View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by AJOL - African Journals Online

Niger J Paed 2013; 40 (3): 264 –269

ORIGINAL

Onubogu CU
Ugochukwu EF

Inter-pregnancy interval and pregnancy outcomes among HIV positive mothers in Nnamdi Azikiwe University Teaching Hospital, Nnewi, South-East Nigeria

DOI:http://dx.doi.org/10.4314/njp.v40i3,12

Onubogu CU (✉)
Ugochukwu EF
Department of Paediatrics
Nnamdi Azikiwe University
Teaching Hospital
Nnewi, Nigeria
E-mail: luvilyamy@yahoo.co.uk

Abstract *Background:* Both short and long inter-pregnancy intervals have been associated with higher risk of adverse pregnancy outcomes. More so, short inter-pregnancy interval among HIV-positive women implies higher birth rate and subsequently a higher number of neonates exposed to HIV and potentially at risk of mother-to-child transmission.

Aims: To study the influence of inter-pregnancy interval on pregnancy outcomes among booked HIV-positive mothers with singleton live-births at Nauth, Nnewi.

Methods: A cross-sectional study was carried out with the aid of structured questionnaires, maternal clinical records and relevant anthropometry, between May and December 2011, among booked multiparous HIV-positive mother/singleton newborn pairs at NAUTH, Nnewi.

Results: More than half (56.5%) of the 175 multiparous HIV-positive women studied had short inter-pregnancy interval (<18 months). Short inter-pregnancy interval was significantly associated with adverse maternal and perinatal outcomes like maternal anaemia (X^2 =14.95, p=0.021) and low values of maternal or neonatal anthropometric parameters. However only adverse maternal outcomes and MAC/OFC ratio of the neonates remained significantly associated with short Inter-pregnancy interval after logistic regression analysis. Long inter-pregnancy interval was significantly associated with low values of neonatal anthropometric parameters and maternal MAC less than 25cm (X^2=15.10, p=0.019) as well as third trimester weight gain rate less than 250g/week (X^2 =31.20, p= 0.000). The proportion of mothers with long inter-pregnancy that had anaemia or intra-partum BMI less than 25kg/m^2 differed only slightly from that of those with inter-pregnancy interval of 18-59 months.

Conclusion: Inter-pregnancy interval of 18 to 59 months is significantly associated with the lowest risk of both adverse maternal and fetal outcomes among HIV-positive women.

Introduction

HIV/AIDS continues to kill women, infants and young children especially in Sub-Saharan Africa with exceptionally high burden of HIV/AIDS.[1] Young women remain disproportionately affected by HIV/AIDS and constitute 71% of 15-24 year olds living with HIV in Sub-Saharan Africa.[2] Above 90% of infections in children result from mother-to-child transmission (MTCT) and without any intervention, 30-45% of HIV-positive pregnant women transmit the virus to their infants during pregnancy, delivery or breastfeeding.[3]

MTCT rate has diminished to less than 2% in high income countries with effective implementation of anti-retroviral prophylaxis during pregnancy, caesarean section delivery and avoidance of breastfeeding.[4] On the contrary, MTCT rate is still very high in developing countries like Nigeria, where prevention of MTCT (PMTCT) coverage is still very limited and breastfeeding is essential for child survival. Only about 18% of HIV-positive pregnant women receive effective anti-retrovirals for PMTCT in Nigeria.[5,6] Nigeria's MTCT rate is 33% with 75,000 new paediatric infections attributed to MTCT in 2010, and the country currently has the highest burden of MTCT as well as maternal deaths attributed to HIV/AIDS globally.[2,5]

Both long and short inter-pregnancy intervals have been associated with increased risk of poor perinatal and maternal outcomes among the general population of women.[8-15] Women who become pregnant within 18-59 months after a preceeding delivery are least likely to have adverse pregnancy outcomes.[8-15] Shorter inter-pregnancy interval has been associated with low birth weight, premature delivery, intrauterine fetal death, as well as higher risk of under-five mortality.[9-11] Poor maternal outcomes like puerperal endometritis, ante-partum haemorrhage, anaemia, poor nutritional status and maternal death have also been associated with short inter-pregnancy interval.[8,9,11,14,16] Likewise, inter-pregnancy interval above 59 months has been associated with higher rates of gestational diabetes and hypertensive disorders in pregnancy as well as adverse fetal outcomes.[8,9]

Addressing inter-pregnancy interval among HIV-positive mothers is essential to achieving the "Global Plan" of eliminating MTCT and improving maternal health by year 2015 in view of the limited PMTCT coverage in developing countries and benefits of optimal pregnancy spacing on maternal health.[2,5] Adequate pregnancy spacing imply lower fertility rate and ensures better pregnancy outcomes.[7-15] This can be achieved by correct and consistent use of effective contraception, which by extension, reduces the number of babies exposed to HIV or potentially at risk of MTCT when applied to populations of HIV-positive women.[7] Unfortunately, this is often neglected in PMTCT programmes.[7] The need for contraception is even higher among non-breastfeeding HIV-positive mothers as ovulation may return as early as six weeks post-partum putting them at risk of another pregnancy shortly after delivery.[7,17]

The current study was set out to examine the inter-pregnancy intervals of HIV-positive mothers as well as the relationship between inter-pregnancy interval and some pregnancy outcomes like low values of maternal or neonatal anthropometric parameters, low maternal CD_4 count, maternal anaemia and occurence of pregnancy complications like hypertensive disorders, antepartum haemorrhage, premature rupture of membranes and diabetes mellitus.

Methods

A cross-sectional questionnaire-based study was conducted to determine the effect of inter-pregnancy interval on some pregnancy outcomes among booked HIV-positive mother/singleton newborn baby pairs at Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Anambra state, South-Eastern Nigeria. NAUTH is a tertiary hospital that serves as the major obstetric referal centre for Anambra state and environs. The centre offers PMTCT services which is supported by the U.S. Presidential Emergency Programme for AIDS Relief (PEPFAR) through the auspices of the Institute of Human Virology, Nigeria (IHVN).

Approval for the study was obtained from the NAUTH Ethics Committee and written informed consent was obtained from all participating mothers. Subjects were booked, multiparous, HIV-positive mothers that had singleton live births at NAUTH, Nnewi together with their newborn infants. Those whose preceeding pregnancy ended in an abortion were excluded.

The mothers were interviewed with a pre-tested, interviewer-administered, semi-structured questionnaire to obtain relevant socio-demographic and obstetric information. A cross-check was made with the mothers' antenatal clinic record after data collection for further validation of the data. Mothers' gestational age (GA) and weight at booking were obtained from their ante-natal records. Mothers' variables were age, educational status, occupation, last menstrual period (LMP), date of last confinement, parity, GA at delivery and pregnancy complications like ante-partum haemorrhage, hypertensive disorders, pre-term premature rupture of membranes and gestational diabetes mellitus. The inter-pregnancy interval in months was obtained by subtracting the date of previous confinement from LMP before the index pregnancy.[8-10] Third trimester weight gain and duration of the weight gain was obtained by subtracting the first documented third trimester weight and the GA at which it was taken from the intra-partum weight and GA at delivery, respectively. The rate of third trimester weight gain in grammes(g) per week was calculated by dividing weight gained during third trimester by the duration of the weight gain.[18] The socio-economic status of the family was assessed based on the highest educational attainment and the occupation of both parents as described by Oyedeji.[19] Mothers' weight, height and mid-arm circumference (MAC) were measured using standard methods.[20] The maternal health indicators were Body Mass Index (BMI), MAC, third trimester weight gain rate, CD_4 count, intra-partum packed cell volume(PCV) and pregnancy complications like ante-partum haemorrhage, hypertensive disorders, diabetes mellitus and premature rupture of membranes.

For every neonate, GA assessment was carried out within 24 hours of birth using the Dubowitz GA assessment chart. This was cross-checked with GA calculated from mother's LMP for further validation. Where discrepancy of more than two weeks occured, the Dubowitz score was used.[18]

Anthropometric assessment of the newborn infants was conducted as soon as possible within 24 hours of birth using standard methods.[20,21] The infants were weighed naked using an infant weighing scale (SALTER MODEL 180) which was checked daily for zero adjustment. Three measurements were obtained and the mean recorded to the nearest 0.05kg.[21] The length was measured with the infant placed in a supine position on an infantometer. An assistant, while gently cupping both ears, held the infant's head snugly touching the fixed head-piece so that the inner and outer canthi of the eyes were in the vertical plane. Using the left hand, the researcher gently pressed the knees firmly against the

board and with the right hand, apposed the movable foot-piece against the infant's heel which was kept perpendicular to the board. Three measurements were obtained and recorded to the nearest 0.1cm. Occipito-frontal circumference (OFC) and MAC were measured with a flexible inelastic tape. For OFC, the tape was applied over the glabella, passed around the head at the same level on each side and over the occipital prominence, then pulled firmly to compress the hair. Three measurements were obtained and the mean recorded to the nearest 0.1cm. The MAC was measured at a level that was mid-way between the tip of acromion and olecranon on the left arm, with the elbow flexed to a right angle. The tape was wrapped snugly around the arm without compressing the underlying tissue. Three measurements were obtained and the mean recorded to the nearest 0.1cm. The anthropometric parameters of the neonates were birth weight, weight-for-GA, MAC/OFC ratio and ponderal index. Ponderal index was calculated using the formula : 100 x birth weight (in grammes) divided by cube of birth length (cm^3).

Data analysis was done with statistical package for social sciences (SPSS) software, version 17. Multinomial logistic regression analysis was used to determine the Odds Ratio (OR) of adverse pregnancy outcomes significantly associated with inter-pregnancy interval in Chi-square test. Probability (p) value of less than 0.05 was considered statistically significant.

Results

Out of a total of 777 mothers that had live births during the study period, 240 were HIV-positive. Among the HIV-positive mothers, 197 were multiparous. Twenty-two out of 197 mothers were excluded on account of multiple births, incomplete ante-natal records, history of abortion in preceeding pregnancy and refusal to give informed consent. Thus final analyses was done with data obtained from 175 multiparous HIV-positive mother/singleton newborn baby pairs.

Some socio-demographic characteristics and obstetric parameters of the mothers are shown in Table 1. The mothers were predominantly from low and middle social classes. All of them were christians, aged 18 years or more and had at least primary school education. They were predominantly married women (94.3%). Inter-pregnancy interval ranged from three to 132 months with a mean of 21.51 $\pm$ 18.45 (n=167) months. Inter-pregnancy interval in 8 extreme cases (outliers) were deselected while calculating the mean and standard deviation as they exerted undue leverage upon the initially obtained values which did not give a true representation of the mean inter-pregnancy interval for the studied population. Inter-pregnancy intervals of 18-59 months occured in 32.6% of cases.

Table 2 shows the relationship between inter-pregnancy interval and some neonatal indices. Inter-pregnancy intervals of 12 months or less and above 59 months were anthropometric parameters assessed in the neonates. There was no significant difference between the anthropometric parameters of neonates whose mothers had inter-pregnancy interval of 13 to 17 months and those whose mothers had inter-pregnancy interval of 18 to 59 months. No pre-term delivery occured in mothers with inter-pregnancy intervals of 18–59 months compared to the other inter-pregnancy intervals. There was, however, no significant association between GA at delivery and inter-pregnancy interval.

Table 1: Socio-demographic and obstetric characteristics of the mothers

Maternal Characteristics	Number (total=175)	Percentage
Inter-pregnancy interval (months)		
≤ 6	29	16.6
7 – 12	36	20.5
13 – 17	34	19.4
18 – 59	57	32.6
> 59	19	10.9
Social-Class		
High	15	8.6
Middle	73	41.7
Low	87	49.7
Educational status		
Tertiary	33	18.9
Secondary	73	41.7
Primary	69	39.4
No formal education	0	0.0
Marital status		
Married	165	94.3
Single	0	0.0
Widowed	10	5.7
Divorced	0	0.0
Age (years)		
<18	0	0.0
18-35	141	80.6
>35	34	19.4
Parity		
Multiparous [>1]	135	77.1
Grandmultiparous [≥5]	40	22.9

High social class = Socio-economic classes I and II
Middle social class = Socio-economic class III
Low social class = Socio-economic class IV and V

Table 3 shows the relationship between inter-pregnancy interval and some maternal health indicators. Inter-pregnancy intervals of 12 months or less was significantly associated with the highest risk of low intra-partum BMI or MAC, 3rd trimester weight gain less than 250g per week and maternal anaemia while intervals of 18-59 months was associated with the lowest risk. Surprisingly, inter-pregnancy intervals of 12 months or less was associated with the lowest risk of maternal CD_4 count less than 250cells/mm^3 although the association was not statistically significant. Though inter-pregnancy interval of 18-59 months had the least risk of pregnancy complications like hypertensive disorders, ante-partum haemorrhage, diabetes mellitus and premature rupture of membranes, the association was not statistically significant.

Table 2 : Relationship between inter-pregnancy interval and neonatal indices

Characteristic	Inter-pregnancy interval (months) ≤12	13-17	18-59	>59	Total (%)	X^2	P-value
Birth weight							
<2.5kg	17(26.2)	4(11.8)	4(7.0)	6(31.6)	31(17.7)		
2.5-3.9kg	48(73.8)	30(88.2)	47(82.5)	9(47.4)	134(76.6)	27.86	0.000
≥4kg	0(0.0)	0(0.0)	6(10.5)	4(21.0)	10(5.7)		
Weight-for-GA							
SGA	16(24.6)	2(5.9)	3(5.3)	4(21.1)	25(14.3)		
AGA	47(72.3)	32((94.1)	40(70.2)	10(52.6)	129(73.7)	32.70	0.000
LGA	2(3.1)	0(0.0)	14((24.5	5(26.3)	21(12.0)		
Ponderal Index							
<2.32	16(24.6)	3(8.8)	7(12.3)	5(26.3)	31(17.7)		
2.32-2.85	47(72.3)	31(91.2)	40(72.0)	8(42.1)	126(72.0)	25.69	0.000
>2.85	2(3.1)	0(0.0)	10(17.5)	6(31.6)	18(10.3)		
MAC/OFC ratio							
< 0.27	26(40%)	5(14.7)	9(15.8)	4(21.1)	44(25.1)	13.29	0.004
≥ 0.27	39(60%)	29(85.3)	48(84.2)	15(78.9)	131(74.9)		
GA at birth (weeks)							
<37	4(6.2)	2(5.9)	0(0.0)	2(10.5)	8(4.6)	4.78	0.188
≥37	61(93.8)	32(94.1)	57(100)	17(89.5)	167(95.4)		
Total (%)	65(37.1)	34(19.4)	57(32.6)	19(10.9)	175(100.0)		

SGA=small for gestational age, AGA=adequate for gestational age
LGA=large for gestatioal age, GA=gestational age
MAC= mid-arm circumference, OFC=occipito-frontal circumference

Table 3: Effect of inter-pregnancy interval on maternal health

Characteristic	Inter-pregnancy interval(months) ≤12	13-17	18-59	>59	Total (%)	X^2	p-value
Intrapartum BMI (kg/m^2)							
<18.5	0(0.0)	0(0.0	0(0.0)	0(0.0)	0(0.0)		
18.5-24.9	21(32.3)	6(17.6)	6(10.5)	2(10.5)	35(20.0)	20.07	0.003
25-29.9	33(50.8)	19(55.9)	24(42.1)	8(42.1)	84(48.0)		
≥30	11(16.9)	9(26.5)	27(47.4)	9(47.4)	56(32.0)		
MAC(cm)							
<25	22(33.9)	7(20.6)	5(8.8)	4(21.1)	38(21.7)		
25-30	29(44.6)	18(52.9)	32(56.1)	6(13.6)	85(48.6)	15.10	0.019
>30	14(21.5)	9(26.5)	20(35.1)	9(47.3)	52(29.7)		
3rd trimester weight gain							
<250g/wk	32(49.2)	9(26.5)	5(8.8)	5(26.3)	51(29.1)		
250-500g/wk	27(41.5)	25(73.5)	42(73.7)	13(68.4)	107(61.1)		
>500g/wk	6(9.2)	0(0.0)	10(17.5)	1(5.3)	17(9.7)	31.20	0.000
Intrapartum PCV(%)							
<30	22(33.8)	6(17.6)	7(12.3)	3(15.8)	38(21.7)		
30-32	26(40.0)	19(55.9)	24(42.1)	6(31.6)	75(42.9)	14.95	0.021
≥33	17(26.2)	9(26.5)	26(45.6)	10(52.6)	62(35.4)		
CD_4count							
<250	4(6.1)	4(11.8)	5(8.8)	2(10.5)	15(8.6)		
250-500	23(35.4)	16(47.1)	26(45.6)	9(47.4)	74(42.3)	4.03	0.671
>500	38(58.5)	14(41.1)	26(45.6)	8(42.1)	86(49.1)		
Pregnancy Complications							
Yes	9(13.8)	4(11.8)	4(7.0)	3(15.8)	20(11.4)		
No	56(86.2)	30(88.2)	53(93.0)	16(84.2)	150(85.7)	1.83	0.608
Total (%)	65(37.1)	34(19.4)	57(32.6)	19(10.9)	175(100.0)		

The result of logistic regression analysis for adverse pregnancy outcomes significantly associated with inter-pregnancy interval in chi-square test is shown in Table 4. The associations that remained statistically significant after logistic regression analysis were maternal anaemia and low anthropometric parameters as well as MAC/OFC ratio of the neonates.

Table 4 : Result of logistic regression analysis for adverse pregnancy outcomes significantly associated with inter-pregnancy

Characteristic	Inter-pregnancy Interval (months)							
	≤12		13-17		18-59		>60	
	OR	95% C1	OR	95% CI	OR	95% CI	OR	95% CI
Intra-partum PCV < 30%	3.35*	0.69-16.23	1.51*	0.22-9.98	0.54	0.09-3.07	+	+
MAC< 25cm	4.26*	0.96-18.99	1.56*	0.27-8.81	0.48	0.09-2.59	+	+
Intrapartum BMI< 25kg/m^2	10.42*	1.53-70.89	2.86*	0.34-23.97	0.78	0.11-5.71	+	+
Third trimester weight gain < 250g/ week	1.59*	0.12-14.46	3.74*	0.58-1.49	0.12	0.01-1.50	+	+
Low Ponderal index	0.63	0.16-2.50	0.06	0.01-0.68	0.31	0.07-1.36	+	+
Low MAC/OFC	4.47*	1.05-19.07	1.00	0.18-5.63	1.0	0.24-5.42	+	+
SGA	0.85	0.23-3.09	0.16	0.25-0.98	0.19	0.36-0.98	+	+
LBW	0.77	0.25-2.39	0.29	0.07-1.20	0.16	0.04-0.66	+	+

+=data insufficient for analysis, *=Statistically significant, OR=Odds ratio,
CI=Confidence interval, LBW= Low birth weight,
SGA=Small for gestational age, MAC=Mid-arm circumference,
OFC= Occipito-frontal circumference, BMI=Body mass Index

Discussion

The high prevalence of HIV infection (30.9%) found among parturients at NAUTH, Nnewi may be explained by the fact that NAUTH is the only obstetrics tertiary referal centre in Anambra state and has the largest PMTCT programme in the state. NAUTH as a centre for PMTCT caters for a considerable number of HIV-positive clients. Similar prevalence of 29.6% was documented in the same centre by a study conducted about 1 year prior to the index study.[22]

Findings of the index study suggest a high rate of short inter-pregnancy intervals among HIV-positive women that enrolled for PMTCT at NAUTH, Nnewi as 56.5% of them had inter-pregnancy intervals less than 18 months. The study, however, was not adequately powered to draw conclusions due to lack of comparison with HIV negative controls.

The obvious benefits of inter-pregnancy interval of 18-59 months in preventing some adverse maternal and perinatal outcomes, found in the index study, is consistent with the report of some studies conducted in both developing and developed countries.[6-14] Most of these studies have shown that both short and long inter-pregnancy intervals are associated with adverse maternal and perinatal outcomes in all women irrespective of their HIV-status. Some authors sugested a "J" shaped relationship between inter-pregnancy interval and pregnancy outcomes with optimal outcome associated with an inter-pregnancy interval between 18-23 months after adequately adjusting for confounders.[9,14] However, some authors have argued that short or long inter-pregnancy interval merely depicts women already at higher reproductive risks due to young age, high parity, unfavourable outcome of preceeding pregnancy, underlying medical disorders, poor socio-economic status, poor antenatal care or life-style factors.[9-11,14,16]

The effect of short inter-pregnancy interval on birth weight is believed to result from inadequate time for replenishment of maternal nutrient stores as well as recovery from the physiologic stress of pregnancy and lactation among women with close succession of pregnancies[12-14] Some hypothesis have been proposed to explain the relationship between long inter-pregnancy interval and adverse pregnancy outcomes. These include a gradual post-partum regression of a woman's reproductive capacity to become similar to that of a primigravidae.[9,16] Another possible explanation is that long interpregnancy interval may be secondary to factors like chronic maternal diseases and genital tract infection which are risk factors for both secondary infertility and adverse perinatal outcomes.[9,16]

The lack of significant association between short inter-pregnancy interval and neonatal anthropometric parameters like low birth weight, low ponderal index and weight-for-gestational age, after logistic regression analysis, suggests that short inter-pregnancy interval may interact with other factors in causing low values of these parameters. This may be explained by the fact that the fetus is an "obligate parasite" and may thrive on limited maternal nutrient stores.[23] However the significant relationship between short inter-pregnancy interval and MAC/OFC ratio suggests a late gestational weight loss in neonates whose mothes had inter-pregnancy interval of 12 months or less.[24] Low MAC/ OFC ratio has been associated with adverse perinatal outcomes among neonates.[24]

The effects of inter-pregnancy interval on both maternal and neonatal health, found in this study, should provide a strong motivating force for PMTCT programmes and

reproductive clinicians to address pregnancy spacing among HIV-positive women of child bearing age. All HIV-positive young women should be educated on the health and nutritional benefits of avoiding another pregnancy less than 18 months or above 59 months after child birth. PMTCT programmes should re-examine the extent of access to birth spacing services and ensure consistent and correct use of effective contraceptives by families who wish to achieve optimal pregnancy spacing. This will not only improve maternal health and child survival but will reduce the number of babies exposed to HIV and thus at risk of MTCT.

Conclusion

Inter-pregnancy interval of 18 to 59 months is significantly associated with the lowest risk of both adverse maternal and fetal outcomes among HIV-positive women.

References

1. The state of the world's children 2012. New York: UNICEF; 2012 (accessed 2012 Dec. 10). Available from: http://www.unicef.org/sowc2012.
2. WHO/UNAIDS/UNICEF. Global HIV/AIDS response: epidemic update and health sector progress towards universal access : progress report 2011. WHO; Geneva: 2011 (accessed 2012 Nov.16). Available from:http://whqlibdoc.who.int./publications/2011/978924502986_eng.pdf.
3. De Cock KM, Fowler MG, Mercier E, De Vincenzi I, Saba J, Hoff E, et al. Prevention of mother-to-child transmissions in resource poor countries: translating research into policy and practice. *JAMA 2000; 283: 1175-82.*
4. AIDSinfo. Panel on treatment of HIV-infected pregnant women and prevention of perinatal transmission : recommendations for use of anti-retroviral drugs in pregnant HIV-infected women for maternal health and interventions to reduce perinatal HIV transmission in the United States. Updated 2012 July 31 (accessed 2013 Jan. 20). Available from http://aidsinfo.nih.gov/guidelines
5. UNAIDS. Together we will end AIDS 2012. UNAIDS; Geneva: 2012 (accessed 2012 Nov. 7) . Available from: www.unaids.org/---/unaids/---/2012/20120718_togetherwewillendaids_en.pdf.
6. NACA/UNAIDS. United Nations General Assembly Special Session (UNGASS) Country Progress Report: Nigeria. Abuja : NACA; 2010.
7. USAID. Strengthening family planning policies and programmes in developing countries: an advocacy toolkit 2005. USAID; Washington DC: 2005.
8. WHO. Report of a WHO Technical Consultation on birth spacing, Geneva, Switzerland 2005 June 13-15. Geneva: WHO; 2007.
9. Zhu BP. Effect of inter-pregnancy interval on birth outcomes: findings from 3 recent US studies. *Int J Gynecol Obstet 2005; 89: S25 -33.*
10. Rutstein SO. Effects of preceeding birth intervals on neonatal, infant and under-five mortality and nutritional status in developing countries: evidence from demographic and health surveys. *Int J Gynecol Obstet 2005; 89: S7-24*
11. Norton M. New evidence on birth spacing: promising findings from for improving newborn, infant, child and maternal health. *Int J Gynecol Obstet 2005; 89: S1-S6.*
12. Adam I, Ismail MH, Nasr AM, Prins MH, Smits LM. Low birth weight, pre-term birth and short inter-pregnancy interval in Sudan. *J Matern Fetal Neonatal Med 2009; 22 (11): 1068-71.*
13. Zilberman B. Influence of short inter-pregnancy interval on pregnancy outcome. *Harefuah 2007; 146: 42-7.*
14. Zhu BP, Haines KM, Le T, McGrath-Miller K, Boulton MC. Effect of interval between pregnancy on perinatal outcomes among white and black women. *Am J Obstet Gynecol 2001; 185: 1403-10.*
15. UNICEF/WHO/UNESCO/UNFPA/UNAIDS/UNDP/WORLD BANK. Facts For Life 2002. New York: UNICEF; 2002.
16. Conde-Agudelo A, Rosas-Bermudez A, Kafury-Goeta AC. Birth spacing and risk of adverse perinatal outcome: a meta analysis. *JAMA 2006; 295 (15): 1809-23.*
17. Jackson E, Glasier A. Return of ovulation and menses in post-partum non-lactating mothers: a systematic review. *Obstet Gynecol 2001; 117 (3): 657-62.*
18. Adebami OJ, Owa JA, Oyedeji GA, Oyelami OA, Omoniyi-Esan GO. Association between placental and cord blood malaria infection and fetal malnutrition and fetal malnutrtion in an area of malaria holoendemicity. *Am J Trop Med Hyg 2007; 77 (2): 209-13.*
19. Oyedeji GA.Socioeconomic and cultural background of hospitalized children in Ilesa, Nigeria. *Nig J Paediatr 1985; 12:111-7.*
20. Bruce Cogill. Anthropometric indicators measurement guide. Food and Nutrition Technical Assistance (FANTA) project, Academy for Educational Development. Washingon, DC: FANTA Project; 2003.
21. Otaigbe BE, Alikor EAD, Nkanginieme KEO. Growth pattern of exclusively breastfed infants in the first 6 months of life: a study of babies delivered at the University of Port Harcourt Teaching Hospital, Rivers state, Nigeria. *Niger J Med 2008; 17(3): 317-23.*
22. Ezebialu IU, Ekeh AC, Ezeagwuna DA, Nwachukwu CE, Ifediata F, Ezebialu CU. Prevalence, pattern and determinants of malaria in a population of South-Eastern Nigerian parturients. *Int J Infect Dis 2012; 16:* e860-(accessed 2013 Jan. 20). Available from www.elsevier.com/locate/ijid
23. WHO. Physical status: the use and interpretation of anthropometry. Technical Report Series 854. Geneva: WHO; 1995.
24. Georgieff SR, Sasanow UM, Chockalinge AM, Pereira GR. A comparison of the mid-arm circumference ratio and ponderal index for the evaluation of newborn infants after abnormal intrauterine growth. *Acta Paediatr Scand 1988; 77: 214-9.*