table 4), the odds of using spectacles currently were higher for those with any level of education, those living in urban study area (odds ratio 2.11; 95% CI 1.20-3.70), and for those with aphakia/pseudophakia in both eyes (odds ratio 21.32; 95% CI 8.25-55.10). There were no significant interactions in this model.

Use of spectacles in those with refractive error as cause of visual impairment

Of the 7,432 subjects >15 years of age, 588 (7.9%) subjects had refractive error as cause of visual impairment. Considering all the study areas together, among those with refractive error as cause of visual impairment, the prevalence of current spectacles use was 12.8% (95% CI 9.9-15.7%; design effect 1.1), and of previous spectacles use was 12.8% (95% CI 10-15.8%; design effect 1.1) after adjusting for the age, gender, and urban–rural distribution of the population of India in the year 2000. On applying multiple logistic regression, the odds of using spectacles

Table 3. Distribution of using spectacles currently (current users) with age, gender, education, socioeconomic status, urban-rural residence, and type of refractive error for those >15 years of age with spherical equivalent ±1.00, ±3.00, and ±5.00 Diopters or worse

	±1.00 Diopter or worse		±3.00 Diopter or worse		±5.00 Diopter or worse	
	Total (n=2,220)	Current users (%)	Total (n=1,030)	Current users (%)	Total (n=525)	Current users (%)
Age groups (years)*						
16-29	120	49 (40.8)	36	22 (61.1)	17	10 (58.8)
30-39	190	57 (30.0)	56	20 (35.7)	28	8 (28.6)
40-49	428	124 (29.0)	114	30 (26.3)	55	16 (29.1)
50-59	605	222 (36.7)	259	72 (27.8)	126	41 (32.5)
60-69	636	222 (34.9)	391	131 (33.5)	199	83 (41.7)
≥70	241	98 (40.7)	174	66 (37.9)	100	44 (44.0)
Gender†						
Male	958	332 (34.7)	464	158 (34.1)	239	96 (40.2)
Female	1,262	440 (34.9)	566	183 (32.3)	286	106 (37.1)
Education‡						
No education	1,338	298 (22.3)	705	171 (24.3)	370	120 (32.4)
With any education	880	473 (53.8)	325	170 (52.3)	155	82 (52.9)
Socioeconomic status§						
Extreme lower	245	54 (22.0)	133	35 (26.3)	75	24 (32.0)
Lower	1,084	303 (28.0)	532	155 (29.1)	293	105 (35.8)
Middle	766	335 (43.7)	325	130 (40.0)	143	67 (46.9)
Upper	89	66 (74.2)	21	13 (61.9)	6	4 (66.7)
Residence‖						
Hyderabad	556	356 (64.0)	195	122 (62.6)	97	59 (60.8)
West Godavari	592	199 (33.6)	264	92 (34.8)	146	55 (37.7)
Adilabad	450	124 (27.6)	223	72 (32.3)	139	52 (37.4)
Mahabubnagar	622	93 (15.0)	348	55 (15.8)	143	36 (25.2)
Type of refractive error¶						
Aphakia/ pseudophakia	80	70 (87.5)	69	63 (91.3)	64	59 (92.2)
Myopia	1,507	381 (25.3)	884	237 (26.8)	436	134 (30.7)
Hyperopia	633	321 (50.7)	77	41 (53.2)	25	9 (36.0)

**p=0.083, 0.009, and 0.330 with univariate chi-square test for spherical equivalent ±1.00, ±3.00, and ±5.00 Diopter or worse, respectively.*

†p=0.179, 0.842, and 0.663 with univariate chi-square test for spherical equivalent ±1.00, ±3.00, and ±5.00 Diopter or worse, respectively.

‡p<0.0001, univariate chi-square test; Data on education not available on 2 subjects for spherical equivalent ±1.00 Diopter or worse.

§p<0.0001, univariate chi-square test for SE ±1.00 and ±3.00 Diopter or worse, and p=0.12 for spherical equivalent ±5.00 Diopter or worse; Socioeconomic status defined according to monthly per capita income in rupees: extreme lower ≤200 (US $4.5), lower 201-500, middle 501-2000, and upper >2000; Data on socioeconomic status not available on 36, 19, and 8 subjects for SE ±1.00, ±3.00, and ±5.00 Diopter or worse, respectively.

‖p<0.0001, univariate chi-square test; Hyderabad is the urban study area, and West Godavari, Adilabad and Mahabubnagar are rural study areas.

¶p<0.001, univariate chi-square test.

currently were significantly higher for those 40 years of age or more (odds ratio 7.93; 95% CI 1.83-34.3) and for those with aphakia/pseudophakia in both eyes (odds ratio 23.2; 95% CI 7.84-68.3). The odds of using spectacles currently were significantly lower for those living in Mahabubnagar rural study area (odds ratio 0.28; 95% CI 0.11-0.67). There were no significant associations of use of spectacles currently with gender, education, socioeconomic status, and level of visual impairment among those with refractive error as cause of visual impairment. There were no significant interactions in this model.

Reasons for not using spectacles currently

Data on reasons were available for 672 (87%), 222 (85.4%), 112 (86.1%), 63 (90%) and 79 (84%) subjects in the study population, spherical equivalent ±1.00, ±3.00, ±5.00 Diopter or worse, and for those with refractive error as cause of visual impairment, respectively.

Figure 1 shows the distribution of reasons for not using spectacles currently by those who had used them previously. A significant proportion of subjects, ranging from 19% to 25.9%, had stopped using spectacles

Table 4. Association of using spectacles currently with age, gender, education, socioeconomic status, type of refractive error, and urban-rural residence for subjects >15 years of age for those with spherical equivalent +1.00, +3.00, and +5.00 Diopters or worse with multiple logistic regression

	Odds ratio for using spectacles currently (95% confidence interval)		
	±1.00 Diopter or worse	±3.00 Diopter or worse	±5.00 Diopter or worse
Age groups (years)			
16- 29	1.00	1.00	1.00
30-39	0.70 (0.40-1.24)	0.44 (0.15-1.17)	0.31 (0.07-1.26)
40-49	0.66 (0.39-1.10)	0.46 (0.18-1.14)	0.38 (0.11-1.36)
50-59	1.34 (0.82-2.19)	0.62 (0.27-1.44)	0.57 (0.17-1.89)
60-69	1.69 (1.03-2.76)	0.92 (0.40-2.11)	0.81 (0.25-2.64)
≥70	2.14 (1.23-3.72)	0.93 (0.39-2.23)	0.77 (0.23-2.61)
Gender			
Male	1.00	1.00	1.00
Female	1.29 (1.02-1.62)	1.29 (0.92-1.79)	1.06 (0.68-1.68)
Education			
No education	1.00	1.00	1.00
With any education	3.13 (2.45-4.01)	2.85 (1.97-4.12)	2.09 (1.25-3.51)
Socioeconomic status*			
Extreme lower	1.00	1.00	1.00
Lower	1.33 (0.92-1.93)	1.27 (0.78-2.06)	1.20 (0.65-2.22)
Middle	1.84 (1.25-2.72)	1.59 (0.94-2.68)	1.60 (0.81-3.15)
Upper	4.01 (2.11-7.61)	2.12 (0.69-6.52)	2.40 (0.35-16.64)
Residence†			
Hyderabad	1.00	1.00	1.00
West Godavari	0.33 (0.25-0.44)	0.42 (0.27-0.66)	0.53 (0.28-1.00)
Adilabad	0.48 (0.35-0.66)	0.63 (0.39-1.02)	0.81 (0.42-1.56)
Mahabubnagar	0.15 (0.11-0.20)	0.16 (0.10-0.26)	0.23 (0.12-0.47)
Type of refractive error			
Aphakia/ pseudophakia	1.00	1.00	1.00
Myopia	0.05 (0.02-0.10)	0.03 (0.01-0.08)	0.04 (0.01-0.10)
Hyperopia	0.12 (0.06-0.24)	0.08 (0.03-0.23)	0.05 (0.01-0.19)

**Socioeconomic status defined according to monthly per capita income in rupees: extreme lower ≤200 (US $4.5), lower 201-500, middle 501-2000, and upper >2000; †Hyderabad is the urban study area, and West Godavari, Adilabad and Mahabubnagar are rural study areas.*

because they thought the *prescription was incorrect*. The other significant reason for not using spectacles currently was *the spectacles were uncomfortable*, ranging from 17.9% to 22.2%, across all the five different groups. *Economic reason* for the inability to purchase a new pair ranged from 14.9% to 27% across all the groups.

The distribution of reasons for not using spectacles currently in those with spherical equivalent ±3.00 or worse who had used them previously was analysed based on the type of refractive error (Figure 2). The reason *incorrect prescription* was cited more often by those with myopia and was not cited by those with hyperopia and aphakia/pseudophakia. Those with hyperopia did not cite economic reasons for the inability to purchase a new pair. On analysing these reasons based on the area of residence in urban and rural areas respectively, *the spectacles were uncomfortable* was cited by 20% and 17.5%, *prescription was incorrect* was cited by 20% and 26.8%, *lost and unable to afford a new pair* was cited by 33.3% and 17.5%. *No need to wear all the time* was cited by 14.4% in the rural areas and was not cited in the urban area. The rest cited *other reasons* for not using spectacles currently.

A similar analysis based on type of refractive error was also done for those with refractive error as cause of visual impairment (Figure 3). Those with myopia cited *prescription was incorrect, lost and cannot afford to buy*, and *other reasons* in similar proportions. Economic reason for the *inability to purchase a new pair* was cited the most by those with hyperopia. On analysing these reasons based on the area of residence, *the spectacles were uncomfortable* was cited by 7.7% and 25.8%, *prescription was incorrect* was cited by 30.8% and 18.2%, *lost and unable to afford a new pair* was cited by 30.8% and 24.2%, and *no need to wear all the time* was cited by 7.7% and 12.1% in urban and rural areas, respectively. The rest cited *other reasons* for not using spectacles currently.

Discussion

The Andhra Pradesh Eye Disease Study was a population-based, cross-sectional epidemiology study of all ages, representative of the population of the Indian state of Andhra Pradesh. Detailed eye examination was performed on all subjects. Detailed interviews covered ocular and systemic history, risk factors for eye diseases, visual function, quality of life, use of eye-care services, and knowledge about common eye diseases for subjects above 15 years of age.

From the total population, we previously reported the prevalence of blindness (presenting distance visual acuity <6/60 or central visual field <20 degrees in the better eye) due to refractive error as 0.3% and of moderate visual impairment (presenting distance visual acuity <6/18-6/60 or equivalent visual field loss in the better eye) due to refractive error as 3.7%.[1,2] Considering both of these

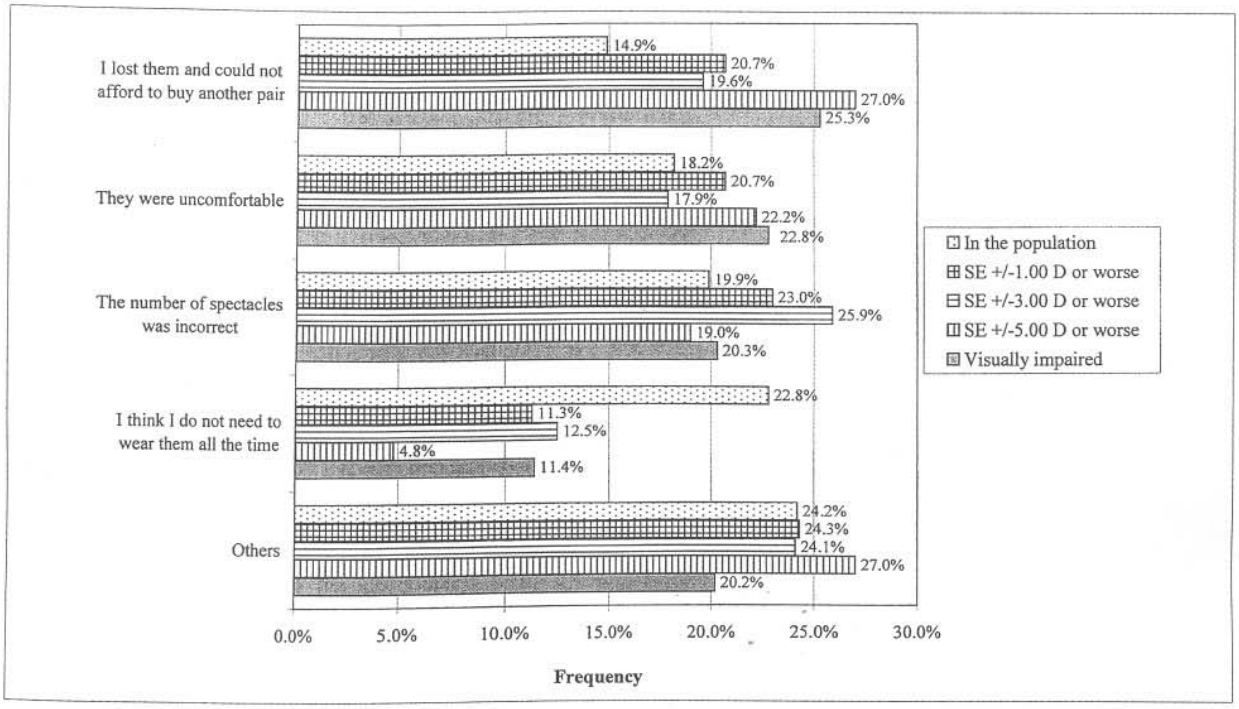

Figure 1. Reasons for not using spectacles currently for those who had used them previously for all the four study areas combined. Visually impaired represents those with refractive error as cause of visual impairment. Visual impairment defined as presenting distance visual acuity less than 6/18 in the better eye.

together, the burden of visual impairment due to refractive error is quite significant. Using the correct refractive correction to improve the vision can easily treat most of the refractive error. The most common form of refractive correction used in India is spectacles. We assessed the use of spectacles in this population. To the best of our knowledge, these are probably the first population-based data on the distribution of the use of spectacles in an Indian population.

Use of spectacles in the population

Seventeen percent of the population reported using spectacles currently. This figure includes all types of refractive needs such as myopia, hyperopia, astigmatism, presbyopia, aphakia and pseudophakia. As expected, the current use of spectacles increased with increasing age, which is probably due to the increased need of presbyopic and post-cataract surgery refractive correction. The current use of spectacles also increased with increasing socioeconomic status possibly related to the increased level of education. Surprisingly, females were more likely to be using spectacles currently. On looking at the age distribution of the females using spectacles currently, 29.2% were below the age of 40 years and 70.8% were 40 years of age or more. This suggests that majority of the use of spectacles was age-related in females. Because females have a higher life expectancy than males, the need to use spectacles may be higher too.

The use of spectacles currently was more common in the urban study area than the rural study areas which could be related to the increased availability and accessibility of eye-care services, including refractive services, in the urban areas.

Use of spectacles in those with refractive error

These data suggest that around two-thirds of those who had refractive error in the population were not using spectacles currently across all the three spherical equivalent groups assessed. A significant proportion of the population who had refractive error had discontinued using spectacles. The less use of spectacles among those with refractive error of spherical equivalent ±3.00 Diopter or worse and with spherical equivalent ±5.00 Diopter or worse is of importance as these are the people who are likely to have visual impairment due to refractive error and also likely to develop refractive error-related amblyopia. In this population for all ages considered together, the prevalence of blindness due to refractive error-related amblyopia was estimated as 0.06%.[1]

The educated in the urban study area were more likely to be using spectacles currently, and we also found a significant interaction between these two variables. Those with aphakia and pseudophakia were more likely to be using spectacles currently as compared with those with myopia or hyperopia. This suggests that

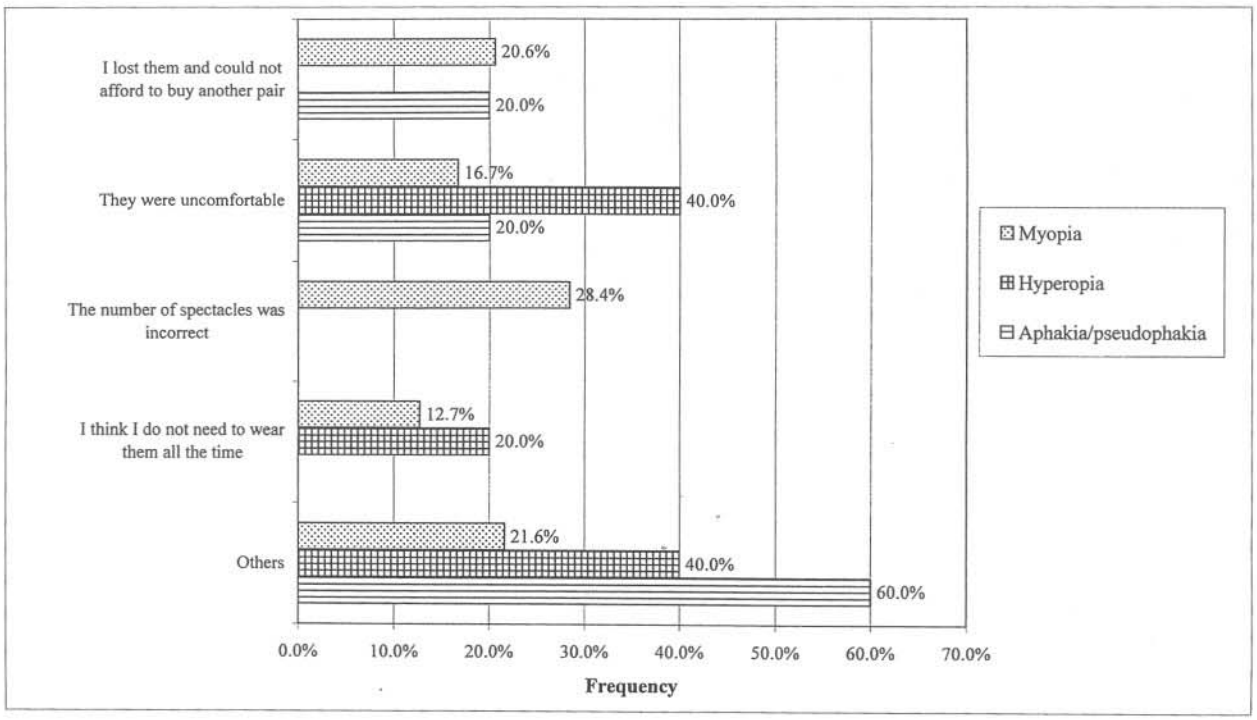

Figure 2. Reasons based on type of refractive error for not using spectacles currently for those with spherical equivalent ±3.00 Diopter or worse who had used them previously. Data are presented for all the four study areas combined.

those who had utilised eye-care services for cataract surgery and were prescribed spectacles after surgery were more likely to use spectacles whereas those with natural refractive error were less likely to use spectacles.

Use of spectacles in those with refractive error as cause of visual impairment

Around 13% of those with refractive error as cause of visual impairment were using spectacles currently but were still visually impaired due to refractive error, implying inadequate refractive correction. Interestingly, a similar proportion of the population had discontinued using the spectacles. The use of spectacles currently was higher in those 40 years of age or more. This could be explained by the finding that those with aphakia or pseudophakia were more likely to be using spectacles currently and these are likely to be among the older population. The finding that those with natural refractive error (myopia and hyperopia) were less likely to use spectacles currently is significant as majority of the blindness and moderate visual impairment caused by refractive error in this population was due to the natural refractive error.[1,2]

Reasons for not using spectacles currently

A significant proportion of the population had stopped using spectacles for various reasons. Many of those who had stopped using spectacles in the population, did so because *the prescription of spectacles was incorrect* or *they were uncomfortable.* These reasons were: 38.1% of those with refractive error of spherical equivalent ±1.00 Diopter or worse, 43.7% of those with refractive error of spherical equivalent ±3.00 Diopter or worse, 41.2% of those with refractive error of spherical equivalent ±5.00 Diopter or worse, and 39.4% in those with refractive error as cause of visual impairment. In addition, a significant proportion could not afford to buy another pair after losing their spectacles.

Implications of the findings

It is significant that the younger population who were in the economically productive age group were likely to be using spectacles currently for refractive error or for visual impairment due to refractive error. Strategies to target this group to encourage the use of spectacles to reduce visual impairment due to refractive error should include vision screening and eye health promotion programmes at the community level. Vision screening programmes in India have traditionally concentrated on the school-going population.[12] In order to detect refractive error in the young adults and in uneducated children, vision screening at community level is necessary.[12] In addition, eye examination could be made mandatory to obtain the driver's license; this will further help reach the young adults. Eye health promotion to increase the awareness

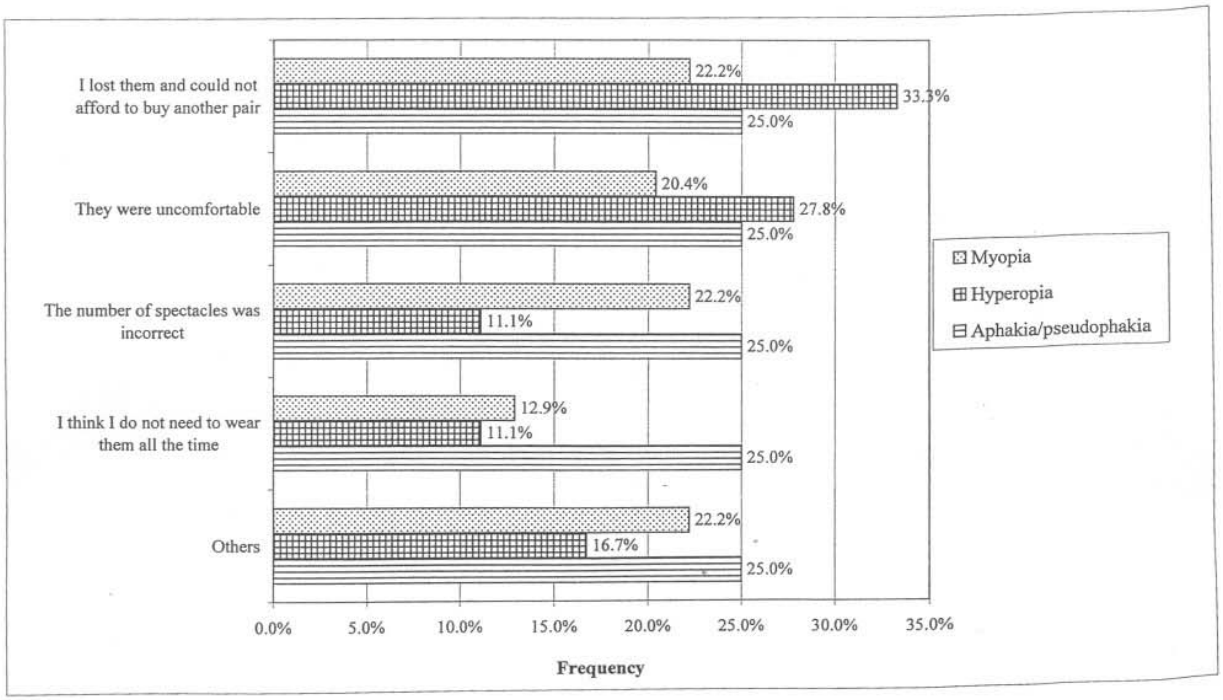

Figure 3. Reasons based on type of refractive error for not using spectacles currently for those with refractive error as cause of visual impairment. Data are presented for all the four study areas combined.

of refractive errors and poor vision is paramount, as in the same population, we found that those with refractive error as cause of visual impairment were less likely to notice change in their vision and seek treatment.[13,14] It is possible that increase in the awareness regarding the vision status especially for those with mypia, could increase the detection of refractive error and therefore the use of spectacles.

Those belonging to the extreme lower socioeconomic status were less likely to be using spectacles currently for refractive error of the magnitude that is likely to cause visual impairment. This could be due to various reasons such as the cost of spectacles, poorer access to the refractive eye-care services, or low awareness of the vision status. It is not possible for us to comment on these issues based on our data. However, regulating the cost of spectacles, availability of low-cost spectacles, de-linking access to refractive eye-care services from the cost of service, and by targeting this group for eye health promotion could help improve detection of refractive error and increase the use of spectacles.

The low use of spectacles currently in the rural areas for refractive error of the magnitude that is likely to cause visual impairment is not surprising. We have reported blindness and moderate visual impairment due to refractive error to be greater in the rural areas as compared with the urban areas.[1,2] This is likely due to the lower availability of eye-care services in the rural areas. To minimise visual impairment due to refractive error in the rural areas, adequate attention should be paid to developing permanent infrastructure for refractive services and provision of spectacles.[12]

The reasons for not using spectacles currently were asked from those who had discontinued using them. Of all the reasons given by the subjects, two reasons, *the spectacles prescription was incorrect* and *they were uncomfortable*, can be considered as an indication of the quality of refractive eye-care services. These reasons were cited by over 40% of study subjects (with refractive error and refractive error as cause of visual impairement) who had discontinued using spectacles. It could be said that the quality of refractive services is not optimum as these people were not satisfied with the spectacles and hence discontinued their use. An analogy can be drawn here with the outcome of cataract surgery. Recent population-based studies in India have shown that a significant proportion of eyes were blind after cataract surgery.[15-17] Good-quality cataract surgery by well-trained ophthalmologists and monitoring of the outcome of cataract surgery have been suggested as strategies to improve the outcome of cataract surgery.[15] Similarly, the refractive services provided to the population need close attention. These include standardised training of the eye-care personnel in refraction procedures, standardised conditions in which refraction is performed, and adequate fitting of spectacles.

Cost of spectacles also accounted for a significant proportion of people to discontinue the use of spectacles after losing a pair. There are no regulations on the cost of spectacles in India. The profit margin in the spectacles industry is reportedly high. Different strategies have been tried in the developing world to increase the availability and affordability of reasonable-quality spectacles, with varying degrees of success. These strategies include manufacture of low-cost spectacles in developing countries using trained staff,[18] and provision of spectacles at cost price to the poor. In addition, regulation of the cost of spectacles should help many of those who would otherwise be visually impaired without them.

In conclusion, these data suggest that use of spectacles in this population in those with refractive error of the magnitude that is likely to cause visual impairment is sub-optimal. In addition, a significant proportion of discontinuation of spectacles use was due to reasons suggesting poor quality of refractive services. The policy implications of these data are that strategies like vision screening programmes and eye health promotion have to be put in place, and monitoring the quality of refractive services and regulating the cost of spectacles are necessary, if the significant burden of visual impairment due to refractive error in this population is to be reduced.

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