Implications of Seasonal Changes on Conception and Birth in Lagos State, Nigeria

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Abstract— This study investigated the influence of temperature on the seasonal birth and conception patterns; and determined monthly variations in birth deliveries in Lagos, South West Nigeria according to the different divisions. The distribution of births by months exhibits a seasonal pattern in most populations. These trends often identify a peak season and a trough season. Data on birth deliveries in Lagos State from 2008-2013 were collected from the Healthcare Planning Research and Statistics Unit of the Lagos State Ministry of Health and analyzed with the average mean temperature values.It was discovered that there is no significant relationship between the temperature and birth seasonality in Lagos. The birth record displayed strong seasonality effect at 99% confidence level, the V(N) for the various divisions in Lagos state varied from 0.029 to 0.088 while the monthly birth distribution displayed a sinusoidal pattern with peak delivery rates in March—May and October and lowest rates in August and December.

Index Terms— Conception pattern, PEPI, Peak season, Seasonality, Trough season.

INTRODUCTION

The Book of Ecclesiastes in the Bible proclaims that there is "a time to be born." [7]. We lived in a world of seasons where many social and ecological processes and events occur regularly every year. These seasonal processes influence many vital rates including birth rates. According to Dorelien [14], births occur throughout the year, but there are groups of months with higher frequencies of births than one would expect by chance alone if the distribution was uniform. Despite the cyclical pattern in the human female reproductive system, humans have the potential of year round reproduction. All human societies have experienced marked seasonal variations in conceptions and births due to the prevailing patterns of economic and social life, often dictated by the seasons or by religious prohibitions. As reported by Ayeni [3],[21] and [11], seasonal variation in the frequency of births is a nearly universal phenomenon in human populations. Consistent patterns of birth seasonality have occurred in virtually all geographic locations, often with remarkable stability across time and during extraordinary social and cultural changes. [8]. Over time, demographic research has shown a seasonal pattern in births for populations of many different countries and regions. These trends often identify a peak season – a period of maximum annual births – and a trough season – a period of minimum annual births. According to Bantje [4], lack of vital statistics data and the prevailing hypothesis that temperature is one of the main drivers of birth seasonality resulted in few studies of birth seasonality in sub-Saharan Africa (SSA).

The distribution of births by months exhibits a seasonal pattern in most populations. Indeed, the absence of birth seasonality in any particular population can be considered a remarkable observation [10]. Variations in fertility and seasonal patterns of childbearing have been of interest to medical scientist and demographers for a long time. Medical sciences are replete with literatures on the seasonal rhythms in humans and have shown that hormone levels fluctuate on the basis of the month [32], [30], [12], [24]. Demographers have documented cyclical patterns in the incidence of cancer risk, depression, obesity, criminality, schizophrenia, insanity, genius and even death on the basis of birth month. [9], [22], [1]. Biometeorologists have observed that temperature is associated with fecundity in both humans and in animal species [33], [25]. There is indication that photoperiod may also be a factor in this relationship [6]. Ogum *et., al* [28], while studying the seasonal birth pattern in South eastern Nigeria from 1971-1976 revealed a seasonal pattern in the monthly distribution of births, with the peak period observed during April-June, and a trough during November-January. Ayeni [3] reported similar findings while analyzing live births between 1965 and 1975 in Igbo-Ora, a rural area in South Western Nigeria, the monthly number of registered births showed a significant seasonal pattern in May and corresponding minima in November. Although, the

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different studies of Ogum [28] and Ayeni [3] mentioned above did not really investigate the causes of the observed seasonality pattern, they nonetheless alluded the observed seasonal pattern to the climatic factors as well as socio-cultural patterns of life associated with cyclical farming activities of a predominantly agricultural community in their study area. However, Enabudoso et.,al [16] noted a sinusoidal pattern with peak delivery rates in April-May and October and lowest rates in July-August and December in their analysis of monthly deliveries in Benin City, Nigeria. The July-August/December trough observed in the Enabudoso et., al [16] study is in contrast to the November minima pattern observed in the studies of Ogum [28]. This may be due to the urban setting of Benin city which is different to the rural setting of the other two studies. According to Ellison et., al [15], the broad prevalence of human birth seasonality does not imply simple causation. Several mechanisms have been proposed to account for the seasonality of births in different specific cases, and most investigators acknowledge that multiple causes are almost certainly involved. However, as affirmed by Doblhammer-Reiter et al. [13]; with the numerous explanatory models that have been proffered, the real causes of birth seasonality patterns are still regarded as a "puzzle" and a "mystery".

The objectives of this study were to investigate the influence of temperature on the seasonal birth and conception patterns; and determine monthly variations in birth deliveries in Lagos, South West Nigeria which have been understudied.

METHODS

Study Site

Lagos State lies to the south-western part of Nigeria, and shares boundaries with Ogun State both in the North and East and is bounded on the west by the Republic of Benin. In the South it stretches for 180 kilometres along the coast of the Atlantic Ocean. [17]. Based on the 2006 national population census, the National Population Commission (NPC) estimated Lagos's population to be 9,113,605 with a sex ratio of 1.074 males to 1 female [25]. The Lagos State government however estimated a population of 17,552,942 [19]. It is located partly in the swampy mangrove and partly rain forest regions of West Africa having bi–modal rainfall maxima annually. It receives mean annual rainfall of about 2000 mm [27]. According to BBC, [5], the average temperature in January is 27°C (79°F) and for July it is 25°C (77°F). On average the hottest month is March; with a mean temperature of 29°C (84°F); while July is the coolest month.

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Fig 1: Map of Lagos (Source:http://fluswikien.hfwu.de/index.php/Group_B_-_Collaborative_Climate_Adaption_Project)

Data Collection

Data on birth deliveries in Lagos State from 2008-2013 was collected from the Healthcare Planning Research and Statistics Unit of the Lagos State Ministry of Health.

Average Mean temperature values over Lagos (Latitude 6.5°N, Longitude 3.3°E) between 2007 and 2013 were obtained from Weatherspark Weather data graphs (http:// http://weatherspark.com/#!dashboard;ws=28568;t0=1/1;t1=12/31;graphs=temperature:1). The integrity of the data has been attested by many researchers [26], [31]. They have found the data set to be of high quality and suitable for study such as this.

Methodology

The first statistical test especially designed for seasonality or more generally speaking for cyclic trends is Edwards' Test published in 1961. As explained by Rau [29]], several others modified this test in order to be valid for small sample sizes or to allow for a different alternative hypothesis. They all use sine and cosine waves to approximate the observed pattern. Given a circle whose circumference is divided into k equal long parts. In the case of months per year, k = 12. Thus, each month's contribution to the surface of the circle is a sector of 30 degrees: January from 0 to 30°, February from 30° to 60°, and finally December from 330° to 360°.

$S = \sum \sqrt{Ni}\ Sin\ \theta i$
$C = \sum \sqrt{Ni}\ Cos\ \theta i$
$W = \sum \sqrt{Ni}$
$d = \frac{\sqrt{(S^2+C^2)}}{W}$
$a = 4d$

Ni corresponds to the number of events (e.g. Births) in month i and $\sum_i^{k(=12)} Ni = N$. The parameter θi indicates the position of the weight of each month on the wheel.

Hewitt's test is based on ranks, it should be used in conjunction with the winter/summer-ratio to have a measurement of the height of the seasonal fluctuations.

Edwards' seasonal test and Ratchet circular scan test were used to determine presence of seasonality and 2-month & 3-month seasonal peaks respectively. These tests were performed using PEPI. Also, the peak amplitude, phase angle were determined using the PEPI. PEPI is a set of statistical programs for epidemiologist. "PEPI" is an acronym for "Programs for EPIdemiologists".[2]

The health centers were categorized into the five (5) administrative divisions (Ibile) in Lagos state. Their birth delivery records were aggregated according to the divisions. The divisions are Ikeja, Badagry, Ikorodu, Lagos (Eko) and Epe.

Data Analysis and Results

Testing for Birth Seasonality in Lagos State

Using PEPI, the monthly birth records of the five divisions and the state as a whole were analyzed to test for presence of seasonality.

Table 1: Summary of Seasonality findings in Lagos state

S/N	Division	V(N)	Amplitude (%)	Edwards' Test (Peak Date)	Ratchet Circular Scan test	
					2 Month Peak	3 Month Peak
1	Badagry	0.036	18.6	June 1st	March-April	March-May
2	Eko	0.045	19.5	April 16th	March-April	March-May
3	Epe	0.074	30.9	June 23rd	March-April	March-May
4	Ikeja	0.029	12.5	July 7th	September-October	May-July
5	Ikorodu	0.084	42.9	May 28th	March-April	June-August
6	Lagos	0.040	19.1	June 1st	March-April	March-May

All the divisions except Ikeja had a 2 month peak in March-April, while Ikeja had its own 2 month peak in September-October. Similarly, all the five divisions except Ikeja and Ikorodu had a 3 month peak of March-May. Ikeja's 3 month peak is from May to July, while Ikorodu's 3 month peak is from June-August. The amplitude of birth seasonality in

Lagos from the aggregate data is 19.1% of peak frequency, with the peak date being June 1st. However, the amplitude for the five Lagos divisions varies from 12.5% to 42.9%. This agrees with the findings of Dorelein (2013) in which Nigeria was found to have peak amplitude of approximately 40 or above.

Furthermore, as seen from the Table 1 above, the Ikorodu division exhibits more seasonality as compared to the other 4 divisions in Lagos state. Ikorodu division has the highest V(N) number of 0.084 with the corresponding highest amplitude of 42.9%.

Fig. 2 to Fig. 7 shows the seasonal variation of Lagos state and the five divisions

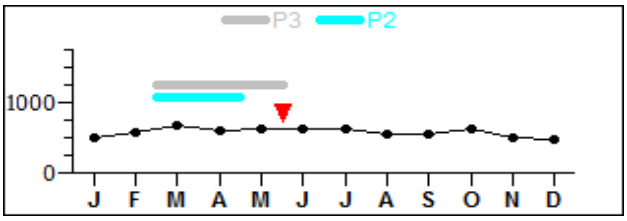

Fig:2 Plot of Seasonal Variation for Lagos

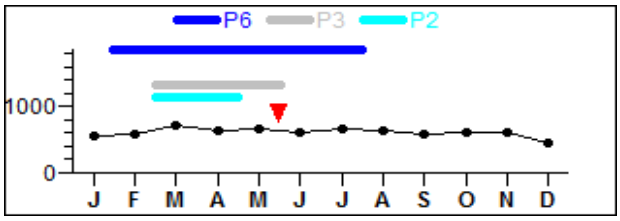

Fig:3 Plot of Seasonal Variation for Badagry

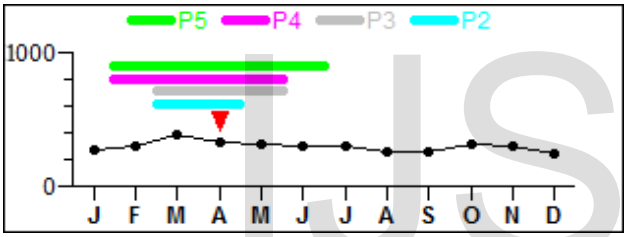

Fig: 4 Plot of Seasonal Variation for Eko

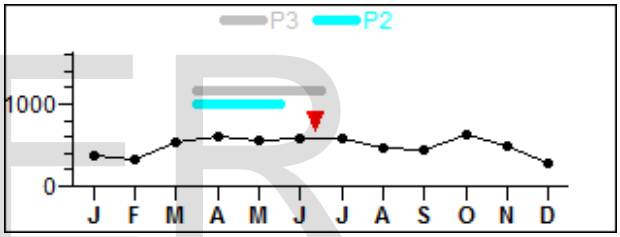

Fig: 5 Plot of Seasonal Variation for Epe

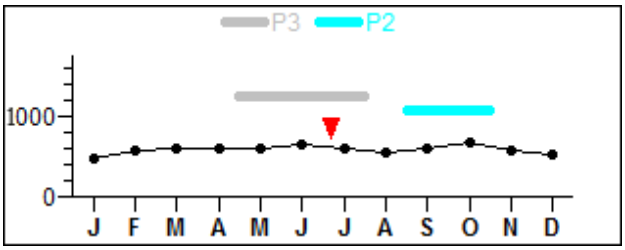

Fig: 6 Plot of Seasonal Variation for Ikeja

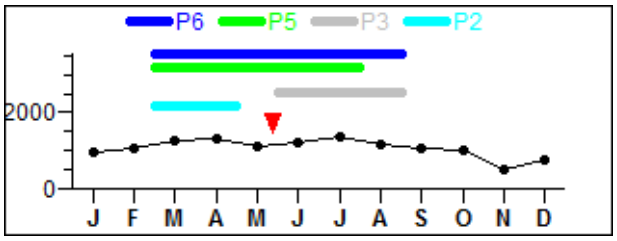

Fig: 7 Plot of Seasonal Variation for Ikorodu

Red marker in the plot denotes the peak of the 12 months sinusoidal curve.

Correlation of Birth Seasonality and Mean Temperature

The birth data that has been seasonally adjusted by a period of 12 was correlated with Mean Temperature.

Table 2: Correlation of Birth Seasonality and Temperature

		Temperature	Birth
Temperat	Correlation	1	-0.024

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ure	Sig. (2-tailed)		0.839
Birth	Correlation	-0.024	1
	Sig. (2-tailed)	0.839	

From Table 2 above, r = -0.024, which means that the correlation between temperature and birth seasonality is very weak or even negligence. This confirms that there is no significant relationship between temperature and birth seasonality in Lagos.

Correlation of Temperature and Conception

The birth data (2008-2013), seasonally adjusted by a period of 12 was correlated with Mean Temperature that was lagged by 9 months (April 2007).

Table 3: Correlation of Conception pattern and Temperature

		Conception	Temperature
Conception	Correlation	1	-0.237*
	Sig. (2-tailed)		0.045
Temperature	Correlation	-0.237*	1
	Sig. (2-tailed)	0.045	

* Correlation is significant at the 0.05 level (2-tailed).

Table 3 above showed r = -0.237 at P < 0.05, this implies that a strong increase in temperature will reduce conception by a small margin. This is consistent with the findings of Lam & Miron (1996).

CONCLUSION

The distribution of births by months exhibits a seasonal pattern in most populations. Indeed, the absence of birth seasonality in any particular population can be considered a remarkable observation. This study documented birth seasonality in Lagos state and investigated the effect of temperature on the birth seasonality pattern and conception pattern.

Furthermore, it was discovered that there is no significant relationship between the temperature and birth seasonality in Lagos. However, there appears to be a negatively weak significant relationship between temperature and conception pattern.

The birth record in Lagos state displayed strong seasonality effect at 99% confidence level. The V(N) for the various divisions in Lagos state varied from 0.029 to 0.088. The monthly birth distribution displayed a sinusoidal pattern with peak delivery rates in March—May and October and lowest rates in August and December. The months of March, April, May, and October had delivery rates that were significantly higher than the rest of the months. This pattern agreed with the pattern observed for Benin City [16].

However, there appears to be a significant relationship between temperature and conception pattern. This is in consonance with the findings of [18], [21], [23].

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