Uncorrected Refractive Errors, Presbyopia and Spectacle Coverage: Rapid Assessment of Visual Impairment (RAVI) Survey Results in Gujarat State of India

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Abstract

Purpose: To estimate the prevalence of refractive errors, presbyopia and spectacle coverage among people 40 years and above using Rapid Assessment of Visual Impairment (RAVI) survey method in Surat district of Gujarat state, India.

Method: A cross sectional population based survey was conducted using 26 randomly selected clusters each having 60 people selected by probability proportional to size of sampling. Households were selected through compact segment sampling within clusters. Visual acuity for both distance and near was recorded. RAVI methodology was used for this study. Visual impairment (VI) was defined as presenting visual acuity < 6/18 in better eye. Presbyopia was defined as binocular near vision <N8 with binocular distant VA ≥ 6/18.

Results: A total 1487 people were examined out of 1560 enumerated (response rate 95.3%). The mean age was 52 years and 51.4% were literate and there were 865 (58.2%) women among total participants. Prevalence of uncorrected refractive errors (UREs) and presbyopia were 17.2% (95% CI: 15.1 - 19.4) and 51.8% (95% CI: 48.8 - 54.7) respectively. Spectacle coverage was 38.2% for UREs and 38.9% for presbyopia. There were 3.81% (20/525) (95% CI: 2.48 - 5.81) people using spectacles for distance, 72.57% (381/525) (95% CI: 68.60 - 76.21) were using spectacles for near and 23.62% (124/525) (95% CI: 20.19 - 27.44) were using spectacles for both distance and near (Bifocals).

Conclusion: There is a significant burden of UREs and presbyopia present in Surat district. This baseline data is first of its kind in the state and will definitely be useful in planning refractive services in the region. The intervention is just a pair of customized or readymade glasses through properly managed channels that can increase productivity of people who use them.

Keywords: Rapid Assessment; RAVI; Visual Impairment; Refractive Error; Presbyopia; Spectacle Coverage

Abbreviations

RAVI: Rapid Assessment of Visual Impairment; WHO: World Health Organization; VI: Visual Impairment; URE: Uncorrected Refractive Error; VA: Visual Acuity

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Introduction

According to the latest World Health Organization (WHO) estimates, there are 2 billion people visually impaired (VI) in the year 2019 [1]. This includes those with moderate or severe distance vision impairment or blindness due to uncorrected refractive errors (UREs) (123.7 million), Cataract (65.2 million), Glaucoma (6.9 million), Corneal opacities (4.2 million), Diabetic Retinopathy (3 million) etc and near vision impairment of 826 million people caused by uncorrected presbyopia [1-3]. UREs and Presbyopia that constitute about 1 billion population can be easily avoidable by just pair of glasses and this is very cost-effective compared to cataract related Visual impairment where surgical facility is necessary and this intervention is costlier [4,5] It is estimated that 80% of blindness is seen in the people of developing world and of this, 80% is avoidable [2].

Refractive error is very common eye condition affecting distance and near eyesight. This condition can easily be corrected by just prescribing pair of spectacles. UREs have largely been overlooked as a cause of visual impairment (VI) and blindness as epidemiological surveys in the past used the WHO definition of "best-corrected visual acuity (VA)" meaning the refractive errors are maximally treated (corrected). Elimination of avoidable blindness and VI due to URE is a major objective of Vision 2020-the right to sight. Universal Health Coverage- Universal Eye Health further emphasizes on wellbeing of people at all ages [6].

UREs along with presbyopia are major causes of blindness and visual impairment in ≥ 40 years age which is working age group of the society. Surat district with population of 6 million of Gujarat state is more urbanised than any other districts [7]. It has mix of population-tribal on its eastern area, urban centred around Surat town and rural-semi-urban in rest of the part. This town draws people from other states as it is most industrialized one. There is a lack of data for the magnitude of UREs and Presbyopia in the district. The available data suggests that Gujarat state is doing well as far as the control of blindness due to avoidable causes is concerned. However, despite these good works, anecdotal reports suggest that Surat and particularly rural and tribal regions have remained underserved and it has been observed that there is a huge load of UREs and presbyopia in tribal area. People in urban areas are largely employed in diamond polishing, Textile companies etc where near vision is very much required. The same is true for rural people who are agrarian. Women also need near correction for cooking, sewing and related household chores. Age group ≥ 40 years is considered productive one and they remain blind or visually impaired because of scarcity of the RE services.

There is lack of data and situation analysis of the problem was necessary for the planning of better eye care services in the area. The aim of the study is to determine prevalence of UREs, presbyopia and to determine how much spectacle need has been covered (spectacle coverage) among people ≥40 age for planning the RE services for the area. For this age group RAVI survey methodology has been developed which is simple to administer, cheap, quick, requires minimal training using simple equipments [8]. This study proposes to use the same RAVI methodology to assess the magnitude of URE, presbyopia and spectacle coverage. The results of the study will provide the sound epidemiological baseline data for developing effective RE service delivery mechanism suited to the need and acceptance of the people of the district.

Material and Methods

Study design and Methods

The total population of the district is 6 million with 43.1% people living in urban areas and 56.9% people in rural-tribal areas [7]. This is a population based cross-sectional study conducted using RAVI methodology conducted in the month of April 2013 [8]. Study was conducted in 10 sub-districts of Surat district of Gujarat state of India.

Sampling size

Stratified cluster random sampling was used. From this sampling frame, the clusters were selected by systematic sampling with a probability proportional to size (PPS). Compact segment sampling (CSS) method was used to survey the households in the segments. The clusters then were divided into the segments and these segments were given numbers and randomly selected through lottery 2 days prior

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to proposed day of survey in that cluster so as to inform the individuals to stay at home. Each household in the selected segment were approached until 60 individuals with ≥40 years were identified. If the particular segment had less than 60 eligible individuals, then the next segment were selected randomly to reach to the number 60. Prevalence of URE assumed was 10% (Lower prevalence of range 10 - 25% is taken). Power used was 80% and relative precision was taken as 20%. We assumed 90% response rate and 95% confidence interval. Design effect was taken as 1.6 (cluster size 60). Based on this a sample size of 1536 was calculated. According to probability proportional to size a total of 26 clusters were chosen.

Survey team

One survey team comprised of 2 ophthalmic assistants, 2 field worker and 2 volunteers. Ophthalmic assistants (OAs) were given one week training for RAVI at base hospital, an NGO working in the rural-tribal area of Surat district (applicant is employed there as an ophthalmologist). Training of the team included aims and objectives, background, Importance and Methodology of the RAVI survey, protocol for examination of individuals, recognizing common blinding conditions, VA examination for OAs with exercise, filling up of questionnaire for OAs with exercise, Inter-observer variation assessment between OAs, Data entry exercise for data entry operator, prescribed role and duties of OAs, field workers, volunteers and cluster informer. Intra and inter observer agreement of ophthalmic assistants was assessed during their training in pilot study was found to be within acceptable range. (Kappa coefficient was > 0.60).

Study definitions

URE was defined as presenting available vision < 6/18 but improving to ≥ 6/18 with pinhole. Presbyopia was defined as binocular near vision < N8 among individuals ≥ 40 years having normal distant visual acuity (≥ 6/18). Presenting, best corrected and pinhole vision was assessed using chart at the distance of 6 meters. Near vision was tested using N chart for near at working distance of approximately 33 - 35 centimetres.

Spectacle coverage was calculated as proportion of met need versus total need (met + unmet need) among respective ages. Met need is number of individuals using spectacles that have binocular presenting vision < 6/18 but improved to ≥ 6/18 with spectacles. Unmet need is defined as individuals having UREs and who potentially improve visual acuity should they use spectacles. Met need for presbyopia is who are having presenting near vision < N8 and improving to ≥ N8. Unmet need being presenting near vision < N8 but improves to ≥ N8 with correction. Formula for calculating spectacle coverage: [met need/ (met need+ unmet need) x 100] %.

Visual acuity (VA) examination

VA was measured using Snellen's chart with tumbling 'E' optotypes. Each eye was tested separately by closing other eye with an ocluder. Subjects were shown 'E' optotype of size 18 of the chart at the distance of 6 meters. One rope having knot at 6 meter distance was used to measure the distance. First 'E' size 18 was shown. If they can't see size 18 at 6 meters then pinhole vision was measured and if not, they were referred for detailed eye exam on agreed day at base hospital. Participants with age ≥ 40 years were tested for near vision irrespective of their distant vision. If one is able to see distance VA ≥ 6/18 and near VA ≥ N8, then no further procedure required of him. Subjects should answer correctly four consecutive 'E's or 4 out of 5 answer correctly for the forms to be finally filled. If one failed to do that, VA testing was carried out second time as if it had been started first time. Participants were examined with torch in side house or semi-dark room for gross eye problem. For spectacle coverage, questionnaire had questions regarding source of spectacles they were currently using.

Data management

Data so obtained was entered into the SPSS statistical analytical software by data entry operator. This was done on daily basis after the team returned from the survey. Corrections and double data entry check was performed by the same person using consistency check menu of the software and was analysed. Prevalence estimates with 95% confidence interval (CI) were calculated. Odds ratio with 95% CI was calculated to describe the strength of associations. Multiple logistic regression analysis was used to analyze demographic associations of UREs and spectacle wear in relation to age, gender and education.

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Ethical clearance

The study adhered to the principles and guidelines of Helsinki declaration. Ethical clearances were obtained from ethical committee, Tejas Eye Hospital, DivyaJyoti trust, Mandvi, Surat district, Gujarat state, India. Written informed consent was taken from the all participants of the study.

Results

A total of 1487 individuals were available for examination out of 1560 enumerated. The study had overall response rate of 95.3% (90.8% among males and 99% among females). There were totally 73 non-responders out of which 71 were not available and 2 refused. The mean age of men was 52.25 and that of women was 51.79 (Average 52.02 years). There were 41.8% males and 58.2% females in the study and 51.4% were educated (males 51.96% and Females 48.04%). More women were available for examination compared to males (P value 0.000).

Sex	Total Eligible n (%)	Examined n (%)	Not Available n (%)	Refused n (%)	Coverage %
Male	685 (43.9)	622 (41.8)	62 (87.3)	1 (50)	90.8
Female	875 (56.1)	865 (58.2)	9 (12.7)	1 (50)	98.8
Total	**1560 (100)**	**1487 (100)**	**71 (100)**	**2 (100)**	**95.3**

Table 1: Response rate and coverage.

Refractive errors

Prevalence of refractive error was 16.75% (249/1487) (95% CI: 14.93 - 18.73). Age and sex adjusted prevalence of RE was 17.26% (95% CI 15.1 - 19.4).

They were corrected (met need) in 95 and not corrected (unmet need) in 154 individuals. This gave spectacle coverage for refractive errors as being 38.2%. Spectacle coverage was not found to be associated with age, gender, level of education and place of living (Table 2).

	Total (n)	Met need (n)	Unmet need (n)	Spectacle Coverage (%)	P value
Age groups (years)					0.11
40 - 49	762	35	35	50	
50 - 59	347	29	53	35.4	
60 - 69	263	22	48	31.4	
70+	115	9	18	31	
Gender					0.6
Male	622	47	71	39.8	
Female	865	48	83	36.6	
Education					0.26
Illiterate	723	31	50	38.27	
Primary level	448	28	59	32.2	
Secondary + level	316	36	45	44.4	
Area					0.15
Rural	463	21	47	30.8	
Urban	1024	74	107	40.8	
Total	**1487**	**95**	**154**	**38.2**	

Table 2: Spectacle coverage for refractive errors.

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Table 3 reveals that the risk of having RE increases significantly with age. The risk of having RE among people of age 50 - 59 is 3 times as compared to people of age 40 - 49. This risk will further increase to 3.6 times among age group 60 - 69. The education level was also associated positively with the risk of refractive errors. No significant association was observed by gender or place of residence.

	Odds (95% CI)	P value
Age		
40-49	1	-
50-59	2.97 (2.09 - 4.21)	0.000
60-69	3.63(2.51 - 5.25)	0.000
70+'	3.02(1.84 - 4.96)	0.000
Gender		
Male	1	-
Female	0.78 (0.59 - 1.04)	0.095
Residence		
Rural	1	-
Urban	1.30 (.94 - 1.78)	0.110
Education		
Illiterate	1	-
Primary level	2.21 (1.54 - 3.17)	0.000
Secondary + level	3.72 (2.54 - 5.45)	0.000

Table 3: *Refractive errors with its demographic association (Multiple logistic regression analysis).*

Presbyopia

Presbyopia was present in 566 of total 1092 (prevalence: 51.8%, 95% CI: 48.87 - 54.75) individuals without visual impairment for distance. Met and Unmet needs for presbyopia were present in 220 and 346 individuals respectively and spectacle coverage was 38.86% (Table 4).

	Total no. (n)	Met need (n)	Unmet need (n)	Spectacle Coverage (%)	P value
Age groups (years)					0.09
40 - 49	684	123	169	42.12	
50 - 59	237	68	96	41.46	
60 - 69	129	24	61	28.23	
70+	42	5	20	20	
Gender					0.00
Male	445	118	118	50	
Female	647	102	228	30.9	
Education					
Illiterate	531	79	176	30.9	0.00
Primary level	338	87	114	43.28	
Secondary + level	223	54	56	49.1	
Area					0.07
Rural	337	85	131	39.35	
Urban	755	135	215	38.57	
Total	**1092**	**220**	**346**	**38.86**	

Table 4: *Unmet need and spectacle coverage for presbyopia.*

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Spectacle wear

The prevalence of current spectacle use was 35.31% (95% CI: 32.92 - 37.77, 525/1487) at the time of examination. There were 3.81% (20/525) (95% CI - 2.48 - 5.81) people using spectacles for distance, 72.57% (381/525) (95% CI - 68.60 - 76.21) were using spectacles for near and 23.62% (124/525) (95% CI - 20.19 - 27.44) were using spectacles for both distance and near (Bifocals) (Table 5). Only 27 people (1.7%) reported previous use of spectacles.

	Type of Glass			
	Distance **n (%)**	**Near** **n (%)**	**Bifocals** **n (%)**	**Total** **n (%)**
Age groups (years)				
40 - 49	6 (30)	170 (44.6)	38 (30.5)	214 (40.3)
50 - 59	4 (20)	125 (32.8)	44 (35.5)	173 (33)
60 - 69	7 (35)	64 (16.8)	28 (22.6)	99 (18.9)
70+	3 (15)	22 (5.8)	14 (11.3)	39 (7.4)
Gender				
Male	8 (40)	192 (50.39)	65 (52.4)	265 (50.5)
Female	12 (60)	189 (49.6)	59 (47.58)	260 (49.5)
Education				
Illiterate	10 (50)	131 (34.4)	37 (29.8)	178 (33.9)
Primary level	3 (15)	147 (38.6)	50 (40.3)	200 (38.1)
Secondary +level	7 (35)	103 (27)	37 (29.8)	147 (28)
Area				
Rural	6 (30)	79 (20.7)	31 (25)	116 (22)
Urban	14 (70)	302 (79.3)	93 (75)	409 (78)
Total	**20 (100)**	**381 (100)**	**124 (100)**	**525 (100)**

***Table 5:** Spectacle details for distance, near corrections and bifocals.*

Discussion

Age group ≥ 40 years is considered productive one and they remain blind or visually impaired because of scarcity of the RE services and might adversely affect their productivity and as result increase socio-economic burden on the society. Several studies estimated annual global economic burden of more than US$ 200 billion due to uncorrected refractive errors and US$ 28 billion for uncorrected presbyopia [9-13].

Surat district is more urbanised than any other districts of Gujarat with blooming industries and thus draws people from other states as it is most industrialized one. A good distant and near vision is required for every person working in rural-tribal or semi-urban areas. The age group of people employed in diamond polishing, rayon companies etc are relatively younger and their work demands good near vision. Women also need near correction for their most of the household chores.

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This study found high prevalence of uncorrected refractive errors, presbyopia and low spectacle coverage in the study area of Surat district of Gujarat state of India. In India, the prevalence of blindness is 1.0% and as far as main cause of blindness is concerned URE stands second with 19.7% just after cataract which is 62.6% [14]. There are estimated 6.7 million blind people (presenting visual acuity < 6/60 in the better eye) due to URE-one fifth of total blindness [13]. However, definition used in India is different than the WHO definition which defines blindness as visual acuity of < 3/60. This is due to categorization of blindness as a social and economical one in Indian definitions. Latest survey (2006-07) conducted in Navsari district of Gujarat state, suggests that though cataract still remains major cause of bilateral blindness, UREs (35.4%) were the main cause of visual impairment (presenting visual acuity < 6/18 to 6/60 among people 50 years just after cataract (50%) and (86.6%) in the eye with visual acuity < 6/9 to 6/18 [15]. In the same study prevalence of UREs was 21%. Another study suggested prevalence of 26% for UREs in south India [16]. Therefore, if presenting VA is considered, UREs are the second largest cause of treatable blindness after cataract and treatment is just to prescribe a pair of glasses.

The prevalence of functional presbyopia in this study was 51.8%. In some south Indian studies based on unaided near vision, the prevalence of presbyopia was found to be around 50% [17,18]. One study in Tanzania has demonstrated that prevalence of presbyopia was 62% and affected individuals had comparatively more difficulties to perform near tasks than those not affected and they are twice as dependant as their counterparts with normal vision [12]. This means there is negative impact on productivity of people with presbyopia.

This study has shown that there is a huge unmet need for both UREs and presbyopia with spectacle coverage for refractive errors and presbyopia being 38.2% and 38.86% respectively. In some studies s done in India spectacle coverage for Refractive errors was 43.2% to 53.6% while in some it was low with Spectacle coverage being 28.4% for refractive errors and 11.1% for presbyopia [17,19]. In Pakistan one study showed overall met need-spectacle coverage for 6/12 and 6/18 cut off as 15.1% and 19% respectively and in Bangladesh with same cut off as 25.2% and 40.5% (presenting VA in both the counties) [20,21]. In Andhra Pradesh state of India surveys suggested prevalence of current use of spectacle as 17.4% and 29% in 2001 and 2009 respectively [22,23]. Another study reports just one third (30%) of people with presbyopia were currently using spectacles [18]. So, need for RE and presbyopia correction is high in India. There were 3.81% (20/525) (95% CI - 2.48 - 5.81) people using spectacles for distance, (95% CI: 68.60 - 76.21). Majority of them were using spectacles for near 72.57% (381) followed by bifocals 23.62% (124) but contrary to this near vision glasses were used less in some studies [23,24].

The impact of UREs is many folds and may include loss of educational, employment and economic opportunities [13]. These together suggest that we have a huge gap to fill with regards to spectacle provision for distance and near is concerned. Both corrections just need pair of glasses and no complicated surgical intervention needed. Near vision correction is even easier by just providing readymade glasses of less than a third of American dollar in India. Productivity of a person can be increased manifolds by just providing them with a pair of spectacles. This also means that UREs and presbyopia can become a huge market for customized or readymade spectacles and is a very good way to introduce sustainability into the hospitals without being dependant on the external funding which is one of the goals of vision 2020- right to sight.

Recommendations

1. Prevalence of UREs and Presbyopia is high and this needs to be addressed as soon as possible.

2. Spectacle coverage for UREs and presbyopia is less and this age group is easily reached target population which is 40+ years.

3. The spectacle coverage is less in both rural and urban areas. So we need to plan for free/subsidized/paid spectacles distribution in the district particularly in rural area where accessibility to provide spectacles is less.

4. Custom made and Ready-made spectacles can address this problem.

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Conclusion

The unmet need of uncorrected refractive errors and Presbyopia particularly in productive age group is of higher concern in Surat district. There should be effective free/subsidized spectacles distribution system in place for both UREs and presbyopia. Custom made spectacles for UREs and Ready-made spectacle for near vision is very cheap remedy which can improve quality of life as well as productivity of young people. This is the first of its kind baseline data which will definitely be useful in planning eye care services in the district.

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Conflict of Interest

There is no conflict of interest to share.

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