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**ORIGINAL RESEARCH ARTICLE**

# Sex-ratio at birth in Nigeria: A demographic perspective

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## Abstract

The study attempts at estimating the sex-ratio at birth in Nigeria. The study focuses on demographic surveys with complete maternity histories, including some 0.50 million births. It compares results with published estimates from births in health facilities and a few data from vital registration, including some 1.13 million births. Results from demographic surveys give an estimate of about 106 boys for 100 girls. There were no significant variations by large region in the country, and no significant trend over the years (1990-2018). Published estimates provided a similar value (106.2), with somewhat lower value in health facilities (105.3), and somewhat higher values in local vital registration (106.8), and major variations among available studies. Despite uncertainty, Nigeria appears to have higher sex-ratios than most African countries, with the exception of Ethiopia, and higher values than its five neighboring countries. Reasons for these high values of the secondary sex-ratio are discussed. *(Afr J Reprod Health 2022; 26[4]: 92-97).*

**Keywords:** Sex-ratio at birth, demographic surveys (DHS), maternity history; vital registration statistics (VRS), Nigeria, sub-saharan Africa

## Résumé

L'étude se propose d'estimer le rapport de masculinité à la naissance (sex-ratio) au Nigéria. L'étude se concentre sur les enquêtes démographiques qui ont enregistré les histoires des maternités des femmes, soit environ 0,50 million de naissances. Elle compare ces résultats aux estimations publiées sur les naissances dans les établissements de santé et à quelques données de l'état civil, soit environ 1,13 million de naissances. Les résultats des enquêtes démographiques donnent une estimation d'environ 106 garçons pour 100 filles. On n'observe pas de variations significatives selon les grandes régions du pays, ni aucune tendance significative selon les années (1990-2018). Les estimations publiées donnent une estimation similaire (106,2), avec une valeur un peu inférieure dans les établissements de santé (105,3), une valeur un peu plus élevée à l'état civil (106,8), et des variations importantes entre les études disponibles. Malgré l'incertitude sur les données, le Nigéria semble avoir des sex-ratios plus élevés que la plupart des pays africains, à l'exception de l'Éthiopie, et des valeurs plus élevées que ses cinq pays limitrophes. Les raisons de ces valeurs élevées du rapport de masculinité à la naissance sont discutées. *(Afr J Reprod Health 2022; 26[4]: 92-97).*

**Mots-clés:** Rapport de masculinité à la naissance, enquetes démographiques (EDS), histoire des maternités, statistiques de l'état civil, Nigéria, Afrique subsaharienne

## Introduction

The sex-ratio at birth, also called the secondary sex-ratio, has been the focus of research since the 18th century in Europe, all based on Vital Registration Statistics (VRS)[1]. Calculated as the ratio of the number of male births to 100 female births, it averages about 105.5 in European populations, with a range from 104 to 107, and similar values in Asian populations[2]. The value of the sex-ratio at birth remains poorly documented in African populations, primarily because defective vital registration statistics. In populations from African descent (Black/African or African/American) living in the United Kingdom or in the United States, the sex-ratio is lower, and averages 103[3-7]. In the earliest studies on African populations published in the classic "*Demography of Tropical Africa*", the sex-ratio was also found to be low in sub-Saharan Africa, in particular in the Congo where it was below 100[8-9].

Available data from African countries show a wide range of variations of the sex ratio, from values around 100 or less, to values around 108 or more. For instance, in South Africa, vital registration data for the 1991-2018 period (28

million births) indicate a sex-ratio of 101.0. Vital registration data in African islands also show low values: 103.6 in Mauritius (1.15 million births), 101.8 in Reunion (0.43 million births), 103.4 in Cape-Verde (0.30 million births)[2]. Note that these populations are a mix of populations from African origin with populations from European or Asian origin. Other sources of data were also used to estimate the sex-ratio at birth in African countries, in particular demographic surveys, and demographic surveillance systems. In earlier reviews of available data, the sex-ratio was found to range from below 100 (Botswana, Namibia, Zambia) to above 107 (Ethiopia, Nigeria)[10-11]. In demographic surveillance systems located in Southern Africa, based on small samples but precise data, low values were also found: 92.4 in Gwembe, Zambia; 99.9 in Agincourt, South Africa; 101.3 in Hlabisa, South Africa; 102.7 in Dikgale, South Africa[11-13]. In demographic surveys, lowest values were found in Southern Africa (around 100), somewhat higher values in Eastern Africa (around 102), higher in Western Africa (around 104), and one outstanding case, Ethiopia, where it averaged 108[14]. Note that these populations have different genetic characteristics, and a variety of anthropometric characteristics[15].

The case of Nigeria is special in Africa. Nigeria is the most populated country in the continent (estimated about 206 million in year 2020), the country with the largest number of births (estimated about 7.6 million in year 2020), the country with the most complex ethnic composition with some 510 ethno-linguistic groups on record, a country with a deep divide between North and South, and a country with complex genetic characteristics, mixing Bantu populations from the Niger delta area with Sahelian populations, and numerous other groups. Nigeria also has an important community of physicians and gynecologists who studied sex-ratios since independence (1960). As will be seen in this study, published estimates of the sex-ratio at birth in Nigeria are confusing, with a wide range from 102 to 120 (see below for details)[16-24]. Some of this confusion could come from data reliability or from sample size. Due to wide random fluctuations, some 1 million births are necessary for providing a relatively small confidence interval for the sex-ratio, say ± 0.4 per 100. The aim of this study was to shed a new light on sex-ratios at birth in Nigeria. The analysis focuses on data sources independent from vital registration or maternity wards, namely demographic surveys. It compares estimated values of the sex-ratio from demographic surveys with other sources, in particular hospital based studies, as well as with neighboring countries.

# Methods

The first data sources used for this study were the demographic sample surveys conducted in Nigeria: one survey, part of the World Fertility Surveys (WFS), conducted in 1982, six Demographic and Health surveys (DHS) conducted in 1990, 1999, 2003, 2008, 2013, 2018, and two Malaria Information Surveys (MIS) conducted in 2010 and 2015. Details on these surveys can be found on the DHS program web site[25]. All these surveys were based on the same methodology: the recording of complete maternity histories, with information of live births by sex for all women age 15-49 interviewed in the survey. These surveys are all based on representative samples of the national population.

The second data source was published material on sex-ratios in Nigeria. These were either data from local health facilities (hospital, health center, maternity), or from local vital registration. These data are of varying quality and restricted to local populations. Thirdly, Nigerian data were compared with data from five neighboring countries, who conducted similar demographic surveys, also based on representative samples of the population (Cameroon, Chad, Niger, Benin, Togo).

The sex-ratio was calculated as the number of male births per 100 female births recorded in maternity histories, or elsewhere. The 95% confidence intervals were calculated using standard formulae for relative risks. A trend analysis was conducted using a linear-logistic regression model, and SPSS-17 software.

# Results

## D*emographic surveys in Nigeria*

Demographic surveys conducted in Nigeria totaled 164,470 women and 501,260 live births. Among the recorded births the sex-ratio was 106.4 (95% CI = 105.8 – 107.0), a much higher value than usually assumed for African populations (around 103). However, the sample of surveys was not homogeneous, and two surveys stood out: the 1982

**Table 1:** Sex-ratio at birth in demographic surveys, Nigeria

| Survey, Year | Live births | | Sex-ratio | 95% CI | | |
|---|---|---|---|---|---|---|
| | Boys | Girls | | Min | Max | Signif. |
| WFS, 1982 | 15852 | 14137 | 112.1 | 109.6 | 114.7 | * |
| DHS, 1990 | 14534 | 13589 | 107.0 | 104.5 | 109.5 | ns |
| DHS, 1999 | 12216 | 11061 | 110.4 | 107.6 | 113.3 | * |
| DHS, 2003 | 11899 | 11139 | 106.8 | 104.1 | 109.6 | ns |
| DHS, 2008 | 53773 | 51035 | 105.4 | 104.1 | 106.6 | ns |
| MIS, 2010 | 10182 | 9462 | 107.6 | 104.6 | 110.7 | ns |
| DHS, 2013 | 61287 | 58099 | 105.5 | 104.3 | 106.7 | ns |
| MIS, 2015 | 13238 | 12212 | 108.4 | 105.8 | 111.1 | ns |
| DHS, 2018 | 65464 | 62081 | 105.4 | 104.3 | 106.6 | ns |
| Total | 258445 | 242815 | 106.4 | 105.8 | 107.0 | Ref. |
| Excluding 1982, 1999 | 230377 | 217617 | 105.9 | 105.2 | 106.5 | |

**NB:** Test of difference from mean: (*) = P<0.05; (ns)= not significant. DHS = Demographic and Health Survey; MIS = Malaria Interview Survey; WFS = World Fertility Survey

**Table 2:** Sex-ratio at birth in demographic surveys, by large region, Nigeria

| Region | Live births | | Sex-ratio | 95% CI | | |
|---|---|---|---|---|---|---|
| | Boys | Girls | | Min | Max | Signif. |
| North-Central | 39101 | 36916 | 105.9 | 104.4 | 107.4 | ns |
| North-East | 49144 | 45869 | 107.1 | 105.8 | 108.5 | ns |
| North-West | 72088 | 68610 | 105.1 | 104.0 | 106.2 | ns |
| South-East | 24934 | 23586 | 105.7 | 103.8 | 107.6 | ns |
| South-South | 28432 | 26569 | 107.0 | 105.2 | 108.8 | ns |
| South-West | 28894 | 27128 | 106.5 | 104.8 | 108.3 | ns |
| Total | 242593 | 228678 | 106.1 | 105.5 | 106.7 | Ref. |

**NB:** Test of difference from mean: (*)= P<0.05; (ns)= not significant

**Table 3:** Sex-ratio at birth in Nigeria from published sources, other than demographic surveys

| Source | Type | Number of births | Sex-ratio | 95% CI | | Signif. |
|---|---|---|---|---|---|---|
| | | | | Min | Max | |
| Ayeni, 1975 | HF | 548,558 | 105.6 | 105.1 | 106.2 | * |
| Ayeni, 1975 | VR | 315,735 | 105.7 | 105.0 | 106.5 | ns |
| Rehan, 1982 | VR | 1,113,313 | 107.1 | 106.7 | 107.5 | * |
| Egwuatu, 1984 | HF | 292,694 | 104.3 | 103.5 | 105.1 | * |
| Sule, 2004 | HF | 12,845 | 112.0 | 108.2 | 115.9 | * |
| Azeez, 2007 | HF | 35,209 | 102.7 | 100.5 | 104.8 | * |
| Oyeniyi, 2012 | HF | 11,426 | 109.9 | 106.0 | 114.0 | ns |
| Eneni, 2013 | HF | 1,856 | 120.2 | 109.7 | 131.7 | * |
| Total | | 2,331,636 | 106.2 | 105.9 | 106.5 | |

**NB:** Test of difference from mean: (*) = P<0.05; (ns)= not significant. Type: HF= Health facility (hospital, health center, maternity); VR = Vital registration

**Table 4:** Sex-ratio at birth in demographic surveys conducted in neighboring countries

| Country | Live births | | Sex-ratio | 95% CI | | |
|---|---|---|---|---|---|---|
| | Boys | Girls | | Min | Max | Signif. |
| Benin | 103785 | 98860 | 105.0 | 104.1 | 105.9 | * |
| Cameroon | 62528 | 60878 | 102.7 | 101.6 | 103.9 | * |
| Chad | 59376 | 56800 | 104.5 | 103.3 | 105.7 | * |
| Niger | 67217 | 64073 | 104.9 | 103.8 | 106.0 | * |
| Togo | 32093 | 31222 | 102.8 | 101.2 | 104.4 | * |
| Nigeria | | | 106.4 | | | Ref. |

**NB:** Test of difference from Nigeria: (*) = P<0.05; (ns)= not significant

WFS, and the 1999 DHS, which exhibited higher values (112.1 and 110.4 respectively), probably because of defective data. Excluding these two surveys, the sex-ratio in Nigeria was still high: 105.9 (95% CI = 105.2 – 106.5) (Table 1).

### *Regional differences*

Nigeria has six main regions for statistical purposes, labeled: North-West; North-East; Central; South-East, South-South and South-West. The first survey (1982) was based on a different breakdown and was not included in this analysis by region. In the 1990 and 1999 surveys the regions were different, but the same six large regions could be calculated from information on the state of residence. After 2003, the breakdown in the six regions was standardized. The regional analysis shows that none of the regions had a sex-ratio different from the mean (106.1). Even though the sex-ratio by survey ranged from 105.1 to 107.1, none of the differences was statistically significant from the mean at $P < 0.05$ (Table 2).

### *Comparison with published values*

Published values came from a mixed-bag of health facility and vital registration data, and were also based on a large number of cases (1,130,753 births). On average, they produced a value for the sex-ratio similar to that of demographic surveys: 106.2 (95% CI = 105.9 – 106.5). However, the samples were very heterogeneous, and the eight studies available showed a wide range of variations, ranging from 102.7 in South-West[19], to 109.9 also in South-West[22], and even more: 120.2 in South-South[20], though the latter study was based on a tiny sample with no statistical value. Among the eight studies, two were not significantly different from the mean, one was borderline, but the other five studies were significantly different, which raises a serious concern about potential biases. The two studies based on vital registration gave somewhat higher values than the mean (106.8), while the six studies based on health facility gave a somewhat lower value (105.3), though still much higher than the assumed 103 for African populations (Table 3).

### *Comparison with neighboring countries*

Comparison of estimates of the sex-ratio from demographic surveys in Nigeria with similar estimates from demographic surveys conducted in neighboring countries show that Nigeria is different from its neighbors. In the five neighboring countries considered, the sex-ratio was always lower (105.0 in Benin, 104.9 in Niger, 104.5 in Chad) or much lower (102.8 in Togo, 102.7 in Cameroon), all differences being statistically significant. Nigeria appears therefore as outstanding in this area of Africa (Table 4).

### *Investigating trends*

Some countries in the world exhibit trends in sex-ratios. Trends were tested using the Nigerian demographic surveys, while excluding the 1982 WFS and the 1999 DHS. Results show no trend when the two deficient surveys were excluded. In the linear-logistic model on year of survey, the slope was slightly negative ($b = -0.00054$), but not significant ($P = 0.211$).

## Discussion

Sex-ratios at birth in Nigeria were often the source of debates, controversies and sometimes confusion, because of a wide range of unexplained variations. This study provides a new perspective, with more stables estimates around 106, confirmed by a variety of sources. The exact estimate can still be questioned, and this issue can be resolved only by analyzing large scale vital registration data over several years. Unfortunately, firstly birth registration is deficient in Nigeria, and secondly the data are not published or difficult to access. If all registration data were available and published, knowledge about the sex-ratio in Nigeria would be more precise.

Demographic data on the sex-ratio were more homogenous than expected, with a small range around 106, and most differences could be explained by random fluctuations. Only two surveys (1982 and 1999) exhibited different values, with higher estimates. This could be due to a variety of factors. A possible explanation could be differential misreporting of live births, with a bias towards over-omitting girls. The child-woman ratio found in the demographic surveys was fairly constant around 3.1 children per women age 15-49 across the eight surveys. In the two defective surveys, the child-woman ratio was below that of the adjacent survey: 3.7% missing births in 1982

compared with 1991, and 6.1% missing births in 1999 compared with 2003. One could fit the sex-ratio to 106 in these surveys by assuming a higher proportion of missing girls than missing boys (5.4% in 1982, and 3.8% in 1999). Even if these proportions are high, they are still realistic in a context of high infant mortality, because babies who die shortly after delivery are more likely to be omitted in retrospective interviews. This assumed pattern of omission could explain the higher sex-ratios in the two defective surveys.

Sex-ratios in health facilities appeared less reliable than those of demographic surveys. This could be due to a variety of reasons: small sample size; selection for deliveries in a clinic; selection for delivering women with specific pathology; some of the studies also selected single births (excluding twins), while others included still-births, etc. Such biases are common in the field, and only a standardized definition of live birth and large numbers can provide reliable estimates of the secondary sex-ratio.

Values of the sex-ratio in Nigeria were found to be higher than elsewhere in Africa, and higher than in neighboring countries. The other documented exception of even higher sex-ratios in Africa is found in Ethiopia (about 108), and possibly in nearby Somalia and Southern Sudan, although reliable data are missing for these countries[14]. One possible reason of high sex-ratios in Nigeria could be searched for in the complex genetic make-up of the country. In particular, many migrants who populated Nigeria over the centuries came from the Nubian area, where populations seem to have high sex-ratio. Furthermore, recent genetic evidence shows that much mixing occurred between Sahelian populations and Eurasian and North African population over the past 5,000 years or so[26-28]. The example of Ethiopia shows that African-Eurasian admixture can be associated with high sex-ratios at birth, and the same phenomenon could have occurred in Nigeria. This point deserves further research for identifying genetic markers of high- and low- African sex-ratios.

With a complex ethnic mix, one could have expected differences in the sex-ratio by region, or at least a divide between North and South. This was not the case in the demographic surveys, but this point deserves more investigation with more data. This would require large numbers of births by sex for each region, and possibly by ethnicity.

Testing for the time trend was not significant in Nigerian demographic surveys. However, changing levels of the sex-ratio are always possible, and in fact occur even in Europe. In France, for instance, the sex-ratio at birth fluctuated between 104 and 107 between 1800 and 2010, with several ups and downs. Monitoring trends in Nigeria would be a next step, worth doing with a comprehensive vital registration system.

According to DHS surveys, the proportion of children whose birth was registered remained low, although it increased in recent years (30.0% in 2008; 30.8% in 2013; 43% in 2018). This completeness is low even by African standards, and needs to be improved in the future. Registration is one step, and the publication of vital statistics is another step. Even with 30% completeness, publishing the number of registered births in each state, by sex and by year since 1960, would have provided enough data for a proper inference on the sex-ratio at national and regional level, and even in smaller geographical areas such as states, and would have permitted to better understand results from demographic surveys and from health facilities. Let us hope that this will be improved in the future.

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## Contribution of Authors

The author conceived and designed the study, analysed the data and wrote the manuscript.

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