

2
3 **Presbyopia and Vision-Related Quality of Life in**
4 **Calabar South, Nigeria**

5
6
7
8
9 **ABSTRACT**
10

Aim: To determine the magnitude of presbyopia and the effect of uncorrected presbyopia on vision-related quality of life in Calabar South, Nigeria.

Study Design: A community-based, descriptive cross-sectional study.

Place and Duration of Study: Calabar South Local Government Area, Nigeria, between November 2016 and February 2017.

Methods: We included 422 adults (198 men, 224 women) aged 35 years and above, selected by cluster random sampling. Subjective distance refraction was done on all participants with distant visual acuity less than 6/6. Near visual acuity was assessed at 40 centimetres with a Times Roman near vision (British N system) chart, with distant correction in place if required. Presbyopia was defined as inability to read N8 at 40 centimetres unaided or with habitually worn distance refractive correction, with improvement of near vision by at least one line on a Times Roman near vision chart with use of a plus lens. An adapted and validated quality of life questionnaires were administered to the participants.

Results: A total of 422 participants were examined and interviewed. The prevalence of presbyopia was 55.5%. There was no significant association between gender and prevalence of presbyopia. The presbyopia correction coverage in the study population was 38.0% with a strong positive correlation between age and the required near vision spectacle lens power ($r = 0.88, p < .001$). Another key finding was a significant association between uncorrected presbyopia and reduced quality of life.

Conclusion: This study has demonstrated that the burden of presbyopia in the study

population is enormous in spite of the fact that it has a cost effective intervention. The key findings in this study underscore the need to scale up presbyopic correction services in the study area.

11

12 *Keywords: Presbyopia, quality of life, Calabar South, Nigeria*

13

14

15

16 **1. INTRODUCTION**

17

18 Presbyopia refers to an age-related loss of accommodation of the crystalline lens that results

19 in an inability to focus at near distances. It is the most common physiological change

20 occurring in the adult eye and is believed to cause universal near vision impairment with

21 advancing age.[1] The amplitude of accommodation decreases with age and symptoms may

22 manifest about the age of 40 years. Symptoms may, however, start earlier or later than this

23 age depending on the refractive state of the patient's eyes, their visual needs and depth of

24 focus among other variables such as residence in the tropics.[2] Variables associated with

25 either earlier onset or increased severity of presbyopia include: female sex, increasing age,

26 higher educational background and urban residence.[3]

27

28 About 1.1 billion people have been estimated to have near vision impairment simply because

29 they do not have a pair of spectacles.[4] This global prevalence of presbyopia is predicted to

30 increase to 1.4 billion by 2020 and to 1.8 billion by 2050.[5] The prevalence of presbyopia in

31 low- and middle-income countries is not well known, as most studies of refractive error in

32 these countries have been limited to distance vision.[1] There are few studies on presbyopia

33 that have used a population-based approach, making it difficult to draw conclusions about

34 the prevalence of presbyopia in the general population.[1] However, a prevalence as high as

35 85.4% have been reported.[6] Another major challenge with research in this area is the

36 absence of a universally accepted definition for presbyopia and no standardized technique of

37 measurement. The prevalence of presbyopia will therefore depend on how it is defined, for
38 instance, the end point chosen and the distance at which near vision is tested.[1]

39

40 Presbyopia affects quality of life both in high-income countries, where reading and writing
41 are the main near vision tasks undertaken,[7] and in populations where reading and writing
42 are less a part of daily life for example in the rural populations of low- and middle-income
43 countries.[8] Uncorrected presbyopia can have a potential negative impact on career choice,
44 ocular health and self-esteem and can therefore hamper development.[7]

45 As low- and middle-income countries undergo the demographic transition towards an ageing
46 population, the number of people with presbyopia will increase. The demand for near vision
47 and near vision correction is also increasing with the widespread use of devices such as
48 mobile phones and computers, even in rural areas of the developing world.[5] Presbyopia is
49 associated with worse vision targeted health-related quality of life compared with young
50 patients with ametropia (refractive error).[7]

51 Few population-based surveys have been conducted to assess the burden of presbyopia in
52 developing countries and even fewer studies on impact of presbyopia on quality of life in
53 developing countries.[9] This is attributed to the perception that presbyopia is not important
54 in areas with low literacy rates such as low- and middle-income countries.[9] This perception
55 lacks evidence as only few population-based studies have assessed presbyopia in the
56 developing world and anecdotal evidence reveals the need for good near vision even among
57 rural dwellers who require it for near vision-related tasks such as threading needles, sorting
58 rice and cutting nails.[8] Service provision for presbyopia begins with estimating the need.
59 This study will among other things estimate this (presbyopic service) need in the target
60 population.

61 With the emphasis on adult education and literacy as well as good quality of life, it becomes
62 necessary to estimate the level of presbyopia in the population with a view to developing
63 refraction and optical services that have a high success rate vis-a-vis visual acuity (distance

64 and near) and improved quality of life. The aim of this study, therefore, was to determine the
65 magnitude of presbyopia and the effect of uncorrected presbyopia on vision-related quality of
66 life in Calabar South Local Government Area of Cross River State, Nigeria with a view to
67 generating data that could be useful in the planning and implementation of successful
68 comprehensive presbyopic correction service in Calabar South, Nigeria.

69
70

71 **2. MATERIAL AND METHODS**

72

73 **2.1 Study design and setting**

74 This descriptive cross-sectional research was conducted among adult residents of Calabar
75 South Local Government Area of Cross River State, Nigeria from 1st November 2016 to 28th
76 February 2017. Calabar South Local Government Area is found in the southern senatorial
77 district of Cross River State. Its headquarters is in the town of Anantigha. It has an area of
78 264 km², a density of 725.4 inhabitants/km² and a population of 191,515 at the 2006
79 Nigerian National census.[10] It is divided into 12 political wards and has a general hospital,
80 28 primary health centres/health posts spread across the 12 political (electoral) wards,
81 numerous private health facilities and optical shops (eye care facilities that are run by
82 optometrists or refractionist). The general hospital in Calabar South is a government owned
83 secondary health facility with an eye unit that is run by the Cross River State Eye Care
84 Programme. The eye unit provides comprehensive eye care services, including refractive
85 error and presbyopic correction services. About 5 kilometres away from the local
86 government headquarters is the University of Calabar Teaching Hospital in Calabar
87 Municipality with an ophthalmology department that provides comprehensive tertiary eye
88 care services, refractive error and presbyopic correction services inclusive.

89

90 **2.2 Sample size determination**

91 Allowing for 10% attrition, a minimum sample size of 420 participants was calculated using
92 the formula for single proportion:[11,12]

93
$$n = z^2 pq/d^2$$

94 Where;

95 n = minimum sample size (when population is >10,000)

96 z = Standard error of the mean which corresponds to 95% confidence level (1.96)

97 p = Proportion of the target population estimated to have the particular characteristic, in this
98 case presbyopia. The prevalence of 53.4% was used in the study.[13]

99 $q = 1-p$

100 d = Precision with which p is determined which is 5% (0.05)

101

102 **2.3 Study population**

103

104 The study population was a randomly selected sample of political (electoral) wards in
105 Calabar South Local Government Area that was obtained from the 2006 census data.

106

107 **2.4 Selection criteria**

108

109 The eligibility criteria were based on criteria used in previous studies on presbyopia.[17,18]

110

111 **2.4.1 Inclusion criteria**

112 Individuals aged 35 years and above who had resided in the selected area for a minimum of
113 6 months were recruited for the study. Another inclusion criterion was presenting visual
114 acuity of 6/60 or better in at least one eye. Participants also had pinhole visual acuity
115 improvement of 6/18 or better in at least one eye.

116

117 **2.4.2 Exclusion criteria**

118 Individuals with mental or other incapacitating illnesses whose vision could not be tested
119 were excluded from the study. Refusal to give inform consent was another exclusion
120 criterion that was utilised.

121

122 All subjects that were excluded on account of visual impairment were examined by the first
123 author and referred to the eye clinic of the University of Calabar Teaching Hospital, where
124 necessary. Minor ocular conditions like allergic conjunctivitis and suspected mild dry eye
125 disease were treated in the field.

126

127 **2.5 Sampling technique**

128 Cluster sampling with equal allocation was used to select a representative sample of the
129 population. The survey was carried out in 7 out of the 12 political wards (which served as
130 clusters) in Calabar South using a simple random sampling technique. All eligible
131 participants in sampled clusters who consented to participate in the research were enrolled
132 into the study until the desired sample size was attained.

133 **2.6 Survey tool**

134 The survey questionnaire was adapted from an interviewer administered semi-structured
135 questionnaire that was validated in the International Centre for Eye Health of the London
136 School of Hygiene and Tropical Medicine and had been used in Nigeria in an earlier
137 study.[13] It comprised four sections: information was collected on basic socio-demographic
138 characteristics; distance/near visual acuity assessment with subjective refraction and service
139 provision; visual function and quality of life.

140 **2.7 Data collection procedure**

141

142 **2.7.1 Examination of participants**

143 Participants were examined and interviewed in their homes. Presenting distance visual
144 acuity was tested in all subjects by an ophthalmic nurse in the team with a tumbling E
145 Snellen chart at 6 meters in ambient outdoor illumination under a shade. Correct
146 identification of more than half of the optotypes in a line constituted success at reading that
147 line. Distance subjective refraction was then performed by the first author (an
148 ophthalmologist) in subjects with visual acuity $\geq 6/60$ but less than 6/6 if improvement of
149 visual acuity to at least 6/18 (in one or both eyes) is demonstrated with a pinhole test. The

150 refraction was conducted with a trial lens set with addition of plus or minus lenses in 0.5
151 dioptre increments until the subject reads 6/6 or has no further improvement in visual acuity.
152 Astigmatism was not corrected to reduce testing time due to time constraints in data
153 collection.

154 Near vision was then tested by the ophthalmologist (first author) with a Times Roman near
155 vision (British N system) chart at a distance of 40cm under ambient illumination. The
156 distance of 40cm from the eyes was maintained with an inextensible string which was
157 attached to the top of the chart at one end, while the other end was placed against the
158 subject's forehead and held taut. A subject was defined as presbyopic (functional
159 presbyopia) if s/he cannot read the N8 optotype (Times Roman Printer's Point) at 40cm
160 unaided or with habitually worn distance refractive correction, with improvement of near
161 vision by at least one line on a Times Roman near vision (British N system) chart with use of
162 a plus lens. The N8 optotype was selected as it matches the type size for newsprint in
163 Nigeria. This definition of presbyopia is the near equivalent of distance visual impairment
164 (i.e. <6/18) which translates to N-sized (typeface size) print at 40cm with a Times Roman
165 near vision chart, requiring at least +1.00 dioptre (D) near add to see clearly.[14]

166 Near visual acuity (VA) was tested binocularly and recorded as the smallest line with over
167 half of the optotypes read, spelled or reported as seen correctly. The distance correction was
168 put in place for those that require it before near vision testing was done. Subjects with
169 uncorrected near VA < N8 on N notation chart underwent vision testing with progressively
170 higher plus sphere power (in increments of +0.5 dioptre and +0.25 dioptre occasionally) in
171 both eyes simultaneously until a binocular vision of at least N8 was obtained or no further
172 improvement occurs. Subjects that present with a VA of 6/6 were assumed to be emmetropic
173 and were tested for near vision as described without undergoing distance refraction. The
174 spherical dioptre corrections along with the corresponding best-corrected near visual acuity
175 were recorded. Subjects that needed presbyopic glasses were provided with a pair of near

176 vision spectacle free of charge while patients with reduced visual acuity that did not
177 improved with refraction and those that needed distance correction were referred to the eye
178 clinic of the University of Calabar Teaching Hospital, Calabar.

179 **The anterior and posterior segments of the eye were examined in detail.**

180 **2.7.2 Interview of participants**

181 The interview questions included: socio-demographic characteristics, visual function and
182 questions on quality of life. Visual functions that were covered in the interview included
183 reading, writing, use of mobile phones, cooking food, sorting out rice/grain, threading a
184 needle, cutting finger nails etc. Participants were asked if they regularly conducted the
185 particular activity. If the answer was 'yes', they were then asked to rate the difficulty they
186 have performing such activity due to poor near vision base on a rating scale of 1-5 where: 1
187 = no difficulty, 2 = little difficulty, 3 = moderate difficulty, 4 = great difficulty, 5 = do not
188 undertake the task (not applicable). Participants were instructed that this is a linear increase
189 in severity and other factors that did not relate to their near vision (e.g. mobility and distance)
190 were not relevant to this question.

191 Regarding near vision-related quality of life, the participants were asked how much
192 satisfaction they have with their distance vision, near vision and general health. They then
193 rated their level of satisfaction as: 1= very satisfied, 2 = satisfied, 3 = do not know, 4 =
194 dissatisfied, 5 = very dissatisfied. These ratings correspond to 100%, 75%, 50%, 25% and
195 0% respectively.

196 Further questions on quality of life assessment included how much difficulty the participant
197 has in carrying out his or her daily tasks and how much near vision contributed to the
198 difficulty among others. All collected data were entered into a study questionnaire for each
199 participant.

200 **2.8 Data management and analysis**

201 Each completed questionnaire was checked at the end of each day to ensure that there was
202 no missing information. Data was double entered and validated in Microsoft Office Excel
203 2007 for Windows XP Professional and was later uploaded and analysed using the
204 Statistical Package for the Social Sciences version 21 (SPSS, Chicago IL). Point prevalence
205 estimates were calculated. Descriptive statistics (frequencies and proportions) were used to
206 summarize qualitative variables. Chi-square test was used to test for association between
207 categorical variables.

208 Presbyopic correction coverage (PCC) was calculated with the formula:

$$209 \text{ PCC (\%)} = 100 \times \text{Met need} / \text{Met need} + \text{Unmet need}$$

210 Level of statistical significance was set at *P* value of less than 5% (.05).

211

212 **2.9 Ethical considerations**

213
214 Ethical clearance was obtained from the Cross River State Health Research Ethics
215 Committee. Permission to conduct the study in the LGA was obtained from the LGA primary
216 health care coordinator, the village chiefs and the Director of Cross River State Eye Care
217 programme.

218

219 **3. RESULTS**

220

221 A total of 422 participants were recruited to participate in the study. There were more
222 females than males in the study sample (224/422, 53.1%). The mean age of participants
223 was 51 years (± 11.2) ranging from 35 to 82 years. Almost three out of every five (59.2%)
224 members of the study population were in the 35 to 50 years age group, while participants
225 aged 67 years and above constituted the least age group (11.4%) [Table 1]. About two-fifth
226 of the study population (40.5%) had tertiary education while at least 9 out of every 10

227 persons examined belong to the most popular religion in southern Nigeria: Christianity.

228 About two out every five person surveyed (41.0%) was self-employed (Table 1).

229

230 **Table 1 Socio-demographic characteristics of study participants (N = 422)**

Variable	Frequency (N=422)	Percentage (100.0%)
Age group (years)		
35-50	250	59.2
51-66	124	29.4
67-82	48	11.4
Sex		
Male	198	46.9
Female	224	53.1
Religion		
Christianity	396	93.8
Islam	20	4.7
Others*	6	1.4
Educational status		
Non-formal	54	12.8
Primary	41	9.7
Secondary	156	37.0
Tertiary	171	40.5
Occupation		
Unemployed	35	8.3
Self-employed	173	41.0
Civil servant	154	36.5
Retired	48	11.4
Others**	12	2.8
Tribe		
Efik	124	29.4
Ibibio	54	12.8
Ekoi	72	17.1
Others***	172	40.8

231 Others* include Grail Message, Eckankar, Rosicrucian and None.

232 Others** include politician and student

233 Others*** Igbo, Anang, Efut, Idoma, Oron, Degema, Quas, Ejagham, Bette, Bekwarra, Boki,

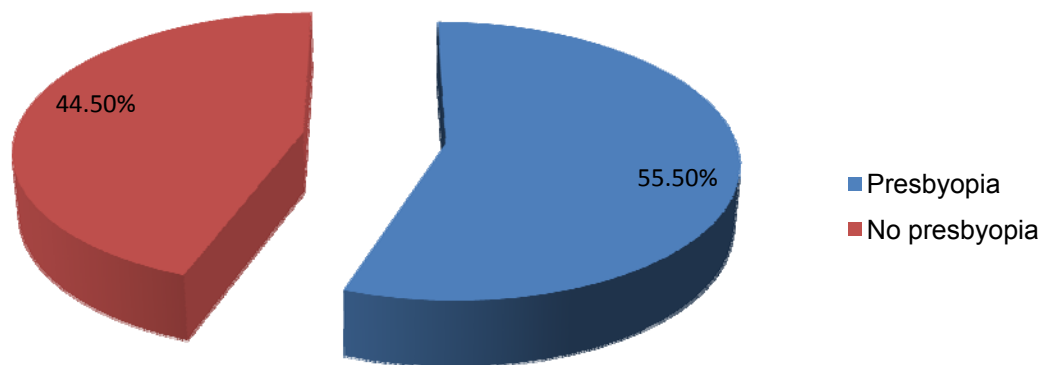
234 Ukelle, Tiv, Andoni, Yoruba, Urobo, Igbira, Nkim, Bansara, Ijaw, Abuo, Igalla, Mbembe,

235 Olulumo, Yakurr, Hausa, Isoko and Nupe

236 **Prevalence of presbyopia in Calabar South**

237 Two hundred and thirty-four out of 422 of the study participants were presbyopic. This gives
238 a prevalence of $234/422 = 0.555$ or 55.5% (95% confidence interval 51.3 – 60.1) ($p < .001$)
239 in the study population (Figure 1).

240



241

242 **Figure 1 Prevalence of presbyopia in the study participants (N = 422)**

243

244

245 **Prevalence of presbyopia among respondents by sex**

246 Chi-square test for assessing relationships between categorical variables indicated no
247 significant association between gender and prevalence of presbyopia among the study
248 participants. However, more female participants 132 (58.9%) compared to males 102
249 (51.5%) had presbyopia (Table 2).

250

251

252 **Table 2 Prevalence of presbyopia among respondents by sex**

Variable	Sex		χ^2	P- value
	Male (n=198) Freq. (%)	Female (n=224) Freq. (%)		
Presbyopia				
Present	102 (51.5)	132 (58.9)	$\chi^2 = 2.05, df = 1$.15*
Absent	96 (48.5)	92 (41.1)		
Total	198 (100)	224 (100)		

253 *P > .05

254 Freq. = Frequency

255

256

257 **Presbyopia correction coverage**

258 Met presbyopic need (number of presbyopic participants who already had near vision
259 spectacles during the study period) = **89**

260 Unmet presbyopic need (number of presbyopic subjects who did not own near vision
261 spectacles during the study period) = **145**

262 Spectacle coverage (%) = Met need / Met need + unmet need x 100

263 = 89 / 89 + 145 x 100

264 = 38.0%

265 The calculation above reveals that the presbyopia correction coverage in the study
266 population during the study period was 38.0%.

267

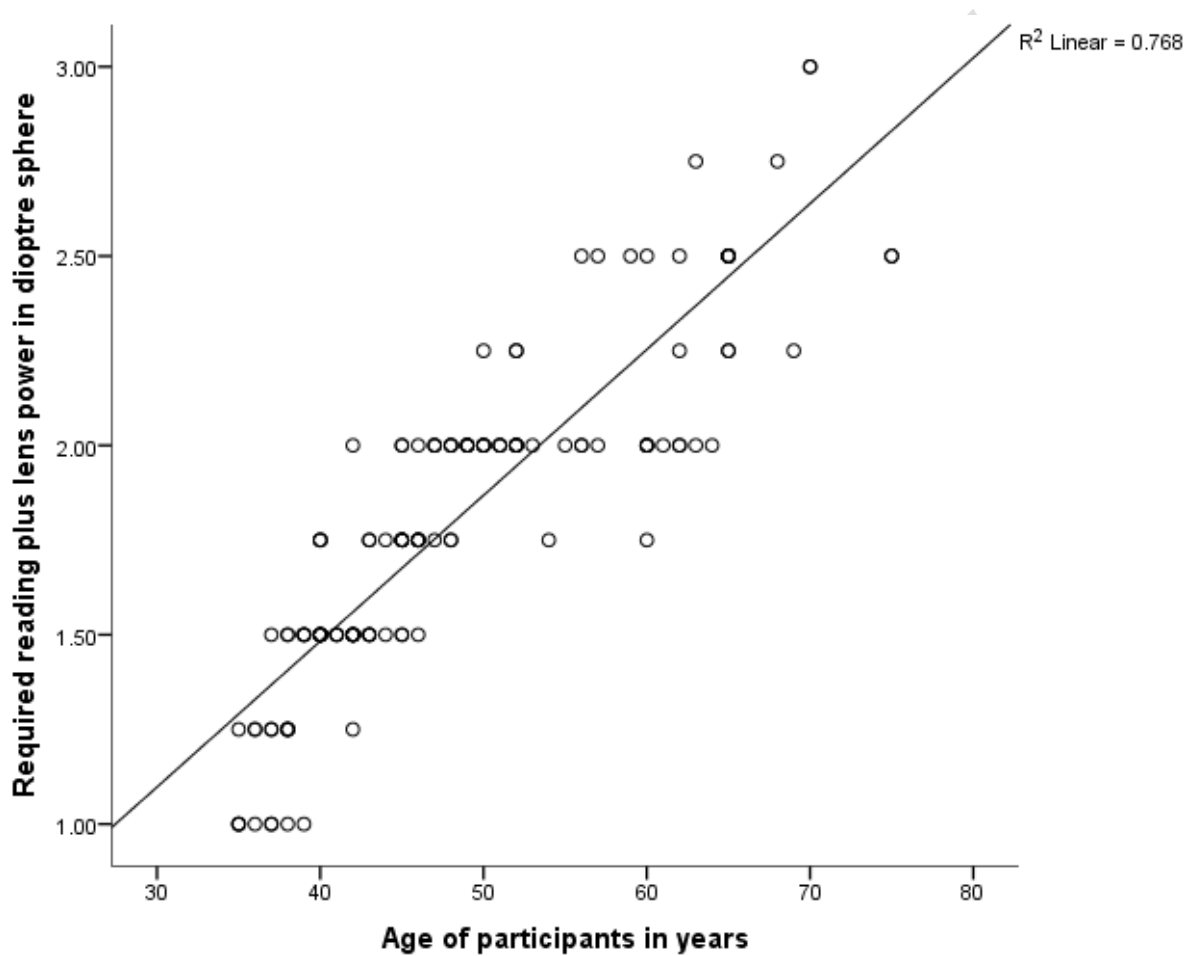
268

269

270 **Age and presbyopia**

271 There was a strong positive correlation between age and the required near vision spectacle
272 lens power ($r = 0.88$, $p < .001$) with increasing age associated with higher presbyopic
273 correction lens power (Figure 2).

274



275

276 **Figure 2 Relationship between age and presbyopic correction lens power**

277 $r = 0.88$, $n = 145$, $P < .001$

278

279 **Association between presbyopia and near vision-related quality of life**

280 A significantly higher proportion of the respondents with uncorrected near vision had low
281 level of satisfaction with their vision-related quality of life compared to participants with

282 corrected presbyopia (Table 3). Further test of association revealed that presbyopes are
 283 more likely to require help from other people as a result of poor near vision than do non-
 284 presbyopes (Table 4).

285

286

287 **Table 3 Association between level of satisfaction with near vision and**
 288 **presbyopia among respondents (n = 234)**

289

Presbyopes (n = 234)	Near Vision-Related QOL			χ^2	P-value
	Satisfied Freq. (%)	Dissatisfied Freq. (%)	Don't Know Freq. (%)		
Corrected (n = 89)	33 (36.6)	53 (59.2)	3 (3.8)	11.77	.008*
Uncorrected (n = 145)	33 (23.1)	108 (74.5)	4 (2.4)		
Total	66 (28.2)	161 (68.8)	7 (3.0)		

290 *P < .05

291 Freq. = Frequency

292

293

294

295

296

297

298

299

300

301 **Table 4 Comparison of the frequency of requiring support/assistance due to**
 302 **poor near vision in presbyopes and non-presbyopes.**

Variable	Assistance Needed due to Poor Near Vision		χ^2	P- value
	Yes Freq. (%)	NO Freq. (%)		
Presbyopes (n = 234)	180 (76.9)	54 (23.1%)	28.54	.001*
Non-presbyopes(n=188)	97 (51.6%)	91 (48.4%)		df = 1
Total (N = 422)	277	145		

303 *P < .001

304 Freq. = Frequency

305

306

307

308 **4. DISCUSSION**

309

310 The effect of presbyopia on quality of life and society in both the developed and developing
 311 worlds is a public health issue.[16] This survey provides a population-based data on the
 312 prevalence of presbyopia and the public health impact of uncorrected presbyopia vis-à-vis its
 313 effect on quality of life in residents of Calabar South, Nigeria.

314 **Prevalence of presbyopia in Calabar South**

315 The prevalence of presbyopia in this study was 55.5%. An earlier study in adults aged 35
 316 years and older in Nike, Enugu State, Nigeria found an objective presbyopia prevalence of
 317 63.4%.[17] A study in Gwagwalada, Nigeria found a functional presbyopic prevalence of
 318 53.4% [18] which is similar to the finding in this study. A similar study which examined 650
 319 individuals aged 40 years and above in Bungudu Local Government Area of Zamfara state in
 320 north-west Nigeria, found a presbyopic prevalence of 30.4%. Other previous studies found
 321 presbyopic prevalence of 85.4% in the Rift valley of Kenya,[6] and 61.7% in rural
 322 Tanzania.[9] An earlier study in Chinese adults aged 40 years and above found a prevalence

323 of 69.3%.[19] The varying differences in prevalence of presbyopia may be due to the
324 different definitions of presbyopia, different minimum age of study participants and different
325 examination conditions (outdoors or indoors). Age as confirmed by the current study (Figure
326 2) is an established risk factor for development of presbyopia.[20] Furthermore, some
327 studies examined for objective presbyopia[17] while others examined for functional
328 presbyopia.[18,21] The current study examined for functional presbyopia. When functional
329 presbyopia is used, people with low or moderate myopia are less likely to be identified as
330 requiring presbyopic correction, so the estimated prevalence will be lower.

331 Another important finding of the present study was that the observed difference in
332 prevalence of presbyopia between male (51.5%) and female (58.9%) participants was not
333 statistically significant (Table 2). Although, these results differ from some published
334 studies,[9,20,18,21] they are consistent with those of a study in Jos, Plateau state,
335 Nigeria.[22]

336 The spectacle coverage of 38.0% in the current study is higher than presbyopia correction
337 coverage obtained in a previous study conducted in a rural community in Enugu, south-east
338 of Nigeria which found presbyopic spectacle coverage of 27.8%.[17] Another study in a rural
339 community in Abuja found a presbyopia correction coverage of 21%,[23] whereas a similar
340 study in a rural population in Zamfara state, north-western Nigeria revealed a presbyopia
341 correction coverage of only 0.7%.[21] A possible explanation for this discrepancy is that
342 unlike the current study, the previous studies cited were all conducted in rural communities
343 where it may be unlikely to find any form of eye care services. Literacy level and requirement
344 for use of reading spectacles are also more likely to be higher in urban community than rural
345 settlements.

346 The strong positive correlation between age and required near vision spectacle lens power
347 observed in the current study is consistent with a previous work which linked increased
348 severity of presbyopia to age and higher educational background.[3] A significant proportion
349 of the participants (40.5%) in the present study had tertiary education.

350 **Effect of uncorrected presbyopia on vision-related quality of life**

351 The current study found significant association between uncorrected near vision and
352 reduced vision-related quality of life among the study participants (Table 3). A higher
353 proportion of presbyopic participants were found to require help from other people as a result
354 of difficulty with near vision than do non-presbyopes (Table 4). The findings observed in this
355 study mirror those of a previous study that have examined the impact of uncorrected
356 presbyopia on vision-related quality of life in a rural African setting.[8] The findings also
357 corroborate the results of previous studies in Nigeria which found an association between
358 uncorrected presbyopia and vision-related quality of life.[24,25] This combination of findings
359 provides some support for the conceptual premise that uncorrected presbyopia has potential
360 negative impact on quality of life and self-esteem.

361

362 **Limitations of the study**

363 An arguable weakness is the use of the WHO recommendations for the definition of
364 presbyopia: inability to read N8 at 40cm. This definition does not consider the fact that some
365 persons may still require spectacles for reading prints tinier than N8 optotype. Finally, the
366 issuance of free reading spectacles to participants that needed it during the study was likely
367 to influence their responses to some of the interview questions. Information bias that likely
368 resulted from this was however reduced to the barest minimum by concealing the fact that
369 free spectacles will be issued until after the survey was completed in a household.

370

371 **4. CONCLUSION**

372

373 This study has shown that presbyopia with a prevalence as high as 55.5% but with a
374 presbyopia correction coverage of only 38.0% in the study population is a major eye health
375 issue that requires intervention. Another obvious finding to emerge from this study is the
376 significant negative impact of presbyopia on vision-related quality of life. To address these
377 issues, there is need to scale up presbyopic correction services in the study area.

378 **COMPETING INTERESTS**

379

380 All authors have declared that no conflict of interests or financial support exist.

381

382

383

384 **ETHICAL APPROVAL**

385

386 Ethical clearance was obtained from the Cross River State of Nigeria Health Research
387 Ethics Committee.

388

389

390

391

392

393

394

395 **REFERENCES**

396

1. Patel I, West SK. Presbyopia: prevalence, impact, and interventions. *Comm Eye
397 Heal J.* 2007;20(63):40-41.

398

2. American Academy of Ophthalmology. Basic and Clinical Science Course, Section
399 3. *Clinical Optics.* San Francisco (CA): American Academy of Ophthalmology; 2016-
400 2017:265.

401

3. Nirmalan P, Sannapaneni K, Gultapalli NR, Ravi T. A population based assessment
402 of presbyopia in the state of Andhra Pradesh, south India: the Andhra Pradesh eye
403 disease study. *Invest Ophthal Vis Sci.* 2006;47:2324-2328.

404

4. IAPB. Vision atlas: *The global burden of vision impairment.* International Agency for
405 *Prevention of Blindness.* 2017. Accessed 22 November 2017. Available:
406 <http://www.atlas.iapb.org>

407

5. Holden BA, Fricke TR, Ho SM, Wong R, Schlenther G, Cronje S et al. Global vision
408 impairment due to uncorrected presbyopia. *Arch Ophthalmol.* 2008;126:1731-1739.

409

6. Sherwin JC, Keeffe JE, Kuper H, Islam FM, Muller A, Mathenge W. Functional
410 presbyopia in a rural Kenyan population: the unmet presbyopic need. *Clin Exp
411 Ophthalmol.* 2008;36(3):245-251.

412

7. McDonnell PJ, Lee P, Spritzear K, Linblad AS, Hays RD. Associations of presbyopia

- 413 with vision-targeted health-related quality of life. *Arch Ophthalmol.* 2003;121:1577-
414 1581.
- 415 8. Patel I, Munoz B, Burke AG, Kayongoya A, McHiwa W, Schwarzwald AW, West
416 SK. Impact of presbyopia on quality of life in a rural African Setting. *Ophthalmology.*
417 2006;113:728-734.
- 418 9. Burke GA, Patel I, Munoz B, Kayongoya A, Mchiwa W, Schwarzwald AW, West
419 SK. Population based study of presbyopia in rural Tanzania. *Ophthalmology.*
420 2006;113:723-727.
- 421 10. National Bureau of Statistics. *Annual abstract of statistics 2010.* Federal Republic of
422 Nigeria, National Bureau of Statistics; 2010.
- 423 11. Naing L, Winn T, Rusli BN. Practical issues in calculating sample size for prevalence
424 studies. *Arch Orolfac Sci.* 2006;1:9-14.
- 425 12. Charan J, Biswas T. How to calculate sample size for different study designs in
426 medical research. *Indian J Psychol Med.* 2013;35(2):121-126.
- 427 13. Muhammad RC. Prevalence of presbyopia and the impact of uncorrected
428 presbyopia on the quality of life in rural Gwagwalada, Abuja Nigeria [master's
429 thesis]. London: London School of Hygiene and Tropical Medicine; 2008. 72 p.
- 430 14. Laviers HR, Omar F, Jecha H, Kassim G, Gilbert C. Presbyopia spectacle coverage,
431 willingness to pay for near correction, and the impact of correcting uncorrected
432 presbyopia in adults in Zanzibar, East Africa. *Invest Ophthal Vis Sci.*
433 2010;51(2):1234-1241.
- 434 15. Bourne RA, Dineen BP, Noorul DM. Correction of refractive error in the adult
435 population of Bangladesh: meeting the unmet need. *Invest Ophthal Vis Sci.*
436 2004;45:410-417.
- 437 16. Goertz AD, Stewart WC, Burns WR, Stewart JA, Nelson LA. Review of the impact of
438 presbyopia on quality of life in the developing and developed world. *Acta*
439 *Ophthalmol.* 2014;92:497-500.

- 440 17. Uche JN, Ezegwui IR, Uche E, Onwasigwe EN, Umeh RE, Onwasigwe CN.
441 Prevalence of presbyopia in a rural African community. *Rural Remote Health*.
442 2014;14(3). Accessed 7 April 2016. Available:
443 <http://www.ncbi.nlm.nih.gov/m/pubmed/25100246>.
- 444 18. Muhammad RC, Jamda MA, Langnap L. Prevalence of presbyopia in rural Abuja,
445 Nigeria. *Ann Niger Med*. 2015;9(2):56-60.
- 446 19. Lu Q, Congdon N, He X, Murthy GV, Yang A, He W. Quality of life and near vision
447 impairment due to functional presbyopia among rural Chinese adults. *Invest Ophthal*
448 *Vis Sci*. 2011;52(7):4118-4123.
- 449 20. Hickenbotham A, Roorda A, Steinmaus C, Glasser A. Meta-analysis of sex
450 differences in presbyopia. *Invest Ophthal Vis Sci*. 2012;53(6):3215-3220.
- 451 21. Umar MM, Muhammad N, Alhassan MB. Prevalence of presbyopia and spectacle
452 correction coverage in a rural population of North West Nigeria. *Clin Ophthalmol*.
453 2015;9:1195-1201.
- 454 22. Malu KZ. Presbyopia in Plateau State, Nigeria: a hospital study. *J Med Trop*.
455 2013;15(2):151-155.
- 456 23. Muhammad RC, Jamda M. Presbyopic correction coverage and barriers to the use
457 of near vision spectacles in rural Abuja, Nigeria. *Sub-Saharan African J Med*.
458 2016;3(1):20-24.
- 459 24. Muhammad N, Alhassan MB, Umar MM. Visual function and vision-related quality of
460 life in presbyopic adult population of Northwestern Nigeria. *Niger Med J*.
461 2015;56(5):317-322.
- 462 25. Bekibele CO, Gureje O. Impact of self-reported visual impairment on quality of life in
463 the Ibadan study of aging. *Br J Ophthalmol*. 2008;92(5):612-615.

464

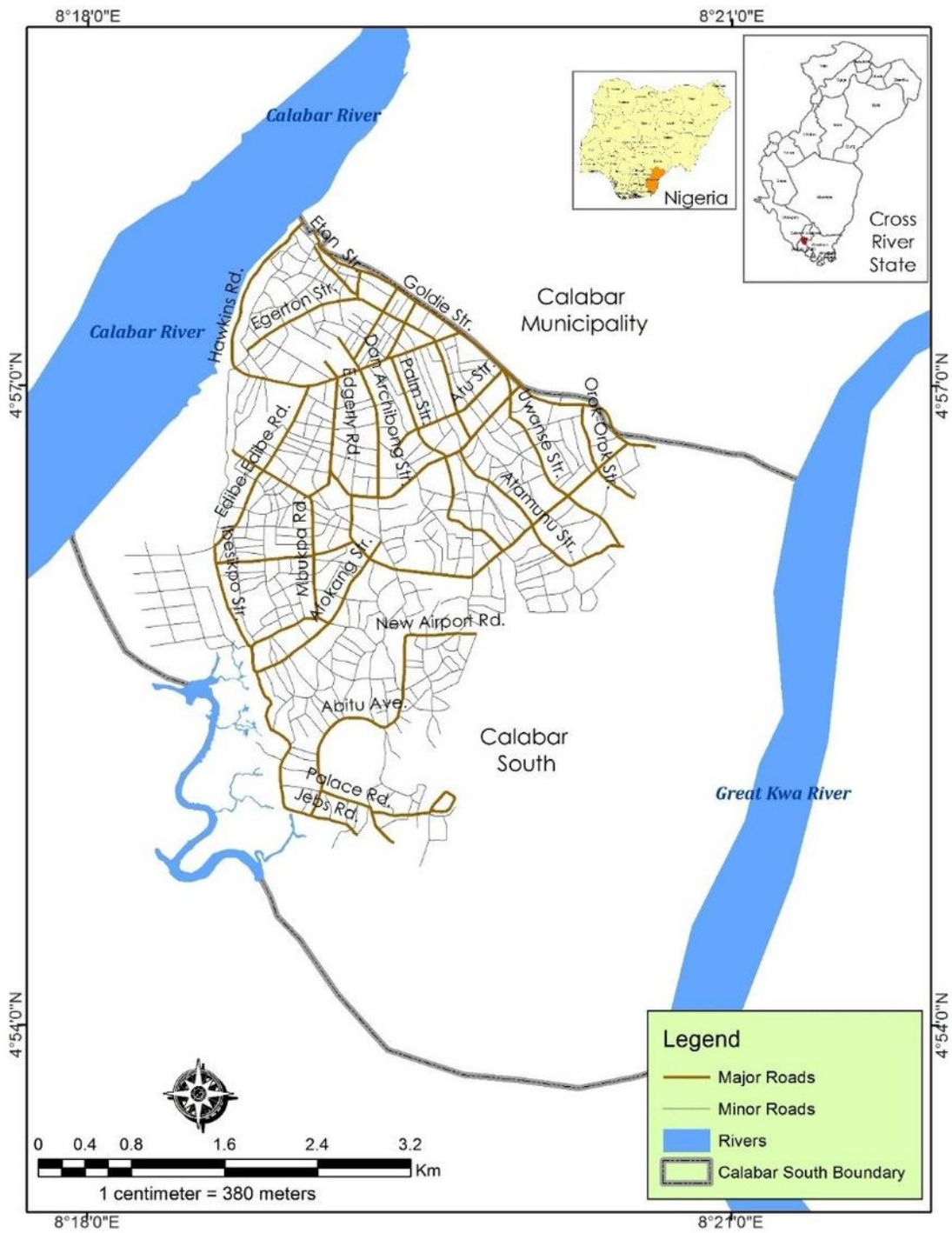
465

466

APPENDIX

467

Map of Calabar South



468

469 Source: https://www.researchgate.net/figure/Map-of-Calabar-South-LGA_fig1_328996399