

## ANALYSIS ON THE QUALITY OF AGE AND SEX DATA COLLECTED IN THE TWO POPULATION AND HOUSING CENSUSES OF ETHIOPIA

Selome Bekele

Department of Statistics, Faculty of Science, Addis Ababa University, PO Box 30193  
Addis Ababa, Ethiopia. E-mail: selome@stat.aau.edu.et

**ABSTRACT:** Demographic data are important for socio-economic planning, political, administrative, research and several other purposes in order to make informed decisions at all levels. The single most important source of such data for a country like Ethiopia is population and housing census. Ethiopia has so far conducted two censuses and preparations are underway for the third one. Given the importance and the immensity of this operation, obtaining quality data is of paramount importance. In this paper, an attempt is made to analyse the quality of data of the last two censuses on the two basic demographic characteristics of a population, age and sex, for the purpose of identifying areas for improvement in the coming third census. Using different demographic techniques, the quality of data from the previous censuses was evaluated and analysis was made on the level of improvement of quality from the first to the second census. The results showed that the quality of data (especially age data) had deteriorated in the second census contrary to expectations. Possible causes are discussed and recommendations made for improving data quality in the planned census.

**Key words/phrases:** age-sex structure, data quality, census, demography, Ethiopia

### INTRODUCTION

Population, the aggregate of human beings, is basic to the production and distribution of material wealth. The scientific study of population, which is known as demography deals with several aspects of its subject-population. Among the many aspects, the major focuses of demography are population size, population distribution, population composition, population dynamics and the socio-economic determinants and consequences of population change (Siegel and Swanson, 2004). These five aspects of any population cover wide areas of both natural and social science fields. Most of the different fields of science benefit from demographic estimates obtained from reliable and detailed data on the size, distribution and composition of population. The single most important source of such data for a country like Ethiopia is population and housing census.

The United Nations (UN, 1998) states, "Population and housing censuses are a primary means of collecting basic population and housing statistics as part of an integrated program of data collection and compilation aimed at providing a comprehensive source of statistical information for economic and social development planning, for administrative purposes, for assessing conditions

in human settlements, for research and for commercial and other uses". It is recommended that a national census be taken at least every 10 years. Some countries may find it necessary to carry out censuses more frequently because of the rapidity of major changes in their population and/or its housing circumstances (UN, 1998). Ethiopia has so far conducted two population and housing censuses. The first census, conducted in May 1984, provided the total population size and characteristics of the country for the first time. The second census was carried out in October 1994, while a third census is planned for May 2007.

In the two censuses, huge data on the size and characteristics of the population as well as on the housing units of the country were collected. The accuracy of data on the age-sex structure of the population was evaluated using available techniques. Since the data from these censuses are the basis for any study about the Ethiopian population, their quality should be given due consideration. The quality of data was rated and included in the analytical reports of both censuses (CSA, 1991; 1999). However, no analysis was made on the improvement of quality from the first to the second census. This work is, therefore, an attempt to analyze the evaluations of data on the two basic demographic characteristics, age and sex. The work aims to indicate some of the strengths and

weakness of the age-sex data from the previous two censuses in order to contribute towards improving the data quality in the coming planned census.

## METHODS

The personal characteristic of age and sex hold prime importance in population studies. Sex is a natural attribute that classifies the humankind into two categories – males and females. The definition and classification of sex presents no statistical problem. The situation with respect to most of the other population characteristics is in contrast to that of sex. Among the many other characteristics, age is the most important one the definition and classification of which is much more complex than sex. This is because it involves numerous categories and is subject to alternative formulation as a result of cultural differences, differences in the uses to which the data will be put, and differences in the interpretations of respondents and enumerators.

The presentation of data by single years of age or in age groups for males and females separately is essential in almost all types of planning, for the analysis of other types of data, for comparative studies and for the evaluation of the completeness and accuracy of the census counts of population. This paper took the advantage of the published data for both censuses presented in the above stated manner and applied the available methods of evaluation. With regard to the data on sex, three values of sex ratio (over all sex ratio, sex ratio at birth and sex ratio of death) are compared with fairly standard values obtained from several populations. With regard to age data calculated values of Whipple's index and Myers's Blended Method are compared. Finally, calculated values of the UN index, which is currently considered as a summary measure for the accuracy of age-sex data, from the analytical reports of the censuses results were used in the analyses.

## RESULTS AND DISCUSSION

### *Sex composition*

The basic measure used to study the sex composition of Ethiopia in both censuses was sex ratio, which is defined as the number of males per 100 females.

Sex ratios for age groups vary widely around the sex ratio for the total population. For many analytic purposes, this variation may be considered as the most important. The sex ratio tends to be high at the very young ages and then tends to decrease with increasing age. Populations with high birth rates tend to have higher overall sex ratios than populations with low birth rates because of the excess of boys among births and children and the excess of male deaths at older ages. Because of the relatively limited variability of the national sex ratio and its independence from the absolute numbers of males and females, it is employed in various ways in measuring the quality of census data on sex, particularly in cross-classification with age. The simplest approach to evaluation of the quality of the data on sex for an area consists of observing the deviation of the sex ratio for the area as a whole from 100, the point of equality of the sexes. With, say, a fairly constant sex ratio at birth of about 105 and a sex ratio of deaths in the range 105 to 125, the overall sex ratio of a population will fall near 100 in the absence of migration. An overall sex ratio deviating appreciably from 100 – say, below 90 or above 105 – must be accounted for in terms of migration (both the volume and sex composition of the migrants being relevant) or a very high death rate, including war mortality. An overall sex ratio deviating even further from 100 – say, above 110 or below 85 – must be accounted for in terms of some unusual feature of the area, such as the location of a military installation in the area (Hobbs, 2004).

While Fig. 1 shows the sex ratios by age groups, Table 1 presents the overall sex ratios for urban and rural residences counted in the 1984 and 1994 censuses. By including the United States census data for 1990 and 2000, it was attempted to observe deviation of the overall sex ratios from 100 as well as the pattern of the sex ratios with increasing ages.

### *Overall sex ratio*

The principal problem relating to the quality of the data on sex collected in censuses concerns the difference in the completeness of coverage of the two sexes. At least in the statistically developed countries, misreporting of sex is negligible; there appears to be little or no reason for a tendency for one sex to be reported at the expense of the other (Hobbs, 2004). Table 1 shows that in both censuses over all sex ratio fell near the point of equality (100.1 and 101.3 in 1984 and 1994, respectively), indicating that the values did not deviate from the

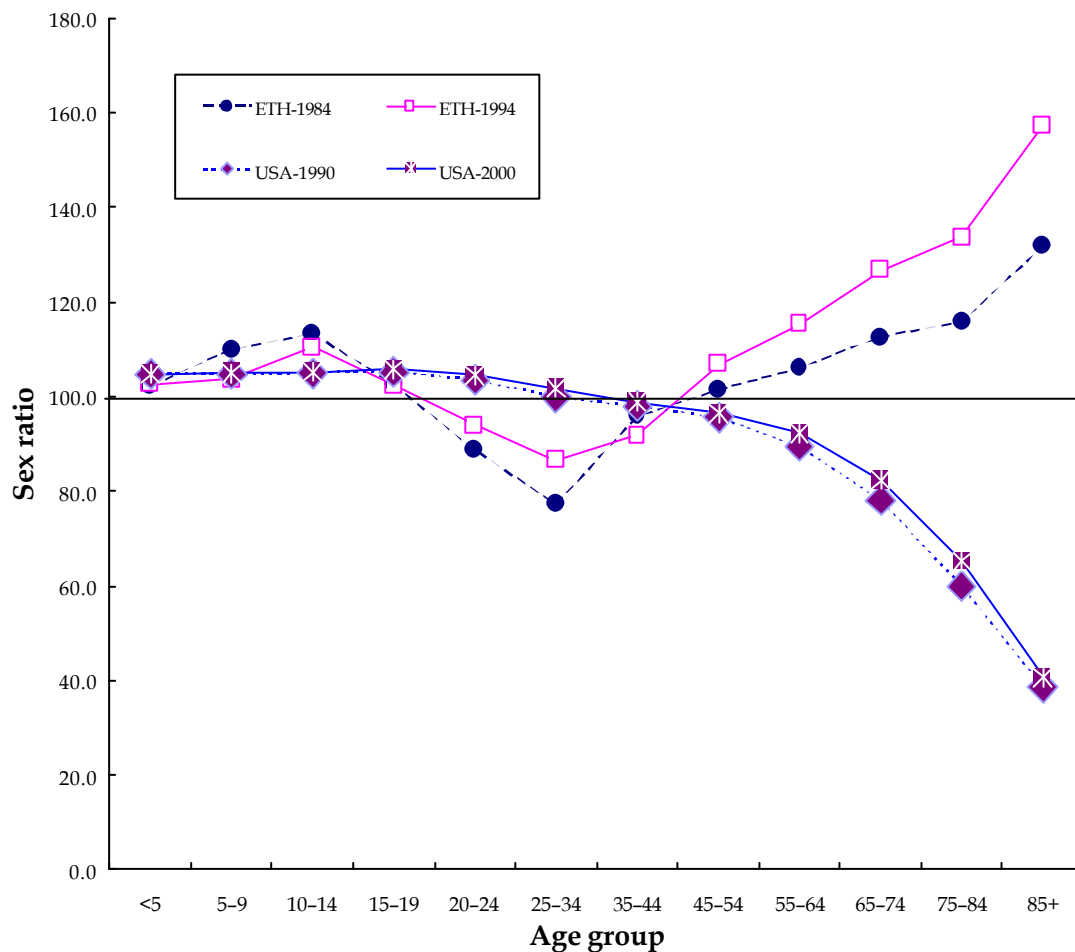
standard values of countries with high birth rates. The other sex ratio values included in this table are sex ratios for urban and rural areas, which were higher for rural areas than urban areas in both censuses. This is consistent with other censuses such as the 1990 United States census in which urban population had lower sex ratio principally because of the greater migration of females to cities (Hobbs, 2004).

**Table 1. Over all sex ratio by urban and rural areas.**

Census year	Ethiopia		USA
	1984	1994	1990
Urban	88.2	93.3	93.5
Rural	102.7	102.6	100.2
Overall	100.1	101.3	95.1

Source: Derived from CSA (1991; 1999); US Census Bureau (1992).

Under normal circumstances the sex ratio tends to be high at the very young ages and then tends to decrease with increasing age in populations which have not experienced substantial migration (Shryock and Siegel, 1976). While this was the case for the US data included in Fig. 1 here as well as for many populations both from the statistically underdeveloped and developed countries (Newell, 1988), Fig. 1 displays a different pattern for the Ethiopian data in both censuses. The sex ratio by age shows considerable variations and does not confirm to expectations. However, the pattern is almost similar at both times in which there was a deficit of males between ages 20 and 44 and excess of males in all the other age groups. Male mortality in the age range 20–44 is not expected to be higher than females in normal conditions and also there is no evidence for migration that could account for the deficit of males in the young adult ages. Some of these deficits could result from misreporting of ages by men of young adult ages.



**Fig. 1. Sex ratio by age group for Ethiopia in 1984 and 1994; and for USA in 1990 and 2000.**

Source: Derived from US Census Bureau (1992, Table 16) US Census Bureau (2002, File 1), CSA (1991, Tables 1.7 and 1.12), CSA (1999, Table 2.3a) and Genevè Bizuneh (2002).

### Sex ratio at birth

From the examination of sex ratios of registered births for a wide array of countries, it is apparent that the component of births tends to bring about or to maintain an excess of males in the general population. The sex ratio of births is above 100 for nearly all countries for which relatively complete data are available and between 104 and 107 in most such countries (Table 3).

The sex ratios at birth for Ethiopia based on data from the two censuses are shown in Table 2 for rural and urban residences separately as well as for the total population.

As evidenced in Table 3 for countries from all the continents including Africa and also from the literature (*e.g.*, Brass *et al.*, 1968; Shryock and Siegel, 1976; Newell, 1988), the ratio at birth normally fluctuates around a constant value of 105, which means about 105 boys are born for every 100 girls. However, in the Ethiopian data the value ranged from 101–102 in both censuses, which is highly unlikely to be true in a society with a strong cultural preference for sons and underreporting of them has the least chance. The deviation of the observed sex ratio at birth from the expected may be explained by undercounting of children who have died shortly after their birth. This is expected in a country with high infant mortality but the under enumeration of live births could strongly affect estimates of fertility and mortality on which

the source of data for these estimates largely depend on census results.

**Table 2. Sex ratio at birth for Ethiopia in 1984 and 1994 (Male births per 100 female births).**

Year	Rural	Urban	Total
1984	102.3	101.0	102.1
1994	101.5	102.1	101.6

Sources: CSA (1991, Table 1.12) and CSA (1999, Tables 2.3a, 2.3b, and 2.3c).

### Sex ratio of death

The sex ratio of deaths is much more variable from country to country than the sex ratio of births. It is expressed as the number of male deaths per 100 female deaths. Since this ratio is affected by differential risk of mortality among the sexes, age groups and different socio-economic characteristics, it is a good measure to differentiate health conditions. As stated previously, a sex ratio of deaths is expected to fall in the range between 105 and 125. This ratio for the 1984 census was calculated from the number of deaths during the 12 months prior to the 'census date' classified by age and sex and found out to be 126.2, which did not deviate much from the expected. Since in 1994 information on mortality was collected only on the number of dead children among the ever born, it was not possible to compute the sex ratio of deaths overall ages to make a comparison on this ratio between the two censuses.

**Table 3. Sex ratio at birth in various countries (male births per 100 female births).**

Country	Period	Sex ratio	Country	Period	Sex ratio
<b>Africa</b>			<b>North America</b>		
Egypt	1983–89	105.4	Cuba	1983–1988	106.9
Tunisia	1985–89	106.8	Guatemala	1983–1988	103.8
<b>Europe</b>			Panama	1983–1990	105.4
France	1983–1990	105.1	United States	1983–1988	105.1
Hungary	1983–1991	105.0	<b>South America</b>		
Netherlands	1983–1991	104.7	Chile	1983–1991	104.7
Poland	1983–1991	105.8	Uruguay	1983–1988	105.5
Rumania	1986–1991	105.0	Venezuela	1983–1991	105.1
United Kingdom	1983–1991	105.2	<b>Asia</b>		
<b>Oceania</b>			Japan	1983–1991	105.6
Australia	1983–1991	105.4	Malaysia	1983–1992	107.4
New Zealand	1983–1990	105.1	Sri Lanka	1983–1987	104.4

Source: Derived from UN (1994).

### Quality of data on age

Age is the most important variable in population study. Data on age are essential in calculating the basic measures relating to the factors of population dynamics and in the study of the components of change (fertility, mortality and migration) as well as in the study of nuptiality. Tabulations on age are necessary in the analysis of the factors of labour supply and in the study of the problem of economic dependency. The importance of census data on age in studies of population growth is even greater for countries such as Ethiopia where vital statistics registration system has not been established at all and for other countries when adequate information on vital events are not available (UN, 1964).

Age is an important variable in measuring potential school population, the potential voting population and potential manpower. Age data are required for preparing current population estimates and projections; projections of households, school enrolment and labour force, as well as projections of requirements for schools, teachers, health services, food and housing. Given the practical needs and many uses of age data, obtaining accurate and complete information on this variable is of paramount importance. However, due to various reasons misreporting of age is a common problem in developing countries, such as Ethiopia. As a result methods had been employed to measure the accuracy of age data in both censuses of Ethiopia. To evaluate the age data two techniques, Whipple's Index and Myers's Blended Method, were used, the values of which, for both censuses as well as for the Demographic and Health Survey of Ethiopia (DHS) 2000 by sex and residence, are summarized in Tables 5 and 7.

It is well known that due to the volume of operation data from sample surveys are of better quality than from censuses. Nevertheless the measures on the quality of age data for DHS Ethiopia were calculated and included in Tables 5

and 7 for the simple reason of checking whether it was possible to get better quality data in Ethiopia from surveys.

The results from the computation of the age data using the two techniques would help in rating the quality of the data by comparing them with the standard values set for the corresponding techniques. In the following paragraphs comparisons will be made between the computed and the standard values to rate the quality of the data then the rates will be compared for the two censuses in order to see whether there were any improvements from the first to the second census.

### Whipple's Index

Whipple's Index measures age heaping (digit preference) on terminal digits 0, 5 or the combination of the two in the age range 23 to 62. The index varies between 100, representing no preference for "0" or "5", and 500, indicating that only digits "0" and "5" were reported. In rating the quality of data using this index the UN recommendations are displayed in Table 4. According to the standard values, the Whipple's indices for the Ethiopian data in both censuses are well above 175 implying that the quality of data fell into the 'very rough' category. The calculated Whipple's indices for the 2000 Ethiopian DHS ranges from 116 to 159 which implies a much better quality data in the survey than in both censuses (Table 5).

**Table 4. UN scores for estimating reliability of age data.**

Quality	Whipple's index
Highly accurate data	Under 105
Fairly accurate data	105-109.9
Approximate data	110-124.9
Rough data	125-174.9
Very rough data	175 and above

Source: Newell (1988:25).

**Table 5. Whipple's indices for urban and rural residences of Ethiopia from two censuses and from a survey.**

Census/Survey	Urban			Rural			Total		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
1984 PHSE	201	232	218	241	278	260	236	271	254
1994 PHSE	233	264	249	264	289	277	259	285	272
EDHS 2000	157	116	124	159	126	141	158	124	140

Note: PHSE, Population and Housing Census of Ethiopia; EDHS, Ethiopia Demographic and Health Survey. Sources: CSA (1991, Table 1.5), CSA (1999, Table 2.6) and CSA and ORC Macro (2001, Tables 2.1 and C.1).

From Table 5, it can be seen that the calculated Whipple's indices for males and females in both urban and rural residences were higher in the second census than the first ever census of Ethiopia. In order to compare these differences the relative standing of the indices for 1994 were computed from the indices for 1984. As we can see from Table 6, all the percentage differences are below zero indicating the deterioration in the quality of age data instead of improving on the second census. The percentage differences of urban males is the highest followed by urban females that resulted in the higher percentage difference value among the urbanities than the rural residences; a clear indication of the deterioration in the quality of age data was more in urban areas than in the rural parts of the country (Table 6).

#### Myers's Blended Method

The principle employed in this method is to begin the count at each of the 10 digits (0 to 9) in

turn and then to average the results. Myers's Blended Method is usually used to measure degree of preference for each digit and it provides summary index for all terminal digits. The summary index is an estimate of the minimum proportion of persons in the population for whom an age with an incorrect final digit is reported. The theoretical range of the index is from zero to ninety (Hobbs, 2004).

The preference or avoidance for specific terminal digits was consistent on both censuses as well as on the DHS data. While the most preferred digits were those ending with zero followed by five and eight, the most avoided terminal digits were one and nine (Table 7). With regard to the minimum proportion of the population whose ages are incorrectly reported in 1984 and 1994, Figure 2 reveals that they were tremendously higher in 1994 in all cases implying that age misreporting increased alarmingly in the second census.

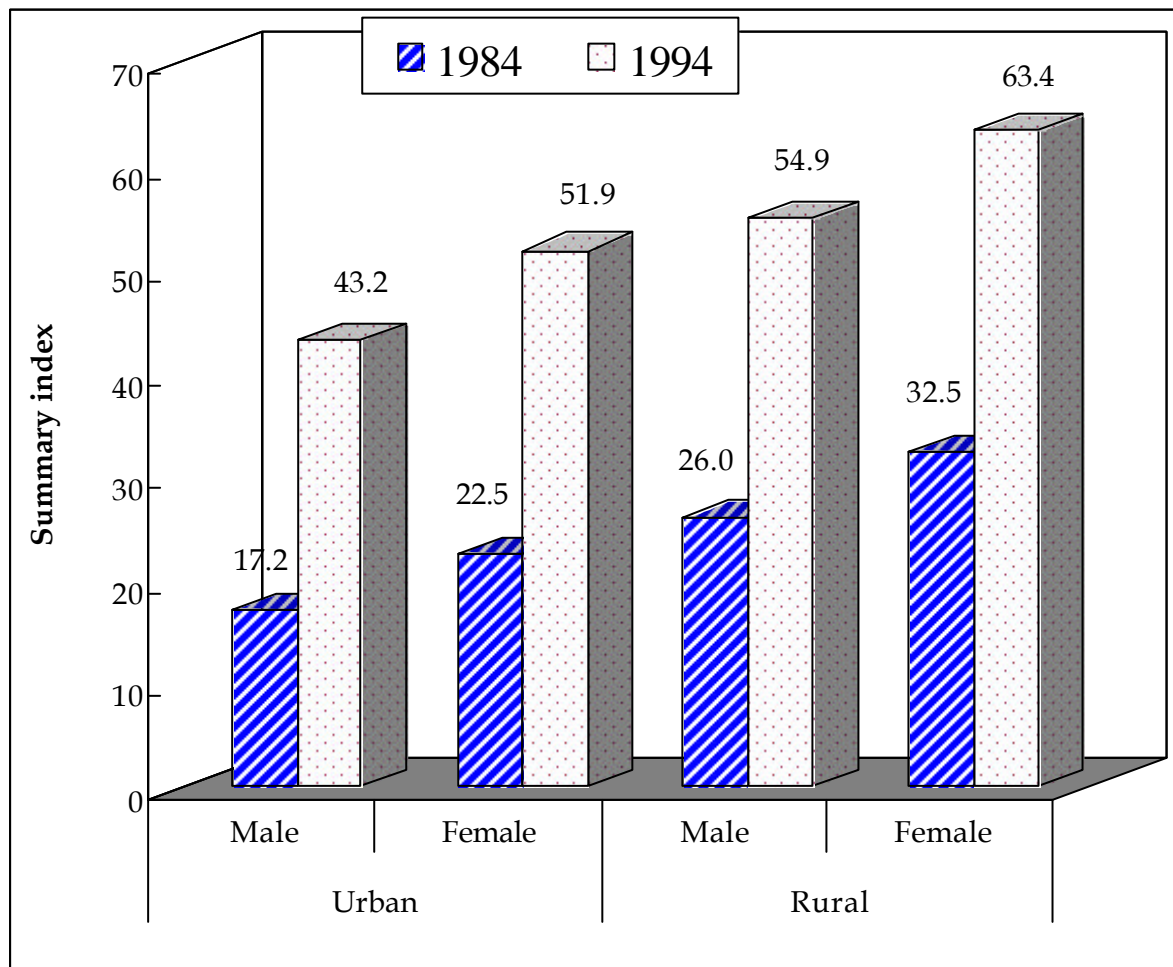


Fig. 2. Reported Myers's summary index for 1984 and 1994 censuses.

**Table 6. The relative standings of the Whipple's indices on 1984 data from the 1994 data.**

Area	Percentage differences of the indices		
	Male	Female	Both Sexes
Urban	-15.9	-13.8	-14.2
Rural	-9.5	-3.9	-6.5
Country	-9.7	-5.2	-7.1

Computed from Table 5.

The comparisons of the proportions in both censuses for urban and rural population separately indicated that, they were almost doubled for rural population and they were more than doubled for urban population. This is contrary to one's expectations, as the educational attainments of urban population are in a better position than the rural population fewer errors are expected in urban than in rural Ethiopia.

The values used to produce Figure 2 are the reported Myers's summary indices in the two

analytical reports of CSA (1991:17, 1999:25). Since the increments in the values of summary indices from the first census to the second one were very large, recalculation of the indices was necessary. It was then found out that all the Myers's indices for the 1994 data were reported without finalizing the procedures required by the blended method. The recalculated indices for both censuses and for the DHS data are sketched in Figure 3. This figure revealed that age data quality deteriorated for all urban population (both sexes) and for rural male population. A little improvement was observed for rural female population. Another comparison on the data quality was made between the two sexes. It was then observed that age reporting was better for males than females in the two censuses whereas the reverse was the case in the DHS data (Table 7). A possible explanation for this may be that the depth of the questions in connection with the collection of fertility data in the DHS could have helped in getting a better quality data on age for females than for males.

**Table 7. Indices of Myers's Blended Method for the two censuses (1984 and 1994) and the DHS (2000).**

Terminal digits	1984 PHSE						1994 PHSE						EDHS 2000					
	Urban		Rural		Total		Urban		Rural		Total		Urban		Rural		Total	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
0	<b>9.3</b>	<b>13.2</b>	<b>15.4</b>	<b>21.1</b>	<b>14.6</b>	<b>19.8</b>	<b>11.6</b>	<b>13.8</b>	<b>15.4</b>	<b>18.5</b>	<b>14.8</b>	<b>17.7</b>	<b>5.1</b>	<b>2.9</b>	<b>5.2</b>	<b>3.7</b>	<b>5.2</b>	<b>3.6</b>
1	-4.1	-5.1	-5.4	-6.5	-5.2	-6.3	-5.5	-6.1	-6.4	-6.7	-6.2	-6.6	-4.1	-3.5	-4.3	-3.0	-4.3	-3.1
2	-0.4	-1.0	-0.7	-1.7	-0.5	-1.6	-0.4	-1.5	-0.7	-1.4	-0.6	-1.5	0.4	-0.4	0.3	0.2	0.3	0.1
3	-1.9	-2.9	-3.6	-4.5	-3.4	-4.3	-3.1	-3.8	-4.2	-4.8	-4.0	-4.6	-2.2	-2.0	-2.2	-1.4	-2.2	-1.5
4	-2.7	-3.9	-4.2	-5.1	-4.0	-4.9	-3.4	-4.2	-4.1	-4.8	-4.0	-4.7	-1.8	-1.7	-1.7	-1.2	-1.7	-1.3
5	<b>6.2</b>	<b>8.0</b>	<b>8.5</b>	<b>9.9</b>	<b>8.2</b>	<b>9.6</b>	<b>7.8</b>	<b>9.7</b>	<b>9.6</b>	<b>11.1</b>	<b>9.3</b>	<b>10.8</b>	<b>5.3</b>	<b>4.8</b>	<b>5.9</b>	<b>4.6</b>	<b>5.9</b>	<b>4.6</b>
6	-1.4	-1.8	-2.1	-3.3	-2.0	-3.1	-2.2	-2.6	-2.3	-3.1	-2.3	-3.0	-0.1	0.1	-0.2	-0.4	-0.2	-0.3
7	-2.6	-2.8	-4.1	-5.0	-3.9	-4.7	-2.5	-2.9	-3.8	-4.5	-3.6	-4.3	-1.7	-1.2	-1.8	-1.9	-1.8	-1.8
8	<b>1.4</b>	<b>1.5</b>	<b>2.1</b>	<b>1.5</b>	<b>2.0</b>	<b>1.5</b>	<b>2.2</b>	<b>2.5</b>	<b>2.4</b>	<b>2.2</b>	<b>2.4</b>	<b>2.2</b>	<b>1.9</b>	<b>2.4</b>	<b>1.7</b>	<b>1.4</b>	<b>1.8</b>	<b>1.6</b>
9	-4.5	-5.0	-6.0	-6.4	-5.8	-6.2	-4.5	-4.9	-6.0	-6.3	-5.8	-6.1	-2.9	-1.5	-2.9	-2.0	-2.9	-1.9
Summary index	17.2	22.5	26.0	32.5	24.8	30.9	43.2	51.9	54.9	63.4	53.1	61.6	12.9	10.4	13.2	9.9	13.1	9.9

Note: PHSE, Population and Housing Census of Ethiopia; EDHS, Ethiopia Demographic and Health Survey 2000. Sources: CSA (1991, Table 1.6), CSA (1999, Table 2.6) and CSA and ORC Macro (2001, Tables 2.1 and C.1).

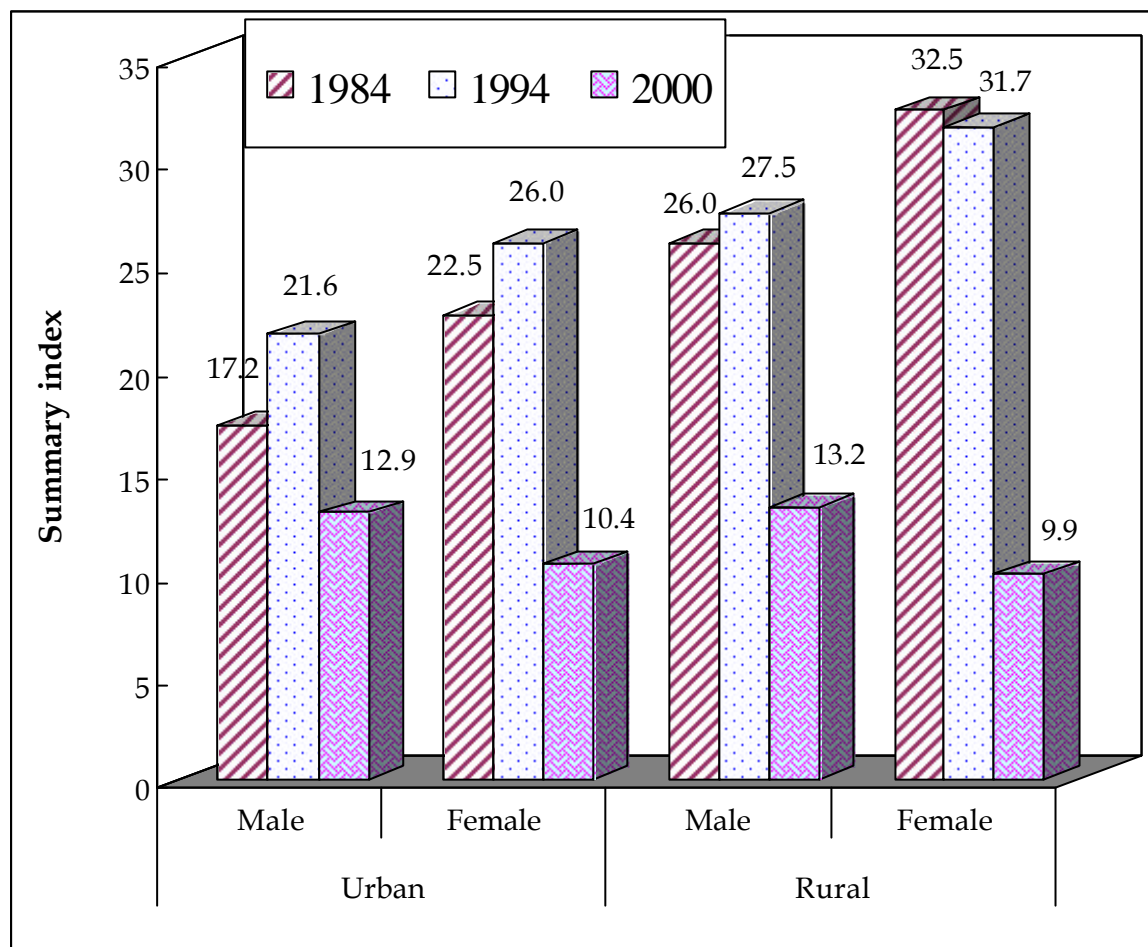


Fig. 3. Myers's summary indices for the 2000 survey together with the recalculated values for 1984 and 1994 censuses.

#### UN age-sex accuracy index

This index combines the sum of the mean deviations of the age ratios from 100 for males and females separately and three times the mean of the age-to-age differences in reported sex ratios. Census age-sex data are described by the United Nations as 'accurate', 'inaccurate', or 'highly inaccurate' depending on whether the UN index is under 20, 20 to 40, or over 40 (Shryock and Siegel, 1976). The UN index is primarily a measure of net age misreporting. Although this index has a number of questionable features as a summary measure, it can be a useful measure for making approximate distinctions between countries with respect to the accuracy of reporting age and sex in censuses. Comparable indices for Ethiopia and a few other countries are included in Table 8.

Table 8. Comparable UN indices for a few countries in the 1990s.

Country	Census year	UN age-sex accuracy index
Argentina	1991	12.7
United States	1990	14.7
Vietnam	1989	22.9
Turkey	1990	23.0
Hungary	1990	26.0
Indonesia	1990	31.0
India	1991	39.6
Ethiopia	1994	64.8

Sources: Hobbs (2004) and CSA (1999).

According to the United Nations's standard values for this index, the age-sex data for the indicated countries in the 1990s may be evaluated as follows: the data for Argentina and United



States as 'accurate'; the data for the five countries (Vietnam, Turkey, Hungary, Indonesia and India) as 'inaccurate' and the data for Ethiopia as 'highly inaccurate'.

In order to see the change of quality on both demographic characteristics (data on age and sex) combined, the calculated UN indices for the accuracy of age-sex data for both censuses were examined. The comparison of the corresponding indices for 1984 and 1994 censuses indicated that while the index for rural Ethiopia decreased from 75 to about 70 during the ten years period, it increased from a value of 45 to 56 for urban Ethiopia that asserted the findings obtained by Whipple's and Myers's methods.

## CONCLUSION AND RECOMMENDATION

In this paper, guided by the general objective, attempts were made to analyze the quality of age-sex data collected in the 1984 and 1994 Population and Housing Censuses of Ethiopia. Furthermore, the various indices for the two data sets from both censuses as well as from the DHS 2000 were compared in order to see whether there were any improvements with regard to data quality.

Data quality with regard to the population characteristic-sex was found to be satisfactory as the values for the overall sex ratio and the sex ratio at death did not vary from values for other populations. A noticeable variation was observed on the pattern of sex ratio by age, which did not confirm to expectations. Since the deviations were higher towards the older ages, after 50 years of age, this could be attributed to age shifting or coverage errors caused by omission of elderly females.

The two methods employed in the evaluation of age data confirmed that the age data were of poor quality in both censuses. The analyses of these indices from the two censuses indicated that the quality of age data deteriorated from the first to the second census instead of improving. More alarming is that the proportion of persons whose ages were incorrectly recorded increased in the second census. The last technique employed to evaluate the quality of age-sex data in combination has also confirmed the findings by categorizing the data as 'highly inaccurate'.

Recognizing the fact that the coming census will be (as all censuses are) the single major source of information for almost all types of planning, for

formulating and evaluating policies and for several other applications, major investment on achieving better quality data is very essential. It is, therefore, recommended that: selection of enumerators should be given serious attention; individual and household characteristics should be obtained from knowledgeable persons; training of enumerators should be coupled with practical exercises; and proper usage of the expertise and experience of the DHS personnel as well as from other institutions should help in getting better quality data from this huge operation.

## ACKNOWLEDGEMENTS

I would like to thank the reviewers of *SINET: Ethiopian Journal of Science* for their constructive comments.

## REFERENCES

1. Brass, W., Coale, A.J., Demeny, P., Heisel, D.F., Lorimer, F., Romaniuk, A. and Van de Walle, E. (1968). *The Demography of Tropical Africa*. Princeton University Press, Princeton, New Jersey.
2. CSA (1991). The 1984 Population and Housing Census of Ethiopia, Analytical Report at National Level. Central Statistical Authority, Addis Ababa, 391 pp.
3. CSA (1999). The 1994 Population and Housing Census of Ethiopia, Results at Country Level, Volume I Analytical Report. Central Statistical Authority, Addis Ababa, 375 pp.
4. CSA and ORC Macro (2001). *Ethiopia Demography and Health Survey 2000*. Central Statistical Authority, Ethiopia and ORC Macro, Calverton, Maryland, USA.
5. Genene Bizuneh (2002). Age and sex composition, Chapter 3, Lecture notes compiled for Stat 378, 1<sup>st</sup> semester 2002. Department of Statistics, Addis Ababa University (Unpublished).
6. Hobbs, F. (2004). Age and sex composition. *In: The Methods and Materials of Demography*, 2<sup>nd</sup> ed., pp. 125-173, (Siegel, J.S. and Swanson, D.A., eds). Elsevier Academic Press. California, USA.
7. Newell, C. (1988). *Methods and Models in Demography*. Belhaven Press, London, UK.
8. Shryock, H.S. and Siegel, J.S. (1976). *The Methods and Materials of Demography*. Studies in Population (Stockwell, E.G., ed.) Academic Press, California, USA.
9. Siegel, J.S. and Swanson, D.A. (eds) (2004). *The Methods and Materials of Demography*, 2<sup>nd</sup>

- edition. Elsevier Academic Press. California, USA, 819 pp.
10. UN (1964). National programs of analysis of population census. Data as an aid to planning and policy-making. *Population Studies Series A*. No. 36.
  11. UN (1994). *Demographic Year Book 1992*. United Nations, New York, USA.
  12. UN (1998). Principles and recommendations for population and housing censuses. Revision I. *Statistical Papers, Series M*. No. 67/Rev. 1, United Nations, New York.
  13. US Census Bureau (1992). General Population Characteristics, United States, 1990. 1990 Census of Population. Washington DC.
  14. US Census Bureau, Census 2000 Summary File 1, Matrices P13 and PCT12. <http://www.census.gov/main/www/cen2000.html> accessed on Nov. 15, 2005.