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Age-pattern of blindness in Nigeria

E. C. Nwogu
Department of Mathematics, Statistics and Computer Science,
Michael Okpara University of Agriculture, Umudike, Nigeria.

Abstract

This paper discusses age pattern of blindness in Nigerian. The ultimate objective is to provide information on which strategies for prevention and treatment of blindness, as well as the rehabilitation on which strategies for prevention and treatment of blindness, as well as the rehabilitation and integration of blind persons into social life could be based. This follows from the fact that most causes, preventive measures and treatment of blindness have been found to be associated with age. Secondary data drawn from the 1994 census of the Federal Republic of Nigeria was analysed using the methods of categorical data and regression analyses. Results show that the quality of data on age and sex on the blind population is very poor. From the census data the level of prevalence of blindness in Nigerian was shown to be grossly under-reported. It was also found that third degree polynomial appears to describe the age-pattern of blindness in Nigeria, though not adequately. The inadequacies were attributed to the distortions in the age reporting. Until further research proves otherwise, estimates of the age-specific prevalence of blindness based on the third degree polynomial has been recommended for use in developing strategies for addressing problems of blindness in Nigeria among others.

Keywords/expression: Blindness, prevalence, disability, age-pattern, visual impairment.

1.0 Introduction

We the reduction in the level of mortality in most countries of the world other problems of the populations are becoming more prominent. One of such problems is that of disability in general and blindness in particular. The estimated global burden of blindness in 2002 is about 37 milling [WHO (2006) 18]. One World Sigh Project (2006) says that more than 42 million people in the world are currently blind, approximately 400,000 Nepalese are now living in "Darkness" and a backlog of six million Indians are total blind. According to Omoti (2004) [10] and Fasina and Ajaiyeoba (2003) [3] an estimated 45 million people are blind and 135 million people are visually impaired worldwide. Of these, about 90% are from developing countries. About nine out of 10 of the world's blind live in developing country [Omoti (2004) 10]. About seven million Africans are blind and in Mozambique one person in a hundred is blind [One World Sight Project (2006)]. An estimated 1.3 percent of the population in sub-Saharan Africa is blind [Kehinde and Ogwurike (2005)]. From Hospital based studies, the prevalence of blindness in Nigeria is about one percent [Omoti 2004]. In Yewa North LGA of Ogun State, Nigeria Fasina and Ajaiyeoba (2003) observed that the prevalence rates are about 1.22% for blindness and 2.09% for visual impairment. From blindness registration data, estimate of the blindness prevalence rate in Singapore was shown to the about 0.05%.

Blindness involves a total loss of the victim's visual capacity. Some persons are born blind, while many others become blind through accidents or disease. The commonest causes of blindness are cataract, trachoma, onchocerciasis, xeropthalmia, leprosy, glaucoma and childhood blindness [See, Wong and Yeo (1998); Fasina and Ahaiyeoba (2003) 3]; Kehinde and Ogwurike (2004) [5], World Health Organization (2006) [18] and One World Sight Project (2006)]. Among children, corneal ulceration and scarring, following measles and vitamin A deficiency, as well as harmful traditional practices are major causes of blindness. Other causes of childhood blindness include genetic disease and congenital abnormalities [Kehinde and Oguwrike (2005) [5].

Cataract accounts for up to 80% of mass blindness in the world [See, Wong and Yeo (1998)] and is responsible for almost half of the seven million blind Africans [One World Sight Project (2006)]. Cataract occurs at a younger ages in Africa and disables many Africans who are in the prime of life. Although cataracts are not preventable, their surgical treatment is one of the most cost-effective interventions in health care. With aging populations the contributions of cataract and other non-preventable diseases such as age related macular degeneration (ARMD), glaucoma and diabetic retinopathy to blindness globally are likely to increase in our population as they are in the west [WHO (2006) 18; See, Wong Yeo (1998); and Omoti (2004) 10].

The adverse of blindness are not only on the victim and his/her family but also on his/her community and the society in general. Blindness and severe visual impairment have a significant impact on the socio-economic development of individuals and societies [WHO (2006, One World Sight Project (2006)]. Blindness is a personal tragedy and an economic nightmare [Fasina and Ajaiyeoba (2003) 3]. And in Africa it carries with it a mortality rate estimated to be four times greater than those who can see [One World Sight Project (2006)]. It devastated and degenerates the victim's quality of life. Therefore, its prevention should be of utmost importance to the individuals, community and the nation [Omoti (2004)]. Childhood blindness influences educational, employment, personal and social prospects [Wilson, Pandry and Thakur (2003) 16].

Furthermore, the amount of money usually spent on providing medical treatment, up keep of the blind and in providing special training, services and equipment such as Braille books could have been saved or invested in development projects. It has been estimated that the cost of global blindness is about one forth to one sixth of the United Kingdom's gross National product [Omoti (2003) 10]. The cost of eye disease and blindness in the U.S. alone is $16 billion a year [One World Sight Project (2006)]. Victims of blindness complain of marginalization, deprivation and abandonment. They are often denied of good food, decent accommodation and medical care. Other disadvantages suffered by the blind include institutionalization, sexual exploitation and lack of recognition in public functions. They are often discriminated against in educational and employment opportunities and in Marriage [Nwogu (2003) [9] and Rehabilitation international (2000) [13]]. As such, they can hardly contribute meaningfully to national development. And often they end up as beggars, as seen in many public places like churches, mosques, market places, motor parks etc.

To address the problems of disability in general and blindness in particular, the United Nations launched the world programme of Action on disabled persons in 1982. The threefold objectives of the programme are prevention of disability, rehabilitation and realization of the full participation of disabled persons in social life and development as well as enjoyment of equality [NPC (1994) [7]]. In 1999, the Global initiative for elimination of avoidable blindness, known as vision 2020 – the Right to Sight was launched as a partnership between World Health Organization (WHO) and International Agency for the prevention of blindness by the year 2020 and to halt and reverse the projected doubling of avoidable visual impairment in the world between 1990 and 2020. Since the vision 20920 was launched, WHO and its partners have been providing technical support to countries starting or strengthening their national eye care services. In the 2004 Nigeria National Policy on population for sustainable development, it was acknowledged that persons with disabilities have not been able to participate fully in National development. Therefore, it has one of its objectives, to encourage the integration of persons with disabilities among others, into the development process.

Furthermore, just like some other demographic events, age has been identified as an important factor in the problem of blindness. A study of 3000 elderly people aged 60 years and above in Singapore shows that the prevalence of blindness and visual impairment among the elderly were 3.0% and 15.2% respectively. Estimates by Framingham Eye Study shows that the prevalence of blindness is 0.60% in US white population aged 50 years and above, 0.2% and 0.7% respectively in United Kingdom and Australia. A population based Eye survey conducted in east Baltimore shows that the rate of total visual loss ranged from 0,74% among whites aged 40 – 49 years to 26.0% among blacks aged 80 years and above [Se, Wong and Yeo (1998)]. WHO (2006) [18] had noted that more than 82% of all blind persons are 50 years of age or older the regrettable aspect of this problem is that a significant proportion of all cases of blindness experienced in the world, especially in developing countries, are avoidable [Kehinde and Ogwurike (2005), WHOO (2006) [18] and Wilson, Pandry and Thakur (2003) [16]. To achieve the Global Initiative Vision 2020, Fashina and Ajaiyeoba (2003) [3] emphasized the need for reliable statistics on the number of blind persons, their distributions, the population at risk and causes of blindness.

From the discussion so far, it is clear that the causes, prevention, treatment and cure of blindness are related to the age of the victims. Therefore, the ultimate objective of this study is to determine the extent to which strategies for prevention and treatment of blindness, as well as the rehabilitation and integration of the blind could be based on age-pattern of blindness in Nigeria. Specifically, the study (*i*) examined the quality of the age-sex data on blind persons, (*ii*) determined the level and age-pattern of blindness and (*iii*) constructed a mathematical model which could be used to describe the age-pattern of blindness in Nigeria.

2.0 Methodology

The data for this study is a secondary data derived from the 1991 Nigerian population census. The census report is the only source of comprehensive and reliable nationwide data that could be used for discussing age-pattern of blindness in Nigeria. Most of the nationwide sample surveys have little or no information on people with disabilities in general and the blind in particular. In the 1991 census, blindness is defined as “physiological impairment of the sense of sight (with or without the use of aid). People who have lost their power of sight are said to be blind”.

In reporting the data on disabilities the total population of each sex was cross-classified by age (in five-year age groups) and blindness status (blind or non-blind) among other variables. In other words, the data is both categorical and cross-sectional. Therefore, the data was analysed using simple descriptive statistics and methods of categorical data and regression analyses. The reliability or otherwise of the estimate of any parameter depends on the quality of data on basis of which it was computed. Therefore, quality of data on sex and age of the blind persons in Nigeria were evaluated using the United Nations joint scores (JS). Age ratios were calculated using the Ramachandran method. Details of the application of these methods can be found in Nwogu (2006) [9], Ramachandran (1989) [12] and Kpedekpo (1982) [6]. To determine the age-pattern of blindness the methods of categorical data analysis and regression analysis were adopted. The details of these methods are outlined below. For the i^{th} age group (i = 1, 2, … w, w, = number of age groups) define

n_i = the total population enumerated (both blind and non blind)
n_{i1} = the total number of persons enumerated as blind
n_{i2} = the total number of persons enumerated as not blind.
Therefore,

$$n_i = n_{i1} + n_{i2} \qquad (2.1)$$

The age specific rate of blindness is

$$p_i = \frac{n_{i1}}{n_i} \qquad (2.2a)$$

The complement $$q_i = \frac{n_{i2}}{n_i}$$
$$= 1 - p_i \qquad (2.2b)$$
is the proportion of the population enumerated as not blind. For all age groups,
$$n = \sum_{i=1}^{w} \sum_{j=1}^{2} n_{ij} \qquad (2.3)$$
is the total population (both blind and non blind)
$$n_{\bullet 1} = \sum_{i=1}^{w} n_{i1} \qquad (2.4a)$$
is the number of persons enumerated as blind and $n_{\bullet 2} = \sum_{i=1}^{w} n_i 2$ (2.4b)

is the number of persons enumerated as not blind, hence
$$p = \frac{n_{\bullet 1}}{n} \qquad (2.5a)$$
is the overall proportion reported as blind and is used as a measure of crude rate of blindness (CRB) in the population. More specifically we define CRB as
$$CRB = \frac{n_{\bullet 1}}{n} X\ 1000 \qquad (2.5b)$$
The complement of *p* in (2.5) is
$$q = \frac{n_{\bullet 2}}{n} \qquad (2.6)$$
is the overall proportion of the population enumerated as not blind.
To test the hypothesis, Ho: $p_1 = p_2 = \ldots p_w = p$, i.e. the age-specific rate of blindness are the same over all age groups, against the alternative, $H_1 : p_i \neq p_i \forall \neq j$ and at least one is different from the others, the test statistic, according to Fleiss (1973), is
$$\chi_c^2 = \sum_{i=1}^{w} \sum_{j=1}^{2} \frac{\left(n_{ij} - n_{i.} n_{\bullet j} / n\right)^2}{n_{i.} n_{\bullet j} / n} \qquad (2.7)$$
Under the null hypothesis, the statistic χ_c^2 follows the chi-square distribution with w-1 degress of freedom. The null hypothesis is rejected at $\propto$ level of significance if χ_c^2 exceeds the tabulated value with w-1 degrees of freedom or accepted otherwise. It can be shown that the expression in (2.7) is equivalent to
$$\chi_c^2 = \frac{1}{pq} \sum_{i=1}^{w} n_{i.} (p_i - p)^2 \qquad (2.8)$$

The relationship between (2.7) and (2.8) is easily shown by substituting the expressions in Equations (2.1) – (2.5a) and (2.6) into (2.7). This test is also referred to as test of homogeneity of proportions. When the null hypothesis is rejected, indicating that at least one of the proportions is significantly different from the others, the next step is to identify the roporton(s) that is different from the others. However, since the proportions are classified by age (a quantitative antecedent factor) it may be more appropriate to check if they vary in any systematic manner with age. From the plot of the proportions (p*i*) against age (x_i) it may be possible to select a tentative regression equation to be fitted to observed data. The methods of fitting an appropriate curve to any observed data are well discussed by

Draper and Smith (1981), Wonnaccott and Wonnacott (1979), Dunn and Clark (1974) and Searle (1971). In particular, suppose a curve, *f(x)*, is fitted to the observed rates of blindness (p_i). Then the estimate from the fitted curve, corresponding to the age x_i is given by

$$\hat{p}_i = f(x_i) \tag{2.9}$$

If the fitted curve describes the observed data adequately, the difference

$$\hat{e} = (p_i - \hat{p}_i) \tag{2.10}$$

would be zero or close to zero. Therefore, the adequacy or otherwise of a curve in describing a set of observed data could be tested using the statistic

$$\chi^2_{fit} = \frac{1}{pq}\sum_{i=1}^{w} n_{i\cdot}(p_i - \hat{p}_i)^2 \tag{2.11}$$

Under the null by hypothesis, that the fitted curve describes the observed data adequately, χ^2_{fit} follows the chi-square distribution with w-1 degrees of freedom, where 1 is the number of parameters of the fitted curve. The null hypothesis is rejected if χ^2_{fit} exceeds the tabulated value or accepted otherwise. When the null hypothesis is rejected, it indicates that the fitted curve does not adequately describe the age-pattern of blindness. The complement χ^2_{fit} is

$$\chi^2_{slope} = \chi^2_c - \chi^2_{fit} \tag{2.12}$$

This, according to Fleiss (1973), is used to test the significance of the parameters of the fitted curve. Under the null hypothesis, that no parameter of the fitted curve is significantly different from zero χ^2_{slope} follows the chi-square distribution with *l*-1 degrees of freedom. The null hypothesis is rejected χ^2_{slope} exceeds the tabulated value or accepted otherwise. When the null hypothesis is rejected it indicates that at least one of the parameters is significantly different from zero the parameter(s) that are actually different from zero may be identified using the method of orthogonal polynomial.

3.0 Levels and age-pattern of blindness in Nigeria

The Chapter discusses the percentage distribution of the blind population and prevalence of blindness by age and sex. Section 3.1 devoted to examining the percentage distribution and evaluation of quality of age and data on the blind population while the prevalence of blindness by age and sex are discussed in Section 3.2

3.1 Percentage distribution of and quality of age and sex data on the blind population

The percentage distribution of the blind population in Nigeria by sex and age (in 5-year age groups) is shown in Appendix A, while the corresponding population pyramid is shown in Figure 1. As Appendix A shows the total number of persons reported as blind in 1991 census is 777930, made up of 49.25 percent males and 50.75 percent females. Of this number, about 29.6 percent (33.3% males and 26.0% females) were reported as aged 60 years and above.

About 38.8 percent (43.2% male and 34.5% females) were reported as aged 50 years and above. These figures are lower than the more than 82 percent of all blind persons reported by WHO (2006) as aged years and above. About 17.8 percent (19.6% for the males and 15.9% for the females).

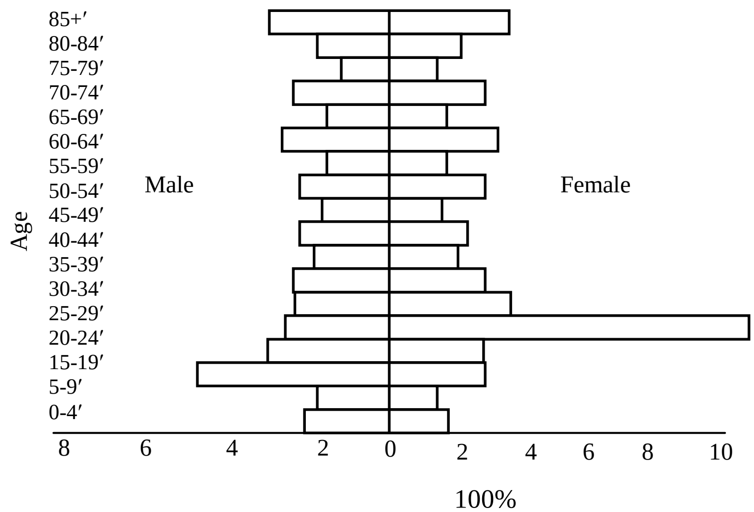

Fig.ure 1: Population pyramid of the blind in the 1991 Nigeria Census

were reported as under 15 years of age. The interpretation of these figures and the distribution of blind population by age and sex should be treated with caution. This is because under-reporting, over-reporting and/or age shifting characterize the age-sex data as shown in Figure 1. The age groups 10-14, 40-44, 50-54, 60-64, 70-74 and 85+ for both sexes, male and-group 30-34 and female age group 20-24 seem to have been over-enumerated or gained from the surrounding age groups. On the other hand, the remaining g age groups appear to have either been grossly under-reported or lost to other age groups. These observations are clearly supported by the age ratios given in Appendix B. appendix B shows that the age groups worst hit by the over-reporting and/or age gain are 40-44, 50-54, 60-64 and 70-74 for both sexes, 20-24 for the females and 10-14 for the males. On the other hand, the age groups worst hit by the under-reporting and/or age loss are those surrounding those worst hit by over reporting. The age-specific sex ratios indicate serious deficits of females in the age groups 10-14 and 40 years and above, and serious excess of females in the age groups 5-9, and 20-29 years. The summary indices for evaluation of quality of age-sex data on blind population aged 0-69 years are shown in Table 3.1

Table 3.1: Age and Sex Ratio scores and the United Nations Joint scores for the total and blindpopulations in Nigeria 1991.

	ARS			
Population	Male	Female	SRS	JS
Blind	17.7	20.0	25.6	114.4
Nigeria	9.3	12.0	12.0	57.3

As Table 3.1 shows, all the summary indices show that the reporting of the age and sex data for the blind population is grossly erroneous. With a United Nations joint score of about 114.4, the quality of age-sex data is worse for the blind than for the entire population. This may be attributable to the relatively low literacy level among the blind population. According to the 1991 census, more than 68 percent (63.71% for the males and 72.56% for the females) of the blind population was reported as illiterate against the 43.3 percent (34.3% for the males and 52.2% for the females) reported for the entire population [NPC (1994)]. Ramachandran (1989) and Nwogu (2006) have attributed poor quality of age data to illiteracy.

3.2 Prevalence and age pattern of blindness in Nigeria

The age-specific rates of blindness (ASRB), p_i, (per 10,000 populations) by sex are shown in Table 3.2 while the graphs for those aged 0-84 years are shown in Figure 2. As Table 3.2 shows, the crude rate of blindness (CRB) in Nigeria is about 8.76 (8.62 for the males and 8.89 for the females) per 10,000 population. That is, out of every 10,000 persons enumerated in the 1991 census, between 8 and 9 persons were reported as blind. This seems an understatement of the true prevalence rate when compared with the rates of 130 per 10,000 (1.3%) reported by Kehinde and Ogurike (2005) for sub-Sahara Africa, the 100 per 10,000

Table 3.2: Age specific rates of blindness (ASRB) in Nigeria by sex

Age group	Male	Fem ale	Both
0-4′	2.60	2.69	2.64
5-9′	1.94	2.26	2.10
10-14′	7.23	5.25	6.29
15-19′	5.93	5.64	5.78
20-24′	6.72	15.99	11.99
25-29′	6.22	7.52	6.93
30-34′	7.42	7.27	7.34
35-39′	7.20	8.40	7.77
40-44′	10.30	9.49	9.91
45-49′	11.73	11.18	11.49
50-54′	16.46	17.65	17.01
55-59′	23.97	26.76	25.17
60-64′	30.05	27.86	29.03
65-69′	36.82	34.19	35.59
70-74′	49.98	48.92	49.51
75-79′	66.15	62.29	64.44
80-84′	76.42	71.02	73.92
85+	123.34	121.29	122.40
ALL	8.62	8.89	8.76
Ac.t Number	38384	39546	77930

(or 1.0 percent) for Nigeria reported by Omoti (2004) [10] and the 122 per 10,000 (1.22%) for Yewa-North L.G.A of Ogun State, Nigeria reported by Fasina and Ajaiyeoba (2003) [3] The estimate of 5 per 10,000 (or 0.05%) derived from Blindness Registry data in Singapore was considered to be a gross underestimation by See, Wong and Yeo (1998).

Table 3.2 also shows that age-specific rates of blindness (ASRB) increased with age for both sexes. For the makes ASRB increased almost consistently from about 2.6 per 10,000 in the age group 0-4 to about 122.34 per 10,000 among those aged 85 years and above. For the females, ASRB increased from about 2.69 per 10000 among those aged 0-4 years to about 121.

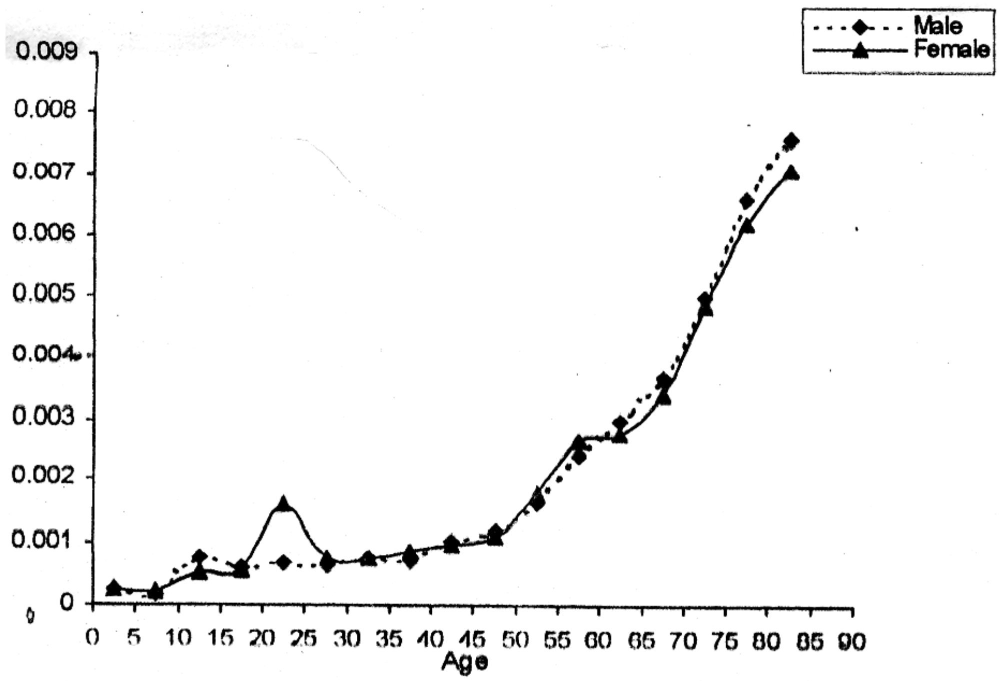

Figure 2: Proportions reported as blind in the 1991 Nigerian Cesnus by age and sex

29 per 10000 among those aged 85 years and above. Prevalence rate is 50.1 (51.53 for the makes and 48.5 for females) per 10000-population aged 60 years and above and about 36.5 (36.8 for the makes and 36.1 for the females) per 10000-population aged 50 years and above. The prevalence rate among those aged 60 years and above is much lower in Nigeria than the 300 per 10000 (or 3.0%) reported in Singapore. The prevalence rate among those age 50 years and above is also much lower in Nigeria than the 60 per 10000 reported in the white population in United States and the 70 per 10000 in Australia, but higher than the 20 per 10000 reported in United Kingdom [(See, Wong and Yeo (1998)].

The graphs shown in Figure 2 (for males and females) indicates that ASRB, (p_i) appears to have increased gradually from the age groups 0-4 to 40-45 and more rapidly from the age groups 45-49 to 0-84 years. The degree of variation of p_i with age, x_i is so wide that no test may be required to show that blindness is associated significantly with age. The plots in Figure 2 also suggest that polynomials may serve to describe the age-pattern of blindness for each sex. In order to determine the degree of the polynomial to be entertained the method of differencing was adopted. The values of the first, second and third order differences shown in Appendices C and D for the two sexes respectively, and their corresponding graphs, shown in Figures 3 (a, b and c) for the males and Figures 4 (a, b, and c) for the females, indicate that only the third order differences (∇^3_{pi}) appear stable. These imply that the third degree polynomial may be required to describe the age-pattern of blindness in Nigeria. Therefore, a third degree polynomial was fitted as the regression equation of ASRB (p_i) on age (x_i). The tentative regression equations given by MINITAB software are:

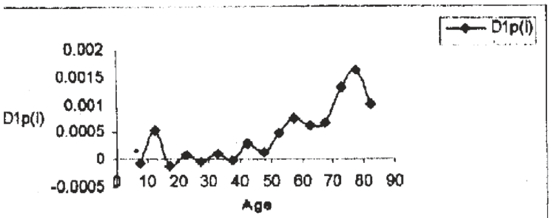

Figure 3a: First order difference of male ASRB

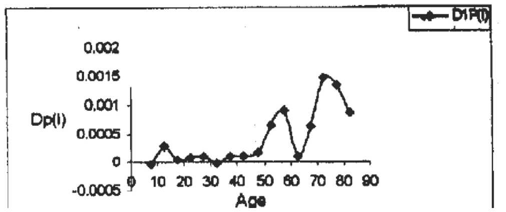

Figure 4a: First order difference of female ASRB

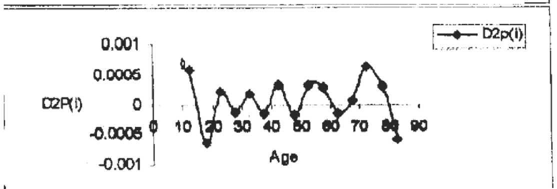

Figure 3b: Second order difference of male ASRB

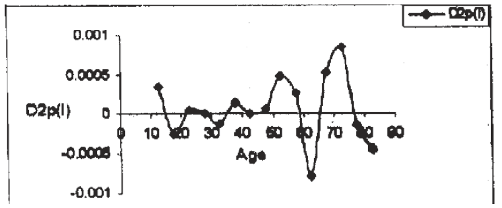

Figure 4b: Second order difference of female ASRB

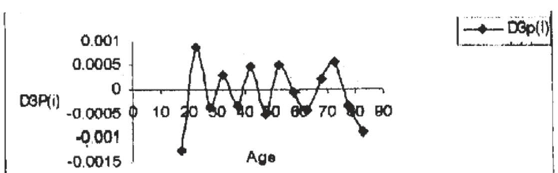

Figure 3c: Third order difference of male ASRB

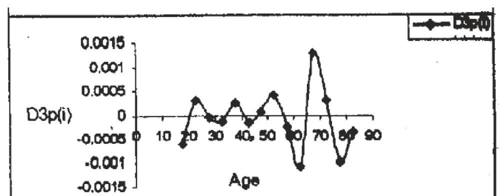

Figure 4c: Third order difference of female ASRB

$$p_i = 1.345 + 0.500X - 0.020X^2 + 0.0003X^3 \qquad (3.1)$$

per 10000 males

$$p_i = 0.492 + 0.679X - 0.023X^2 + 0.0003X^3 \qquad (3.2)$$

per 10000 females.

Analysis of variance table (Table 3.3) shows that though the coefficients appear very small, they are all significantly different from zero. Therefore, the expressions in (3.1) and (3.2) may be taken as the tentative regression equations for describing the age pattern of blindness among makes and females respectively in Nigeria. The equations imply that the estimate of proportions of the population reported as blind at birth (x = 0) are about 1.34 per 10000 for the makes and about 0.49 per 10,000 for the females. The expressions also implies that a change of one year in age results, on the average, to a change of about 0.48 blind per 10000 males and to about 0.66 blind per 10000 females. The actual and fitted proportions based on these equations are given in Table 3.4 while their corresponding graphs are shown in Figures 5(a) and 5(b) for the makes and females respectively. As Table 3.4 and Figures 5(a) and 5(b) show, the prevalence of blindness appear much higher at older age (40 years and above) than the younger ones under 40 years. Below age 40 years, the prevalence rate is under 10 per 10000 and increased gradually as age increased, while the prevalence rate is more than 10 per 10000 at ages 40 years and above the increased more rapidly as age increased. This may be attributable to accumulation of untreated cases of avoidable or treatable blindness at younger ages.

3.3 Adequacy of the fitted Models

The adequacy or otherwise of the expression in Equations (3.1) and (3.2) in describing the age-pattern of blindness was tested using the text statistic in (2.11). The null hypothesis tested is Ho: the third degree polynomial describes the age-pattern of blindness adequacy, against the alternative; H_1: the third degree polynomial does not describe the age pattern of blindness adequately. The decision rule is to reject H_0 if the calculated value χ^2_{fit}, exceeds the tabulated value, which for α= 0.01 level of significance and 13 degree of freedom, equals 27.7 or accept it otherwise. From Table 3,4, the computations are: for the

Table 3.3: Analysis of variance table to determine the parameters of the model

(a) Male

Source of variation	***df***	***Sum of square***	***MS***	F_{cal}	***P-value***
Regression	3	0.00008390	0.00002800	1039.03	0.000
Linear	1	0.00006430	0.00006430	48.55	0.000
Quadratic	1	0.00001750	0.00001750	103.92	0.000
Cubic	1	0.00000201	0.00000201	74.71	0.000
Error	13	0.00000035	0.00000035	-	-
Total	16	0.00008420	-	-	-

(b) Female

Source of variation	***df***	***Sum of square***	***MS***	F_{cal}	***P-value***
Regression	3	0.0000706	0.0000235	212.27	0.000
Linear	1	0.0000552	0.0000552	49.12	0.000
Quadratic	1	0.0000133	0.0000133	52.42	0.000
Cubic	1	0.00000211	0.00000211	19.04	0.000
Error	13	0.00000144	0.000000011	-	-
Total	16	0.0000720	-	-	-

(a) Males

$p = 0.0008023,\ q = 0.9991977\ \ and\ \ \sum n_i(P_i - p_i)^2 = 0.757938$. Hence,

$$\chi^2_{fit} = \frac{0.757938}{(0.000823)(0.999197)} = 945.46$$

This value is greater than the tabulated value (27.7). We therefore, reject H_0 and conclude that the third degree polynomial is not adequate for describing the age-pattern of blindness among males.

(b) Females

$p = 0.000840,\ q = 0.999160\ \ and\ \ \sum n_i(P_i - p_i)^2 = 4.000000$. Hence,

$$\chi^2_{fit} = \frac{4.00000}{(0.000840)(0.999160)} = 4764.43$$

Table 3.4**: Actual and estimated proportions of populations blind by sex and age**

Age Group	**Male**		**Female**		**Both**	
	Actual	**Est**	**Actual**	**Est**	**Actual**	**Est**
0-4′	2.6006	2.4661	2.6916	2.0495	2.645	2.2627
5-9′	1.9365	4.089	2.2607	4.4146	2.096	4.2488
10-14′	7.2326	5.0685	5.2547	5.9747	6.286	5.5022
15-19′	5.9287	5.6323	5.6356	6.9631	5.778	6.3178
20-24′	6.7194	6.0082	15.994	7.6131	11.987	6.9193

Age Group	Male		Female		Both	
	Actual	Est	Actual	Est	Actual	Est
25-29′	6.2183	6.4239	7.5245	8.158	6.934	7.3743
30-34′	7.4164	7.1072	7.2682	8.8312	7.339	8.0122
35-39′	7.2002	8.2858	8.4011	9.8661	7.772	9.0397
40-44′	10.2983	10.1874	9.4947	11.4958	9.907	10.8248
45-49′	11.7334	13.0398	11.1812	13.9537	11.491	13.4412
50-54′	16.462	17.0706	17.6543	17.4732	17.01	17.2577
55-59′	23.9671	22.5076	26.7556	22.2876	25.166	22.4146
60-64′	30.0511	29.5786	27.8559	28.6302	29.023	29.1373
65-69′	36.8229	38.5113	34.1914	36.7343	35.592	37.6847
70-74′	49.9811	49.5333	48.9196	46.8333	49.509	48.3331
75-79′	66.1533	62.8725	62.289	59.1604	64.436	61.2262
80-84′	76.4166	78.7566	71.0156	73.9489	73.915	76.522
ALL	8.0228	8.0744	8.4006	8.4026	8.2116	8.2385

This value is again greater than the tabulated value, indicating that the fitted model is not adequate for the observed age-patter of blindness. However, the departures from the third degree polynomial are sufficiently small to make the hypothesis of third degree polynomial reasonable. The observed large departures may be attributable to the distortions in the age reporting as earlier highlighted. The estimated populations, using these equations and the actual populations reported as blind are given in Table 3.5. As Table 3.5 shows, populations aged 5-9, 25-29, 35-39, 45-49, 65-69 and 80-84 for both sexes; 50-54 and 65-69 for the males and 10-19, 30-34, 40-44 and 60-64 for the females seem to have been under enumerated. On the other hand, populations aged 0-4, 20-24, 55-59 and 70-79 for both sexes; 10-15, 30-34 and 60-64 for the males appear to have been over enumerated.

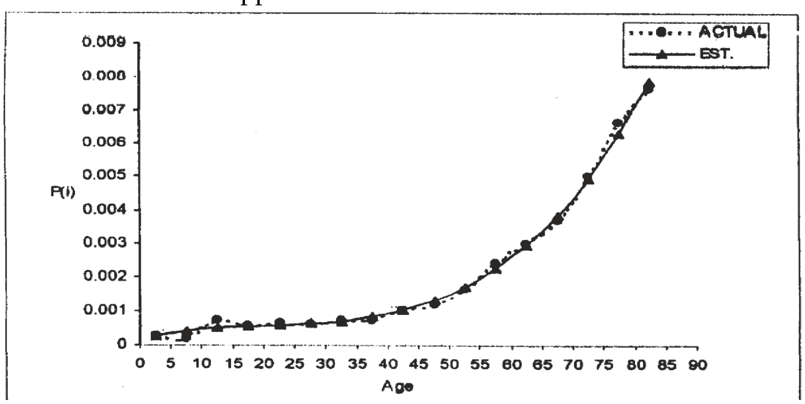

Figure 5a: Actual and estimated proportion of males reported as blind in the 1991 Nigerian Census by age.

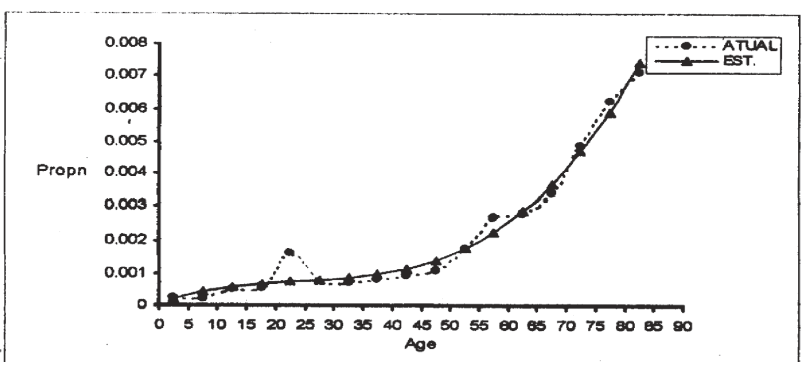

Figure 5b: Actual and estimated proportion of females reported as blind in the 1991 Nigerian Census by age.

Table 3.5: Actual And Estimated Blind Populations in Nigeria by sex and Age

Age	Male		Female		Both	
Group	Actual	Est	Actual	Est	Actual	Est
0-4′	1910	1811	1884	1435	3794	3246
5-9′	1428	3015	1611	3146	3039	6161
10-14′	4204	2946	2804	3188	7008	6137
15-19′	4685	2551	2709	3347	5394	5898
20-24′	2227	1991	6969	3317	9196	5308
25-29′	2055	2123	3015	3269	5070	5392
30-34′	2083	1996	2257	2742	4340	4738
35-39′	1589	1829	1687	1981	3276	3810
40-44′	2030	2008	1780	2155	3810	4163
45-49′	1590	1767	1187	1481	2777	3248
50-54′	2286	2371	2087	2066	4373	4437
55-59′	1530	1437	1288	1073	2818	2510
60-64′	2710	2659	22055	2266	4906	4928
65-69′	1498	1566	1222	1313	2719	2879
70-74′	2460	2438	1928	1846	4388	4284
75-79′	1293	1229	974	925	2267	2154
80-84′	1972	2032	1581	1646	3553	3678
85+	2844		2358		5202	
Total	**38384**	**35769**	**39546**	**37197**	**77930**	**72966**

4.0 Summary, recommendation and conclusion

In summary, this paper has discussed the age pattern of blindness in Nigeria using data derived from the 1991 Nigeria census. The ultimate objective is to determine the extent to which strategies for prevention and treatment of blindness could base on knowledge of age-pattern of blindness. The relevance have been associated with the age of the victims. The data was analysed using methods of categorical data analysis and regression analysis.

The results of the analyses show that the quality of the age and sex data on the blind population in Nigeria is very poor. The quality was found to be lower than that of the entire population, which has been adjudged grossly erroneous. This may be attributable to the low literacy status of the blind population as shown in the distribution of the blind population by literacy status [NPC, 1994]. The estimate of crude rate of blindness (CRB) is 8.8 (8.6 for the make and 8.9 for the females) per 10000 population. This was considered an understatement of the true blindness prevalence rate when compared with the values from developed and some developing countries. The results also show that the third degree polynomial appear to describe the age patter of blindness in Nigeria, though not adequately. The large departures from the third degree polynomials may be attributable to the distortions in age reporting. Except in few age groups, the departures are so small that the assumption of third degree polynomial may not be invalidated. The fitted values indicate that age-specific rate of blindness (ASRB) is under 10 per 10000 among the population under 40 years and grew gradually as age increased. However, among those age 40 years and above, ASRB remained more than 10 per 10000 population and increased more rapidly with increasing age.

In view of these, the following suggestions are considered relevant. Development of strategies for prevention and treatment of blindess as well as the rehabilitation and integration of the blind into social life should be based on estimates from the third degree polynomial until further research proves otherwise. All efforts to prevent or treat blindness, especially among those under 40 years, should be intensified. This is because, the sudden surge in the blindness prevalence rate at age 40 years and above appear to be as a result of accumulation of untreated cases at lower ages. All causes of blindness, which are peculiar to those aged 40 years and above, should be identified and eliminated early. Furthermore quality of age-sex reporting of the blind population could be improved upon by improving their levels of participation in the socio-economic activities such as education and in the enumeration proper. This is hereby recommended, since improved quality of age-sex data will yield a better model for describing age-pattern of blindness more adequately.

Appreciation

I wish to acknowledge and appreciate the contributions of Dr. I. S. Iwueze of Department of Statistics, Abia State University, Uturu and Prof. I. B. Onukogu of Department of Statistics, University of Nigeria, Nsukka.

Appendix A: Percentage distribution of blind population in Nigeria 1991 by Sex and Age (in 5-year Age Group)

Age group	Male	Female	Both	Actual number
0-4′	2.45	2.42	4.87	3794
5-9′	1.83	2.07	3.90	3039
10-14′	5.39	3.60	8.99	7008
15-19′	3.45	3.48	6.92	5394
20-24′	2.86	8.94	11.8	9196
25-29′	2.64	3.87	6.51	5070
30-34′	2.67	2.90	5.57	4340
30-34′	2.67	2.90	5.57	4340
35-39′	2.04	2.16	4.20	3276
40-44′	2.60	2.28	4.89	3810
45-49′	2.04	4.52	3.56	2777
50-54′	2.93	2.68	5.61	4373
55-59′	1.96	1.65	3.62	2818
60-64′	3.47	2.83	6.30	4906
65-69′	1.92	1.57	3.49	2719
70-74′	3.16	2.47	5.63	4388
75-79′	1.66	1.25	2.91	2267
80-84′	2.53	2.03	4.56	3553
85+	3.65	3.03	6.68	5202
Total	42.25	50.75	100	
Actual Number	38384	39548		77930

Appendix B: Age and Sex Ratios from data on Persons Reported as Blind in the 1991 Census

Age group	Age ratios (AR)		Sex Ration (S_i)	AR – 100		$S_{i+1} - S_i$
	Male	Female		Male	Female	
0-4	-	-	101.4	-	-	-
5-9	63.7	81.5	88.6	-36.3	-18.5	-42.8

Age group	Age ratios (AR) Male	Age ratios (AR) Female	Sex Ration (S_i)	AR – 100 Male	AR – 100 Female	$S_{i+1} - S_i$
10-14	134.3	113.0	149.9	34.3	13.0	61.3
15-19	91.0	71.3	99.1	-9.0	-28.7	-50.8
20-24	96.9	141.8	32.0	-3.1	41.8	-67.1
25-29	97.6	91.0	68.2	-2.4	-9.0	36.2
30-34	106.7	98.0	92.3	6.7	-2.0	24.1
35-39	87.2	91.1	94.2	-12.8	-8.9	1.9
40-44	112.2	110.7	114.0	12.2	10.7	19.9
45-49	84.8	76.1	134.0	-15.3	-23.9	20.2
50-54	118.9	125.6	109.5	18.9	25.6	-24.5
55-59	76.0	75.0	118.8	-24.0	-25.0	9.3
60-64	128.3	127.5	122.8	28.3	27.5	4.0
65-69	73.4	74.3	122.5	-26.6	-25.7	-0.3
70-74	127.6	127.4	127.6	27.6	24.4	5.1
75-79	73.7	71.4	132.8	-26.3	-28.6	5.2
80-84	-	-	124.7	-	-	-8.1
85	-	-	120.6	-	-	-
All						
0 – 69						
Sum				229.8	260.3	3321
Mean				17.1	20.02	25.55

$$ARS = \frac{1}{13}\sum_{i=1}^{14}\left|AR_i - 100\right|,$$

$$SRS = \frac{1}{13}\sum_{i=1}^{14}\left|S_{i+1} - S_i\right|,$$

Joint score = ARMS + ARSF + 35RS

ARMS is for males, ARSF is for females

Appendix C: Differencing to determine the appropriate curve of the age-pattern of blindness in males (per 10000 population)

Age group	P_i	∇P_i	$\nabla^2 p_i$	$\nabla^3 p_i$
0-4	2.60	-	-	-
5-9	1.94	-0.66	-	-
10-14	7.23	5.30	5.96	-
15-19	5.93	-1.30	6.60	-12.56
20-24	6.72	0.79	2.09	8.70
25-29	6.22	-0.50	-1.29	-3.38
30-34	7.42	1.20	1.70	2.99
35-39	7.20	-0.22	-1.41	-3.11
40-44	10.30	3.10	3.31	4.73
45-49	11.73	1.44	1.66	-498
50-54	16.45	4.73	3.29	4.96
55-59	23.97	7.51	2.78	-.052
60-64	30.05	6.08	1.42	-1.36
65-69	36.82	6.77	0.69	-0.73
70-74	49.98	13.16	6.39	5.70
75-79	66.15	16.17	3.10	-3.77
80-84	76.42	10.26	-5.91	-8.92

Appendix D: Differencing to determine the appropriate curve of the age-pattern of blindness in females

Age group	P_i	∇P_i	$\nabla^2 p_i$	$\nabla^3 p_i$
0-4′	2.69	*	*	*
5-9′	2.26	-0.43	*	*
10-14′	5.25	2.99	3.43	*
15-19′	5.64	0.38	-2.61	-6.04
20-24′	6.56	0392	0.54	3.15
25-29′	7.52	0.97	0.05	-0.49
30-34′	7.27	-0.26	-1.22	-1.27
35-39′	8.40	1.13	1.39	2.61
40-44′	9.49	1.09	-0.04	-1.43
45-49′	11.18	1.69	0.59	0.63
50-54′	17.65	6.47	4.79	4.19
55-59′	26.76	9.10	2.63	-2.16
60-64′	27.86	1.10	-8.00	-10.63
65-69′	34.19	6.34	5.24	13.24
70-74′	48.93	14.73	8.39	3.16
75-79′	62.29	13.37	-1.36	-9.75
80-84′	71.0156	8.267	-4.64267	-3.2838

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