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Research Paper

Sex ratio at birth in Kogi state, North-Central Nigeria

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Abstract

The human secondary sex ratio is the male-to-female ratio at birth. Studies have shown that due to some factors, there has been deviation towards one sex in different populations. There has been no report on the sex ratio at birth (SRB) from Kogi State, North-Central Nigeria. We conducted a retrospective study on the SRB in the three geopolitical zones of Kogi State covering six federal and state hospitals, and factors that might have influenced the process. Data on childbirth from 1991 to 2020 collected from the Federal Medical Centre Lokoja, General Hospital Mopa-Muro, Zonal Hospital Kabba, Specialist Hospital Obangede, Zonal Hospital Okene, and Prince Audu Abubakar University Teaching Hospital Anyigba were analyzed using descriptive statistics. The annual SRB was 98.1:100, 104.6:100, 101.5:100, 108.3:100, 102.2:100, and 104.9:100 for the six hospitals, respectively. The pooled data had an SRB of 100.7:100 for Kogi State indicating slightly more male than female births. There was no significant difference ($p>0.05$) between the variations in sex ratio. The SRB might have been influenced by the preference for male children, the use of oral contraceptives, family size, urbanization, and socioeconomic factors.

Introduction

The percentage of males among all live births per 100 female births is commonly used to compute the sex ratio at birth (Lou et al., 2020). Although at conception, equal numbers of X-bearing or Y-bearing sperm fertilize the egg, skewness toward the male is usually observed in

the sex ratio at birth (SRB), which indicates that more females are lost in early human pregnancies (Wedenoja et al., 2019). This skewness leads to an imbalance in the sex ratio, which is influenced by several endogenous or exogenous factors including birth order, family size, sex-selective abortion, race or ethnicity, endocrine and immunological effects, stress, geographical location, war, maternal age at conception, coital rate, wealth or socioeconomic status, timing of conception within the menstrual cycle, assisted reproductive technology, and decline in fertility (Bae et al., 2018; Chao et al., 2021; Pirrie & Ashby, 2021). For example, seasonal variation in the coital rate may impact the SRB because spermatozoa have varying vitalities in the male reproductive system (Melnikov, 2015). The Y-bearing gametes have lower viability as sperm age increases, hence low intercourse frequency decreases the likelihood of male birth, resulting in a majority of female zygotes (Melnikov, 2015).

While some studies indicated that a long period between births is linked to the loss of male fetuses and that women who have longer birth intervals are more likely to successfully carry a subsequent female fetus to term, other studies indicated that female fetuses are lost at disproportionately higher rates than male fetuses (Morse & Luke, 2021). In a society where there is no evidence of prenatal sex selection, it is projected that the secondary sex ratio will fall between 105 and 107 boys per 100 girls (Rettaroli & Scalone, 2021).

As birth order increases, the sex ratio also increases. Education, wealth index, caste, religion, and household landholding size are some of the socioeconomic factors also affect the sex ratio (Singh et al., 2021). The global SRB has been attributed to several causes. Preference for male children is the main cause of skewness towards the male sex in China (Liu & Feldman, 2021). An association between maternal exposure to chemical substances like dioxins and polybrominated biphenyls (PCBs) has been observed to cause a decline in male births in Japan (Tatsuta et al., 2022). In Africa, a lower sex ratio is observed, which increases gradually from the south to the north, with Nigeria having an extremely high value attributed to the population size, complex ethnic composition, genetic characteristics, and high birth rate (Garrene, 2022). In Uganda, house ownership influences the sex ratio as it leads to more male births than female births (Wallner et al., 2012).

There are reports (Sule & Madugu, 2004; Azeez et al., 2007; Bakare et al., 2011; Eneni et al., 2013; Fakorede et al., 2022) on the secondary sex ratio from some parts of Nigeria, however, there is no report on the SRB from Kogi State, one of the six North-Central States in Nigeria.

Therefore, this study was conducted to determine the secondary sex ratio in Kogi State. The expected results will extend current knowledge on the subject matter in Nigeria.

Materials and Methods

Study Site

This study was carried out in Kogi State located at a latitude of 7º 45' 0 N and longitude of 6º 45' 0 E (Figure 1). It is one of the six North-Central States (Benue, Kogi, Kwara, Nasarawa, Niger, and Plateau) and ranks as the 13th largest State in Nigeria. It has a total land mass of 29,833 km^2 and a population of 4,473,500 (National Bureau of Statistics, Nigeria; Official Gazette (FGP 71/52007/2500(0L24). The State is home to three major ethnic groups (Okun, Ebira, and Igala) and several minor ethnic groups including the Ogori, Bassa-Nge, Bassa-Kwomu, Koton, Nupe, Oworo, and Gwari (Jimba, 2012; Bello-Williams, 2019). Data for this study was sourced from six Hospitals in Kogi State, North-Central Nigeria (Figure 1) which serve as primary, secondary, and tertiary health centers. They include one Federal [Federal Medical Centre (FMC) Lokoja, established on the 9th of November 1999] and five State Hospitals [Zonal Hospital (ZH) Kabba, established on the 1st of January 1989; Zonal Hospital (ZH) Okene, established on the 1st of January 1960; General Hospital (GH) Mopa-Muro, established on the 1st of January 1999; Specialist Hospital (SH) Obangede, established on the 10th of January 1982; and Prince Abubakar Audu University Teaching Hospital (PAAUTH) Anyigba, established on the 29th of February 2011.

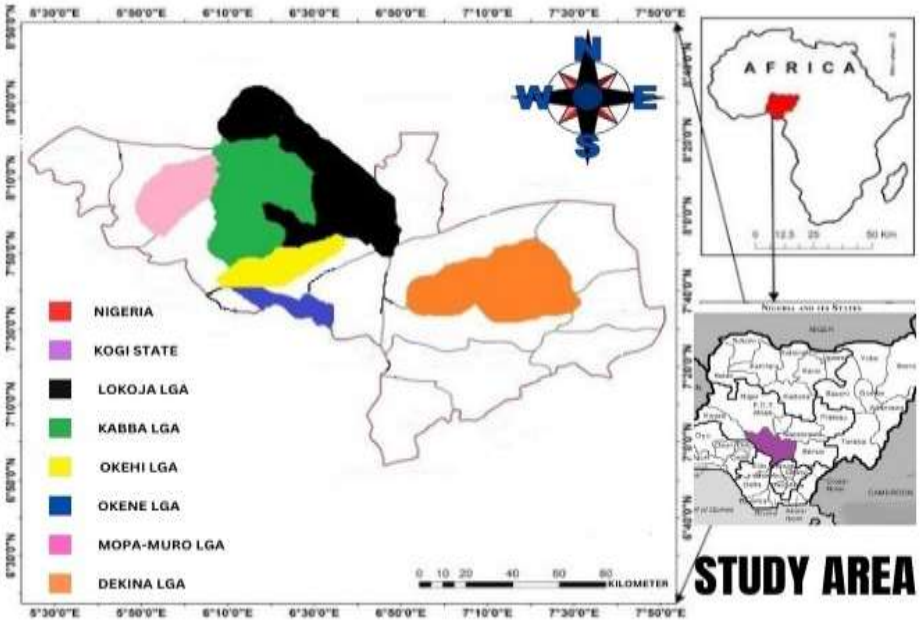

Figure 1: Map of Kogi State showing the Local Government areas of the Hospitals used for data collection

Data collection and analysis

Childbirth records from 1991 to 2020 were extracted from the maternity sections and the central records departments of the six selected hospitals. The data extracted include the number of births, the number of live births, and seasons of the year per birth. The records for some months and years were missing from the data due to inadequate record-keeping in some of the hospitals, unregistered childbirths occurring at home and in some traditional maternity homes and industrial strike action by workers. The number of live births from each hospital was analyzed monthly, quarterly, and annually using descriptive statistics. The sex ratio at birth was determined using the formula (X/Y x 100):100 (where 'X' is number of male live births and 'Y' is the number of female live births). In the analysis of seasonal variation, the months of the year were classified into two, i.e., rainy and dry seasons. The rainy season in the North-Central Nigeria Zone where Kogi State is located includes the months of April to October, while November to March constitutes the dry season (Oguntoyin, 1987; Nche, 2024). Chi-square analysis was performed at 0.05 level of significance. All statistical analyses were performed using the Microsoft Office Excel®version 2023.

Results

Tables 1-6 show the annual record of live births and sex ratio in the 6 hospitals in the present study from 2019 to 2020. The total live births for the period of study include 30,012 for FMC Lokoja, 18,769 for ZH Okene, 7,912 for ZH Kabba, 2,429 for SH Obangede, 2,187 for GH Mopa-Muro, and 3,596 for PAAUTH Anyigba. The annual SRB at the FMC Lokoja from 2000 to 2019 showed a combined yearly average of 98.1:100, with the highest and lowest records of 146.4:100 and 79.1:100 in 2018 and 2000, respectively. Similarly, the annual SRB at the General Hospital Mopa-Muro (1999 to 2020), Zonal Hospital in Kabba (1993 to 2020), Specialist Hospital Obangede (2003 to 2020), Zonal Hospital Okene (1991 to 2020), and Prince Abubakar Audu University Teaching Hospital Anyigba (2005 to 2020) was 104.6:100, 101.5:100, 108.3:100, 102.2:100, and 104.9:100, respectively. The highest and lowest SRB for General Hospital Mopa-Muro were 171.4:100 (2019) and 60.0:100 (2015), respectively; while the Zonal Hospital in Kabba recorded 135.4:100 (2020) and 73.0:100 (1999), respectively. Specialist Hospital Obangede, Zonal Hospital Okene, and Prince Abubakar Audu University Teaching Hospital Anyigba recorded their highest and lowest SRB in the years: 2012 (153.0:100) and 2007 (66.7:100); 2016 (116.0:100) and 1992 (85.5:100); 2008 (127.7:100) and 2016 (85.1:100), respectively.

Table 1: Annual live births and sex ratio recorded in the Federal Medical Centre Lokoja, Kogi State between 2000 and 2019.

Years	Males	Females	Total	Sex ratio
2000	250	316	566	79.1:100
2001	392	427	819	91.8:100
2002	663	731	1394	90.7:100
2003	760	815	1575	93.3:100
2004	918	990	1908	92.7:100
2005	932	969	1901	96.2:100
2006	803	871	1674	92.2:100
2007	1084	1141	2225	95.0:100
2008	1081	1183	2264	91.4:100
2009	795	777	1572	102.3:100
2010	700	671	1371	104.3:100
2011	1135	1119	2254	101.4:100
2012	989	1026	2015	96.4:100
2013	1179	1206	2385	97.8:100
2014	737	738	1475	99.9:100
2015	710	642	1352	110.6:100
2016	615	563	1178	109.2:100
2017	222	160	382	138.8:100
2018	123	84	207	146.4:100
2019	777	718	1495	108.2:100
Total	14865	15147	30012	98.1:100

(χ^2 = 0.0000809, df=19, p>0.05).

Table 2: Annual live births and sex ratio recorded in the General Hospital Moppa-Muro, Kogi State between 1999 and 2020.

Years	Males	Females	Total	Sex ratio
1999	30	25	55	120.0:100
2000	32	34	66	94.1:100
2001	40	54	94	74.0:100
2002	42	40	82	105:100
2003	47	44	91	106.8:100
2004	67	58	125	115.5:100
2005	66	57	123	115.8:100
2006	64	60	124	106.7:100
2007	74	65	139	113.8:100
2008	68	84	152	81.0:100
2009	51	60	111	85.0:100
2010	71	66	137	107.6:100
2011	67	59	126	113.6:100
2012	77	66	143	116.7:100
2013	59	57	116	103.5:100
2014	65	60	125	108.3:100
2015	18	30	48	60.0:100
2016	34	39	73	87.2:100
2017	28	23	51	121.7:100
2018	34	28	62	121.4:100
2019	48	28	76	171.4:100
2020	36	32	68	112.5:100
Total	1118	1069	2187	104.6:100

(χ^2=0.66, df=21, p>0.05).

Table 3: Annual live births and sex ratio recorded in the Zonal Hospital Kabba, Kabba Kogi State between 1993 and 2020.

Years	Males	Females	Total	Sex ratio
1993	153	140	293	109.3:100
1994	121	121	242	100.0:100
1995	106	126	232	84.1:100
1996	114	101	215	112.9:100
1997	114	99	213	115.2:100
1998	84	93	177	90.3:100
1999	46	63	109	73.0:100
2000	106	101	207	105.0:100
2001	97	96	193	101.0:100
2002	107	113	220	94.7:100
2003	125	137	262	91.2:100
2004	148	173	321	85.6:100
2005	205	187	392	109.6:100
2006	110	117	227	94.0:100
2010	240	251	491	95.6:100
2011	243	254	497	95.7:100
2012	351	336	687	104.5:100
2013	340	320	660	106.3:100
2014	286	279	565	102.5:100
2015	72	80	152	90.0:100
2016	145	143	288	101.4:100
2017	155	126	281	123.0:100
2018	169	159	328	106.3:100
2019	177	184	361	96.2:100
2020	172	127	299	135.4:100
Total	3986	3926	7912	101.5:100

(χ^2 =0.53, df=24, p>0.05).

Table 4: Annual live births and sex ratio recorded in the Specialist Hospital Obangede, Kogi State between 2003 and 2020.

Years	Males	Females	Total	Sex ratio
2003	42	46	88	91.3:100
2005	64	60	124	106.7:100
2006	105	90	195	116.7:100
2007	22	33	55	66.7:100
2008	55	56	111	98.2:100
2009	49	57	106	86.0:100
2010	75	67	142	111.9:100
2011	39	39	78	100.0:100
2012	101	66	167	153.0:100
2013	143	94	237	152.1:100
2014	141	124	265	113.7:100
2015	35	40	75	87.5:100
2016	58	72	130	80.6:100
2017	57	56	113	101.8:100
2018	82	78	160	105.1:100
2019	104	98	202	106.1:100
2020	91	90	181	101.1:100
Total	1263	1166	2429	108.3:100

(χ^2 =0.16, df=16, p>0.05).

Table 5: Annual live births and sex ratio recorded in the Zonal Hospital Okene, Kogi State between 1991 and 2020.

Years	Males	Females	Total	Sex ratio
1991	416	448	864	92.9:100
1992	224	262	486	85.5:100
1993	285	276	561	103.3:100
1994	486	561	1047	86.6:100
1995	361	355	716	101.7:100
1996	106	108	214	98.1:100
1998	109	108	217	100.9:100
1999	241	263	504	91.6:100
2000	359	340	699	105.6:100
2001	458	407	865	112.5:100
2002	622	615	1237	101.1:100
2003	523	518	1041	101.0:100
2004	524	489	1013	107.2:100
2005	189	189	378	100.0:100
2013	776	760	1536	102.1:100
2014	772	739	1511	104.5:100
2015	309	272	581	113.6:100
2016	478	412	890	116.0:100
2017	425	411	836	103.4:100
2018	578	535	1113	108.0:100
2019	639	613	1252	104.2:100
2020	608	600	1208	101.3:100
Total	9488	9281	18769	102.2:100

(χ^2 =0.30, df=21, p>0.05).

Table 6: Annual live births and sex ratio recorded in the Prince Abubakar Audu University Teaching Hospital Anyigba, Kogi State between 2005 and 2020.

Years	Males	Females	Total	Sex ratio
2005	31	32	63	96.9:100
2006	75	63	138	119.1:100
2007	80	72	152	111.1:100
2008	83	65	148	127.7:100
2009	97	82	179	118.3:100
2010	131	127	258	103.2:100
2011	104	83	187	125.3:100
2012	179	176	355	101.7:100
2013	224	204	428	109.8:100
2014	184	162	346	113.6:100
2015	120	108	228	111.1:100
2016	97	114	211	85.1:100
2017	49	56	105	87.5:100
2018	88	99	187	88.9:100
2019	151	148	299	102.0:100
2020	148	164	312	90.2:100
Total	1841	1755	3596	104.9:100

(χ^2 =0.71, df=15, p>0.05).

Table 7 shows the pooled monthly sex ratio of live births recorded in the six hospitals between 1991 and 2020. The data showed that the mean monthly value for the rainy season (May to October) was 103.6:100, while the mean monthly value for the dry season (November to April) was 103.9:100. Generally, the highest mean sex ratio was recorded in September while the least was recorded in January. The annual SRB of all the hospitals pooled together gives an overall SRB of 100.7:100 for the study period in Kogi State (Table 8).

Table 7: Pooled monthly sex ratio of live births recorded in six hospitals in Kogi State, North Central Nigeria between 1991 and 2020

Months	FMC	ZHK	GHMM	ZHO	SHO	PAAUTH	Mean sex ratio /month*
Jan	101.2	78.9	100.0	94.2	98.7	111.2	97.4:100
Feb	97.0	101.0	110.4	97.2	103.4	119.0	104.7:100
Mar	96.8	123.4	103.5	109.6	110.7	100.0	107.3:100
Apr	97.9	107.1	105.1	106.6	119.4	92.8	104.8:100
May	98.2	97.0	86.7	106.9	120.5	90.2	100.0:100
Jun	98.5	96.6	96.8	107.0	96.7	102.0	99.6:100
Jul	97.9	102.6	100.0	102.0	105.4	90.5	99.7:100
Aug	104.4	106.2	93.8	113.3	105.3	100.0	103.8:100
Sep	100.7	100.5	118.8	100.4	128.3	140.1	114.8:100
Oct	93.3	113.7	109.0	102.6	95.0	109.7	103.9:100
Nov	93.2	87.1	116.7	104.5	112.9	99.4	102.3:100
Dec	100.7	109.2	113.6	101.8	105.6	109.2	106.9:100

*Mean monthly value for the rainy season (May to October) = 103.6:100; Mean monthly value for the dry season (November to April) = 103.9:100; (χ^2 =0.81, df=11, p>0.05). FMC=Federal Medical Centre Lokoja; GHMM=General Hospital Moppa-Muro; ZHK=Zonal Hospital Kabba; SHO=Specialist Hospital Obangede; ZHO=Zonal Hospital Okene; PAAUTH=Prince Abubakar Audu University Teaching Hospital Anyigba.

Table 8: Annual sex ratio of live births recorded in six hospitals in Kogi State, North Central Nigeria between 1991 and 2020

Name of Hospitals	Males	Females	Total	Sex ratio
Federal Medical Centre Lokoja	14865	15147	30012	98.1:100
General Hospital Moppa-Muro	1118	1069	2187	104.6:100
Zonal Hospital Kabba	3986	3926	7912	101.5:100
Specialist Hospital Obangede	1263	1166	2429	108.3:100
Zonal Hospital Okene	9488	9281	18769	102.2:100
Prince Abubakar Audu University Teaching Hospital Anyigba	1841	1755	3596	104.9:100
Total	32561	32344	64905	100.7:100

(χ^2 =0.04, df=5, p>0.05).

Discussion

The human secondary sex ratio, an important demographic factor, was assessed in six hospitals across Kogi State, North-Central, Nigeria. The study was designed to cover the record of childbirth from 1991 (when Kogi State was created) till December 2020. Throughout the study period, the SRB varied and showed no clear trend probably because of unregistered childbirths, and other factors such as genetics, birth order, family size, preference of male child, ethnicity, stress, geographical location, seasonal variation, maternal age at conception, coital rate, socioeconomic status, and assisted reproductive technology.

The overall SRB of 100.7:100 for Kogi State suggests that there were slightly more males than females in the state. This might not be the absolute value for the state as studies have shown that only about one-third of births in Nigeria are registered within health facilities, others are conducted at home by local midwives without any record (National Planning Commission/UNICEF, 2001; Bakare et al., 2011). From the 2006 population census, data showed a population of 3,314,043 (1,672,903 males and 1,641,140 females, sex ratio of 101.9:100) residents in Kogi State with a projection of 4,153,734 people by 2019 (National Bureau of Statistics, 2020). Nigeria's projected population from 2018 – 2020 is 206,283,338 (103,242,979 males and 103,040,359 females) with a sex ratio of 100.2:100 (National Bureau of Statistics, 2021).

The data from FMC Lokoja showed a slight female preponderance with an SRB of 98.1:100. This incidence of more female births has been previously reported in other parts of Nigeria. For example, Fakorede et al. (2022) reported a low sex ratio of 99.7:100 in Lagos, a megacity with about 6.9% of the total population in Nigeria. The low sex ratio recorded in FMC Lokoja can be attributed to environmental factors such as pollution from industrial waste, and increased stress among adult males and females. Lokoja, the state capital, is the most industrialized and densely populated metropolitan area with poor transportation systems, unlike other locations such as Kabba and Okene which are less industrialized. Stress, a primary hallmark of high blood pressure, can lead to the development of preeclampsia (a health condition related to high blood pressure that leads to the loss of male fetuses in late gestation) (Wedenoja et al., 2019). It is generally observed that people in the city are exposed to more stress than those in the village. Stress also increases the level of the corticotrophin hormone, which in turn reduces testosterone and increases estrogen, resulting in more female births (Fakorede et al., 2022). Furthermore, over 70% of the people living in this city are educated, and some of them practice family planning and birth control, which will invariably reduce family size. The high cost of living in the cities also causes couples to reduce their

family size. Socio-economic status and family size also played vital roles in the SRB outcome. Some of the areas studied are towns and villages where privately owned companies engage in a wide range of economic operations, most of which are small-scale; the primary source of income is obtained from public service employment, rural farming, and trading activities (Oyeniyi, 2012).

The overall SRB of 100.7:100 reported in this study is lower than previously reported in other parts of Nigeria. Nigeria has high fertility rates and higher sex ratios than most African countries (Kaba, 2015; Garenne, 2022). Azeez et al. (2007) and Bakare et al. (2011) reported an average pooled SRB of 102.7:100 and 110.1:100, respectively for some parts of South-Western Nigeria. Sule and Magudu (2004) recorded an SRB of 112:100 at Ahmadu Bello University Teaching Hospital in Zaria, Kaduna, North-Western Nigeria. An SRB of 120:100 was recorded in the Niger Delta University Teaching Hospital in South Nigeria (Eneni et al., 2013). The SRB value in the present study is also lower than the average of 105.5:100 for all races of the world and 101.1:100 and 107:100 reported for several other black populations (Gray & Bortolozzi, 1977; Hesketh & Zhu, 2006).

The preference of males over females is significantly a social and cultural issue in Nigeria (Fayehun et al., 2011; Awoleke et al., 2020). It is believed that males are expected to continue the family name, provide support in agriculturally sustained economies, and have the right of inheritance. Women are valued more as domestic hands, for procreation and better emotional support for aged parents (Dharmalingam, 1994; Chhetri et al., 2011; Awoleke et al., 2020). This has prompted marriageable men to decide to have many children, and some have resorted to a polygamous lifestyle of marrying many wives. They do this to preserve their posterity and show strength among their peers.

Seasonal variation did not appear to play any role in the sex-ratio determination in this study because the pooled value of the rainy and dry seasons did not show any significant difference in the SRB. This is different from the findings of Fakorede et al. (2022) who observed seasonal variation in the SRB in some South-Western states in Nigeria. Birth intervals have been reported to affect the SRB. A lower birth interval (parity) favors male birth, while a longer birth interval favors female birth. Postpartum amenorrhea, which is the period between the first birth and the second birth, can be prolonged by fetal loss and the breastfeeding period, as most women's ovulation ceases during breastfeeding (Morse & Luke, 2021). In a rural setting, reproductive-age women are either breast-feeding or in their gestation period. This is not so in the city, because an average woman is a working-class and would have to regulate her

conception period due to their daily engagements. To our knowledge, this is the first scientific report on the human secondary sex ratio from Kogi State in North-Central Nigeria.

Conclusion

In this study, data on child births between 1991 and 2020 at the Federal Medical Centre Lokoja, Zonal Hospital Kabba, Zonal Hospital Okene, General Hospital Mopa-Muro, Specialist Hospital Obangede, and Prince Abubakar Audu University Teaching Hospital Anyigba were used for the first time in scientific literature to determine the secondary sex ratio at birth in Kogi State, north-Central Nigeria. The analysis showed a secondary sex ratio that is male-biased in all the hospitals except at the FMC Lokoja. Overall, a secondary sex ratio of 100.7:100 was obtained for Kogi State. Heredity, geographical location, urbanization, social status, and family size are some factors that might have influenced the secondary sex ratio for Kogi State. Our experience during data collection and the findings showed the need for proper documentation of childbirth in Kogi State and Nigeria. Further studies are necessary to elucidate more on the factors that influence the secondary sex ratio in Nigeria.

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References

Awoleke, J. O., Olofinbiyi, B. A., & Olaogun, O. D. (2020). Spousal influence on son preference among antenatal attendees in a developing nation with limited prenatal sex-detection technology. *Pan African Medical Journal, 3*(1). https://doi.org/10.11604/pamj-cm.2020.3.1.22024.

Azeez, A. M., Akinboro, A., & Bakare, A. A. (2007). Human sex ratio at birth in South West Nigeria. *Indian Journal of Human Genetics, 13*(2), 59-64.

Bae, J., Kim, S., Barr, D. B., & Buck Louis, G. M. (2018). Maternal and paternal serum concentrations of persistent organic pollutants and the secondary sex ratio: A population-based preconception cohort study. *Environmental Research, 161*, 9–16. https://doi.org/10.1016/j.envres.2017.10.047.

Bakare, A. A., Elegbede, E. O., & Osowole, O. I. (2011). Trends of human sex ratio at birth and twinning rate in Ibadan, South-Western Nigeria. *The Zoologists, 9*, 47-56. https://www.ajol.info/index.php/tzool/article/view/73128.

Bello-Williams, D. (2019). Ethnic identity politics in Kogi State, Nigeria: Exploring the implications of the fault lines for Inclusive Development. *National Institute for African Studies.* https://www.africanstudies.co.uk/2019/09/30/ethnic-identity-in-kogi-state-exploring-the-fault-lines-of-the-nigerian-culture-of-politics/.

Chao, F., Gerland, P., Cook, A. R., & Alkema, L. (2021). Global estimation and scenario-based projections of sex ratio at birth and missing female births using a Bayesian hierarchical time series mixture model. *The Annals of Applied Statistics, 15*(3), 1499–1528.

Chhetri, U. D., Ansian, I., Bandary, S., & Adhikari, N. (2011). Sex preference among mothers delivering at Patan Hospital. *Kathmandu University Medical Journal, 9*(36), 229-232.

Dharmalingam, A. (1994). Old Age Security: Expectations and experiences in a South Indian Village. *Population Studies (Camb), 48*(1), 5-19.

Eneni, O. N., Mukoro, G. D., & Tabowei, B. (2013). Trend of male–female birth ratio in a South-South Nigerian Teaching Hospital. *The Internet Journal of Health, 14*(1). https://ispub.com/IJH/14/1/1447.

Fakorede, S. T., Ojo, S. D., Shonde, K. M., Adekoya, K. O., Ogunkanmi, L. A., & Oboh, B. (2022). Trends and seasonal variations in human secondary sex ratio in Southwest Nigeria: A 10-year survey. *Advances in Human Biology, 12*, 271-276. https://doi.org/10.4103/aihb.aihb_165_21.

Fayehun, O. A., Omololu, O. O., & Isiugo-Abanihe, U. C. (2011). Sex of preceding child and birth spacing among Nigerian ethnic groups. *African Journal of Reproductive Health, 15*(2), 79-90.

Garenne, M. (2022). Sex-ratio at birth in Nigeria: A demographic perspective. *African Journal of Reproductive Health, 26*(4), 92. https://doi.org/10.29063/ajrh2022/v26i4.10.

Gray, E., & Bortolozzi, J. (1997). Human sex ratio and family size in Brazil. *Journal of Heredity, 68*, 241-244.

Hesketh, T., & Zhu, W. X. (2006). Abnormal sex ratios in human populations: Causes and consequences. *Proceedings of the National Academy of Science USA, 103*, 13271-13275.

Jimba, M. M. M. (2012). Muslims of Kogi State: A survey. *Nigeria Research Network (NRN) Oxford Department of International Development Queen Elizabeth House University of Oxford.* https://www.qeh.ox.ac.uk/sites/www.odid.ox.ac.uk/files/BP2Jimba.pdf.

Kaba, A. J. (2015). Explaining the rapid increase in Nigeria's sex ratio at birth: Factors and implications. *African Journal of Reproductive Health, 19*(2), 17-33.

Liu, X., & Feldman, M. W. (2021). Effects of cultural transmission of surnaming decisions on the sex ratio at birth. *Theoretical Population Biology, 141*, 44–53.

Lou, H., Li, N., Zhang, X., Sun, L., Wang, X., Hao, D., & Cui, S. (2020). Does the sex ratio of singleton births after frozen single blastocyst transfer differ in relation to blastocyst development? *Reproductive Biology and Endocrinology, 18*(1), 72. https://doi.org/10.1186/s12958-020-00623-x.

Melnikov, V. N. (2015). Seasonal inconstancy of human sex ratio at birth. *Early Human Development, 91*(12), 817-821. https://doi.org/10.1016/j.earlhumdev.2015.10.008

Morse, A., & Luke, N. (2021). Foetal loss and feminine sex ratios at birth in Sub-Saharan Africa. *Population Studies: A Journal of Demography, 75*(2), 239-254. https://doi.org/10.1080/00324728.2021.1877793.

National Planning Commission/UNICEF. (2001). *Children's and Women's rights in Nigeria: A wake up call: Situation Assessment and Analysis.* Abuja: NPC/UNICEF. edited by Anthony Hodges, ISBN: 9291860212, 9789291860210, 332pp.

National Bureau of Statistics. (2020). *Demographic Statistics Bulletin, Sixth edition.* https://nigerianstat.gov.ng. Accessed 20 August 2024.

National Bureau of Statistics. (2021). *2020 Statistical report on women and men in Nigeria.* https://www.nigerianstat.gov.ng/pdfuploads/2020_ReportWomenMen_August2021.pdf. Accessed 20 August 2024.

Nche, G. C. (2024). 'We need rain to survive, but it shouldn't be too much': A tale of flood victims in Kogi State, Nigeria. *Cogent Social Sciences, 10*(1). https://doi.org/10.1080/23311886.2024.2350140.

Oguntoyin, J. S. (1987). *A geography of Nigerian development.* Heinemann.

Oyeniyi, T. (2012). Secondary sex ratio in a South-Western Nigerian town. *International Journal of Genetics, 4*(3), 92-94.

Pirrie, A., & Ashby, B. (2021). Does differential mortality after parental investment affect sex ratio evolution? No. *Evolution, 75*(12), 3175-3180. https://doi.org/10.1111/evo.14374

Rettaroli, R., & Scalone, F. (2021). The human sex ratio at birth and late fetal mortality: The Italian case. *Biodemography and Social Biology, 66*(2), 172-190. https://doi.org/10.1080/194855,2021.1879627.

Singh, A., Kumar, K., Yadav, A. K., James, K. S., McDougal, L., Atmavilas, Y., & Raj, A. (2021). Factors influencing the sex ratio at birth in India: A new analysis based on births occurring between 2005 and 2016. *Studies in Family Planning, 52*(1), 41–58. https://doi.org/10.1111/sifp.12147.

Sule, S. T., & Madugu, H. N. (2004). Sex ratio at birth in Zaria, Nigeria. *Journal of Annual Human Biology, 31*(2), 258-262.

Tatsuta, N., Nakai, K., Nakayama, S. F., Takeuchi, A., Arima, T., Yaegashi, N., Kamijima, M., Yamazaki, S., Ohya, Y., Kishi, R., Hashimoto, K., Mori, C., Ito, S., Yamagata, Z., Inadera, H., Nakayama, T., Iso, H., Shima, M., & Katoh, T. (2022). Effects of maternal exposure to lead on secondary sex ratio in Japan: The Japan Environment and Children's Study. *The Science of the Total Environment, 817*, 152726. https://doi.org/10.1016/j.scitotenv.2021.152726.

Wallner, B., Fieder, M., & Seidler, H. (2012). Ownership of dwelling affects the sex ratio at birth in Uganda. *PLOS ONE, 7*(12), e51463. https://doi.org/10.1371/journal.pone.0051463.

Wedenoja, S., Yoshihara, M., Teder, H., Sariola, H., Gissler, M., Katayama, S., Wedenoja, J., Häkkinen, I. M., Ezer, S., & Linder, N. (2019). Balancing selection at HLA-G modulates fetal survival, preeclampsia, and human birth sex ratio. *BioRxiv*, 851089.