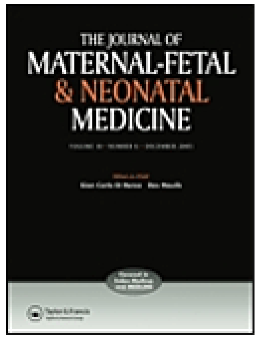

Effects of birth spacing on adverse childhood health outcomes: Evidence from 34 countries in Sub-Saharan Africa

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Keywords:	Interpregnancy interval, neonatal mortality, birth spacing, global health, Sub-Saharan Africa

Effects of birth spacing on adverse childhood health outcomes: Evidence from 34 countries in Sub-Saharan Africa

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Abstract

Background: Interpregnancy intervals (IPI) are independently associated with maternal, perinatal, infant and child outcomes. Birth spacing is a recommended tool to reduce adverse health outcomes especially among children. This study aims to determine the prevalence of adverse child health outcomes in Sub-Saharan Africa (SSA) countries and to examine the association between the length of preceding birth interval child health outcomes.

Methods: Secondary data from Demographic and Health Survey (DHS) in 34 SSA countries with 299,065 births was used in this study. The outcome variables were infant mortality, low birth weight, stunting, underweight, wasting, overweight and anemia. Percentage was used in univariate analysis. Cox proportional hazard regression was used to examine association between the adjusted model of preceding birth interval and infant mortality. Multinomial and binary logistic regression models were used to examine the association between under-five children adverse health outcomes and interpregnancy birth interval.

Results: Infant mortality was lowest in Gambia (3.4%) and highest in Sierra Leone (9.3%). Comoros (16.8%) accounted for the highest percentage of low birth weight (<2.5kg). Child stunting was as high as 54.6% in Burundi. IPIs of <24 months, 24-36 months, 37-59 months and ≥60 months accounted for 19.3%, 37.8%, 29.5% and 13.4% respectively. Median IPI was 34 months. Results from Cox proportional hazard regression showed that children with preceding birth interval <24 months had 57% higher risk of infant mortality, compared to children with IPI of 24-36 month (HR= 1.57; 95%CI: 1.45, 1.69). However, there were 19% and 10% reduction in the risk of infant mortality at IPIs of 37-59 months and ≥60 months, compared to 24-36 months IPI (37-59 months: HR= 0.81; 95%CI: 0.75, 0.87; ≥60 months: HR= 0.90; 95%CI: 0.81, 0.99).

Conclusion: The findings of this study suggest the need for urgent intervention to promote the recommended interpregnancy interval of 24–36 months to reduce adverse child health outcomes. These data also bring into limelight the importance

of exclusive breastfeeding to enhance proper nutritional approach and to prolong lactational amenorrhea. Health care system stakeholders would find this study interesting as a base for policy formulation and implementation.

Keywords: Interpregnancy interval, neonatal mortality, low birth weight, Anemia, birth spacing, global health, Sub-Saharan Africa

Introduction

The time interval between a delivery and the next pregnancy signifies a modifiable feature of the prenatal care. Conjointly, long and short birth intervals are connected to adverse perinatal and maternal health outcomes [1]. The length of interpregnancy interval (IPI) depends on several factors, which vary based on pregnancy intention. World Health Organization (WHO) recommends 24-36 months between pregnancies to reduce foetal, child and maternal morbidity and mortality [2] [3,4]. Also, there are numerous and complex range of factors associated with IPIs [5], while some are rooted in the reproductive behaviours and histories of women, others are influenced by cultural and social norms determining the utilization of sexual and reproductive health services [7,6].

Women may lack the physiological recovery from a preceding birth if she has the next pregnancy almost immediately, resulting to adverse child and maternal outcomes; while too many children closely spaced puts resource pressures on families leading to poor survival rate and morbidity [12]. Generally, the time between index and previous births has remarkable impact on child and maternal health outcomes. Inappropriate birth spacing has large risk of preterm birth, perinatal, neonatal, infant mortality [8,9] and morbidity such as low birth weight [10,11] and childhood anemia [17]. As a major public health issue, anemia increases susceptibility to infections, compromises the psychomotor development and raise maternal and child morbidity and mortality.

In spite several studies that have been conducted on IPIs and maternal and child outcomes in individual SSA countries, the findings have been inconclusive and inconsistent findings. To address the knowledge gaps about outcomes of IPIs, this study utilized DHS regional data from several SSA countries. We targeted short and long IPIs as those intervals have usually been associated with adverse child and maternal health outcomes [12,21]. Notwithstanding, there is paucity of studies investigating the optimum IPIs and related outcomes. The objective of our study is to estimate the effects of the duration of the preceding IPI on child and maternal outcomes in SSA region.

Materials and methods

Data source

This study used DHS data from birth histories in thirty-four Sub-Saharan Africa countries. Data of children born in the five years prior to the interview was used. The data is in public domain and was accessed at; http://dhsprogram.com/data/available-datasets.cfm. DHS were based on nationally representative sample using a stratified multistage cluster sampling technique. Data from the birth history have been recoded into separate records for individual children listed by the mothers with data on date of birth, sex of the child, whether child is alive, age at death (if dead), and so forth. Thirty-four (34) countries in sub-Saharan Africa region were included based on availability of current data collected between 2008 and 2017. Madagascar, Congo, Democratic Republic of Congo, Gabon, Angola, Tanzania, Burundi, Ethiopia, Mozambique, Kenya, Malawi, Rwanda, Comoros, Zambia, Uganda, Swaziland, Lesotho, Zimbabwe, Namibia. Sao Tome & Principe, Nigeria, Guinea, Togo, Gambia, Niger, Benin, Cameroon, Sierra Leone, Chad, Liberia, Ghana, Cote d'Ivoire, Burkina-Faso, Mali, and Senegal were included in the study. Details of DHS data collection procedure has been reported previously [22].

Measurement

Outcome variable

Anemia: In measuring hemoglobin levels, the blood of the children was obtained through a finger or heel prick and tested for hemoglobin level. The blood obtained was collected in a micro-cuvette. A battery operated portable Hemacue analyzer was used to measure hemoglobin concentration [22]. Based on the results, anemia was classified into three degree according to WHO; mild, moderate and severe. Hb cut-off values of anemia for children below 5 years were 10.0-10.9 g/dl (mild), 9.0-9.9 g/dl (moderate) and < 9.0 g/dl (severe).

Low birth weight: This was categorized as underweight (<2.5kg) and normal (≥2.5kg) [23].

Infant mortality: The death of a child aged 0 to 12 months was used for estimating infant mortality for all births in the 5 years preceding data collection. The time to death was measured in months and children who lived beyond 12 months were censored at that time for the purpose of survival analysis.

Nutritional status: This was categorized as children who are stunted, underweight, wasted and overweight. DHS surveys routinely collect the height and weight of children under age 5 years. Together with the child's age, this information was used to assess the nutritional status of children when compared to a reference standard using standard deviation values (z-scores). The DHS data are compared to the NCHS/CDC/WHO international reference standards for height for age, weight for age, and weight for height. Children whose z-scores are less than two standard deviations below the mean (-2 S.D.) on the reference standard are considered moderately or severely undernourished. Chronic under-nutrition or stunting is determined by a height-for-age z-score below two standard deviations below the mean. Acute under-nutrition or wasting is measured by a z-score less than -2 S.D. for weight for height, and overall under-nutrition or underweight, is measured by a z-score less than 2 S.D. for weight for age [24].

Explanatory variables

Preceding birth interval: The key independent variable is the length of the preceding birth interval measured as the number of months between the birth of the child under study (index child) and the immediately preceding birth to the mother; categorized as <24, 24-36, 37-59, ≥60.

Maternal and household factors: Mother's age (years): <25, 25-34, ≥35. Mother's educational level: No education, primary, secondary, higher. Marital status: single vs married. Number of children ever born: 1-2, 3-4, ≥5. Number of antenatal care visits: <4 vs ≥4. The place of residence: urban vs rural. Contraceptive use: yes vs no. Body mass index: underweight (<18.5kg/h^2), normal (18.5-24.9 kg/h^2), overweight (25.0-29.9 kg/h^2) and obese (≥30 kg/h^2).

Wealth index: For the computation of wealth index, principal components analysis (PCA) was used to assign the wealth indicator weights. This procedure assigned scores and standardized the wealth indicator variables such as; floor type, wall, roof, water source, sanitation facilities, radio, electricity, television, refrigerator, cooking fuel, furniture, number of persons per room. Thereafter, the factor coefficient scores (factor loadings) and z-scores were calculated. Finally, for each household, the indicator values were multiplied by the loadings and summed to produce the household's wealth index value. The standardized z-score was used to disentangle the overall assigned scores to poor (poorest + poorer), middle and rich (richer + richest) categories [25].

Ethical clearance

This study used publicly available data from DHS. Informed consent was obtained from participants prior to the survey. DHS Program is consistent with the standards for ensuring the protection of respondents' privacy. ICF International ensures that the survey complies with the U.S. Department of Health and Human Services regulations for the respect of the right of human subjects. No further approval was required for this study since the data is secondary and available in the public domain. More details about data and ethical standards are available at: http://goo.gl/ny8T6X.

Multicollinearity testing

A correlation value of 0.6 was used to examine interdependence of explanatory variables [26]. The correlation matrix values were below the cut-off; confirming lack of multicollinearity to raise concerns of removing interdependent variable from the model. Therefore, all covariates were added in the model based on multicollinearity testing.

Data analysis plan

Data was analysed using STATA version 14 (STATACorp, College Station, TX). [30] The Survey ('Svy') command was used to adjust for clustering (enumeration areas) and sampling weights. The prevalence of child health outcomes was calculated and presented as percentage. The association between the focal predictor and infant mortality was analyzed used Cox hazard regression while adjusting for other covariates. Univariate and multivariate binary and multinomial logistic regression analysis was performed for child nutritional factors including anemia. P<0.05 was used at significance level.

Results

Data for this study was collected 2008-2017 across thirty-four (34) countries. Infant mortality was lowest in Gambia (3.4%) and highest in Sierra Leone (9.3%). Gabon (15.4%), Mali (15.7%), Comoros (16.8%) accounted for the highest percentage of low birth weight (<2.5kg). Child stunting was as high as 41.9% in Niger, Chad had 42.9%, Benin reported 44.0%, 48.4% in Madagascar and Burundi had 54.6% respectively. Child underweight was highest in Mali (25.2%), Nigeria (26.9%), Burundi (28.9%), Chad (32.5%) and Niger (35.5%) respectively. Wasting was highest in Burkina-Faso (14.6%), Nigeria (14.8%) and Niger (15.6%) respectively. Burkina-Faso, Nigeria and Niger were the leading countries of child overweight. Approximately one-third of births in majority of Sub-Saharan Africa countries had mild or moderate anemia. See Table 1 for details.

[Insert Table 1 about here].

Mothers characteristics across interpregnancy intervals

Results showed that 299,065 births were extracted in the study. IPIs of <24 months, 24-36 months, 37-59 months and ≥60 months accounted for 19.3%, 37.8%, 29.5% and 13.4% respectively. Median IPI was 34 months. Women aged <25 years accounted for 27.4%

short IPIs, but women aged ≥35 years had 20.8% of long IPIs which outscored other maternal age categories. Further, mothers with no maternal education had the highest percentage of short IPIs, while those with higher educational level had increased percentage of long (≥60 months) IPIs. Single mothers have higher report of long IPIs (≥ 60 months); while multiparous women accounted for 21% of short IPIs. Rural mothers reported more short IPIs, in contrast to their urban counterpart with higher percentage of mothers who reported long IPIs. Poor, unemployed or non-users of contraceptive methods accounted for 20.7%, 21.2% and 20.2% respectively of short IPIs. However, the converse was true for the rich, employed and users of contraceptive methods. While women having inadequate antenatal care visit reported 18.3% of short IPIs, however, mothers with adequate antenatal care visits had 18.8% of long IPIs, higher than their counterpart. Underweight mothers reported 21.4%, higher than normal (19.5%), overweight (18.5%) and obese (16.2%) women. Nonetheless, the obese women accounted for the highest (24.7%) long (≥ 60 months) IPIs among the other women. See Table 2 for details.

[Insert Table 2 about here].

Adverse pregnancy outcomes by interpregnancy intervals

From the results, the prevalence of infant mortality decreased as IPIs increased as infant mortality was 9.3% in short IPIs (<24 months) and 4.2% in long IPIs (≥60 months). Further, both long and short IPIs accounted for approximately 10% of low birth weight each. There was a decreasing trend in children stunting across IPIs; stunted growth among children was 42.5% in short IPIs, while long IPIs accounted for 27.0%. Births <24 months showed more underweight (24.7%) and wasting (9.0%), compared to long IPIs (13.2% and 7.1% respectively). The prevalence of severe anemia was least compared to moderate and mild cases, reporting between 2.4% and 4% across IPIs. Moderate anemia cases were between 37.6% and 31.4% across IPIs. See Table 3 for details.

[Insert Table 3 about here].

Interpregnancy interval and adverse pregnancy outcomes

Results from Cox proportional hazard regression showed that children with preceding birth interval <24 months had 57% higher risk of infant mortality, compared to children with IPI of 24-36 month (HR= 1.57; 95%CI: 1.45, 1.69). However, there were 19% and 10% reduction in the risk of infant mortality at IPIs of 37-59 months and ≥60 months, compared to 24-36 months IPI (37-59 months: HR= 0.81; 95%CI: 0.75, 0.87; ≥60 months: HR= 0.90; 95%CI: 0.81, 0.99).Logistic regression model showed higher odds of low birth weight across <24 months, 37-59 months and ≥60 months IPIs, compared to 24-36 months IPI. In addition, children from <24 months IPI were 1.26 times as likely to be stunted, compared to children 24-36 months IPI (OR= 1.26; 95%CI: 1.21, 1.31). However, there were reduction in the odds of being stunted across 37-59 months and ≥60 months respectively, compared to 24-36 months IPI. Births in short IPIs were 1.29 times as likely to be underweight, compared to births in 24-36 months (OR= 1.29; 95%CI: 1.23, 1.35). Births in long IPIs had reductions in the odds of underweight, wasting and overweight, compared to 24-36 months IPI. In relation to not anemic children, there were reductions in relative-risk ratios of long IPIs (37-59 months and ≥60 months) across anemia levels (mild, moderate and severe), compared to 24-36 months IPI. See Table 4 for details.

[Insert Table 4 about here].

Discussion

In this study, a series of representative DHS data in SSA children showed that between 2008 and 2017, there was high prevalence of stunting, anemia, low birth weight and underweight. Over the same period, infant mortality, wasting, overweight and severe anemia occurred in SSA countries. These findings is consistent with previous study which reported increase in the prevalence of stunting, underweight and overweight among children below five years [27]. The cause of the increase in prevalence of childhood nutritional problems could be attributed to changes in nutrition patterns, as recent economic meltdown in several SSA countries have resulted in large shift in dietary intake and under nutrition.

Consistent to our study, both short and long birth intervals were independently associated with higher odds of low birth weight [28]. Further, children from short birth intervals were associated with higher risk of infant mortality and increased odds of stunting and underweight. This implies that infants born 24–36 months after the previous birth had lower risk of death and reduction in the outcomes of under nutrition. However, these adverse effects on child health outcomes including mortality, stunting, underweight, wasting, overweight and anemia decreased with an increase in IPI. These findings on the adverse childhood health outcomes are consistent with previous reports [9,29-33]. The high risk of mortality among infants who were born after short IPI could be attributed to the effect of low birth weight or prematurity. Children who are born with low birth weight or premature have higher risk of death. More so, the high risk of infant mortality after short IPI may be attributed to recurrence of correlates of fetal and child death between pregnancies [8].

Interpregnancy interval plays a major role in pregnancy outcomes, particularly among women who experience malnourishment, social and physical trauma as compared to advantaged women. Our findings confirm that long IPI would provide women sufficient time to recover from nutritional depletion inherent during prenatal period. Maternal nutrient depletion would pose biological competition between mother and child. This could be the possible explanation for higher risks of adverse child health outcomes among women with short IPI in this study. In addition, short IPI has been linked with maternal iron and folic acid depletion which is also associated with higher risks of low birth weight, growth restriction and preterm birth [11,34]. This could be the reason for increased risk of low birth weight in the current study involving several SSA countries. Also, it could be that the higher risk of low birth weight resulted from small for gestation age or preterm delivery which is a major determinant of low birth weight and indirect causes of infant mortality as previously reported [9].

Strength and limitation

This study used nationally representative data from thirty-four SSA countries making the findings generalizable. However, causal inference is difficult to draw from cross-sectional studies and the quality of both exposure and outcome measures may be poor in datasets that heavily depend on maternal recall.

Conclusion

This study has shown regional burden of childhood mortality, low birth weight, stunting, underweight, wasting, anemia and overweight which should be points of focus for SSA health authorities. Notable methods to tackle these issues would include a widespread nutrition programs and improvements in hygiene, delivery of health care services, sanitation, availability and accessibility to clean water. These strategies would help address childhood nutritional, biological and health issues. Policies and programs targeting to deal with childhood under nutrition need to emphasize the significance of appropriate weight and linear growth alike, and should balance the promotion of physical activity and healthy diets. Further, improvements in diets should commence at prenatal period to prevent nutritional depletion among pregnant women, which in turn is a risk factor for low birth weight, childhood anemia, stunting and wasting. More so, adopting the optimum IPIs is key in addressing childhood problems inherent in short and long IPIs unless the long IPI is consequent upon secondary infertility. Exclusive breastfeeding would act as a panacea of modern contraceptive methods in child spacing. However, prolonged breastfeeding should be complimented with proper feeding practices. Therefore, behaviour change communication regarding the importance of breastfeeding together with healthy feeding practices is crucial in SSA region.

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Table 1. Pooled Demographic and Health Survey (DHS) from 34 Sub-Saharan Africa (SSA) countries; 2008-2016

Table 2. Mothers' characteristics in relation to interpregnancy interval (n= 299,065 births)

Table 3. Pregnancy outcomes across interpregnancy intervals

Table 4. Association between interpregnancy interval and adverse pregnancy outcomes

Country	Study year	Sample size (n)	Infant mortality (%)	Low birth weight (%)	Stunted (%)	Underweight (%)	Wasting (%)	Overweight (%)	Anemia		
									Mild (%)	Moderate (%)	Severe (%)
Central SSA											
Madagascar	2008/09	12,448	5.0	12.4	48.4				30.4	19.6	0.9
Angola	2015/16	14,322	4.4	10.9	37.4	19.4	4.9	4.8	30.1	32.1	2.6
Congo	2011/12	9,329	4.4	10.5	26.8	13.0	5.3	5.2	31.5	33.5	1.2
Gabon	2012	6,067	4.5	15.4	22.9	8.3	3.8	3.8	29.5	32.5	1.8
Democratic Republic of Congo	2013/14	18,716	6.6	6.9	44.1	23.2	7.5	7.2	24.7	34.6	3.7
East SSA											
Burundi	2016/17	13,192	4.9	9.6	54.6	28.9	5.1	3.6	24.9	30.9	3.3
Comoros	2012	3,149	3.6	16.8	27.7	14.5	9.6	11.7			
Ethiopia	2016	10,641	5.4	11.1	36.4	25.3	11.1	10.7	23.7	32.5	4.0
Kenya	2014	20,964	3.9	7.5	27.1	13.2	5.3	4.8			
Malawi	2015/16	17,286	4.3	12.1	35.2	12.0	3.1	2.7	27.0	34.4	1.8
Mozambique	2011	11,102	6.8	13.5	39.3	13.1	4.9	5.0	26.2	36.7	3.4

Rwanda	2014/15	7,856	3.5	6.3	37.4	9.0	2.2	1.8	20.4	14.7	0.7
Tanzania	2015/16	10,233	4.7	7.1	33.6	13.7	4.8	4.3	27.2	29.7	1.5
Uganda	2016	15,522	4.8	9.8	28.4	10.8	3.8	3.8	24.4	27.8	2.3
Zambia	2013/14	13,457	4.9	8.8	39.6	14.9	5.8	5.9			
South SSA											
Lesotho	2014	3,138	6.8	10.9	34.6	11.2	3.3	3.1	25.5	26.3	1.7
Namibia	2013	5,046	4.2	12.1	23.2	13.8	6.4	6.9	24.7	25.4	1.0
Zimbabwe	2015	6,132	4.7	9.7	25.6	7.7	3.3	0.0	22.2	15.4	0.5
West SSA											
Sao Tome & Principe	2008/09	1,931	3.6	8.8	27.6	13.3	9.9	12.3	31.5	27.9	1.0
Nigeria	2013	31,482	8.1	7.3	36.1	26.9	14.8	15.9			
Guinea	2012	7,039	7.6	8.4	30.8	17.8	9.4	9.7	23.4	45.2	7.6
Niger	2012	12,558	6.0	10.7	41.9	35.5	15.6	16.3	26.1	46.0	2.8
Benin	2012	13,407	4.6	12.8	44.0	21.5	10.4	16.1	26.4	29.4	2.9
Cameroon	2011	11,732	7.2	7.7	31.6	13.7	5.4	4.9	27.8	32.3	2.0
Chad	2014/15	18,623	7.8	7.9	42.9	32.5	12.9	12.1			
Ghana	2014	5,884	4.5	10.0	19.2	11.0	4.8	4.4	27.4	39.4	2.8

Burkina-Faso	2010	15,044	7.4	13.9	34.2	24.9	14.6	14.1	18.5	59.0	10.9
Cote d'Ivoire	2011/12	7,776	7.6	14.4	29.8	14.6	6.5	6.5	24.9	47.0	3.5
Liberia	2013	7,606	6.3	10.7	30.9	15.3	6.3	6.3			
Mali	2012/13	10,326	6.1	15.7	37.8	25.2	11.2	11.6	21.4	51.1	8.6
Senegal	2010/11	12,326	5.0	14.8	29.1	19.3	8.0	8.4	23.8	48.8	5.4
Sierra Leone	2013	11,938	9.3	6.6	37.7	16.0	7.7	9.1	26.2	47.6	6.6
Togo	2013/14	6,979	5.4	9.6	28.3	16.8	7.1	6.5	26.0	42.4	2.6
Gambia	2013	8,088	3.4	11.5	25.8	18.0	10.0	10.7	24.4	44.8	4.7

Variable	**N**	**Interpregnancy interval (month)**				**P**
		<24 (%)	**24-36 (%)**	**37-59 (%)**	**≥60 (%)**	
Maternal age						<0.001
<25	50,294	27.4	44.8	23.8	4.0	
25-34	162,050	18.9	38.5	30.2	12.3	
≥35	86,721	15.4	32.5	31.3	20.8	
Maternal education						<0.001
No education	138,061	20.5	39.6	29.6	10.3	
Primary	105,324	18.6	38.2	29.4	13.8	
Secondary	50,253	17.7	33.2	29.4	19.7	
Higher	5,392	18.2	28.1	28.0	25.7	
Marital status						<0.001
Single	7,061	16.1	32.6	28.9	22.3	
Married	292,003	19.4	38.0	29.5	13.2	
Parity						<0.001
1-2	46,907	17.2	35.3	30.0	17.5	
3-4	113,760	18.2	37.1	29.9	14.7	
≥5	138,398	21.0	39.3	28.9	10.9	
Place of residence						<0.001
Urban	81,756	17.7	33.8	29.7	18.8	
Rural	217,309	19.9	39.3	29.4	11.3	
Wealth index						
Poor	147,717	20.7	40.5	28.6	10.2	
Middle	59,181	18.9	37.9	29.9	13.3	
Rich	92,167	17.4	37.9	30.6	18.5	
Maternal working status						<0.001
Employed	189,520	18.3	37.7	30.1	13.9	

Unemployed	100,632	21.2	38.3	28.4	12.0	
Number of ANC visits						<0.001
<4	95,394	18.3	38.5	30.7	12.6	
≥4	106,178	14.4	34.4	32.3	18.8	
Maternal contraceptive use						<0.001
Yes	77,663	16.8	33.4	31.7	18.1	
No	221,402	20.2	39.4	28.7	11.7	
Maternal body mass index (kg/m^2)						<0.001
Underweight (<18.5)	18,081	21.4	39.7	28.6	10.4	
Normal (18.5-24.9)	122,066	19.5	39.7	29.3	11.5	
Overweight (25-29.9)	29,094	18.5	33.8	29.9	17.8	
Obese (≥30)	10,960	16.2	29.0	30.0	24.7	

Outcome	**Interpregnancy interval (month)**			
	<24 (%)	**24-36 (%)**	**37-59 (%)**	**≥60 (%)**
Infant mortality	9.3	5.4	4.1	4.2
Low birth weight (<2.5kg)	10.0	9.3	9.4	10.5
Stunting	42.5	37.9	33.5	27.0
Underweight	24.7	21.0	18.0	13.2
Wasting	9.0	8.8	8.6	7.1
Overweight	8.6	8.7	8.7	7.2
Childhood anemia (g/dl)				
Mild (10.0g/dl-10.9g/dl)	25.9	25.7	25.1	25.8
Moderate (7.1g/dl-9.9g/dl)	36.1	37.6	35.8	31.4
Severe (<7.0g/dl)	4.0	3.8	3.3	2.4

Outcome	Interpregnancy interval (month)			
	<24	**24-36 (reference)**	**37-59**	**≥60**
Infant mortality (HR; 95%CI)	1.57 (1.45-1.69)*	1.00	0.81 (0.75-0.87)*	0.90 (0.81-0.99)*
Low birth weight (OR; 95%CI)	1.18 (1.09-1.29)*	1.00	1.07 (1.01-1.15)*	1.19 (1.10-1.30)*
Stunting (OR; 95%CI)	1.26 (1.21-1.31)*	1.00	0.88 (0.85-0.91)*	0.74 (0.71-0.77)*
Underweight (OR; 95%CI)	1.29 (1.23-1.35)*	1.00	0.86 (0.83-0.89)*	0.70 (0.66-0.74)*
Wasting (OR; 95%CI)	1.04 (0.98-1.11)	1.00	0.99 (0.95-1.04)	0.91 (0.85-0.97)*
Overweight (OR; 95%CI)	0.99 (0.93-1.05)	1.00	1.00 (0.95-1.05)	0.92 (0.85-0.98)*
Childhood anemia (RR; 95%CI)				
Mild (10.0g/dl-10.9g/dl)	0.98 (0.92-1.05)	1.00	0.92 (0.88-0.98)*	0.90 (0.84-0.96)*
Moderate (7.1g/dl-9.9g/dl)	0.93 (0.87-0.99)*	1.00	0.91 (0.87-0.96)*	0.84 (0.79-0.90)*
Severe (<7.0g/dl)	0.99 (0.87-1.13)	1.00	0.86 (0.78-0.96)*	0.72 (0.61-0.84)*

OR = Odds ratio
HR = Hazard ratio
RR = Relative-risk ratio
*significant at $p<0.05$
Models adjusted for maternal age, education, marital status, parity, antenatal care visits, rural-urban residence, wealth index, employment, contraceptive use, body mass index.

Effects of birth spacing on adverse childhood health outcomes: Evidence from 34 countries in Sub-Saharan Africa

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Abstract

Background: Interpregnancy intervals (IPI) are independently associated with maternal, perinatal, infant and child outcomes. Birth spacing is a recommended tool to reduce adverse health outcomes especially among children. This study aims to determine the prevalence of adverse child health outcomes in Sub-Saharan Africa (SSA) countries and to examine the association between the length of preceding birth interval child health outcomes.

Methods: Secondary data from Demographic and Health Survey (DHS) in 34 SSA countries with 299,065 births was used in this study. The outcome variables were infant mortality, low birth weight, stunting, underweight, wasting, overweight and anemia. Percentage was used in univariate analysis. Cox proportional hazard regression was used to examine association between the adjusted model of preceding birth interval and infant mortality. Multinomial and binary logistic regression models were used to examine the association between under-five children adverse health outcomes and interpregnancy birth interval.

Results: Infant mortality was lowest in Gambia (3.4%) and highest in Sierra Leone (9.3%). Comoros (16.8%) accounted for the highest percentage of low birth weight (<2.5kg). Child stunting was as high as 54.6% in Burundi. IPIs of <24 months, 24-36 months, 37-59 months and ≥60 months accounted for 19.3%, 37.8%, 29.5% and 13.4% respectively. Median IPI was 34 months. Results from Cox proportional hazard regression showed that children with preceding birth interval <24 months had 57% higher risk of infant mortality, compared to children with IPI of 24-36 month (HR= 1.57; 95%CI: 1.45, 1.69). However, there were 19% and 10% reduction in the risk of infant mortality at IPIs of 37-59 months and ≥60 months, compared to 24-36 months IPI (37-59 months: HR= 0.81; 95%CI: 0.75, 0.87; ≥60 months: HR= 0.90; 95%CI: 0.81, 0.99).

Conclusion: The findings of this study suggest the need for urgent intervention to promote the recommended interpregnancy interval of 24–36 months to reduce adverse child health outcomes. These data also bring into limelight the

importance of exclusive breastfeeding to enhance proper nutritional approach and to prolong lactational amenorrhea. Health care system stakeholders would find this study interesting as a base for policy formulation and implementation.

Keywords: Interpregnancy interval, neonatal mortality, low birth weight, Anemia, birth spacing, global health, Sub-Saharan Africa

Introduction

The time interval between a delivery and the next pregnancy signifies a modifiable feature of the prenatal care. Conjointly, long and short birth intervals are connected to adverse perinatal and maternal health outcomes [1]. The length of interpregnancy interval (IPI) depends on several factors, which vary based on pregnancy intention. World Health Organization (WHO) recommends 24-36 months between pregnancies to reduce foetal, child and maternal morbidity and mortality [2] [3,4]. ~~Higher prevalence of short IPIs among older women is an indication that childbearing at an advanced age creates the burden to produce a family with desired family size and composition [1]. Further, maternal socioeconomic advantage is commonly linked to high prevalence of short IPI when pregnancies are intended [3]. Overall, since the pregnancies of the advantaged women have higher likelihood of being intended [3,4], the extent of distinctiveness following short birth interval is sometimes uncertain.~~ Also, there are numerous and complex range of factors associated with IPIs [5], while some are rooted in the reproductive behaviours and histories of women, others are influenced by cultural and social norms determining the utilization of sexual and reproductive health services [7,6].

Women may lack the physiological recovery from a preceding birth if she has the next pregnancy almost immediately, resulting to adverse child and maternal outcomes; while too many children closely spaced puts resource pressures on families leading to poor survival rate and morbidity [12]. Generally, the time between index and previous births has remarkable impact on child and maternal health outcomes. Inappropriate birth spacing has large risk of preterm birth, perinatal, neonatal, infant mortality [8,9] and morbidity such as low birth weight [10,11] and childhood anemia

[17]. As a major public health issue, anemia increases susceptibility to infections, compromises the psychomotor development and raise maternal and child morbidity and mortality. Women may lack the physiological recovery from a preceding birth if she has the next pregnancy almost immediately, resulting to adverse child and maternal outcomes; while too many children closely spaced puts resource pressures on families leading to poor survival rate and morbidity [12]. In the instances of live births, short IPIs can result from under-breastfeeding of the preceding child, as constant breastfeeding helps to prolong lactational amenorrhea, which obstructs fecundity in women. Short IPIs is one of the prominent factors influencing the morbidity and mortality of children [13]. Several adverse outcomes have been associated with short and long intervals between pregnancies [14]. Report from low-income and middle-income countries (LIMIC) has indicated that short IPI of within 6 months is associated with higher risk of fetal growth restriction, low birth weight, early neonatal, infant and child mortality as compared to IPI of within 36 months [5,15].

Short IPIs commonly leads to maternal folate depletion; a foremost feature of increased risk of fetal growth restriction [11]. The plausible supposition expected to show causation to explain the risk of adverse maternal outcomes is mainly nutritional depletion. Mothers with closely spaced births often have inadequate time to gain the nutritional elements, essential for fetal growth and development in successive pregnancies. The nutritional depletion often results in anemia, a public health problem affecting women and children alike; with global prevalence of about 50% in under-five years children, approximately 40% in pregnant women and about one-third in non-pregnant women of reproductive age [16]. The highest burden of anemia is reported in Sub-Saharan Africa (SSA) countries where two-third of young children and about 60%

~~of pregnant women are anemia [16]. Notably, childhood anemia in Africa has multifactorial causes, including nutritional iron and folate deficiencies which commonly result from short IPIs [17].~~

~~Similarly, iron deficiency anemia is another condition associated with the reduction in hemoglobin concentration [18]. It remains the prominent isolated nutritional deficiency worldwide and a major cause of nutritional anemia, particularly in resource-constrained settings. The problem is prevalent in developing countries due to insufficient diet and poor prenatal vitamins, iron and folic acid intake. Children, women of childbearing age and pregnant women are the key population for iron deficiency [19]. As a major public health issue, anemia increases susceptibility to infections, compromises the psychomotor development and raise maternal and child morbidity and mortality. These problems are often associated with the lack of adherence to ideal IPI, attributed to low contraceptive utilization [20]. Breastfeeding is a natural birth control strategy to delay mother's return to ovulation. It improves child survival and lengthens the interval between pregnancies.~~

In spite several studies that have been conducted on IPIs and maternal and child outcomes in individual SSA countries, the findings have been inconclusive and inconsistent findings. To address the knowledge gaps about outcomes of IPIs, this study utilized DHS regional data from several SSA countries. We targeted short and long IPIs as those intervals have usually been associated with adverse child and maternal health outcomes [12,21]. Notwithstanding, there is paucity of studies investigating the optimum IPIs and related outcomes. The objective of our study is to estimate the effects of the duration of the preceding IPI on child and maternal outcomes in SSA region.

Materials and methods

Data source

This study used DHS data from birth histories in thirty-four Sub-Saharan Africa countries. Data of children born in the five years prior to the interview was used. The data is in public domain and was accessed at; http://dhsprogram.com/data/available-datasets.cfm. DHS were based on nationally representative sample using a stratified multistage cluster sampling technique. Data from the birth history have been recoded into separate records for individual children listed by the mothers with data on date of birth, sex of the child, whether child is alive, age at death (if dead), and so forth. Thirty-four (34) countries in sub-Saharan Africa region were included based on availability of current data collected between 2008 and 2017. Madagascar, Congo, Democratic Republic of Congo, Gabon, Angola, Tanzania, Burundi, Ethiopia, Mozambique, Kenya, Malawi, Rwanda, Comoros, Zambia, Uganda, Swaziland, Lesotho, Zimbabwe, Namibia. Sao Tome & Principe, Nigeria, Guinea, Togo, Gambia, Niger, Benin, Cameroon, Sierra Leone, Chad, Liberia, Ghana, Cote d'Ivoire, Burkina-Faso, Mali, and Senegal were included in the study. Details of DHS data collection procedure has been reported previously [22].

Measurement

Outcome variable

Anemia: In measuring hemoglobin levels, the blood of the children was obtained through a finger or heel prick and tested for hemoglobin level. The blood obtained was collected in a micro-cuvette. A battery operated portable Hemacue analyzer was used to measure hemoglobin concentration [22]. Based on the results, anemia was classified into three degree according to WHO; mild, moderate and severe. Hb cut-off values of anemia for children below 5 years were 10.0-10.9 g/dl (mild), 9.0-9.9 g/dl (moderate) and < 9.0 g/dl (severe).

Low birth weight: This was categorized as underweight (<2.5kg) and normal (≥2.5kg) [23].

Infant mortality: The death of a child aged 0 to 12 months was used for estimating infant mortality for all births in the 5 years preceding data collection. The time to death was measured in months and children who lived beyond 12 months were censored at that time for the purpose of survival analysis.

Nutritional status: This was categorized as children who are stunted, underweight, wasted and overweight. DHS surveys routinely collect the height and weight of children under age 5 years. Together with the child's age, this information was used to assess the nutritional status of children when compared to a reference standard using standard deviation values (z-scores). The DHS data are compared to the NCHS/CDC/WHO international reference standards for height for age, weight for age, and weight for height. Children whose z-scores are less than two standard deviations below the mean (-2 S.D.) on the reference standard are considered moderately or severely undernourished. Chronic under-nutrition or stunting is determined by a height-for-age z-score below two standard deviations below the mean. Acute under-nutrition or wasting is measured by a z-score less than -2 S.D. for weight for height, and overall under-nutrition or underweight, is measured by a z-score less than 2 S.D. for weight for age [24].

Explanatory variables

Preceding birth interval: The key independent variable is the length of the preceding birth interval measured as the number of months between the birth of the child under study (index child) and the immediately preceding birth to the mother; categorized as <24, 24-36, 37-59, ≥60.

Maternal and household factors: Mother's age (years): <25, 25-34, ≥35. Mother's educational level: No education, primary, secondary, higher. Marital status: single vs married. Number of children ever born: 1-2, 3-4, ≥5. Number of antenatal care visits: <4 vs ≥4. The place of residence: urban vs rural. Contraceptive use: yes vs no. Body mass index: underweight (<18.5kg/h^2), normal (18.5-24.9 kg/h^2), overweight (25.0-29.9 kg/h^2) and obese (≥30 kg/h^2).

Wealth index: For the computation of wealth index, principal components analysis (PCA) was used to assign the wealth indicator weights. This procedure assigned scores and standardized the wealth indicator variables such as; floor type, wall, roof, water source, sanitation facilities, radio, electricity, television, refrigerator, cooking fuel, furniture, number of persons per room. Thereafter, the factor coefficient scores (factor loadings) and z-scores were calculated. Finally, for each household, the indicator values were multiplied by the loadings and summed to produce the household's wealth index value. The standardized z-score was used to disentangle the overall assigned scores to poor (poorest + poorer), middle and rich (richer + richest) categories [25].

Ethical clearance

This study used publicly available data from DHS. Informed consent was obtained from participants prior to the survey. DHS Program is consistent with the standards for ensuring the protection of respondents' privacy. ICF International ensures that the survey complies with the U.S. Department of Health and Human Services regulations for the respect of the right of human subjects. No further approval was required for this study since the data is secondary and available in the public domain. More details about data and ethical standards are available at: http://goo.gl/ny8T6X.

Multicollinearity testing

A correlation value of 0.6 was used to examine interdependence of explanatory variables [26]. The correlation matrix values were below the cut-off; confirming lack of multicollinearity to raise concerns of removing interdependent variable from the model. Therefore, all covariates were added in the model based on multicollinearity testing.

Data analysis plan

Data was analysed using STATA version 14 (STATACorp, College Station, TX). [30] The Survey ('Svy') command was used to adjust for clustering (enumeration areas) and sampling weights. The prevalence of child health outcomes was calculated and presented as percentage. The association between the focal predictor and infant mortality was analyzed used Cox hazard regression while adjusting for other covariates. Univariate and multivariate binary and multinomial logistic regression analysis was performed for child nutritional factors including anemia. P<0.05 was used at significance level.

Results

Data for this study was collected 2008-2017 across thirty-four (34) countries. Infant mortality was lowest in Gambia (3.4%) and highest in Sierra Leone (9.3%). Gabon (15.4%), Mali (15.7%), Comoros (16.8%) accounted for the highest percentage of low birth weight (<2.5kg). Child stunting was as high as 41.9% in Niger, Chad had 42.9%, Benin reported 44.0%, 48.4% in Madagascar and Burundi had 54.6% respectively. Child underweight was highest in Mali (25.2%), Nigeria (26.9%), Burundi (28.9%), Chad (32.5%) and Niger (35.5%) respectively. Wasting was highest in Burkina-Faso (14.6%), Nigeria (14.8%) and Niger (15.6%) respectively. Burkina-Faso, Nigeria and Niger were the leading countries of child overweight. Approximately one-third of births in majority of Sub-Saharan Africa countries had mild or moderate anemia. See Table 1 for details.

[Insert Table 1 about here].

Mothers characteristics across interpregnancy intervals

Results showed that 299,065 births were extracted in the study. IPIs of <24 months, 24-36 months, 37-59 months and ≥60 months accounted for 19.3%, 37.8%, 29.5% and 13.4% respectively. Median IPI was 34 months. Women aged <25 years accounted for 27.4% short IPIs, but women aged ≥35 years had 20.8% of long IPIs which outscored other maternal age categories. Further, mothers with no maternal education had the highest percentage of short IPIs, while those with higher educational level had increased percentage of long (≥60 months) IPIs. Single mothers have higher report of long IPIs (≥ 60 months); while multiparous women accounted for 21% of short IPIs. Rural mothers reported more short IPIs, in contrast to their urban counterpart with higher percentage of mothers who reported long IPIs. Poor, unemployed or non-users of contraceptive methods accounted for 20.7%, 21.2% and 20.2% respectively of short IPIs. However, the converse was true for the rich, employed and users of contraceptive methods. While women having inadequate antenatal care visit reported 18.3% of short IPIs, however, mothers with adequate antenatal care visits had 18.8% of long IPIs, higher than their counterpart. Underweight mothers reported 21.4%, higher than normal (19.5%), overweight (18.5%) and obese (16.2%) women. Nonetheless, the obese women accounted for the highest (24.7%) long (≥ 60 months) IPIs among the other women. See Table 2 for details.

[Insert Table 2 about here].

Adverse pregnancy outcomes by interpregnancy intervals

From the results, the prevalence of infant mortality decreased as IPIs increased as infant mortality was 9.3% in short IPIs (<24 months) and 4.2% in long IPIs (≥60 months). Further, both long and short IPIs accounted for approximately 10% of low birth weight each. There was a decreasing trend in children stunting across IPIs; stunted growth among children was 42.5% in short IPIs, while long IPIs accounted for 27.0%. Births <24 months showed more underweight (24.7%) and wasting (9.0%), compared to long IPIs (13.2% and 7.1% respectively). The prevalence of severe anemia was least compared to moderate and mild cases, reporting between 2.4% and 4% across IPIs. Moderate anemia cases were between 37.6% and 31.4% across IPIs. See Table 3 for details.

[Insert Table 3 about here].

Interpregnancy interval and adverse pregnancy outcomes

Results from Cox proportional hazard regression showed that children with preceding birth interval <24 months had 57% higher risk of infant mortality, compared to children with IPI of 24-36 month (HR= 1.57; 95%CI: 1.45, 1.69). However, there were 19% and 10% reduction in the risk of infant mortality at IPIs of 37-59 months and ≥60 months, compared to 24-36 months IPI (37-59 months: HR= 0.81; 95%CI: 0.75, 0.87; ≥60 months: HR= 0.90; 95%CI: 0.81, 0.99).Logistic regression model showed higher odds of low birth weight across <24 months, 37-59 months and ≥60 months IPIs, compared to 24-36 months IPI. In addition, children from <24 months IPI were 1.26 times as likely to be stunted, compared to children 24-36 months IPI (OR= 1.26; 95%CI: 1.21, 1.31). However, there were reduction in the odds of being stunted across 37-59 months and ≥60 months respectively, compared to 24-36 months IPI. Births in short IPIs were 1.29 times as likely to be underweight, compared to births in 24-36 months (OR= 1.29; 95%CI: 1.23, 1.35). Births in long IPIs had reductions in the odds of underweight, wasting and overweight, compared to 24-36 months IPI. In relation to not anemic children, there were reductions in relative-risk ratios of long IPIs (37-59 months and ≥60 months) across anemia levels (mild, moderate and severe), compared to 24-36 months IPI. See Table 4 for details.

[Insert Table 4 about here].

Discussion

In this study, a series of representative DHS data in SSA children showed that between 2008 and 2017, there was high prevalence of stunting, anemia, low birth weight and underweight. Over the same period, infant mortality, wasting, overweight and severe anemia occurred in SSA countries. These findings is consistent with previous study which reported increase in the prevalence of stunting, underweight and overweight among children below five years [27]. The cause of the increase in prevalence of childhood nutritional problems could be attributed to changes in nutrition patterns, as recent economic meltdown in several SSA countries have resulted in large shift in dietary intake and under nutrition.

Consistent to our study, both short and long birth intervals were independently associated with higher odds of low birth weight [28]. Further, children from short birth intervals were associated with higher risk of infant mortality and increased odds of stunting and underweight. This implies that infants born 24–36 months after the previous birth had lower risk of death and reduction in the outcomes of under nutrition. However, these adverse effects on child health outcomes including mortality, stunting, underweight, wasting, overweight and anemia decreased with an increase in IPI. These findings on the adverse childhood health outcomes are consistent with previous reports [9,29-33]. The high risk of mortality among infants who were born after short IPI could be attributed to the effect of low birth weight or prematurity. Children who are born with low birth weight or premature have higher risk of death. More so, the high risk of infant mortality after short IPI may be attributed to recurrence of correlates of fetal and child death between pregnancies [8].

Interpregnancy interval plays a major role in pregnancy outcomes, particularly among women who experience malnourishment, social and physical trauma as compared to advantaged women. Our findings confirm that long IPI would provide women sufficient time to recover from nutritional depletion inherent during prenatal period. Maternal nutrient depletion would pose biological competition between mother and child. This could be the possible explanation for higher risks of adverse child health outcomes among women with short IPI in this study. In addition, short IPI has been linked with maternal iron and folic acid depletion which is also associated with higher risks of low birth weight, growth restriction and preterm birth [11,34]. This could be the reason for increased risk of low birth weight in the current study involving several SSA countries. Also, it could be that the higher risk of low birth weight resulted from small for gestation age or preterm delivery which is a major determinant of low birth weight and indirect causes of infant mortality as previously reported [9].

Strength and limitation

This study used nationally representative data from thirty-four SSA countries making the findings generalizable. However, causal inference is difficult to draw from cross-sectional studies and the quality of both exposure and outcome measures may be poor in datasets that heavily depend on maternal recall.

Conclusion

This study has shown regional burden of childhood mortality, low birth weight, stunting, underweight, wasting, anemia and overweight which should be points of focus for SSA health authorities. Notable methods to tackle these issues would include a widespread nutrition programs and improvements in hygiene, delivery of health care services, sanitation, availability and accessibility to clean water. These strategies would help address childhood nutritional, biological and health issues. Policies and programs targeting to deal with childhood under nutrition need to emphasize the significance of appropriate weight and linear growth alike, and should balance the promotion of physical activity and healthy diets. Further, improvements in diets should commence at prenatal period to prevent nutritional depletion among pregnant women, which in turn is a risk factor for low birth weight, childhood anemia, stunting and wasting. More so, adopting the optimum IPIs is key in addressing childhood problems inherent in short and long IPIs unless the long IPI is consequent upon secondary infertility. Exclusive breastfeeding would act as a panacea of modern contraceptive methods in child spacing. However, prolonged breastfeeding should be complimented with proper feeding practices. Therefore, behaviour change communication regarding the importance of breastfeeding together with healthy feeding practices is crucial in SSA region.

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Table 1. Pooled Demographic and Health Survey (DHS) from 34 Sub-Saharan Africa (SSA) countries; 2008-2016

Table 2. Mothers' characteristics in relation to interpregnancy interval (n= 299,065 births)

Table 3. Pregnancy outcomes across interpregnancy intervals

Table 4. Association between interpregnancy interval and adverse pregnancy outcomes