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RESEARCH ARTICLE

DIGIT PREFERENCE AND ITS IMPLICATIONS ON POPULATION PROJECTIONS IN ZAMBIA: EVIDENCE FROM THE CENSUS DATA

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A B S T R A C T

Introduction: Tests of the age preference are not only important because of the major role it plays in describing the population but also because of its importance in making population projections and planning for resource distribution by government agencies and other stakeholders. A common error that most developing countries face in age data is tendency by respondents to round-off or misstate their ages.
Objective: The aim of the study was to assess whether age preference exists in Zambia and its implications on population projections and resource allocation.
Methods: This study utilised age data in single years to determine digit preference as reported in the 1969, 1990 and 2010 censuses by using the Whipples and Myers Blended Indices used. In addition, for grouped data the United Nations Age-Sex Accuracy Index was used.
Results: Although the quality of census data has been improving with successive census undertakings, the fact is age heaping in ages ending with 0 and 5 still exist in Zambia, with more males than females, having heaped ages at the two terminal digits. However, besides remarkable improvement from a score 72.9 in 1969 to a score of 27.9 in 2010 as indicated by the United Nation Age-Sex Accuracy Index, age data still remains inaccurate.
Conclusion: Therefore, this study shows that, age data from censuses is misreported and inaccurate in Zambia, which if not adjusted may result in wrong projections for age dependent variables. Therefore, whenever age data is being collected in future censuses date of birth should also be collected.

INTRODUCTION

Age distribution is one of the most important pieces of data that are derived from census (ESCWA, 2013). World over, not only does it provide the demographic make-up (Yazdanparast et al; 2012) but it also acts as a base for future population estimates and projections on life expectancy, fertility and migration (Daluru and Dikko, 2013) thus making it one of the vital demographic variables that should be accurately collected and reported (West et al, 2003). However, in spite of its importance, it constitutes one of demography's most frustrating problems (Ewbank 1981) as it often suffers from reporting errors and irregularities, which impacts negatively on its usage.

Digit preference is most pronounced among populations or sub-groups having a low educational status. Though the cause and patterns differs from one culture to another, preferences for ages in "0" and "5" is quite wide spread apparently, this has existed for much of human history (Gray 1987). For example, Gini (1933) observed a profound digit preference in data from Egypt before and after the beginning of the Christian era. In some developed countries, age misstatements of this type have drastically reduced to almost negligible in recent years. However, for most developing countries Zambia inclusive, data still suffers from digit preference (Byerlee and Terera 1981; Gray 1987; Palamuleni 1995; and Shyrock et al 1976). Therefore, these irregularities must be detected, adjusted or corrected before demographic data could be used for any meaningful analysis.

Studies shows that censuses conducted in African countries usually suffer from digit preference also referred to us as a content (or response) error or non-random measurement error (ESCWA 2013; Harling et al 2015; West et al, 2003; and Yazdanparast et al 2012). Age preference is likely to be us a result of uncertainty arising from poor date of birth knowledge or ignorance of exact age leading to approximation by the respondents (Coale and Li, 1991; Ewbank 1981; ESCWA 2013; Gray 1987; and Hill et al 1997) or cognitive biases towards reporting landmark ages leading to 'heaping' of data (Pardeshi 2010; and Stockwell and Wicks 1974). Others argue that, it is due to social-cultural (e.g.

conscious or sub-conscious of certain ages) values that people in different societies attach to these numbers which consequently results in age misstatement. In addition, others just choose not to reveal their actual age, like rounding up ages, illiteracy are also high in these African countries. For example among the elderly and younger ages, age may be over or under estimated just for preferences of certain numbers (West et al, 2003). Moreover, intentional reporting biases may arise from efforts to meet age-eligibility cut-offs (Harling et al 2015).

The role that age data plays in most demographic analysis cannot be overemphasized. This is because most national developmental plans for the provision of public services and goods such as housing, food, education, health, employment, manpower etc depends on socio-economic statistics usually disaggregated by age and sex (Bello 2012 and Palamuleni 1995). Moreover, most of the fertility, mortality and migration measurements depend most only age and sex of the respondents, Therefore age data if not well collected leads to demographers, statisticians, planners and researchers to make wrong and inaccurate inferences

In Zambia, all inclusive censuses have been undertaken since 1969 (more than five decades ago) and various projections have been conducted based on the ages reported by subjects during the census processes. However, to date, no study has been conducted on whether this phenomenon exists in Zambian Censuses. Therefore, this paper seeks to assess whether age preference exists in Zambian Censuses using three established demographic techniques for evaluating age data in population counts. These techniques are the Whipples index, Myers Blended Index and the United Nations Age-Sex Accuracy Index also known (or the United Nations Joint Score)

Study Objective

The aim of the study is to assess whether age preference exists in Zambian Censuses and if that's the case what implications it has on the population estimates and projections.

METHODS AND MATERIALS

This study utilised single year age data from five previous census reports (1969, 1980, 1990, 2000 and 2010). SINAGE and AGESEX spread sheets developed by US Census Bureau were used to perform analysis of age errors.

Statistical Data Analysis

It is difficult to measure digit preference in the age distribution, because a precise distinction cannot be made between errors due to digit preference, other errors and real fluctuations in birth cohort size. However, indices have been developed to help address some of these problems (West et al 2000). Therefore, for purposes of this study, three statistical methods were used, whipples index, myers blended index and the United Nations Age-Sex Accuracy Index Scores (UNAI) also known as United Nations Joint Score (UNJS) method (Dahiru and Dikko 2013; ESCWA 2013).

Whipples Index

This method is used to measure the tendency for individuals to inaccurately report their actual age or date of birth. The index score is obtained by summing the number of persons in the age range 23 and 62 inclusive, who report ages ending in '0' and '5' or both digits, dividing that sum by the total population between ages 23 and 62 years inclusive, and multiplying the result by 5 (Kpedekpo 1982; Siegel and Swanson 2004; and Whipples 1919). The index is computed using the following formula;

- WI = (∑(P25 + P30+…+ P55 + P60)/1/5(∑(P23 + P24+…+ P61 + P62))*100(1)

To test for heaping at ages ending with '0' the index is computed using the following formula;

- WI = (∑(P30 + P40+…+ P50 + P60)/1/10(∑(P23 + P24+…+ P61 + P62))*100(2)

It varies between 1 (indicating no preference for ages ending by 0 and 5) and 5 (indicative of a complete report on ages ending by 0 and 5). In computing this index, the ages of childhood and old ages are often excluded because they are more strongly affected by other types of errors of reporting than by preferences for specific terminal digits and the assumption of equal decrements from age to age is less applicable (Siegel and Swanson 2004). The UN recommends a standard for measuring the age heaping using Whipples index as follows:

Table 1 United Nations Recommendation for Age Heaping as Identified by Whipples Index

Whipples Index	Quality of Data	Deviation from Perfect
<105	Highly accurate	< 5%
105 - 110	Fairly accurate	5 – 9.99%
110 – 125	Approximate or Ok	10 – 24.99%
125 - 175	Rough or Bad	25 – 74.99%
>175	Very Rough/Bad	≥75%

In spite of its useful nature in detecting digits in census age data, this method has some weaknesses some of which are: It does not measure preference for digits other than '0' and '5', It considers only the arbitrary interval 23 to 62 years and not the entire life span of 0 to 80 or 100 years, It does not take into account consideration the decreasing nature of the age distribution due to depletion by death and It is applicable only to single years data

Myers Blended Index

Myers (1940) developed a "blended" method to avoid the bias and short comings of indexes computed in the way just describe that is due to the fact that numbers ending in '0' would normally be larger than those ending in 1 to 9 because of the effect of mortality. This method has been very useful to measure the extent of digit preference error in the single year age data (Pal et al 2014), Conceptually this method is similar to Whipple's index, except that the index considers preference (or avoidance) of age ending in each of the digits 0 to 9 in deriving overall age accuracy score. The theoretical range of Myers' Index is from 0 to 90, where 0 indicates no age heaping and 90 indicates the extreme case where all recorded ages end in the same digit (Siegel and Swanson 2004 and Yazdanparast et al 2012).

This method has a number of underlying assumptions: in the absence of systematic irregularities in the reporting of age, the blended sum at each terminal digit should be approximately equal to 10 percent of the total blended population; If the sum of at any given digit exceeds 10 percent of the total blended population, it indicates over selection of ages ending in that digit (i.e. digit preference); On the other hand, a negative deviation or sum that is less than 10 percent of the total blended population indicates an under selection of the ages ending in that digit (i.e. digit avoidance); and if age heaping is non-existent, the index would be approximately zero. This procedure is calculated using the following steps:

- Sum the populations ending in each digit over the whole range, starting with the lower limit of the range (e.g., 10, 20, 30 . . . 80; 11, 21, 31 . . . 81).
- Ascertain the sum excluding the first population combined in step 1 (e.g., 20, 30, 40 . . . 80; 21, 31, 41 . . . 81).
- Weight the sums in steps 1 and 2 and add the results to obtain a blended population (e.g., weights 1 and 9 for the 0 digit; weights 2 and 8 for the 1 digit).
- Convert the distribution in step 3 into percentages.
- Take the deviation of each percentage in step 4 from 10.0, the expected value for each percentage.

The results in step 5 indicate the extent of concentration (preference) on or avoidance of a particular digit. Although this method is an improvement on the Whipples index, it also has its own shortcomings among them been: having no sound theoretical basis; does not capture other forms of age bias; and not suitable for grouped data

United Nations Age - sex Accuracy Index Score (or UN Joint Score Method)

This index which was proposed by the United Nations is used for evaluation of five year age sex data. This method has got three components: (1) Average sex ratio score (S). This score is obtained by first calculating the sex ratio at each age group. Successive differences irrespective of sign are added and averaged

- $S=({}_5P_x m/{}_5P_x\ f)*100$ (3)
- Where: ${}_5P_x m$ = males age x to x+5
  – ${}_5P_x f$ = females age x to x+5

Average Male age ratio score (M). For each age group of males, calculate the age ratios computed as Age ratio

$$M = ({}_5\mathbf{P_x}/1/2({}_5\mathbf{P_x}\text{-}5 + {}_5\mathbf{P_x}\text{+}5))*100 \quad (4)$$

The deviations from unity irrespective of sign are added and averaged (M). Average female age ratio score (F). For each group for females, the age ratios are calculated using the same formulae as for males.

$$F = ({}_5\mathbf{P_x}/1/2({}_5\mathbf{P_{x-5}} + {}_5\mathbf{P_{x+5}}))*100 \quad (5)$$

The deviations from unity irrespective of sign are added and averaged (F). Therefore, the (UNJS) or (UNAI) is computed as:

$$\text{UNAI OR UNJS} = 3\ (S) + M + F \quad (6)$$

The reported age sex data for a given population is presumed to be accurate if the UNAI is between 0 and 19.9, inaccurate if the index is between 20 and 39.9, and highly in accurate if the index is above 40

RESULTS

Table 2 below shows that, when the Whipples index is computed for both age data ending with 0 and 5 the data for all the three censuses is OK as per UN recommendation 121.0 in 1969, 119.8 in 1990 and 123.8 in 2010. However, when data is disaggregated by gender, age data was bad for females (125.4) for digit '0' in 1969; for males (126.0) for '0' in 1990; and for both males (130.7) and females (126.1) for digit '5' in 2010 census.

Table 2 Whipple's indices for Zambian census showing preference for ages ending with 0 and 5 for age data by gender in 1969, 1990 and 2010

Digit Preference	1969			1990			2010		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0	115.0	125.4	120.3	126.0	121.3	123.6	123.0	115.4	119.1
5	122.7	120.5	121.6	117.7	114.4	116.0	130.7	126.1	128.4
0 and 5	118.8	122.9	121.0	121.9	117.8	119.8	126.8	120.7	123.8

Table 3 below shows that, the percentages of the last digits that were preferred by the respondents were those ending with

Table 3 Percent distribution of age's last digits for the age data and Myers blended index according to gender in Zambia in 1969, 1990 and 2010

Last Digit	1969			1990			2000		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
0	11.5	13.2	12.4	13.0	13.2	13.1	12.7	12.5	12.6
1	9.7	10.3	10.0	8.6	8.6	8.6	7.8	7.9	7.9
2	8.8	9.0	8.9	11.1	11.2	11.1	10.7	10.7	10.7
3	8.4	8.9	8.7	8.5	8.1	8.3	8.7	8.8	8.7
4	8.4	8.4	8.4	9.0	10.1	9.6	9.0	9.3	9.2
5	11.8	11.0	11.4	10.8	10.4	10.6	11.6	11.2	11.4
6	7.7	7.6	7.6	10.5	10.5	10.5	10.2	10.3	10.3
7	11.4	9.9	10.6	8.6	8.4	8.5	9.0	8.9	8.9
8	10.0	8.2	9.1	11.7	11.6	11.6	11.6	11.6	11.6
9	12.5	13.4	13.0	8.1	8.0	8.0	8.6	8,7	8.7
Total	100	100	100	100	100	100	100	100	100
Blended index	7.1	7.9	7.3	7.2	6.9	7.0	6.8	6.4	6.6

0 and 5 in all the three censuses. Disaggregated by year and sex similar pattern was observed across the three censuses and between males and females. More females (13.2 percent) than males (11.5 percent and 13.0 percent) had over selected ‘0’ in the 1969 and 1990 census while males (11.8 percent and 10.8 percent) than females (11.0 percent and 10.4 percent) had over selected those ending with ‘5’ in the same years. In addition, in the 2010 census males (12.7 percent and 11.6 percent) tended to prefer both ‘0’and ‘5’ age ending digits than females (12.5 percent and 11.2 percent) respectively. On the contrary, the ages ending with terminal digits: 1, 2, 3, 6, and 7 were the most avoided in the three censuses.

Myers blended indexes for the three censuses 1969, 1990 and 2010 were 7.3, 7.0 and 6.6 respectively. These results show that the quality of reporting of age data has improved in Zambia even though the pace of improvement has been very slow in the past 50 years.

Data from the UNAI as measured by the sex ratio score in table 4 below indicates that the quality of data has been improving with each successive census enumeration in the past five decades from 15.4 in 1969 to 6.1 in 2010. In addition, the age ratio cores reveals similar trend with a higher male age ratio in 1969 (17.2) than females (9.6) to (4.4) for males and (5.4) for females in 2010.

Table 4 Sex and Age ratio scores and the United Nations Age-Sex Accuracy Index Score for Zambia in 1969, 1980, 1990, 2000 and 2010

	1969	1980	1990	2000	2010
Sex Score	15.4	8.3	6.1	6.3	6.1
Male Age Scores	17.2	5.1	5.1	5.2	4.4
Female Age Score	9.6	9.9	8.4	7.1	5.4
UNAI	72.9	39.8	31.7	31.2	27.9

The data further shows that the degree of variations in the age ratio scores in the five census data were increasing with advancing age in both male and female populations. More variations or inaccuracies in females’ age ratio scores were noticed than males in all the censuses. Additionally, across all the five censuses, the pattern of age ratio scores is the same with peaks in age groups 5 to 9, 20 to 24, 25 to 29, 30 to 34, 40 to 44, 45 to 49, 50 to 54 and 60 to 64 compared with those ending with 4. Therefore, among all the censuses, it can be inferred that end digits ending with 4 and five were preferred by the respondents.

Findings based on the UNAI shows that age reporting in Zambia is inaccurate. In spite of the decrease from highly inaccurate (72.9) in 1969 to inaccurate (27.9) in 2010 the data is still distorted and roughly reported based on UN recommendations as discussed in the preceding paragraphs.

DISCUSSION

Findings from our study clearly demonstrate that data on age in Zambia has consistently remained of poor quality from 1969 to 2010 as shown by all the three techniques of assess age data quality.

Concentration was evident on ages ending with ‘0’ and ‘5’ as shown by Whipples and Myers Indices similar to other studies (Bello 2012; Dahiru and Dikko, 2013; and Gray 1987). When the data is disaggregated by gender looking at the whipples index, except for the 1969 census, the 1990 and 2010 censuses indicated that males tended to prefer digits ending with 0 and 5 than their female counter parts which is contrary to what others have found (Bello 2012; Dahiru and Dikko, 2013 and Yazdanparast et al 2012). The reason for such a result may be due to the widely held notion that females are in a better position to recall when they were born than their male counterparts. While on the other hand the preference for the digits among males may be attributable to their greater tendency to overestimate their ages

In addition, the results from this study based on the Myers Index shows that, males were more inclined towards to ‘5’ compared to females who preferred ‘0’. In addition, besides digits 0 and 5, preference for ages with last digits ending with 9 in 1969; 2 and 8 in 1990; and 8 in 2010 by both sexes was also common which is in agreement with other similar studies (Bello 2012 and Gray 1987). The data also showed marked avoidance of age ending with 1, 2, 3, 6 and 7 (Gray 1987). However, the preference for these digits by Zambia people is on the decline as time goes by though at a very slow rate as shown by the blended index.

The overall pattern of the in age enumeration in Zambia is inconsistent. In 1969 for example ages 10 – 14 and those equal to or above 40 – 44 years were over-enumerated as compared to those aged 30 – 34 to 45 – 49 in 2010. In addition, it is also important to note that the age group equal to or above (40 – 44) which had overstated their age in 1969, tended to do the same even in the sub-sequent censuses until about 2000 of which some of the age groups are similar to what Palamuleni (1995) found in his analysis of age misreporting in Malawian censuses and sample surveys.

The UN sex ration scores revealed that the quality of data has been improving in Zambia with each succeeding census undertaken. However, the sex ratios in all the censuses in Zambia are still above 1.5 that the UN recommendation in 1952. Similarly, the age ratios in the Zambia censuses are way above the 2.6 for males and 2.4 for females UN recommended minimum standards.

The United Nation Age-Sex Accuracy Index further indicates that, the age data are inaccurate in Zambian Censuses. The index has however, improved from the highly in accurate (72.9) in 1969 to inaccurate (27.9) in 2010. Therefore, this finding just confirms that Zambia age data is distorted and is indicative of the fact that wrong ages are reported during data collection. However, our finding though comparable to other similar studies conducted within the region is better as compared studies conducted in Malawi and Nigeria by Bello (2012) and Palamuleni (1995).

Implications on Age dependent Population Projections and Government Distribution of Resources

Our study findings strongly casts doubt on the age dependent population projections such as life expectancy, maternal mortality rates, infant and child mortality, school enrolments, and planning for social services and public goods to mention just a few. Reason being if projections are made without taking into account age adjustments during analysis of census data even the projection estimates obtained from them have these errors. Therefore, it implies when government resources are being distributed the chances that they will be channelled towards the wrong age group are quite high, thus suffocating other age groups which requires more of the resources.

Study Limitations

Whipples and Myers Indexes were not computed for the census years 1980 and 2000 because the researchers relied on official census reports which did not have single age data to use for computing the indices. The researcher had no access to the official census datasets for all the five censuses officially conducted by the Central Statistical Office in Zambia.

CONCLUSION

Our findings indicate that truly age distortions exist in Zambian census data. There is a tendency of age heaping with terminal digits '0' and '5' indicating preference for such ages. In addition, gender differences exist in age reporting in Zambia with more males than females reporting their ages wrongly. However, this should not overshadow the fact that over time the quality of age reporting has improved. Therefore, whenever age data is been collected in future, the use of both the date of birth and asking respondents to report their completed years will complement each other in overcoming this problem where possible, use of personal identification cards (such as national registration cards, passports and drivers licences) should be emphasised. Further research is recommended to understand the factors as to why males tend to misstate their ages when their literacy levels are high compared to females.

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Authors Contribution

BBB: Conceptualised the study, manipulated the data and wrote the first draft of the paper in close collaboration with **MP**.
MP: Contributed to the write up of the first draft and summarisation of the results into tables. **CM:** entered the data into the excel files for manipulation and also in the proof reading of the final document. All authors contributed to the revision of the final text and approved the final manuscript.

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The authors declares that they have no competing interests

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