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ORIGINAL RESEARCH

Understanding Presbyopia in Asmara: Prevalence, Association with Refractive Error, and Age-Based Addition

Tsige Mnasie Smret[1], Rahel Kesete Weldegergis[2], Oliver Okoth Achila[3], Alexander Mulugeta Tekle[4]

[1]Department of Optometry, Biet Mekae Community Hospital, Asmara, Eritrea; [2]Department of Optometry, Vision Express Eye Care Clinic, Addis Ababa, Ethiopia; [3]Department of Clinical Laboratory Science, Orotta College of Medicine and Health Sciences, Asmara, Eritrea; [4]Department of Optometry, Hazhaz Zonal Referral Hospital, Asmara, Eritrea

Correspondence: Tsige Mnasie Smret; Rahel Kesete Weldegergis, Email tsigemnasie@gmail.com; rachelkesete@gmal.com

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Background: Presbyopia is an age-related progressive decrease of near vision, corrected by near addition glasses. These age-appropriate glasses, however, vary across different geographical locations and populations. But there is no existing information on the age-based addition for Asmara and high number of uncorrected presbyopes, so this study determined the required age-based addition for the presbyopes in Asmara.

Methods: A cross-sectional study was conducted on patients aged 35–60 years who visited all eye centers in the city. Patients with best-corrected visual acuity in both eyes better than 6/9 were included in the study. Near add was calculated using Monocular Estimation Method (MEM) and amplitude of accommodation results. Data entry and analysis were performed using Statistical Package for the Social Sciences v. 20.

Results: This study included 1310 participants of whom 48.5% were females and 51.5% were males. The prevalence of presbyopia was found to be 74.1% out of which 44% were females. There were 35.6% of the participants with a previous prescription for glasses, though only 24% of the participants presented with glasses on. Among the different occupational categories, laborers were the ones who had the highest number of presbyopes (79.5%), office workers (73%), and housewives (68.7%). The mean age of those with presbyopes was 49.5 ± 5.8 years. Multivariable analysis performed for presbyopia showed that older age and female sex were associated with a higher likelihood of presbyopia (<0.005). An addition table was prepared separately for males and females. On post-hoc tests, no significant association was found between the given and the different refractive status.

Conclusion: The study showed that there is a high level of uncorrected presbyopes in the city, so the availability of refraction sites and glasses accessibility needs to increase. The near addition demand for this population varies from the previously stated amount in other countries. Therefore, guidelines specifically prepared for a society are necessary.

Keywords: presbyopia, near addition glasses, Asmara, amplitude of accommodation

Introduction

According to Global Burden of Disease in 2020 presbyopia was estimated to be the cause of vision impairment in 510 million people of whom 280 million were females.[1] It was estimated to affect 1.8 billion people around the globe in 2015, with an unmet need of 45% globally.[2] The global productivity loss of working-age group (>50 years) was estimated at US $11 billion annually in 2011 because of uncorrected and under-corrected presbyopia.[3] As life expectancy and demand for clear vision are increasing, presbyopia poses a significant public health concern.

Various studies have been conducted in different countries on the prevalence of presbyopia and its impact on quality of life of their individuals. In population based cross-sectional studies conducted in Japan and Kenya the prevalence of presbyopia was 43.8% and 25.1% in those above 30 years of age,[4,5] in Haryana, India in those above 35 years there was prevalence of 42.9%.[6] A study conducted in Nigerian school teachers in the age range of 30–61 years had a prevalence of 81.3%[7] with 38.5% of them without correction; a similar study conducted in Gondar, Ethiopia in school teachers found a prevalence of presbyopia of 68.7%. In Ghana it was 68.1% with an unmet need of 54.1%.[7–9]

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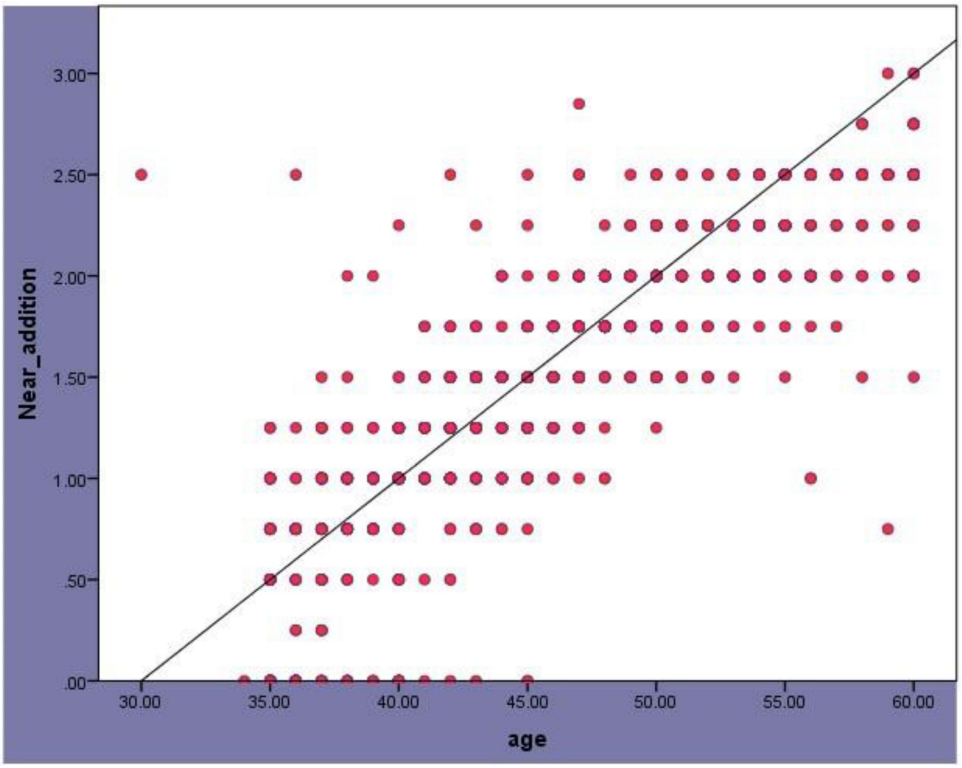


Figure 1 Near addition distribution across the age groups.
Notes: Vertical line = near addition. Horizontal line = age. Figure 1 illustrates the result of post hoc tests which were run on the addition across the age groups and the result showed there was a significant difference in the addition across the different age groups with a p-value of <0.001.

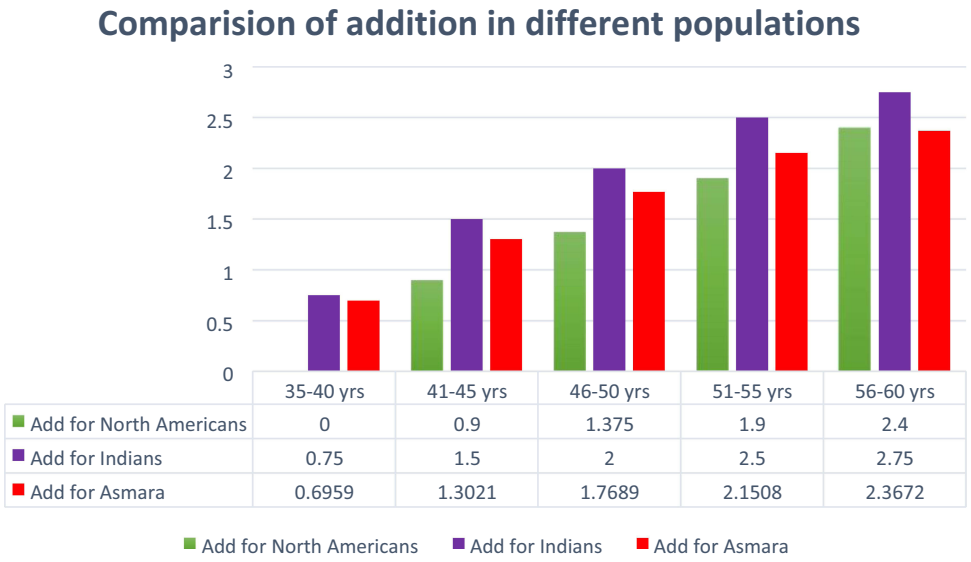


Figure 2 Comparison of the addition of different populations.
Notes: Vertical line = near addition values. Horizontal line = age groups. The variation in addition for these populations is illustrated in Figure 2.

Presbyopia is an age-related visual impairment that results from the gradual decrease in accommodation expected with age. It affects quality of vision and quality of life (QoL).[10] It comes from the gradual thickening and loss of viscoelasticity of the crystalline lens. Blurred vision and asthenopia at near working distance are hallmarks of

presbyopia.[10,11] As Hickenbotham et al have stated gender, occupation, arm length, solar radiation and refractive error are some of the factors that affect the age of onset of presbyopia.[12] Presbyopia starts to become functionally apparent around 40 years old and affects individuals for a considerable part of their working life.

The adoption of digital technology and the internet for social and professional purposes has made near vision a necessity owing to increased screen time. Lack of clear near vision also affects regular reading, office work and manuscript working negatively.[13] A study conducted in Nigeria on the quality of life of people aged greater than 40 in 2015 found a decrease in quality of life by 22%[14] and another literature review done by Berdahl et al in 2020, stated uncorrected presbyopia has caused a 2-fold increase in difficulty in near vision related activities, and an 8-fold increase in difficulty in very demanding near vision related tasks.[3]

The only study done on presbyopia in Eritrea was done in 2013, a community based study conducted in Zoba Maekel. It found a prevalence of presbyopia of 32.9% with only 9.9% spectacle coverage. There is no other study in the rest of the country or a newer study showing the current status of presbyopia in Eritrea. But based on the 2013 study, there is a large load of unmet presbyopia requirements.[15] The main objective of this study was to determine an age-appropriate presbyopic correction for Asmara inhabitants. The observation of other variables such as age, gender, occupation, refractive error, and finding out the prevalence of presbyopia and other demographic details were sub-objectives of this study.

Methods

Study Design, Population and Settings

This was a hospital-based cross-sectional study performed on all patients visiting hospitals during the course of the study. The study population were the inhabitants of Asmara whose population is 613,512, according to a 2013 study of the office of demographics of Asmara. This study was conducted at Biet-Mekae Community Hospital, Godaif Community Hospital and Brhan Ayni Referral Eye Hospital in Asmara from June to September 2017.

Sample Size Determination and Sampling Procedure

$$n = z^2(p \times q)/e^2$$

Where:

n = sample size; z = 1.96 (with confidence interval 95%);

e = 0.03 (error of acceptance); p = 0.5 (probability of occurrence);

q = (1-p); n = 385

The sample size calculation yielded a sample size of 385, to strengthen the results of the study 1310 participants were included. The sampling procedure was as follows: anyone who visited the hospital during the study period.

Inclusion and Exclusion Criteria

The inclusion criteria were living in Asmara, age 35–60 years, a best-corrected visual acuity (VA) of 6/9 or better in both eyes. Participants with anisometropia greater than 1.5 diopter spherical (DS) and binocular vision problems (amblyopia, strabismus, nystagmus or monocular patients) were excluded. Aphakic or pseudophakic participants were also excluded and those with ocular or systemic pathologies that could affect their accommodation or fusional vergence. Patients taking medication that could affect accommodation were excluded.

Examination Procedures and Measurements

The following procedures were performed as per the following sequential order on the participants to determine the near addition.

Performa: was used to record the participants' profile; their age, gender, job, address and examination results. Based on their occupation the participants were classified as office workers, housewives or laborers to provide an idea about their daily sun exposure.

Visual acuity: was measured using ICEE Snellen E chart at 2.5 meters under ambient indoor illumination, both eyes monocularly and the measurement was stopped at 6/6. Near VA was obtained using a LVRC Bailey-Lovie Near chart, it was measured in both eyes monocularly at 40 cm and it was stopped at Log MAR 0.00.

Ocular exam: an anterior segment exam was performed using a Haag Streit slit lamp and the posterior segment exam was performed using Keeler direct ophthalmoscope.

Static dry retinoscopy: was performed in a darkened room with the patient fixating on the distance chart and the working distance lens placed on the trial frame.

Subjective refraction: was performed binocularly with a fogging lens placed on one eye while refraction is done on the other eye. The retinoscopic result was used as the starting point, and the maximum plus that gave the best VA was taken as the end point of refraction. Those with best-corrected monocular VA less than 6/9 were excluded.

Dynamic retinoscopy: the monocular estimation method was used with the results of the subjective refraction on place and Tigrinya letters as target at 40 cm, the customary working distance. The result was used as the baseline for the subjective verification of the near addition after reducing +0.75 DS for lag of accommodation.

Amplitude of accommodation: was measured afterwards using the push-up method with the Royal Air Force (RAF) rule using target of 0.7 Log MAR.

Near addition: the dynamic retinoscopy result was used as a starting point after reducing 0.75 DS for lag of accommodation. Subsequently, subjectively verified until VA of 0.00 Log MAR was reached.

Procedure: Inter Observer Agreement Study

The agreement between the three examiners was evaluated before the start of the study by evaluating the same 5 participants. The study commenced after the examiners agreed in their results to 0.25 DS.

Operational Definitions

Presbyopia: participants were defined as presbyopic if they were unable to read 20/50 optotype at 40 cm in ambient room illumination with distance correction in place and their VA improved by at least one line with 1 DS.[16]

Near add: lens power which enabled patients to read the 0.00 Log MAR with the minimum plus at 40 cm.[17]

Data Analysis

The obtained data were entered into SPSS version 20, and various statistical tests were run on the software. For two-by-two variables Fisher's exact test was performed, for variables with more than two values; however, one-way analysis of variance (ANOVA) was used. Automatic linear progression was performed to determine the effect of the variables on the given addition in terms of their predictive importance. To see the effect of refractive error on the near addition, the participants were regrouped based on their refractive status and one-way ANOVA was run on them. A confidence interval of 95% was taken and a p-value less than 0.05 was considered significant.

Ethical Considerations

Ethical approval was obtained from the Ethics Committee of Asmara College of Health Sciences and Ministry of Health of Eritrea, after they have proved that the study follows the Helsinki Declaration. The ethical committee approved of obtaining an informed verbal consent from the participants prior to the examination.

Results

Demographic Characteristics

This study included 1310 participants of whom 48.5% were females and the remaining 51.5% males. It included people of varying occupations who were classified as office workers, laborers and housewives. Table 1 shows the demographic distribution of the participants, and the number of participants who had refraction performed for them previously.

Table 1 Demographic Distribution of Participants

Categories	Previous Refraction		P-value (x^2)	Total
	Yes	No		
Gender				
Female	228 (35.9%)	407 (64.1%)	0.818 (0.06)	635 (48.5)
Male	238 (35.3%)	437 (64.7%)		675 (51.5)
Age				
35–40 years	61 (20.9%)	231 (79.1%)	< 0.001 (91.245)	292 (22.3%)
41–45 years	84 (26.9%)	228 (73.1%)		312 (23.8%)
46–50 years	128 (38.1%)	208 (61.9%)		336 (25.6%)
51–55 years	88 (45.4%)	106 (54.6%)		194 (14.8%)
56–60 years	105 (59.7%)	71 (40.3%)		176 (13.4%)
Occupation				
Office worker	203 (40.3%)	301 (59.7%)	0.019 (7.946)	504 (38.5%)
Housewife	112 (32.3%)	235 (67.7%)		347 (26.5%)
Labour worker	151 (32.9%)	308 (67.1%)		459 (35.0%)
Address				
South east	99 (36.7%)	171 (63.3%)	0.073 (6.981)	270 (20.6%)
North east	115 (35.1%)	213 (64.9%)		328 (25%)
South west	109 (30.7%)	246 (69.3%)		355 (27.1%)
North west	143 (40.1%)	214 (59.9%)		357 (27.3%)
Refractive error				
Hyperopic	189 (44.4%)	235 (55.6%)	<0.001 (52.038)	423 (32.3%)
Emmetropic	177 (26.7%)	488 (73.3%)		663 (50.6%)
Myopic	68 (42.2%)	95 (57.8%)		161 (12.3%)
Mixed Astigmatism	32 (56.1%)	25 (43.9%)		57 (4.4%)

Among those with a previous prescription only 54.3% presented with their glasses, the remaining 45.7% did not have their spectacles. Among those who presented with glasses 19.4% of them had no prescription and were near glasses they bought themselves. There was no significant difference in previous refraction between the two sexes.

Results of Ocular Examinations

Prevalence of Presbyopia and Associated Factors

Out of the 1310 participants 74.1% were found to be presbyopic and the remaining 25.9% were not yet presbyopic. Table 2 illustrates the percentage of presbyopic people found in the study across genders and occupations.

Multivariable Analysis of Factors Associated with Presbyopia

A multivariable analysis was performed on the variables to observe their association to presbyopia, and Table 3 shows the results of the analysis. As age had the highest level of association to presbyopia, the analysis was performed in two

Table 2 Prevalence of Presbyopia in Different Variables

Variables	Categories	Non-Presbyopic	Presbyopic	P value Chi-square
Overall		339 (25.9)	971 (74.1)	
Age				
	35–40 years	260 (89.3%)	31 (10.7%)	< 0.001 (832.3)*
	41–45 years	702 (2.4%)	242 (77.6%)	
	46–50 years	6 (1.8%)	330 (98.2%)	
	51–55 years	0 (0%)	194 (100%)	
	56–60 years	3 (1.7%)	174 (98.3%)	
Mean age±SD		38.87±3.4	49.49±5.77	<0.001
Gender				
Gender	Females	189 (29.8%)	448 (70.2%)	0.002 (9.70)
	Males	149 (22.2%)	524 (77.8%)	
Occupation	Office worker	135 (27%)	369 (73%)	0.002 (12.18)
	Housewives/unemployed	109 (31.3%)	239 (68.7%)	
	Labor	94 (20.5%)	364 (79.5%)	
Sub zone	South east	40 (14.8%)	230 (85.2%)	0.157 (5.86)
	North east	39 (11.9%)	289 (88.1%)	
	South west	51 (14.4%)	304 (85.6%)	
	North west	52 (14.6%)	305 (85.4%)	
Previous prescription	With prev. Px	30 (6.4%)	436 (93.6%)	< 0.001 (69.11)
	No prev. Px	152 (18%)	692 (72%)	

Note: *High association of age and addition.

steps. The first one included all the variables and observed their impact on addition, while the second one removed age and observed the association of the other variables with presbyopia.

Among the different variables observed to be associated with the given addition, only age and sex showed statistically significant association. For every increase in age by one year there was an increased risk of presbyopia by 1.76 times, and males were 0.67 times less likely to develop presbyopia than females of the same age.

Unmet Needs for Presbyopia

The study found that 35.6% of the study participants had a previous glass prescription but only 54.3% of them presented with their glasses. Among those who presented with glasses on, 19.4% of them had no prescription for their glasses, 83.6% of those who presented with glasses they had no prescription for were presbyopic. In the presbyopic population, 40.5% of them had a previous prescription and only 29.8% of the presbyopic had previous glasses on presentation.

Age Based Addition for Different Age Groups

The addition was affected by various factors, and factors such as age, gender, occupation affected it more significantly than others. Table 4 shows the addition determined in this study for males and females across all the age groups.

Table 3 Multivariate Analysis of the Factors Affecting Presbyopia Age Adjusted and Non- Adjusted

Age Included Analysis					Age Excluded Analysis			
Variables	**Crude OR (95% CI)**	**P value**	**Adjusted OR (95% CI)**	**P value**	**Crude OR (95% CI)**	**P value**	**Adjusted OR (95% CI)**	**P value**
Age	1.76 (1.64–1.88)	<0.001	1.76 (1.64–1.88)	<0.001				
Gender								
Females	1(Ref)	0.031	1(Ref)	0.051	1 (Ref)	0.059	1 (Ref)	0.051
Males	0.59 (0.36–0.95)		0.67 (0.45–1.00)		1.34 (0.99–1.83)		1.35 (0.99–1.84)	
Occupation								
Office worker	1(Ref)	0.156	1(Ref)		1(Ref)	0.037	1 (Ref)	0.037
Housewives/ unemployed	0.98 (0.55–1.73)	0.94	0.97 (0.55–1.67)		1.02 (0.72–1.45)	0.92	1.01 (0.71–1.44)	0.95
Laborer	1.53 (0.96–2.45)	0.077	1.76 (1.64–1.88)		1.47 (1.08–2.00)	0.014	1.47 (1.08–1.99)	0.015
Sub Zone								
South East	1 (Ref)	0.57			1 (Ref)	0.219		
North East	1.42 (0.77–2.6)	0.26			1.09 (0.74–1.61)	0.665		
South West	0.99 (0.55–1.79)	0.97			0.76 (0.53–1.10)	0.150		
North West	1.07 (0.6–1.93)	0.82			0.90 (0.62–1.32)	0.599		
Chief Complaint								
Vision comp.	1 (Ref)	0.96			1 (Ref)	0.666		
Ocular disease	1.06 (0.64–1.75)	0.82			1.15 (0.84–1.57)	0.396		
Discomfort	0.95 (0.40–2.22)	0.89			1.12 (0.65–1.92)	0.679		
Previous prescription								
With previous	1 (Ref)	0.92			1 (Ref)	<0.001	1 (Ref)	<0.001
No previous prescription	1.02 (0.64–1.63)				0.40 (0.30–0.54)		0.39 (0.29–0.53)	

Figure 1 illustrates the result of Post Hoc tests which were run on the addition across the age groups and the result showed there was a significant difference in the addition across the different age groups with a p-value of <0.001.

The near addition determined for this population was higher than the addition found in Chandigarh, India and lower than pointer determined for the North American population. This could be due to geographical factors as Miranda stated or genetic and racial differences.Figure 2[18–20]

The Influence of Refractive Error on the Age Based Addition

To see the effect of distance refractive error on the near addition, a post-hoc-Tukey and one-way ANOVA tests were performed. The significance of the difference of the given addition across the different refractive status on one-way ANOVA was that it was significant in the age group of 35–40 years, but as age increased the difference in addition significantly decreased.

Table 5 shows the results of the required addition by the different refractive status and the significance of this variation. The post hoc tests revealed that the given addition was similar across all the refractive status in all age groups except between hyperopia and emmetropia in the 35–40 years age group ($p < 0.001$) and again in the 41–45 years age group ($p = 0.003$). The remainder showed that refractive error had no significant effect on the near addition.

Table 4 Addition Table for the Different Genders Across the Age Groups

Gender	Age Groups	N	Addition	Standard Deviation	Lower Bound	Upper Bound	ANOVA P value (F)
Females	35–40 years	181	0.75 DS	0.48	0.68	0.82	<0.001 (425.7)
	41–45 years	149	1.35 DS	0.27	1.31	1.40	
	46–50 years	152	1.81 DS	0.28	1.76	1.85	
	51–55 years	81	2.18 DS	0.28	2.12	2.24	
	56–60 years	72	2.35 DS	0.31	2.28	2.43	
Males	35–40 years	111	0.60 DS	0.41	0.52	0.68	<0.001 (05.63)
	41–45 years	163	1.25 DS	0.36	1.20	1.31	
	46–50 years	184	1.75 DS	0.29	1.69	1.78	
	51–55 years	113	2.13 DS	0.24	2.08	2.18	
	56–60 years	104	2.38 DS	0.31	2.32	2.44	
All	35–40 Years	292	0.70 DS	0.46	0.64	0.75	<0.001 (914.97)
	41–45 Years	312	1.30 DS	0.32	1.27	1.34	
	46–50 Years	336	1.77 DS	0.29	1.74	1.80	
	51–55 Years	194	2.15 DS	0.26	2.11	2.19	
	56–60 Years	176	2.37 DS	0.31	2.32	2.41	

Table 5 Near Addition to Different Refractive Status

Age Category	Refractive Error	N	Near Addition	Anova p value (F)
35–40 years	Emmetropic	201	0.61	<0.001 (11.51)
	Hyperopic	57	0.99	
	Myopic	28	0.66	
	Mixed astigmatism	5	1.00	
41–45 years	Emmetropic	174	1.27	<0.007 (4.08)
	Hyperopic	93	1.40	
	Myopic	29	1.22	
	Mixed astigmatism	16	1.22	
46–50 years	Emmetropic	156	1.77	<0.029 (3.04)
	Hyperopic	114	1.80	
	Myopic	49	1.67	
	Mixed astigmatism	14	1.86	

(*Continued*)

Table 5 (Continued).

Age Category	Refractive Error	N	Near Addition	Anova p value (F)
51–55 years	Emmetropic	89	2.16	<0.019 (3.41)
	Hyperopic	68	2.18	
	Myopic	24	2.01	
	Mixed astigmatism	12	2.25	
56–60 years	Emmetropic	43	2.31	<0.446 (0.89)
	Hyperopic	91	2.38	
	Myopic	31	2.37	
	Mixed astigmatism	10	2.48	

Table 6 Predictive Factors for Addition

Categories	Variables	Coefficient	Significance	Importance
Addition	Age	0.061	0.00	0.774
	AA	−0.138	0.00	0.199
	Gender	0.085	0.00	0.014
	Refractive error	−0.061	0.001	0.009
	Occupation	0.049	0.005	0.004

Factors Affecting Near Addition

Logistic regression analysis was performed to determine the influence of different variables on addition. The included variables were age, refractive error, occupation, sex, and amplitude of accommodation (AA), which were assessed to determine their predictive importance. Table 6 shows the result of the logistic regression. Among those variables those that displayed importance values less than 0.005 are not shown in the table. The result showed that age had the highest predictive importance of all other variables (0.774), an increase in age was directly proportional to near addition.

Discussion

Prevalence of Presbyopia

In this study, the prevalence of presbyopia was 74.2%, this is significantly higher than similar studies conducted in Brazil (54.7%),[21] south India (55.3%),[22] Tanzania (62%),[23] and Nigeria (30.4%).[24] The prevalence was higher with increasing age as shown in Table 3; for every 1-year increase in age there was a 1.785 times risk of developing presbyopia after the age of 35 years, matching the results of a Tanzanian study.[16]

The prevalence of presbyopia differs according to gender and occupation as demonstrated in Table 2. Among 1310 participants 48.7% were female, out of which 70.2% were presbyopic; in the case of males, they contributed to 51.3% of the total participants and 77.8% of them were presbyopic. This higher prevalence of presbyopia in males observed was different from a Brazilian study that found a higher prevalence in females.[21] But this result could be attributed to the fact that the females were younger, with a mean age of 45 years, while the males had an average age of 47 years.

In terms of occupation, prevalence of presbyopia varied again. Laborers had a higher prevalence of presbyopia at 79.5%, followed by office workers among which 73% were presbyopes. The odds ratio were 1 for laborers, 0.628 for office workers, and 0.618 for housewives/unemployed within the same age group. This contradicted a Brazilian study, in

which presbyopia prevalence increased with an increasing level of education,[21] but the findings of Abdulrhman et al clarifies this stating that by having more exposure to the sun, there is a higher ocular temperature which in turn facilitates presbyopia onset.[25]

When previous refraction is considered, ie participants who had previous eye exams and glasses prescribed for them, there was no significant association between gender and previous refraction with a p value of 0.8. But there was a significant association of previous refraction with age and occupation having p values respectively 0.001 and 0.019. This shows that increasing age and having office work were strongly associated with the likelihood of having ocular exams and glasses prescribed. There was no significant association with the address of the participants and previous glass prescription.

Variables Associated with Near Add

According to the study results, addition had the strongest association with age (p = 0.00). In Table 6 the logistic regression data shows that age had a predictor importance of 0.774 and the highest value, followed by AA with a predictor importance of 0.199 and the logistic regression had an accuracy of 75.1%. There was a direct relationship of increasing addition with age, with a coefficient of 1.643 in the age group of 35–40 years, later this coefficient decreased. The study result showed that for every five years of age there was an increase in the given addition by 0.4–0.5 DS. This was in line with Duane's[26] and Donder's[27] studies who both worked in European populations stating that AA decreases with age which in turn raises the given addition; in their study groups the age of onset of presbyopia was 45 years. A Bolivian study found that the onset of presbyopia was at 38 years and their AA was lower than Duane's study group. This variety of AA caused due to geographical difference also resulted in a variety in addition.

The addition power for this population was higher than that determined for the North American population but lower than that reported in Chandigarh, India.[18] Figure 2 demonstrates a graphic representation of this variation. This variation could be due to geographic variation, average temperature difference in which the average annual temperature of Chandigarh is 28.9 °C, while Asmara's temperature is 15.6 °C, as Miranda previously stated that the average temperature had the highest impact on the onset of presbyopia.[20]

The addition accepted by female participants was higher than males of the same age category, similar to the findings of Andrew et al. This could be due to a shorter working distance preference in females as stated by Hickenbotham et al and their lower AA.

Near Addition and Refractive Error

In this study the majority of participants, 636 (48.5%), were emmetropic, 480 (36.6%) were hyperopic, and 194 (14.8%) were myopic. The results showed that there was no statistically significant difference in addition among the different refractive statuses except between emmetropic and hyperopic groups in age groups 35–40 years and 40–45 years.

This study obtained valuable information on presbyopes and examined other variables that may have an impact on presbyopia in an area with scarce similar information. However, the inter-observer difference of 0.25 DS could be a source of imprecision in the results. The results can be used as baseline data for future studies in the region and the stated variables can help renovate clinical presbyopia management and identify patients early by identifying risk factors.

Limitations

There was an inter-observer difference in the refraction of 0.25 DS, which could have caused a certain discrepancy in the results.

Conclusion

The study has found a high number of uncorrected presbyopes in Asmara, poor adherence to their previously prescribed glasses, and also a high association of presbyopia with the female gender. It has also determined the near-addition table, which will facilitate the management of the high number of uncorrected presbyopes in the city. Therefore, an increased

access to affordable glasses and vision programs that target women is advisable in the city. The study showed that there is a significant difference in the required addition for different populations owing to various environmental and genetic factors, therefore determination of addition, primarily in areas identified with high number of uncorrected presbyopes, is a prudent step.

Abbreviations

AA, amplitude of accommodation; DS, diopter spherical; MAR, minimum angle of resolution; MEM, monocular estimation method; RAF, Royal Air Force; VA, visual acuity.

Supporting Documents

The data-set supporting the findings of this article is available from the corresponding authors.

Ethics Statement

Ethical approval for the study was issued from the Eritrean Ministry of Health.

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Author Contributions

All authors made a significant contribution to the work reported whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests.

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