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ABSTRACT:
Season is known to influence human secondary sex ratio but information on this subject is lacking in Nigeria. The objective of this study was to determine the secondary sex ratio (SSR) during the wet and dry seasons in Nigeria. In this retrospective cohort study, the records of all deliveries at St Philomena Catholic Hospital (SPCH), Benin City, Edo State, Nigeria between 1st January, 2005 and 31st December, 2014 (10 years) were retrieved and analyzed. The births were recorded according to the year and month of delivery. Stillbirths and infants with ambiguous genitalia were excluded from the analyses. The total number of live-births during the 10-year period under review was 13,702 and this consisted of 7,007 males and 6,695 females, resulting in a secondary sex ratio of 104.6:100 (1.05:1). In general, the monthly distribution of births was bimodal with a greater peak in May and a lesser peak in October with the highest and lowest SSRs in the months of June and March, respectively. In the dry season, the proportion of male births was higher than the proportion of female births; $p > 0.05$. In contrast, in the wet season the proportion of male births was lower than the proportion of female births; $p > 0.05$. In addition, the SSR was higher in the dry season (1.04) compared with the wet season (0.99). In Edo State, Nigeria, the proportion of male births tended to be higher than the proportion of female births during the dry seasons.

Key words: Dry season, seasonality of births, secondary sex ratio, wet season, Nigeria.
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INTRODUCTION:

The phrase “secondary sex ratio” is defined as the number of male live-births for every 100 female births [1]. The close proximity of Nigeria to the equatorial belt and the Atlantic Ocean confers on her a humid tropical climate with two main seasons. The seasons are the wet (rainy) and the dry seasons [2]. In Nigeria, the average annual rainfall varies from 1,770mm (70 inches) in the west to 4,310mm (170 inches) along the east coast and to 470mm (50 inches) in the central areas. The average temperature range all year round is 23 to 32 degrees Celsius (73 to 90 degrees Fahrenheit) [2]. In almost all human populations, the number of births varies by season of the year but this variation is not identical in all populations [3]. It has been documented that the most important environmental factors that influence the monthly distribution of births are seasonal variation in temperature [4] and rainfall [5]. The mechanisms by which any variable that brings about seasonal

changes in birth pattern operates include sperm quality, sexual activity, seasonal pregnancy loss, seasonal availability of food and cultural factors [3,5,6]. Observations in Hong Kong, Bangladesh, Uganda and Singapore indicate that a negative correlation exist between environmental temperature and the number of monthly conceptions and this has been attributed to hormonal changes [6]. Intra-population variation in sex ratio has been linked to season of conception and by extension, the season of birth [7-10]. In the study by Helle et al [8], fluctuations in rainfall and temperature influenced human secondary sex ratio (SSR). It has been proposed that climate may cause a physiological stress and thus, play a role in sex allocation in humans. In this regard, it may affect the SSR if the mothers are exposed to shifts in temperature during gestation [11]. Evolutionary theory predicts that fewer males should be born during stressful periods, as a weaker male will not survive to reproduce where a female might [12]. The report by McLchlan and Storey suggested that more males would be born during the warmer periods [9]. Studies in Finland and other Scandinavian countries found that more males are born in warmer years [11,13]. In addition, increases in temperature increase the likelihood of a male fetus surviving [11]. In contrast, a study in New Zealand on the effects of fluctuations in mean annual temperature found that it was unrelated to rates of male births [14].

SSR differs from one population to the other. This variation has been attributed to various factors including season. In this regard, it might be useful to examine the influence of season (a natural factor) on the likelihood of the birth of a male child. The knowledge gained might find an application in the reproductive health of families, allowing for some degree of parental choice of sex of offspring. To the best of our knowledge, there are no previous published studies that have assessed the relationship between season and SSR in Nigeria. In most cultures in Nigeria, parents depend on their sons for immediate status and future security [15,16]. The resultant effect is that the birth of a male child is more celebrated than that of a female child [15]. These considerations prompted the present study. The purpose of the study is to determine the secondary sex ratio during the wet and dry seasons in Edo State, Nigeria.

SUBJECTS AND METHODS:

A retrospective audit of the birth records of all deliveries at St Philomena Catholic Hospital (SPCH) between 1st January, 2005 and 31st December, 2014 (10 years) was carried out. The hospital has a large maternity unit (ranks second in Edo State) located at the centre of Benin City, Edo State, Nigeria and it is easily accessible. Stillbirths were excluded in the analysis in conformity with the definition of secondary sex ratio. Infants with ambiguous genitalia were also excluded from the analysis. The deliveries were recorded according to the month and year of delivery. The study design was approved by the hospital authority. The secondary sex ratio was

computed, using the formula B/G (where 'B' is number of male births and 'G' is number of female births). In this study, the seasons were defined as wet (rainy) season May to October and dry season November to April.

Statistical analysis was performed using the statistical package for social sciences (SPSS, version 16.0). Descriptive statistics such as frequencies, ratios, and percentages were used to describe all the variables. The Z-test was used in ascertaining the significance of differences between two proportions with $p < 0.05$.

RESULTS:

During the 10 years covered in this study, a total of 13,702 live-births were recorded at SPCH and this consisted of 7,007 males and 6,695 females. Males accounted for 51.1% of the total live-births. A quarter (24.9%) of the total births was recorded in the years 2013 and 2014. A total of 6,703 (48.9%) and 6,999 (51.1%) babies were born during the dry and wet seasons, respectively. The overall secondary sex ratio (SSR) for the 10 years pooled together was 1.05:1.0. Table 1 shows the monthly distribution of births and SSRs for the 10 years period. The cumulative monthly distribution of births was bimodal with a greater peak in May and a lesser peak in October as can be seen in Figure 1. The highest and lowest SSRs were in the months of June and March, respectively. As depicted in Table 2, the proportion of male births was higher than the proportion of female births during the dry season ($p > 0.05$). In the wet season, the proportion of male births was lower than female births ($p > 0.05$). In addition, the SSR was higher in the dry season (1.04) compared with the wet season (0.99).

Table 1: Monthly cumulative number of live births, gender distribution and secondary sex ratios from 2005 to 2014

Months of study (2005-2014)	Total by month of study (2005-2014)	Number of males	Number of females	Secondary sex ratio
January	1124	571	553	1.03
February	967	498	469	1.06
March	1199	595	604	0.98
April	1151	599	552	1.09
May	1371	712	659	1.08
June	1139	599	540	1.11
July	1199	598	601	0.99
August	1106	569	537	1.06
September	1156	594	562	1.06
October	1262	643	619	1.04
November	960	499	461	1.08
December	1068	530	538	0.99
Jan-Dec	13702	7007	6695	1.05

Figure 1: Monthly cumulative number of live births and gender distribution of births from 2005 to 2014

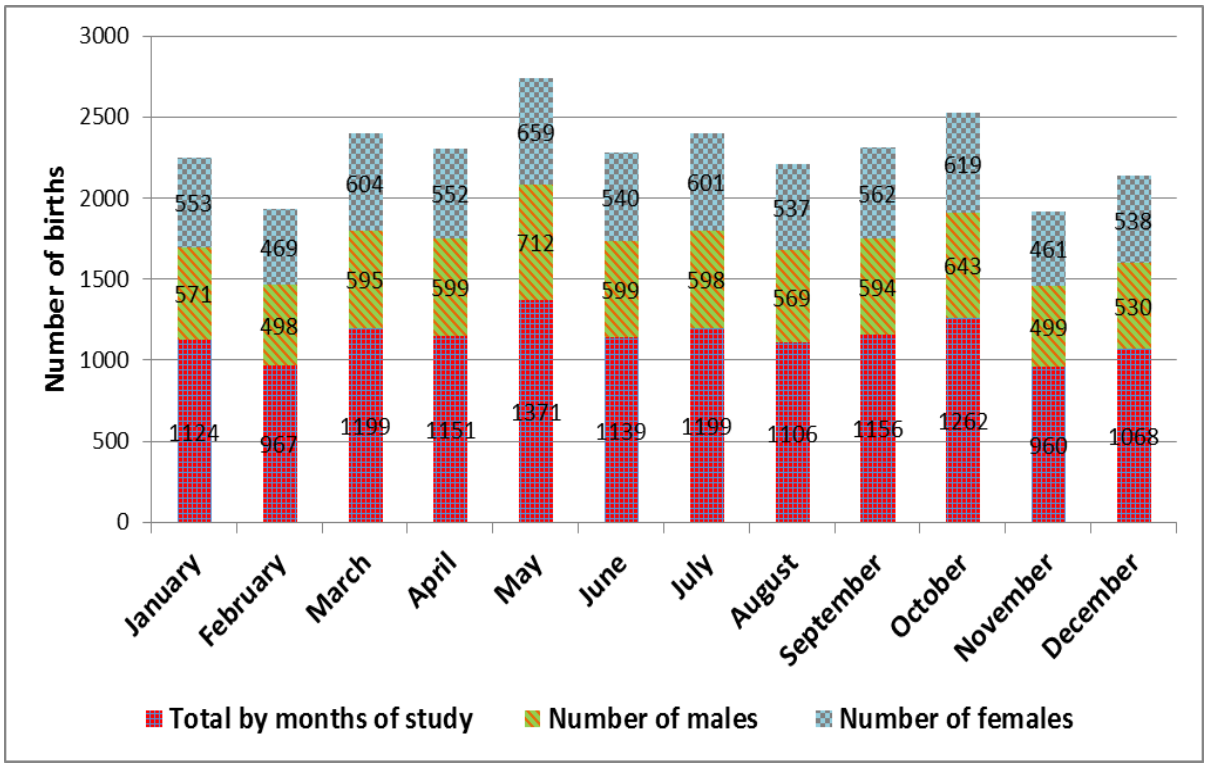

Table 2: Yearly distribution of secondary sex ratio (SSR) of live births in the period 2005 to 2014

Year of study	Yearly total	Season of the year					
		Dry season (n=6703)			Wet season (n = 6999)		
		Males	Females	SSR	Males	Females	SSR
2005	1128	312	310	1.01	252	254	0.99
2006	1487	363	350	1.04	386	388	0.99
2007	1304	277	274	1.01	375	378	0.99
2008	1230	316	311	1.02	303	300	1.01
2009	1304	295	284	1.04	357	368	0.97
2010	1332	285	286	1.00	379	382	0.99
2011	1105	275	244	1.13	294	292	1.01
2012	1398	379	366	1.04	325	328	0.99
2013	1653	436	415	1.05	399	403	0.99
2014	1761	472	453	1.04	420	416	1.01
2005-2014	13,702	3410	3293	1.04	3490	3509	0.99
SSR				1.04			0.99
Percentage		50.9%	49.1%		49.9%	50.1%	
Z-statistic		0.98; p > 0.05			1.00; p > 0.05		

DISCUSSION:

Although the data from our study showed that a higher proportion of male births compared with female births occurred in the dry season, the difference was not statistically significant. In contrast, during the wet season, the proportion of male births was lower than the proportion of female births. Again, this difference was not statistically significant. In general, these findings suggest that there was a greater tendency to deliver male babies during the dry season compared with during the wet season. No published similar study from Nigeria for comparison. However, the results of the studies by several authors indirectly supported our finding [9,11,13]. In contrast, our results contradict the findings in New Zealand [14]. Maconochie and Roman did not find any evidence that season influenced secondary sex ratio [17]. In that study, they concluded that gender determination is purely a chance process. The reason for the different finding is not clear. However, it suggests that other factors, apart from season, influence SSR. Various mechanisms have been postulated to explain the influence of season on SSR. These include the influence of temperature on coital frequency and hormonal changes. The coital frequency is known to vary with season with a lower rate during the hot weather [18]. Infants conceived during the dry season when coital frequency is relatively lower are usually delivered during the wet season. Similarly, infants conceived during the wet season when there is higher coital frequency are usually delivered in the dry season. A lower coital rate elongates the average interval between ovulation and fertilization (the German hypothesis), causing overripeness ovopathy [19]. The resultant effect may be an increased likelihood of chromosomal anomalies and spontaneous abortions [19,20]. Male fetuses are known to be more vulnerable, leading to a greater loss and subsequently, a lower proportion of male births [19]. Similarly, a lower coital frequency causes ageing of the spermatocytes, resulting in spermatopathy [20,21]. Ageing Y-bearing spermatocyte may move more sluggishly, reducing the chances of fertilizing an ovum [21]. The resultant effect of the above considerations is a relatively higher male birth rate during the dry season compared with during the wet season. In addition, during the wet seasons of the year, spontaneous abortions induced by infections (e.g., malaria) are more likely and these miscarriages are often unknown to women and so, are unreported to interviewers [22]. Male fetuses are more vulnerable to such abortions.

Our data indicate that the cumulative monthly distribution of births is bimodal with the greater peak in May and the lesser peak in October with the troughs in the months of February and November. In a multicentre (Obafemi Awolowo University Teaching Hospital, Ile Ife, Wesley

Guild Hospital, Ilesa, General Hospital, Ogbomosho and Ekiti State Specialist Hospital, Ado-Ekiti) study, a similar cumulative monthly distribution of births from 1995 to 2004 was found on analysis of the data involving 14,579 live births subjects derived from Obafemi Awolowo University Teaching Hospital, Ile Ife, Nigeria [23]. However, in the same study, data from the remaining three other hospitals with lower delivery rates, the cumulative monthly distribution of births were different, suggesting that the monthly delivery rate might influence the monthly SSRs. The reason for this disparity is not clear. In our study, we found that the highest SSR was in the month of June. In consonance with our finding, Azeez et al [23], also reported that the highest SSR was in the month of June. On the other hand, we found that the lowest SSR was in the month of March whereas Azeez et al [23] found that the lowest SSR was in the month of October. Overall, the monthly SSR during the period covered by our study did not reveal a regular pattern of variation. This observation is similar to a previous study in Nigerian which reported a similar finding [23]. In that study involving four different hospitals in southwest Nigeria, the highest and lowest SSRs according to the month of birth were different for each of the four hospitals, illustrating the wide variability in monthly distribution of live births.

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REFERENCES:

1. Hesketh T, Xing WZ. Abnormal sex ratio in human populations: causes and consequences. Proc Natl Acad Sci, USA 2006;103(36):13271-13275.
2. Anonymous. Nigeria-Atlapedia Online. Available www.atlapedia.com/online/countries/nigeria.htm. Accessed on May 20, 2015.
3. Bobak M, Gjonca A. The seasonality of live birth is strongly influenced by sociodemographic factors. Hum Reprod 2001;16(7):1512-1517.
4. Lam DA, Miron JA. Temperature and the seasonality of births. Adv Exp Med Biol 1991;286:73-88.
5. Bronson FH. Seasonal variation in human reproduction: environmental factors. Q Rev Biol 1995;70(2):141-164.
6. Dyson T, Crook N. Causes of seasonal fluctuation in vital events. Available at: www.popline.org/node/390563. Accessed on June 1, 2015.
7. Lerchl A. Seasonality of sex ratio in Germany. Hum Reprod 1998b; 13:1401-1402.
8. Helle S, Helama S, Lertola K. Evolutionary ecology of human birth sex ratio under the compound influence of climate change, famine, economic crises and wars. J Animal Ecology 2009;78:1226-1233.
9. McLachlan TC, Storey H. Hot male: can sex in humans be modified by temperature? J Theor Biol 2003;222:71-72.
10. Kumari JR, Rao TV. Seasonal variation of human sex ratio at birth and the modifying factors. Indian J Pediatr 1982;49(4):541-546.

11. Catalano R, Brucker T, Smith KR. Ambient temperature predicts sex ratio and male longevity. Proc Natl Acad Sci USA 2008;105:2244-2247.
12. Trivers RL, Willard DE. Natural selection of parental ability to vary the sex ratio of offspring. Science 1973;179:90-92.
13. Helle S, Helama S, Jokela J. Temperature-related birth sex ratio bias in historical Sami: Warm years being more sons. Biol Letters 2008;4:60-62.
14. Dixson BJ, Haywood J, Lester PJ, Ormsby DK. Whatever the weather: Ambient temperature does not influence the proportion of males born in New Zealand. PLosONE 6(9):e25064.
15. Nnadi I. Son preference - A violation of women's human rights: A case study of Igbo custom in Nigeria. J Politics Law 2013;6(1):134-141.
16. Milazzo A. Son preference, fertility and family structure: evidence from reproductive behaviour among Nigerian women. Policy Research Working Paper; no. WPS 6869. Washington, DC: World Bank Group, 2014.
17. Maconochie N, Roman E. Sex ratio: are there natural variations within the human population? Br J Obstet Gynaecol 1997;104:1050-1053.
18. Athanassena GA. Seasonal variation of births in Greece: Temporal changes and regional differences over a 24-year period. Chronobiologia 1985;12:351.
19. German J. Mongolism, delayed fertilization and human sexual behavior. Nature 1968;217:516.
20. Guerrero V, Rojas OI. Spontaneous abortion and aging of human ova and spermatozoa. New Engl J Med 1987;293:573.
21. Reijneveld SA, De Bock GH. Seasonal preovulatory overripeness ovopathy: A reappraisal of the concept. Med Hypothesis 1992;37:151-157.
22. Pitt MM, Sigle W. Seasonality, weather shocks and timing of births and child mortality in Senegal. A paper presented at the 10th anniversary conference of the Centre for Study of African Economies, Oxford University, Oxford, England, April 17-18, 1997.
23. Azeez MA, Akinboro A, Bakare AA. Human sex ratio at birth in southwest Nigeria. Indian J Hum Genet 2007;13(2):59-64.