

## Demographic assessment and adjustment of census age distribution in selected West African Countries

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### Abstract

**Context/background:** Despite the public acknowledgment of improvement in sub-Saharan African censuses and surveys in the recent time, the quality of age-sex data still remains relatively poor. This study assessed the quality of reported age-sex data in selected West African countries.

**Data source and methods:** We utilized the available recent West African census data to address the study objective. Data adjustments were made using the UN-moving average technique, Carrier Far-rag, Karup-king newton and Arriaga methods.

**Results:** First, the age- distribution in five years was examined for errors. The UN-Age-sex accuracy index showed that all the selected countries had inaccurate age-distribution, with the exception of Cameroon (2005) and Senegal (2002) censuses which revealed a lesser distorted age- distribution. Utilizing the strong smoothing techniques, the results showed that virtually all the censuses were plagued with the overestimation error at older ages, particularly the female population. The error margin ranged between 10-25%.

**Conclusion:** The study concludes that inaccuracies in West African census data persist and recommends more quality age-sex data in region.

**Keywords:** Age misstatement, Age distribution, Adjustment, West Africa

### Introduction

Across all levels of governance, data classified by age has been increasingly used as a basis for socio-economic, political, health and developmental planning, policy design and distribution of resources. Unfortunately for developing countries, their continuous quest to keep pace with the population policies aimed at reducing population growth and achieving overall development, have re-currently been thwarted due to inaccuracies in age data (Adebowale, Fagbamigbe, & Bello, 2012; Mba, 2004, 2006, 2014; Randall & Coast, 2016; Raymer & Rogers, 2007). Censuses and surveys have been major sources of age data in the developing countries due to the difficulty in the availability and completeness of other sources of age data such as vital statistics, civil registrations and population register (Makannah, 1990; Sembajwe, 1990; Williams, 2014). West Africa, houses the most populous countries in sub-Saharan Africa especially in figures Nigeria as an example. Undoubtedly, the quantity and quality of the regions' age data raises reliability question as the basic error from censuses

and survey have been linked to the technical and political context (Masquelier et al., 2016; Williams, 2014) as well as the personnel's involved (i.e individuals and enumerators) (Adebowale et al., 2012; Gibril, 1979; Mba, 2004). Error-ridden data have implication for the fundamental estimation of demographic parameters (Adebowale et al., 2012) and components of population dynamics (Coale & Kisker, 1986).

While age misstatement persists and the data quality not ascertained (Chevan & Sutherland, 2009; Gibril, 1979) the indices assessment techniques (Spoorenberg, 2007) like Myer's, Whipple's and Bachi's indexes have been employed in most recent multi-country African studies to assess the magnitude of digit preference in age data (Mba, 2003, 2014; Randall & Coast, 2016), no attempt have been made to refine the age data across all age sub-groups either utilizing the demographic techniques or to further estimate the population parameters as was done in the study of (Adebowale et al., 2012; Randall & Coast, 2016) Although, the latter study utilized a multi-source, it was not a multi-country study. This identified gap necessitated this study in that available

and accessible age data of the last two censuses of West African countries elicited from IPUMS was utilized in an attempt to assess and modify the age data of West Africa countries using the demographic techniques. In this way, contributing to the improvement of the quality of age distribution of the observed population which have developmental planning and policy implications.

### Literature review

As far as 1960, a decennial census exercise had begun in some African countries and three census rounds (1990, 2000 and 2010) have been observed (UN, 2016). In all the 17 countries in West Africa, only Liberia missed out in the first two consecutive rounds, but Ghana, Cameroon, Chad, and Nigeria have missed one of the three rounds. Besides some underlining fundamental error in censuses which have been argued to also affect the national representative sample surveys like DHS (Williams, 2014), data from these sources have aided development in the region.

The continuous public demand and use of age as a requisite criterion in administrative issues in Africa have led to some variances in the levels and patterns of age distortions observed in the regions' censuses across all the population sub-groups (Mba, 2004, 2014; Randall & Coast, 2016). This recurrent errors in age distribution have been majorly classified into coverage and content errors. The former relates to errors due to completeness, which is difficult in real life, as an individual could either be omitted (under-enumeration) or counted more than once (over-enumeration). Alternatively, the content error is tied to the whole process of the census. This includes respondent errors in reporting their ages which may be due to their ignorance or biases, educational level, preferences like sex selectivity in age preferences or avoidance (Makannah, 1990; Mba, 2003; Siegel, 2004). Likewise, enumerators biases or mistakes in recording age data, tabulating and coding errors (Siegel, 2004).

One of the recurrent trends and patterns of misreporting in some countries in West Africa is to under-report the age of children and that of adolescents, when they are far or near puberty or unmarried, and to over-report age when pubescent or married. For example, in Gambia, Senegal, Mali, Burkina-Faso and Ghana etc, the observed irregularities in the population pyramid around ages 15 to 20, is rooted in under-reports in age brackets from 10 to 24 years which in turn favor the two year age- groups of 5-9 and 25-29 (Ewbank, 1981; Gendreau & Nadot, 1967; Hertrich & Lardoux, 2014; Mba, 2014). Also sex-selective age inflation is another observed trend for men i.e exaggeration of age by 3 years on average between 30 and 49 years

of age, and at least 5 years beyond age 50, while age avoidance and age inflation is the case for the women i.e high possibilities to report lower ages when below 40 years and overstated when above 40 years. Generally, enumerators in censuses and survey exercises may have challenges of age precision (Gilles Pison & Ohadike, 2006), reporting ages ending in even numbers (Mba, 2004), exact ages when age heaping is either sensitive or preference driven i.e ages ending in 0 or 5 (Gendreau & Nadot, 1967; Mba, 2004, 2006, 2014; Udjo, 2005) or avoiding reporting deficit in ages ending "0 and 5" as in Guinea 1955 and surplus in others i.e in digits "4 or 9" as in Senegal census of 1988 (G Pison, Hill, Cohen, & Foote, 1995). However, demographers and other population scientist such as (Axinn, Pearce, & Ghimire, 1999) suggested the use of the life history calendars and landmark events, as strategies to better elicit good age data, the procedures which was also approved by (Helleringer et al., 2014).

Several approaches have been adopted for the errors and bias diagnosis and this includes Post-enumeration surveys (PES) and matching of Independent surveys, comparison of sources, cross-tabulating by age, cohort survival rates and stable population analysis. While the census survival analysis is also a very good measures in assessing age data and estimating the components of change especially when countries have a well-established practice of having census continuously overtime, PES dual-system estimation seemed to be the best analytical measure in that it provides the variances in content bias and also seemed best estimating coverage errors especially where data on the components of population change is reasonably in-accurate i.e migration, fertility and mortality rates, as in West Africa. This measure is also limited partly on the objectives of conducting PES as the probability of obtaining a better measure is dependent on accurate reporting of age in the PES as against the original census or survey and the cost of re-interview (Krótki, 1978). This method has been applied to study age misreporting in US and Ghana in 1960 and 1964 respectively (Ewbank, 1981). Recent studies have also analyzed age misreporting by comparing age data from different data sources in addition to the use of other analytical techniques like cross-tabulating approach commonly referred to as the indices techniques used in the study of (Randall & Coast, 2016) or stable population analysis used in (Adebowale et al., 2012). In these studies, whilst the target population, analytical approach, the study focus and scope differed, the results obtained from both measures had credits of satisfying the assumptions of the techniques used as well as the focus of the study. Although it appeared that the stable population

analysis seems preferred over the indices analysis because of the advantage of either age error comparison from different sources or the refinement of age data as well. Also using indices analysis which also has also an added methodological advantage of doing the graphical analysis first to understand the distortions in the age distribution and to inform the choice of the type of indices analysis (Arriaga, Johnson, & Jamison, 1994). The choice of Whipple's index in (Randall & Coast, 2016) was beneficial in providing information on the individual tendencies to misreport age as well as the extent of systematic age heaping in ages ending with digits 0 and 5 but this method is also limited in that it is a fair measure rather than been a better estimates of the overall reliability of the age distributions (UN, 1986 ). Besides, that these two studies made a plausible impact having attempted to make some modifications to the methodologies utilized, they concluded that the countries reviewed had poor age data.

Considering the previous works of (Mba, 2004, 2006) unlike his more recent study (Mba, 2014) which was more expansive in that he utilized multi-country censuses at different dates to evaluate age misreporting applying similar analytical technique as in (Randall & Coast, 2016), only that in the latter study the authors made some specific refinement of age data utilizing similar analytical technique as in (Mba, 2014). These studies also concluded that the age data quality was poor but there were no attempts made to better refine the observed irregularities across all the reported ages, a gap this study intends to fill knowing the implications of such attempts on the age data quality so as to provide a relatively fair data for further estimation of population parameters which is useful to policy planners and decisions makers.

**Data and methods**

This study is focused on cross-country analysis which UNAI is most suitable in providing a summary index instead of the choice to use Whipple's, Bachi or Myres Indexes which are more of individual tendency measures (Hobbs, 2004; UN, 1955). Although the index does not consider real irregularities in age groups such as mortality caused by natural occurrences, human mortal activities, temporary fertility reduction, migratory movements among some age groups and sex, it, however, performs well in larger population which permits a neglect of any chance of irregularity or fluctuations.

Lastly, the demographic adjustment techniques such as the light smoothing techniques such as Carrier Farrag, United Nation Moving Average, Karup King Newton and Arriaga methods where were all employed and compared, hence the best

performing method in assessing the extent and distribution of age-sex specific coverage errors was identified as taken as the assumed true population figure. The best method was assessed with the error percent. All these are based the assumptions of no or insignificance distortions in fertility, mortality and migration in the selected West African countries namely Burkina-Faso, Cameroun, Ghana, Mali, and Senegal, hence the applicability.

**(a) Average sex ratio score (S)**

This score is obtained by first calculating the sex ratio at each age group. Successive differences irrespective of the sign are added and averaged.

$$\text{Age-specific sex ratio} = \frac{5P_x^m}{5P_x^f} \times 100$$

$$5P_x^m = \text{males aged } x \text{ to } x + 5$$

$$5P_x^f = \text{females aged } x \text{ to } x + 5$$

**(b) Average male age ratio score (M)**

For each age group for males, calculate the age ratios computed as

$$\text{Age ratio} = \frac{5P_x^m}{\frac{1}{2}(5P_{x-5}^m + 5P_{x+5}^m)} \times 100$$

The deviations from unity irrespective of the sign are added and averaged (M).

**(1) Sex ratio**

Sex ratio is the ratio of males to females in a given population, usually expressed as number of males for every 100 females i.e.  $\frac{P_i^m}{P_i^f} \times 100$ ,  $i$  = each 5-year age group

**Carrier - Farrag graduation method**

This method consists essentially of splitting the total numbers reported in two adjacent five-year age groups (quinary age groups) by first grouping the quinary age groups into 10-years age groups (denary age groups). The graduate population is then obtained by the Manipulation of simple algebraic formulae i.e.

$D_i$  = individual 10-year age group

$$K4 = \frac{V_{i-1}}{V_{i-1}}, \quad K = \sqrt[4]{\frac{V_{i-1}}{V_{i+1}}}$$

Where  $K$  = a constant which depicts the average rate

$$V_i = \frac{D_i}{1+K}$$

$$\therefore \text{Smoothed Population (P)} = D_i - V_i$$

**Karup King Newton**

The Karup King Formulas (Carrier & Farrag, 1959) are as follows:

$$5P_x = \frac{1}{2} 10P_x + \frac{1}{16} (10P_{x-10} - 10P_{x+10}) \text{ and}$$

$$5P_{x+5} = 10P_x - 5P_x$$

**Arriaga method**

This method does not modify the total i.e. it takes age data in 10-year and redistributes for to get 5-year age groups. Also, separate the first and last 10-year age groups, unlike the other methods.

$${}_5P_{x+5} = \frac{10(P_{x-10}) + 11(10P_x) + 2(10P_{x+10})}{16} \quad (-)$$

$${}_5P_{x+5} = (-10P_{x-10} + 110P_x + 20P_{x+10}) \frac{1}{24}$$

$${}_5P_{x+5} = 10P_x - 5P_x$$

Where:  ${}_5P_{x+5}$  = population age x+5 to x+9

$10P_x$  = population age x to x+9

${}_5P_x$  = population at x to x+4

**United Nations Moving Average**

This method is appropriate for graduating errors inherent in age statistics i.e. it adjusts age data which is fraught with digit preference and age shift. It assumes that assumes that the expected age distribution is a smooth one.

$$S_i = \frac{P_{i-2} + 4P_{i-1} + 10P_i + 4P_{i+1} - P_{i+2}}{16} \quad (-)$$

$S_i$  represents the smoothed population x to x + 4

Where  $P_{i-2}, P_{i-1}, P_i, P_{i+1}, P_{i+2}$  are the enumerated 5-year age groups

**Strong smoothing formula**

The strong moving average was calculated using the formula below (Arriaga, 1968):

$${}_{10}P'_x = \frac{P_{i-2} + 4P_{i-1} + 10P_i + 4P_{i+1} - P_{i+2}}{16} \quad (-)$$

${}_{10}P'_x$  = the smoothed population ages x to x+9

**Percent error**

The percent errors in enumerated population were computed using the formula below:

$$\mu = T - S$$

Where  $\mu$  = Error

T = True population

E = Enumerated Population or

S = Smoothed Population

$$\therefore \% \mu = \frac{T-S}{T} \times 100$$

**Table 1.1 Error Detection in Age-Sex Population Data of Burkina Faso in 1996 and 2006**

Age	Burkina Faso 1996							Burkina Faso 2006						
	Population		Age Ratio		Age Ratio Deviation		Sex ratio	Population		Age Ratio		Age Ratio Deviation		Sex ratio
	Male	Female	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female	
0-4	904230	890640					101.5	1239190	1221500					101.4
5-9	922480	901020	112.9	114.8	12.9	14.8	102.4	1180370	1150420	94.9	94.4	-5.1	-5.6	102.6
10-14	729440	679640	96.5	92.0	-3.5	-8.0	107.3	908210	851690	103.2	102.5	3.2	2.5	106.6
15-19	588980	576700	101.9	102.1	1.9	2.1	102.1	724700	777350	104.8	102.0	4.8	2.0	93.2
20-24	426080	449590	91.0	92.2	-9.0	-7.8	94.8	539460	666370	88.9	95.8	-11.1	-4.2	81.0
25-29	347210	398170	96.7	101.7	-3.3	1.7	87.2	455300	573940	101.7	105.8	1.7	5.8	79.3
30-34	291820	333700	101.0	100.4	1.0	0.4	87.4	366900	438650	99.4	93.9	-0.6	-6.1	83.6
35-39	230760	266720	96.1	95.7	-3.9	-4.3	86.5	303380	362030	105.9	101.9	5.9	1.9	83.8
40-44	188340	223420	97.6	102.5	-2.4	2.5	84.3	253430	302740	91.6	86.7	-8.4	-13.3	83.7
45-49	155120	169050	96.6	89.6	-3.4	-10.4	91.8	196020	236090	96.8	101.7	-3.2	1.7	83.0
50-54	132980	153960	102.0	112.1	2.0	12.1	86.4	169130	195080	97.2	103.7	-2.8	3.7	86.7
55-59	105640	105590	91.4	81.9	-8.6	-18.1	100.0	132350	141800	88.6	81.0	-11.4	-19.0	93.3
60-64	98140	103760	114.2	120.7	14.2	20.7	94.6	111470	128880	102.1	111.5	2.1	11.5	86.5
65-69	66200	66340	86.6	80.6	-13.4	-19.4	99.8	80340	82990	93.1	94.0	-6.9	-6.0	96.8
70-74	54810	60780					90.2	63560	72360					87.8

**Mean Age Ratio (Male) = 5.68**  
**Mean Age Ratio (Female) = 8.74**  
**Age-sex accuracy index = 31.8**

**Mean Age Ratio (Male) = 4.80**  
**Mean Age Ratio (Female) = 5.95**  
**Age-sex accuracy index = 28.6**

**Table 1.2 Error Detection in Age-Sex Population Data of Ghana in 2000 and 2010**

Age	Ghana 2000						Ghana 2010					
	Population		Age Ratio		Age Ratio Deviation		Population		Age Ratio		Age Ratio Deviation	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-4	1379660	1398100					1728510	1673350				
5-9	1392090	1384260	109.9	110.1	9.9	10.1	1589080	1533130	99.1	98.6	-0.9	-1.4
10-14	1153610	1117420	97.9	96.5	-2.1	-3.5	1478890	1437550	102.0	101.7	2.0	1.7
15-19	965000	931080	100.6	95.3	0.6	-4.7	1310120	1294310	101.3	97.2	1.3	-2.8
20-24	764500	835840	92.2	97.3	-7.8	-2.7	1107300	1225180	98.0	102.1	-2.0	2.1
25-29	693370	787200	104.3	106.5	4.3	6.5	950110	1106320	100.0	104.6	0.0	4.6
30-34	564780	642640	95.4	96.8	-4.6	-3.2	792030	890460	97.3	96.2	-2.7	-3.8
35-39	490380	540270	97.0	99.3	-3.0	-0.7	677540	744140	99.3	98.9	-0.7	-1.1
40-44	446800	446050	103.1	100.7	3.1	0.7	572110	614900	101.5	99.9	1.5	-0.1
45-49	376700	345760	103.9	94.2	3.9	-5.8	449890	487080	93.1	92.2	-6.9	-7.8
50-54	278020	287830	99.3	110.7	-0.7	10.7	394240	442070	110.9	117.6	10.9	17.6
55-59	183160	174400	80.3	73.2	-19.7	-26.8	261390	264680	84.3	76.9	-15.7	-23.1
60-64	178340	188500	114.5	124.5	14.5	24.5	226270	246670	113.3	117.1	13.3	17.1
65-69	128270	128290	90.5	83.4	-9.5	-16.6	137880	156480	73.6	70.0	-26.4	-30.0
70-74	105180	119030					148510	200240				

**Mean Age Ratio (Male) = 5.98**  
**Mean Age Ratio (Female) = 8.32**  
**Age-sex accuracy index = 34.7**

**Mean Age Ratio (Male) = 6.02**  
**Mean Age Ratio (Female) = 8.09**  
**Age-sex accuracy index = 28.8**

**Table 1.3 Error Detection in Age-Sex Population Data of Cameroon in 1987 and 2005**

Cameroon 1987								Cameroon 2005						
Population			Age Ratio		Age Ratio Deviation			Population		Age Ratio		Age Ratio Deviation		
Age	Male	Female	Male	Female	Male	Female	Sex Ratio	Male	Female	Male	Female	Male	Female	Sex ratio
0-4	829510	807600					102.7	1514280	1474210					102.7
5-9	707020	677380	101.7	102.7	1.7	2.7	104.4	1272380	1244730	96.6	98.1	-3.4	-1.9	102.2
10-14	561530	511000	99.0	89.7	-1.0	-10.3	109.9	1120080	1063700	99.5	94.4	-0.5	-5.6	105.3
15-19	427750	462500	95.5	101.9	-4.5	1.9	92.5	979880	1008600	102.9	102.5	2.9	2.5	97.2
20-24	333850	396840	91.6	96.7	-8.4	-3.3	84.1	785340	904650	96.0	103.1	-4.0	3.1	86.8
25-29	301540	358230	102.7	104.8	2.7	4.8	84.2	657080	746220	99.2	101.2	-0.8	1.2	88.1
30-34	253170	286630	101.6	101.1	1.6	1.1	88.3	539230	569900	100.3	96.2	0.3	-3.8	94.6
35-39	196980	208890	91.9	86.2	-8.1	-13.8	94.3	418600	438990	93.4	93.7	-6.6	-6.3	95.4
40-44	175740	197800	101.0	107.7	1.0	7.7	88.8	357150	367390	100.3	101.0	0.3	1.0	97.2
45-49	151040	158400	95.6	91.1	-4.4	-8.9	95.4	293620	288670	98.9	94.9	-1.1	-5.1	101.7
50-54	140390	149950	112.8	118.6	12.8	18.6	93.6	236700	241000	103.7	110.8	3.7	10.8	98.2
55-59	97910	94480	86.8	78.0	-13.2	-22.0	103.6	162720	146390	86.1	74.7	-13.9	-25.3	111.2
60-64	85330	92300	112.8	125.0	12.8	25.0	92.4	141070	150740	106.8	117.6	6.8	17.6	93.6
65-69	53350	53170	82.7	75.9	-17.3	-24.1	100.3	101540	109920	90.9	89.7	-9.1	-10.3	92.4
70-74	43690	47870					91.3	82450	94440					87.3

**Mean Age Ratio (Male) = 6.39**  
**Mean Age Ratio (Female) = 10.30**  
**Age-sex accuracy index = 38.3**

**Mean Age Ratio (Male) = 3.81**  
**Mean Age Ratio (Female) = 6.75**  
**Age-sex accuracy index = 27.9**

Table 1.4

## Error Detection in Age-Sex Population Data of Mali in 1998 and 2009

Age	Mali 1998							Mali 2009						
	Population		Age Ratio		Age Ratio Deviation		Sex ratio	Population		Age Ratio		Age Ratio Deviation		Sex ratio
	Male	Female	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female	
0-4	847040	830660					102.0	1325350	1294030					102.4
5-9	830180	805460	111.3	112.9	11.3	12.9	103.1	1198520	1155640	106.8	107.1	6.8	7.1	103.7
10-14	644810	596040	97.3	88.3	-2.7	-11.7	108.2	918980	864900	95.1	89.3	-4.9	-10.7	106.3
15-19	494950	545000	97.6	107.8	-2.4	7.8	90.8	734710	781690	101.5	105.7	1.5	5.7	94.0
20-24	369030	415030	93.3	91.8	-6.7	-8.2	88.9	528090	613630	89.4	92.4	-10.6	-7.6	86.1
25-29	296050	359380	93.0	98.8	-7.0	-1.2	82.4	446480	547230	97.5	105.0	-2.5	5.0	81.6
30-34	267690	312780	100.4	102.3	0.4	2.3	85.6	388010	428380	100.6	98.3	0.6	-1.7	90.6
35-39	237240	251970	102.2	96.2	2.2	-3.8	94.2	324660	324490	98.2	92.3	-1.8	-7.7	100.1
40-44	196360	210800	99.9	104.4	-0.1	4.4	93.1	273340	274610	99.4	101.7	-0.6	1.7	99.5
45-49	156020	151820	93.4	85.0	-6.6	-15.0	102.8	225340	215510	97.5	92.0	-2.5	-8.0	104.6
50-54	137580	146620	104.4	117.1	4.4	17.1	93.8	188660	193710	100.9	110.9	0.9	10.9	97.4
55-59	107600	98580	90.5	78.9	-9.5	-21.1	109.1	148540	133750	93.8	84.6	-6.2	-15.4	111.1
60-64	100150	103170	113.2	128.8	13.2	28.8	97.1	128070	122600	108.6	116.1	8.6	16.1	104.5
65-69	69410	61660	89.2	78.7	-10.8	-21.3	112.6	87260	77520	89.2	82.2	-10.8	-17.8	112.6
70-74	55500	53460					103.8	67610	66000					102.4
<b>Mean Age Ratio (Male) = 5.52</b>								<b>Mean Age Ratio (Male) = 4.16</b>						
<b>Mean Age Ratio (Female) = 11.11</b>								<b>Mean Age Ratio (Female) = 8.24</b>						
<b>Age-sex accuracy index = 42.6</b>								<b>Age-sex accuracy index = 34.4</b>						



**Table 1.5 Error Detection in Age-Sex Population Data of Senegal in 1988 and 2002**

Age	Senegal 1988							Senegal 2002						
	Population		Age Ratio		Age Ratio Deviation		Sex ratio	Population		Age Ratio		Age Ratio Deviation		Sex ratio
	Male	Female	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female	
0-4	666100	661530					100.7	732590	724590					101.1
5-9	551090	578140	102.8	107.4	2.8	7.4	95.3	741530	733170	106.7	107.1	6.7	7.1	101.1
10-14	406520	415120	91.8	86.0	-8.2	-14.0	97.9	657970	644260	100.7	95.9	0.7	-4.1	102.1
15-19	334430	387740	98.7	107.2	-1.3	7.2	86.3	565640	611100	101.1	108.6	1.1	8.6	92.6
20-24	271180	308430	92.6	90.1	-7.4	-9.9	87.9	461220	480890	99.4	95.6	-0.6	-4.4	95.9
25-29	251140	296740	109.3	116.7	9.3	16.7	84.6	362110	394810	96.1	97.8	-3.9	-2.2	91.7
30-34	188380	200010	90.6	83.1	-9.4	-16.9	94.2	292520	326440	99.7	100.2	-0.3	0.2	89.6
35-39	164670	184760	111.4	117.0	11.4	17.0	89.1	224670	256590	90.2	93.5	-9.8	-6.5	87.6
40-44	107280	115950	77.7	77.6	-22.3	-22.4	92.5	205780	222700	107.9	107.6	7.9	7.6	92.4
45-49	111300	114090	114.7	115.0	14.7	15.0	97.6	156710	157410	91.0	86.0	-9.0	-14.0	99.6
50-54	86710	82450	89.2	84.7	-10.8	-15.3	105.2	138450	143430	113.6	118.2	13.6	18.2	96.5
55-59	83010	80690	113.9	120.3	13.9	20.3	102.9	86960	85230	76.6	71.6	-23.4	-28.4	102.0
60-64	59060	51670	86.9	80.5	-13.1	-19.5	114.3	88630	94510	120.5	135.3	20.5	35.3	93.8
65-69	52960	47740	119.4	125.5	19.4	25.5	110.9	60120	54510	84.0	71.4	-16.0	-28.6	110.3
70-74	29660	24420					121.5	54520	58210					93.7

**Mean Age Ratio (Male) = 10.29**  
**Mean Age Ratio (Female) = 14.79**  
**Age-sex accuracy index = 44.8**

**Mean Age Ratio (Male) = 8.11**  
**Mean Age Ratio (Female) = 11.80**  
**Age-sex accuracy index = 39.5**

Table 1. MALE POPULATION OF BURKINA FASO, 1996

AGE	REPORTED	CARRIER FARAG	K.KING	ARRIAGA	UN MOVING AVERAGE	STRONG MOVING AVERAGE	%ERROR
0-4	904230			975356		987697	8.45
5-9	922480			851354		839013	9.95
10-14	729440	729772	725049	725816	750621	694915	4.97
15-19	588980	588648	593371	592604	577637	573745	2.66
20-24	426080	431172	436385	430251	436519	453742	6.10
25-29	347210	342118	336905	343039	345248	366922	5.37
30-34	291820	287707	288154	286663	288479	288650	1.10
35-39	230760	234873	234426	235917	232869	235087	1.84
40-44	188340	188504	189478	187930	187633	191962	1.89
45-49	155120	154956	153983	155530	156255	158855	2.35
50-54	132980	130272	130505	129868	130398	130694	1.75
55-59	105640	108348	108115	108752	109973	107939	2.13
60-64	98140	92629	91726	91817	92561	88491	10.90
65-69	66200	71711	72614	72523	71078	69708	5.03
70-74	54810			52868		51588	6.25
75-79	30910			32852		34132	9.44
80+	30850						

## FEMALE POPULATION OF BURKINA FASO, 1996

AGE	REPORTED	CARRIER FARAG	K.KING	ARRIAGA	UN MOVING AVERAGE	STRONG MOVING AVERAGE	%ERROR
0-4	890640			968026		970363	8.22
5-9	901020			823634		821297	9.71
10-14	679640	686757	687164	684523	710441	678757	0.13
15-19	576700	569583	569176	571817	561546	568851	1.38
20-24	449590	462890	464875	461516	461378	468667	4.07
25-29	398170	384870	382885	386244	391965	391536	1.69

<b>30-34</b>	333700	329021	328666	327845	332722	322837	3.36
<b>35-39</b>	266720	271399	271754	272575	270529	268281	0.58
<b>40-44</b>	223420	216732	217539	215976	218101	218561	2.22
<b>45-49</b>	169050	175738	174931	176494	176732	179763	5.96
<b>50-54</b>	153960	143289	143673	142768	144436	144522	6.53
<b>55-59</b>	105590	116261	115877	116783	115712	117410	10.07
<b>60-64</b>	103760	96041	95536	95305	94411	93971	10.42
<b>65-69</b>	66340	74059	74564	74795	74061	73484	9.72
<b>70-74</b>	60780			55213		54563	11.39
<b>75-79</b>	30990			36557		37207	16.71
<b>80+</b>	44180						

Table 2. MALE POPULATION OF BURKINA FASO, 2006

AGE	REPORTED	CARRIER FARAG	K.KING	ARRIAGA	UN MOVING AVERAGE	STRONG MOVING AVERAGE	%ERROR
<b>0-4</b>	1239190			1314299		1321775	6.25
<b>5-9</b>	1180370			1105261		1097785	7.52
<b>10-14</b>	908210	906796	905505	902411	932733	883877	2.75
<b>15-19</b>	724700	726114	727405	730499	712626	720377	0.60
<b>20-24</b>	539460	552512	557544	551010	552468	569520	5.28
<b>25-29</b>	455300	442248	437216	443750	446898	461386	1.32
<b>30-34</b>	366900	368314	369222	367063	369427	367768	0.24
<b>35-39</b>	303380	301966	301058	303218	303988	301002	0.79
<b>40-44</b>	253430	247095	247775	246257	249742	246306	2.89
<b>45-49</b>	196020	202355	201675	203193	200919	202938	3.41
<b>50-54</b>	169130	166724	166843	166045	164993	164844	2.60
<b>55-59</b>	132350	134756	134638	135435	135596	133959	1.20
<b>60-64</b>	111470	108969	108454	108067	108298	106277	4.89
<b>65-69</b>	80340	82841	83356	83743	83377	82435	2.54
<b>70-74</b>		63560		60965		60432	5.18

<b>75-79</b>	37140		39735		40268	7.77
<b>80+</b>	40850					

**FEMALE POPULATION OF BURKINA FASO, 2006**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	1221500			1293576		1284639	4.91
<b>5-9</b>	1150420			1078344		1087281	5.81
<b>10-14</b>	851690	880386	885246	877868	896257	899782	5.34
<b>15-19</b>	777350	748654	743794	751173	757586	761577	2.07
<b>20-24</b>	666370	675072	671928	672988	673658	644278	3.43
<b>25-29</b>	573940	565238	568383	567322	563756	543126	5.67
<b>30-34</b>	438650	441911	444183	440479	447579	447628	2.01
<b>35-39</b>	362030	358769	356498	360201	360989	369835	2.11
<b>40-44</b>	302740	298457	298403	297155	299134	295515	2.44
<b>45-49</b>	236090	240373	240428	241675	240522	240163	1.70
<b>50-54</b>	195080	188005	188875	187272	189421	191298	1.98
<b>55-59</b>	141800	148875	148005	149608	149673	153161	7.42
<b>60-64</b>	128880	120315	119930	119386	120033	119365	7.97
<b>65-69</b>	82990	91555	91940	92484	90779	91882	9.68
<b>70-74</b>	72360			67756		67311	7.50
<b>75-79</b>	40600			45204		45649	11.06
<b>80+</b>	56940						

**Table 3. MALE POPULATION OF GHANA, 2000**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	1379660			1467201		1478091	6.66
<b>5-9</b>	1392090			1304549		1293659	7.61
<b>10-14</b>	1153610	1144198	1141423	1141581	1176269	1114093	3.55

15-19	965000	974412	977188	977029	952311	958851	0.64
20-24	764500	792289	795401	790025	785006	804342	4.95
25-29	693370	665581	662469	667845	674715	686558	0.99
30-34	564780	565183	567228	563665	573219	579992	2.62
35-39	490380	489977	487932	491495	492503	495229	0.98
40-44	446800	454197	448874	451596	443345	422437	5.77
45-49	376700	369303	374626	371904	374546	352046	7.00
50-54	278020	258924	262896	258568	274656	278889	0.31
55-59	183160	202256	198284	202613	197004	223619	18.09
60-64	178340	171356	170941	170379	165370	172243	3.54
65-69	128270	135254	135669	136231	134987	134630	4.72
70-74	105180			104331		102664	2.45
75-79	73830			74679		76346	3.30
80+	188000						

## FEMALE POPULATION OF GHANA, 2000

AGE	REPORTED	CARRIER FARAG	K.KING	ARRIAGA	UN MOVING AVERAGE	STRONG MOVING AVERAGE	%ERROR
0-4	1398100			1495763		1488207	6.05
5-9	1384260			1286598		1294153	6.96
10-14	1117420	1093154	1096708	1090283	1137601	1108900	0.77
15-19	931080	955346	951793	958218	934524	967659	3.78
20-24	835840	867136	865619	865925	841966	846147	1.22
25-29	787200	755904	757421	757115	769661	735864	6.98
30-34	642640	644377	643407	642385	653399	632649	1.58
35-39	540270	538533	539503	540525	539031	534944	1.00
40-44	446050	442195	440948	439666	442134	434412	2.68
45-49	345760	349615	350863	352144	354903	354155	2.37
50-54	287830	257465	260804	256968	270274	275648	4.42
55-59	174400	204765	201426	205263	198454	220891	21.05

<b>60-64</b>	188500	175936	175416	175029	168056	174954	7.74
<b>65-69</b>	128290	140854	141374	141761	141734	139058	7.74
<b>70-74</b>	119030			110038		108030	10.18
<b>75-79</b>	70870			79862		81870	13.44
<b>80+</b>	182100						

**Table 4. MALE POPULATION OF GHANA, 2010**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	1728510			1716408		1734223	0.33
<b>5-9</b>	1589080			1601182		1583367	0.36
<b>10-14</b>	1478890	1477691	1473266	1477496	1471868	1431454	3.31
<b>15-19</b>	1310120	1311319	1315744	1311514	1306673	1274257	2.81
<b>20-24</b>	1107300	1110918	1111170	1108175	1115188	1109264	0.18
<b>25-29</b>	950110	946492	946240	949235	944423	959207	0.95
<b>30-34</b>	792030	798887	799498	796576	796968	805686	1.69
<b>35-39</b>	677540	670683	670072	672994	676998	681069	0.52
<b>40-44</b>	572110	562381	561871	560180	565284	564289	1.39
<b>45-49</b>	449890	459619	460129	461820	464086	465623	3.38
<b>50-54</b>	394240	369868	368931	367370	374321	370464	6.42
<b>55-59</b>	261390	285762	286699	288260	281761	295874	11.65
<b>60-64</b>	226270	205046	208198	204760	207314	224940	0.59
<b>65-69</b>	137880	159104	155953	159390	157961	175642	21.50
<b>70-74</b>	148510			127770		134914	10.08
<b>75-79</b>	89160			109900		102756	13.23
<b>80+</b>	123880						

**FEMALE POPULATION OF GHANA, 2010**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
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<b>0-4</b>	1673350			1665662		1663851	0.57
<b>5-9</b>	1533130			1540818		1542629	0.62
<b>10-14</b>	1437550	1420310	1420616	1419069	1424171	1421317	1.14
<b>15-19</b>	1294310	1311550	1311244	1312791	1309661	1299555	0.40
<b>20-24</b>	1225180	1240486	1234329	1240507	1220394	1184832	3.41
<b>25-29</b>	1106320	1091014	1097171	1090993	1092957	1048278	5.54
<b>30-34</b>	890460	893638	894145	890723	904148	897272	0.76
<b>35-39</b>	744140	740962	740455	743878	741840	760393	2.14
<b>40-44</b>	614900	608528	608981	606118	608834	617815	0.47
<b>45-49</b>	487080	493452	492999	495862	505616	506303	3.80
<b>50-54</b>	442070	397560	397052	395143	410386	400134	10.48
<b>55-59</b>	264680	309190	309698	311607	297388	321683	17.72
<b>60-64</b>	246670	221818	226020	221518	219314	248746	0.83
<b>65-69</b>	156480	181332	177130	181632	185773	203512	23.11
<b>70-74</b>	200240			159752		169355	18.24
<b>75-79</b>	115390			155878		146275	21.11
<b>80+</b>	194030						

**Table 5. MALE POPULATION OF CAMEROON, 1987**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	829510			844728		844044	1.72
<b>5-9</b>	707020			691802		692486	2.10
<b>10-14</b>	561530	549018	550961	546933	561939	549077	2.27
<b>15-19</b>	427750	440262	438319	442347	428154	446416	4.18
<b>20-24</b>	333850	348863	351391	347877	340060	356360	6.32
<b>25-29</b>	301540	286527	283999	287513	296172	293684	2.67
<b>30-34</b>	253170	243740	244363	243074	251012	242232	4.52
<b>35-39</b>	196980	206410	205787	207076	202054	204482	3.67

<b>40-44</b>	175740	176353	176631	175904	172245	174136	0.92
<b>45-49</b>	151040	150427	150149	150876	155002	147745	2.23
<b>50-54</b>	140390	131867	130906	131138	133664	124262	12.98
<b>55-59</b>	97910	106433	107394	107162	104849	101691	3.72
<b>60-64</b>	85330	80934	80374	79901	79641	79286	7.62
<b>65-69</b>	53350	57746	58306	58779	58350	59208	9.89
<b>70-74</b>	43690			39549		40025	9.16
<b>75-79</b>	18070			22211		21735	16.86
<b>80+</b>	31470						

**FEMALE POPULATION OF CAMEROON, 1987**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	807600			818635		809500	0.23
<b>5-9</b>	677380			666345		675480	0.28
<b>10-14</b>	511000	527804	532369	526264	529068	549107	6.94
<b>15-19</b>	462500	445696	441131	447236	451297	460966	0.33
<b>20-24</b>	396840	409328	407409	408265	403356	389111	1.99
<b>25-29</b>	358230	345742	347661	346805	352799	329574	8.69
<b>30-34</b>	286630	270960	272689	270185	283759	275458	4.06
<b>35-39</b>	208890	224560	222831	225335	219374	231698	9.84
<b>40-44</b>	197800	193792	193793	193219	188161	190998	3.56
<b>45-49</b>	158400	162408	162407	162981	166977	159363	0.60
<b>50-54</b>	149950	135839	135386	135119	138808	131951	13.64
<b>55-59</b>	94480	108591	109044	109311	106389	107002	11.70
<b>60-64</b>	92300	84596	83916	83519	82236	83016	11.18
<b>65-69</b>	53170	60874	61554	61951	61264	61946	14.17
<b>70-74</b>	47870			41968		42091	13.73
<b>75-79</b>	17670			23572		23449	24.64



80+

37430

**Table 6. MALE POPULATION OF CAMEROON, 2005**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	1514280			1480383		1489718	1.65
<b>5-9</b>	1272380			1306278		1296942	1.89
<b>10-14</b>	1120080	1136215	1133995	1133388	1119389	1109304	0.97
<b>15-19</b>	979880	963745	965965	966573	968189	947358	3.43
<b>20-24</b>	785340	791753	792593	788990	796371	789594	0.54
<b>25-29</b>	657080	650667	649827	653430	654413	660398	0.50
<b>30-34</b>	539230	526406	528393	524695	534533	536188	0.57
<b>35-39</b>	418600	431424	429437	433135	426301	441965	5.29
<b>40-44</b>	357150	360819	360286	359125	352778	357749	0.17
<b>45-49</b>	293620	289951	290484	291645	295643	290991	0.90
<b>50-54</b>	236700	224218	225220	223250	230884	230137	2.85
<b>55-59</b>	162720	175202	174200	176170	171445	182762	10.97
<b>60-64</b>	141070	138693	138401	137566	134287	140270	0.57
<b>65-69</b>	101540	103917	104209	105044	106458	106295	4.47
<b>70-74</b>	82450			75861		76124	8.31
<b>75-79</b>	43430			50019		49756	12.71
<b>80+</b>	52630						

**FEMALE POPULATION OF CAMEROON, 2005**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	1474210			1449684		1443733	2.11
<b>5-9</b>	1244730			1269256		1275207	2.39
<b>10-14</b>	1063700	1100688	1102904	1098213	1079466	1111451	4.30
<b>15-19</b>	1008600	971612	969396	974088	998028	971547	3.81

<b>20-24</b>	904650	899505	891898	896493	902011	844460	7.13
<b>25-29</b>	746220	751365	758972	754377	744551	717084	4.06
<b>30-34</b>	569900	562376	566621	560597	572988	582939	2.24
<b>35-39</b>	438990	446514	442269	448293	444011	475075	7.60
<b>40-44</b>	367390	367092	366874	365120	360853	368504	0.30
<b>45-49</b>	288670	288968	289186	290940	295930	294089	1.84
<b>50-54</b>	241000	215945	218408	215450	227007	230324	4.64
<b>55-59</b>	146390	171445	168983	171940	164517	183491	20.22
<b>60-64</b>	150740	146523	145627	145445	137325	144675	4.19
<b>65-69</b>	109920	114137	115033	115215	117833	112531	2.32
<b>70-74</b>	94440			85710		83889	12.58
<b>75-79</b>	48200			56930		58751	17.96
<b>80+</b>	67660						

**Table 7. MALE POPULATION OF MALI, 1988**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	847040			908408		915872	7.52
<b>5-9</b>	830180			768812		761348	9.04
<b>10-14</b>	644810	635479	633139	631831	658284	613730	5.06
<b>15-19</b>	494950	504281	506621	507929	492414	500643	1.14
<b>20-24</b>	369030	366266	372217	365664	371363	394219	6.39
<b>25-29</b>	296050	298814	292863	299416	298449	323051	8.36
<b>30-34</b>	267690	272469	272009	271850	265292	265426	0.85
<b>35-39</b>	237240	232461	232921	233080	236033	223384	6.20
<b>40-44</b>	196360	192057	192424	191480	195711	190037	3.33
<b>45-49</b>	156020	160323	159956	160900	159445	160749	2.94
<b>50-54</b>	137580	133768	134016	133358	133361	133360	3.16
<b>55-59</b>	107600	111412	111164	111822	112593	110717	2.82

<b>60-64</b>	100150	95841	94740	94909	94779	90538	10.62
<b>65-69</b>	69410	73719	74820	74651	73674	71036	2.29
<b>70-74</b>	55500			53716		52098	6.53
<b>75-79</b>	30320			32104		33722	10.09
<b>80+</b>	30190						

**FEMALE POPULATION OF MALI, 1988**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	830660			885297		886667	6.32
<b>5-9</b>	805460			750823		749453	7.47
<b>10-14</b>	596040	623707	624377	621701	632284	618499	3.63
<b>15-19</b>	545000	517333	516663	519339	520590	518846	5.04
<b>20-24</b>	415030	421158	423223	419953	428688	428888	3.23
<b>25-29</b>	359380	353252	351187	354457	356754	359930	0.15
<b>30-34</b>	312780	309076	308112	307955	309211	299419	4.46
<b>35-39</b>	251970	255674	256638	256795	256426	249919	0.82
<b>40-44</b>	210800	200150	201282	199517	203985	203876	3.40
<b>45-49</b>	151820	162470	161338	163103	162333	168207	9.74
<b>50-54</b>	146620	134644	134962	134190	134614	135916	7.88
<b>55-59</b>	98580	110556	110238	111010	110718	110780	11.01
<b>60-64</b>	103170	93956	92778	92884	92036	89555	15.20
<b>65-69</b>	61660	70874	72052	71946	69913	69015	10.66
<b>70-74</b>	53460			50586		49220	8.61
<b>75-79</b>	25930			28804		30170	14.05
<b>80+</b>	29740						

**Table 8. MALE POPULATION OF MALI, 2009**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
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<b>0-4</b>	1325350			1378668		1385956	4.37
<b>5-9</b>	1198520			1145202		1137914	5.33
<b>10-14</b>	918980	924732	923676	919696	941830	902232	1.86
<b>15-19</b>	734710	728958	730014	733994	718149	728350	0.87
<b>20-24</b>	528090	538368	546099	537407	543667	570117	7.37
<b>25-29</b>	446480	436202	428471	437163	441864	463818	3.74
<b>30-34</b>	388010	386110	386078	385080	385202	378374	2.55
<b>35-39</b>	324660	326560	326592	327590	326261	316089	2.71
<b>40-44</b>	273340	272596	272807	271713	272296	266897	2.41
<b>45-49</b>	225340	226084	225873	226967	226763	223592	0.78
<b>50-54</b>	188660	186234	186309	185484	186294	183117	3.03
<b>55-59</b>	148540	150966	150891	151716	152483	149527	0.66
<b>60-64</b>	128070	122793	121943	121624	122977	118561	8.02
<b>65-69</b>	87260	92537	93388	93706	91602	91465	4.60
<b>70-74</b>	67610			67064		66149	2.21
<b>75-79</b>	41150			41696		42611	3.43
<b>80+</b>	42290						

**FEMALE POPULATION OF MALI, 2009**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	1294030			1338443		1334242	3.01
<b>5-9</b>	1155640			1111227		1115428	3.61
<b>10-14</b>	864900	899926	903846	897234	905666	907548	4.70
<b>15-19</b>	781690	746664	742744	749356	751759	754334	3.63
<b>20-24</b>	613630	637028	636288	634668	634919	621523	1.27
<b>25-29</b>	547230	523832	524573	526192	533385	514974	6.26
<b>30-34</b>	428380	416852	418356	415330	430153	417628	2.57
<b>35-39</b>	324490	336018	334514	337540	330883	342267	5.19
<b>40-44</b>	274610	270471	271648	269563	267751	273360	0.46

<b>45-49</b>	215510	219649	218472	220557	223134	222667	3.21
<b>50-54</b>	193710	181986	181855	181119	183558	179406	7.97
<b>55-59</b>	133750	145474	145605	146341	144357	144405	7.38
<b>60-64</b>	122600	114456	114104	113480	113211	113213	8.29
<b>65-69</b>	77520	85664	86016	86640	84944	86695	10.58
<b>70-74</b>	66000			62298		62405	5.76
<b>75-79</b>	36750			40453		40345	8.91
<b>80+</b>	43900						

**Table 9. MALE POPULATION OF SENEGAL, 1988**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	666100			678859		672727	0.99
<b>5-9</b>	551090			538331		544463	1.22
<b>10-14</b>	406520	409508	413904	408538	416875	424167	4.16
<b>15-19</b>	334430	331442	327046	332413	328304	343709	2.70
<b>20-24</b>	271180	285291	285404	284375	278699	279383	2.94
<b>25-29</b>	251140	237029	236916	237945	240659	230397	9.00
<b>30-34</b>	188380	195671	195509	194784	198036	189002	0.33
<b>35-39</b>	164670	157379	157541	158266	154181	155914	5.62
<b>40-44</b>	107280	119268	120748	118965	118849	125003	14.18
<b>45-49</b>	111300	99312	97832	99615	102580	103812	7.21
<b>50-54</b>	86710	91934	91520	91704	92375	87251	0.62
<b>55-59</b>	83010	77786	78200	78016	78058	72464	14.55
<b>60-64</b>	59060	64640	63556	63667	63632	59738	1.13
<b>65-69</b>	52960	47380	48464	48353	48884	45799	15.64
<b>70-74</b>	29660			32596		31662	6.32
<b>75-79</b>	19330			16394		17328	11.55
<b>80+</b>	22790						

**FEMALE POPULATION OF SENEGAL, 1988**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	661530			684400		677888	2.41
<b>5-9</b>	578140			555270		561782	2.91
<b>10-14</b>	415120	437317	441086	436105	440298	452293	8.22
<b>15-19</b>	387740	365543	361774	366755	368545	375897	3.15
<b>20-24</b>	308430	330327	328716	329189	325443	314167	1.83
<b>25-29</b>	296740	274843	276454	275981	276791	261384	13.53
<b>30-34</b>	200010	215533	215831	214463	218858	212452	5.86
<b>35-39</b>	184760	169237	168939	170308	168788	172714	6.97
<b>40-44</b>	115950	127309	128872	127042	129528	133981	13.46
<b>45-49</b>	114090	102731	101168	102998	104316	107953	5.68
<b>50-54</b>	82450	90093	89734	89668	89750	87234	5.48
<b>55-59</b>	80690	73047	73406	73472	73847	70152	15.02
<b>60-64</b>	51670	57933	57223	57073	57722	55616	7.10
<b>65-69</b>	47740	41477	42188	42337	42664	41547	14.91
<b>70-74</b>	24420			28200		27971	12.70
<b>75-79</b>	18440			14660		14889	23.85
<b>80+</b>	26280						

**Table 10. MALE POPULATION OF SENEGAL, 2002**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	732590			762133		773888	5.34
<b>5-9</b>	741530			711987		700232	5.90
<b>10-14</b>	657970	656270	652479	655600	663411	625330	5.22
<b>15-19</b>	565640	567340	571131	568010	564345	544189	3.94
<b>20-24</b>	461220	455808	455816	453855	460794	455405	1.28

<b>25-29</b>	362110	367522	367514	369475	365359	379574	4.60
<b>30-34</b>	292520	285020	287398	284243	287833	301078	2.84
<b>35-39</b>	224670	232170	229793	232948	232568	246182	8.74
<b>40-44</b>	205780	199993	199481	199114	197022	198986	3.41
<b>45-49</b>	156710	162497	163009	163376	164524	162759	3.72
<b>50-54</b>	138450	125202	126064	124805	129048	131011	5.68
<b>55-59</b>	86960	100208	99346	100605	97568	106128	18.06
<b>60-64</b>	88630	83270	83076	82783	80103	84023	5.48
<b>65-69</b>	60120	65480	65674	65968	65948	66115	9.07
<b>70-74</b>	54520			50328		50128	8.76
<b>75-79</b>	31670			35863		36062	12.18
<b>80+</b>	33590						

**FEMALE POPULATION OF SENEGAL, 2002**

<b>AGE</b>	<b>REPORTED</b>	<b>CARRIER FARAG</b>	<b>K.KING</b>	<b>ARRIAGA</b>	<b>UN MOVING AVERAGE</b>	<b>STRONG MOVING AVERAGE</b>	<b>%ERROR</b>
<b>0-4</b>	724590			746794		759040	4.54
<b>5-9</b>	733170			710966		698720	4.93
<b>10-14</b>	644260	667612	664059	667752	663388	636237	1.26
<b>15-19</b>	611100	587748	591301	587608	592726	562934	8.56
<b>20-24</b>	480890	479697	479871	478058	491365	481355	0.10
<b>25-29</b>	394810	396003	395829	397642	394358	407293	3.06
<b>30-34</b>	326440	321816	322489	320620	322901	329346	0.88
<b>35-39</b>	256590	261214	260541	262410	263140	270185	5.03
<b>40-44</b>	222700	212191	212203	211131	213321	215407	3.39
<b>45-49</b>	157410	167919	167907	168979	168550	173718	9.39
<b>50-54</b>	143430	127651	128773	127277	130478	135885	5.55
<b>55-59</b>	85230	101009	99887	101383	99509	108310	21.31
<b>60-64</b>	94510	83774	83543	83236	81401	85069	11.10
<b>65-69</b>	54510	65246	65477	65784	65302	66141	17.59

<b>70-74</b>	58210	49562	49371	17.90
<b>75-79</b>	25920	34568	34759	25.43
<b>80+</b>	37170			



**Error detection**

Table 1.1 shows that there was a reduction in the level of inaccuracy (from 31.8 to 28.6) in Burkina Faso population data between years 1996 and 2006. Also, the average age ratio reduced for both sexes (Male 5.68 in 1996 to 4.80 in 2006; Female 8.74 in 1996 to 5.95 in 2006). The maximum positive and negative deviations in the male population in 1996 were in age group 60-64 (14.2%) and 65-69 (13.4%) respectively while in the female population it was noted in age groups 60-64 (20.7%) and 65-69 (19.4%) respectively. For the male population in 2006, the maximum positive and negative deviations were noted in 35-39 (5.9%) and 55-59 (11.4%); in the female population, it was observed that the maximum positive and negative deviations were in age groups 60-64 (11.5%) and 55-59 (19%) respectively.

Table 1.2 shows a reduction in the level of inaccuracy in Ghana male and female population data between years 2000 and 2010 (from 34.7 to 28.8). The average age ratio for the males ranged from 5.98 (in 2000) to 6.02 (in 2010), but there was no significant decline in the female population for between the years i.e. both approximated to 8. In terms of the deviations, age group 60-64 and 55-59 have the maximum positive and negative deviations respectively in the male population in the year 2000, but age groups 60-64 (13.3%) and 65-59 (26.4%) have the maximum positive and negative deviations respectively in 2010. In the female population, it was observed that the maximum positive and negative deviations were in age groups 60-64 (24.5%) and 65-59 (16.6) in the year 2000. On the other hand, it was observed that age groups 60-64 (13.3%) and 65-69 (26.4%) have the maximum positive and negative deviations respectively in 2010.

Table 1.3 shows that there was a decline in the level of inaccuracy (from 38.3 to 27.9) in Cameroon population data between years 1987 and 2005. Also, the average age ratio reduced for both sexes (males: 6.39 in 1987 to 3.81 in 2005; females 10.30 in 1987 to 6.75 in 2005). The maximum positive and negative deviations in the male population (in 1987) were in age groups 50-54 and 60-64 (12.8% respectively) and 65-69 (24.1%) respectively while in the female population it was noted in age groups 60-64 (25%) and 65-69 (24.1%) respectively. Again, for the male population in 2005, the maximum positive and negative deviations were noted in 60-64 (6.8%) and 55-59 (13.9%); in the female population, it was observed that the maximum positive and negative deviations were in age groups 60-64 (17.6%) and 55-59 (25.3%) respectively.

According to Table 1.4, the age accuracy index ranged from 42.6 to 34.4 between Mali 1998 and

2009 population censuses. Besides, the average age ratio for the males ranged from 5.52 to 4.16 while it declined from 11.11 to 8.24. The maximum positive deviations in the 1998 male and female population were in age groups 60-64 (13.2% and 28.8% respectively). It was also observed in the age group 60-64 in the male and female population (8.6% and 16.1% respectively) in the year 2009. With respect to the negative deviations, it was observed that the maximum negative deviation was 10.8% (in the age group 65-69) in years 1998 and 2009 in the male population while it ranged from 21.3% to 17.8% in the same age groups in the female population in 2009.

According to Table 1.5, that there was a decline in the level of inaccuracy (from 44.8 to 39.5) in Senegal population data between years 1988 and 2002. Also, the average age ratio reduced for both sexes (males: 10.29 in 1988 to 8.11 in 2002; females 14.79 in 1988 to 11.80 in 2002). The maximum positive deviations in the Senegal 1988 male and female population were in age groups 65-69 (19.4% and 25.5% respectively). It was also observed in the age group 60-64 in the male and female population (20.5% and 35.3% respectively) in the year 2002. With respect to the negative deviations, it was observed that the maximum negative deviation was 22.3% and 22.4% (in the age group 40-44) in the male and female population respectively in the year 1998. It was 23.4% (55-59) in the male population and 28.6% (65-69) in the female population in 2002.

**Age smoothing****Male and female population of Burkina Faso, 1996 and 2006**

Table 1. shows that in 1996, males and females in the younger age groups were less under enumerated than older age groups. Males belonging to age group 60-64 (11%) where largely over-enumerated. Females belonging to age group 75-79 (17%) where largely over-enumerated while those in the group 35-39 (1%) were the most under-enumerated. Table 2. shows that in 2006, males belonging to age group 5-9 and 75-79 where over-enumerated while those in the group 35-39 (1%) were the most under-enumerated. Females belonging to age group 75-79 (11%) where largely over-enumerated.

**Male and female population, Ghana 2000 and 2010**

Table 3 shows that in 2000, males and females in the younger age groups were less under-enumerated than older age groups. Males belonging to age group 55-59 (18%) where largely over-enumerated while those in the group 25-29 (1%) were the most under-enumerated group. Females belonging to age group

55-59 where largely over-enumerated while those in the group 10-14 were under-enumerated. Table 4 shows that over-enumeration was largely present in both males and females in older age groups. Those male populations in the groups 65-69 (22%) and 60-64 (1%) were the most over-enumerated and under-enumerated groups respectively. Females belonging to age groups 65-69 (23%) and 60-64 (1%) were largely over-enumerated and under-enumerated respectively.

#### **Male and female population, Cameroon, 1987 and 2005**

Table 5 shows that in 1987, males and females in the younger age groups were less under-enumerated than older age groups. Males belonging to age group 75-79 (17%) were largely over-enumerated while those in the group 40-44 (1%) were under-enumerated. Females belonging to age group 75-79 (25%) were largely over-enumerated while those in the group 45-49 (1%) were the most under-enumerated group. Table 6 shows that over-enumeration was largely present in both males and females in older age groups. Those male populations in the groups 75-79 (13%) and 45-49 (1%) were the most over-enumerated and under-enumerated groups respectively. Females belonging to age groups 55-59 (20%) and 60-64 (4%) were largely over-enumerated and under-enumerated respectively.

#### **Male and female population, Mali, 1988 and 2009**

Table 7 shows that in 1988, males and females in the younger age groups were less under-enumerated than older age groups. Males belonging to age group 60-64 (11%) were largely over-enumerated but those in 30-34 (1%) were under-enumerated. Females belonging to age group 75-79 (14%) were largely over-enumerated while those in the group 35-39 (1%) were under-enumerated. Table 8 shows that in 2006, males belonging to age group 20-24 (7%) and 15-19 (1%) were the most over-enumerated and under-enumerated respectively. Females belonging to age group 65-69 (11%) were largely over-enumerated while those in 40-44 (0.5%) were under-enumerated.

#### **Male and female population of Senegal, 1988 and 2002**

Table 9 shows that in 1988, males in the younger age groups were less under-enumerated than older age groups. Males belonging to age group 65-69 (16%) were largely over-enumerated but those in 0-4 (1%) were under-enumerated. Females belonging to age group 75-79 (24%) were largely over-enumerated. Table 8 shows that in 2002, males belonging to age group 75-79 (18%) were the most

over-enumerated. Females belonging to age group 65-69 (25%) were largely over-enumerated while those in 30-34 (0.5%) were the most under-enumerated.

#### **Discussion and policy implications**

Having applied the smoothing technique, to the two census periods observed in this study, an upward pattern of over-enumeration ranging between 10-25% was noticed for both sexes in the older ages. Besides, women were more likely to be overestimated than men in virtually all the countries save the male and female census data of Cameroon in 2005 and Senegal in 2002, in which both males and females were equally over-enumerated. Studies have established that age misreporting results from imbalances in the age-sex population coverage within the technical and political contexts and similarly from resulting contents errors associated with the enumerators' error which is a more plausible reason for the obvious age misreporting (Adebowale et al., 2012; Gibril, 1979; Mba, 2004). In addition, misreporting of true ages, either irrespective of the sex age, particularly at older ages, is typical of Africa as earlier reported (Siegel, 2004).

On the other hand, an unchanged proportion of under-enumeration was a usual pattern among the females i.e. (1%) under-enumeration among those aged 35-39 in Burkina-Faso, in Ghana, ages 10-14, 45-49 in Cameroun and 35-39 in Mali and the least (0.5%) in Senegal. Nevertheless, a sharp spike was noticed for males in ages 5-9 in the earlier census (1996) but not observed in the latter census (2006) in Burkina-Faso, also in Mali, about 7% over-enumeration was observed for the male adolescents (20-24 years). This unsustainable distortion observed especially among the male population might be indicative of increasing literacy and knowledgeability of mothers in knowing their wards' birthdays in their early years of life, and maybe the presence of other more enlightened older children in helping with age reporting and sometimes, perhaps children's rapid growth as a result of improved nutrient uptake may be pivotal in misleading the enumerators to assume and report wrong ages. In the same vein, past observations in these countries (Ewbank, 1981; Gendreau & Nadot, 1967; Hertrich & Lardoux, 2014; Mba, 2014) showed that adolescents often times possess a lot of attitudinal and behavioral challenges- which may not be un-connected with peer pressure, indecisions and preferences- that gives rise to inaccuracies in age reporting.

The highly prevalent habitual age misreporting in African countries could be alluded to lack of birth certificate, recall lapse, deliberate age shifting, digit preference, age heaping which render any

subsequent analyses inaccurate and unreliable (Makannah, 1990; Mba, 2003, 2014; Gilles Pison & Ohadike, 2006; Siegel, 2004; Williams, 2014); unfortunately this trend is not divorceable from administrative benefits derivable from age misreporting. In light of these findings, it is crystal clear on reasons planning and programmatic interventions especially based on census data have continued to suffer huge setbacks (Adebowale et al., 2012; Mba, 2004, 2006; Randall & Coast, 2016; UN, 1967) amidst increasing literacy rate, high global awareness of quality census exercise as well as increased external census funding among others in sub-Saharan African countries.

### Conclusion

This study found that the strong smoothing method, among other smoothing techniques was effective in unmasking and adjusting the error-ridden census data of all the selected West African countries. Hence, it is recommended that alongside implementing a great deal of data quality assurance operations in enumeration exercises, the strong smoothing technique should be adopted as a better way of unearthing and adjusting census data in West Africa and perhaps in Africa compared to the error-concealing tendency of the light smoothing techniques.

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