

# Non-adherence of WHO recommended inter-birth interval in Rufiji, Tanzania

Amon Exavery<sup>1\*</sup>, Sigilbert Mrema<sup>1</sup>, Amri Shamte<sup>1</sup>, Kristin Bietsch<sup>2</sup>, Dominic Mosha<sup>1</sup>, Godfrey Mbaruku<sup>1</sup>, Honorati Masanja<sup>1</sup>

<sup>1</sup>fakara Health Institute (IHI), Plot 463, Kiko Avenue, off Old Bagamoyo Road, Mikocheni P.O Box 78373, Tel: +255 222 771 714, Fax: +255 222 771 714, Dar es Salaam, Tanzania. <sup>2</sup>Office of Population Research, Princeton University.

\* Corresponding author

Email addresses

AE	aexavery@ihi.or.tz
SM	smrema@ihi.or.tz
AS	ashamte@ihi.or.tz
KB	kbietsch@princeton.edu
DM	dmosha@ihi.or.tz
GM	gmbaruku@ihi.or.tz
HM	hmasanja@ihi.or.tz

## **Abstract**

### **Background**

Poorly spaced pregnancies have been documented worldwide to result into unwanted maternal and child health outcomes. The World Health Organization (WHO) recommends an inter-birth interval length of at least 33 months between two live births in order to reduce the risk of adverse maternal and child health outcomes. However, birth spacing practices in many developing countries, including Tanzania remain scanty addressed.

### **Methods**

Longitudinal data collected from Rufiji Health and Demographic Surveillance System (HDSS) from January 1999 to December 2010 were analyzed to investigate levels of birth spacing and factors affecting non-adherence to the WHO recommended minimum inter-birth interval length among women aged 15-49 years in Rufiji district. Non-adherence was considered as an inter-birth interval length below 33 months. Thus, we created a binary outcome variable and subsequently applied logistic regression to fit a multivariate model to identify correlates of non-adherence. STATA (11) statistical software was used to carry out this process at 5% significance level.

### **Results**

A total of 15,373 inter-birth intervals were recorded from 8,979 women aged 15-49 years. Overall, median inter-birth interval length was 33.4 months. Of these, 48.8% did not adhere to the WHO recommended length of  $\geq 33$  months between two live births. Non-adherence to the recommendation was associated with young maternal age, low maternal education, multiple births to the index, non-health facility delivery of the index child, being an in-migrant resident, increasing parity and being married.

### **Conclusion**

Generally, one in every two inter-birth intervals among 15-49 year-old women in Rufiji district is poorly spaced. Maternal, Newborn and Child Health services should be improved with an urgent attention on community- and health facility-based optimum birth spacing education in order to enhance better health outcomes of mothers and their babies especially in rural settings.

## Background

Poorly spaced pregnancies have been documented worldwide to result into unwanted maternal and child health outcomes [1]. An estimated 11 million under-five children die yearly, 99 percent of which occur in developing countries [2]. Evidence showing a relationship between shorter birth intervals and high infant and child mortality has been established globally [3-9]. Other studies, in addition, have shown that closely spaced pregnancies are linked to low birth weight, intrauterine growth retardation, preterm delivery [10;11] and infant mortality [3]. Evidence on the other hand shows that longer intervals translate into declining fertility and consequently result into beneficial effects on population size [12].

On the other hand, women who space their pregnancies inappropriately have an elevated risk of preeclampsia, high blood pressure, and premature rupture of membranes [1]. It has been established that the undesirable consequences of shorter inter-birth intervals on perinatal, infant and child survival and maternal mortality have been attributed to *Maternal depletion syndrome*, a biological phenomenon that refers to an inadequate recuperation of the mother from one pregnancy that avails an inhospitable intrauterine environment to accommodate the subsequent pregnancy [13;14].

Sibling competition has been reported to upshot in the situation of shorter inter-birth intervals. It is argued that, when a newborn comes, it is likely that the family will invest more of its limited resources in form of care to the newborn and the other children more likely to suffer or merely receive inadequate share of the resources distributed among siblings. Disease transmission is another mechanism through which shorter inter-birth intervals may be pernicious. Presence of many young children in a household may facilitate the spread of many communicable diseases such as respiratory infections and measles [15].

Although, other research findings advocate an interval length of 2 years between two consecutive births for a better child health [21], Recent findings show that intervals of 3 to 5 years are safer for both the mother and the baby compared to  $\leq 2$  years [20;22;23]. However, too long birth intervals ( $> 5$  years) are associated with increased risk of complications such as preeclampsia as the mother loses protective effect from the previous pregnancy [20].

Tanzania like many other sub Saharan Africa countries, fertility, maternal mortality and child mortality are still high. Recent estimates shows that the country still experiences higher rates of maternal and neonatal mortality of 454 deaths per 100,000 live births and 26 deaths per 1000 live births, respectively [16]. Therefore, analysis of birth intervals in this set up is reasonable. This stands a better chance to unveil possible circumstances leading into inappropriate spacing which if acted upon may also beneficially influence both the mortality and fertility.

### **WHO recommended inter-birth interval**

In 2005, WHO held a **Technical Consultation and Scientific Review of Birth Spacing** [24] in Geneva, Switzerland, that comprised 30 international experts, and indorsed the following two recommendations on birth spacing.

1. *After a live birth, the recommended interval before attempting the next pregnancy (i.e. birth-to-pregnancy interval) is at least 24 months in order to reduce the risk of adverse maternal, perinatal and infant outcomes.*
2. *After a miscarriage or induced abortion, the recommended minimum interval to next pregnancy is at least six months in order to reduce risks of adverse maternal and perinatal outcomes.*

Our analysis bases on the first recommendation, which impliedly means that the minimum birth-to-birth or simply inter-birth interval is at least or minimum of 33 months (33 months = 24 months for not conceiving + 9 months period of pregnancy) in order to reduce the adverse risks. This recommendation, according to WHO, was considered consistent with the WHO/UNICEF recommendation of breastfeeding for at least 2 years [24].

Considering a slow progress towards achieving the Millennium Development Goals (MDGs) 4 (especially neonatal mortality) and 5 for Tanzania [25] and the limited evidence on birth spacing practices, this study, attempts to (1) describe median (in months) level of inter-birth interval length, (2) estimate proportions of inter-birth intervals that are below the recommended minimum inter-birth interval length ( $\geq 33$  months) by characteristics of the mother and the child and (3) identify factors associated with non-adherence to the recommended inter-birth interval length among 15-49 year-old *multiparous* women in Rufiji district of Tanzania.

## **Methods**

### **Study area**

The Rufiji Health and Demographic Surveillance System (HDSS) is located in Rufiji district of the Coast region, 178 kilometres in the south of Dar es Salaam, Tanzania. The area is geographically between latitude 7.47°–8.03° S and longitude 38.62°–39.17° E. The HDSS was inceptioned in September 1998 and as of 2010, it was made up of 33 villages with over 16,000 households resided by more than 80,000 people. In the same year, an estimated average household size of 5.0 was recorded. The HDSS is mainly rural with a scattered population, though clustering around Ikwiriri, Kibiti and Bungu townships is known. The largest and original native ethnic group in the HDSS is *Ndengereko*. Others include *Matumbi*, *Ngindo*, and *Zaramo*. In terms of religion, Muslim accounts for over 90% of the population. Most people speak their ethnic languages, even though the national language, *Swahili*, is well understood and widely spoken.

### **Data and study population**

The study used longitudinal data collected in Rufiji HDSS in Tanzania for a total period of eleven years from 1<sup>st</sup> January 1999 to 31<sup>st</sup> December 2010. A HDSS is a longitudinal, population-based health and vital events registration system that monitors demographic events such as births, deaths, pregnancies, migrations and socioeconomic status of a geographically well-defined setting of individuals, households and residential units. In the Rufiji HDSS, every household is visited once in every four months in order to update previously recorded household information, and also registry of new demographic events that may have occurred. Between household visits, community-based key informants report births and deaths as they occur.

A particular focus of this study was to analyze inter-birth intervals. Therefore, Rufiji HDSS resident women of childbearing age (15–49) who were followed-up for vital statistics, particularly childbearing information were of interest. At the end of the defined follow-up period, only women who had given birth at least twice (i.e. *multiparous*) were retained for this analysis because the focus was on closed intervals.

### **Study variables**

This study examined inter-birth or birth-to-birth interval as a dependent variable (outcome) against background characteristics of the mother and the child. The inter-birth interval length was collapsed into two categories according to the WHO recommendation as; (i) <33 months which was referred to as non-adherence or poor spacing and (ii) ≥33 months and referred to as appropriate spacing.

The maternal and child characteristics investigated (with their categories in bracket) were maternal age (broken into categories of 5 years interval size starting from 15-19 and ending with 45-49), maternal education (secondary and higher, primary and never been to school), maternal occupation (no job, self employment and formal employment), marital status of the mother (married, single, widowed, ever married (i.e. divorced or widowed)), sex of the index child (female and male). Others were place of residence (urban and rural), number of births of the index pregnancy (singleton and multiple), parity (2, 3 and ≥4) and place of delivery (health facility and elsewhere) and HDSS entry type (enumeration and in-migration).

### **Statistical analyses**

Inter-birth interval was referred to as the length of time between two successive live births [16]. Thus, a woman could have several inter-birth intervals depending on her parity. For example, a primipara (i.e. para 1) woman has no inter-birth or closed interval. One closed interval requires two consecutive births. Two consecutive inter-birth intervals require three consecutive births and so on. Thus, women considered in this case were those who were *multiparous* and we generalized their inter-birth intervals mathematically as:

$$I_n = \frac{D_{n+1} - D_n}{30.4}, \quad n = 1, 2, 3 \dots k$$

Where  $I_n$  =  $n^{\text{th}}$  interval length between two consecutive births.  
 $k$  = highest parity a woman has had at a given point in her reproductive lifetime,  
 $D_n$  = date of birth of an  $n^{\text{th}}$  pregnancy,  
 $D_{n+1}$  = date of birth of the subsequent  $((n+1)^{\text{th}})$  pregnancy and  
 $30.4$  = average number of days in a month

Analytically, the inter-birth intervals were first described in order to assess their distributional features. Binary outcome variable was then defined and assigning the inter-birth intervals in two categories according to the WHO recommended minimum inter-birth intervals length such that:

$$\text{Non-adherence} = \begin{cases} 1 & \text{if inter-birth interval length} < 33 \text{ months} \\ 0 & \text{if inter-birth interval length} \geq 33 \text{ months} \end{cases}$$

We computed summary statistics by women's characteristics and presented them in tables. Proportions of intervals that were below the WHO recommended minimum length by background characteristics of the mother and the child were presented. Pearson's Chi-square ( $\chi^2$ ) was used to test the degree of associations between non-adherence to the recommendation and each of the explanatory variables.

Correlative effect of the background characteristics was assessed on non-adherence using multivariate logistic regression to obtain independent factors associated with non-adherence to the recommendation. Odds ratios (OR) and their corresponding 95% confidence intervals (CI) were presented. Data analysis was conducted using STATA (version 11) statistical software (StataCorp, Texas, USA).

## Results

From 1<sup>st</sup> January 1999 to 31<sup>st</sup> December 2010, a total of 15,373 closed inter-birth intervals were recorded from 8,979 women aged 15-49 years. Overall, median inter-birth interval was 33.4 (inter-quartile range = 16.5) months long. Of these intervals, 48.8% (7,446) were below (non-adherence) the WHO's recommended minimum inter-birth interval length of at least 33 months between two consecutive live births for better maternal and child health outcomes (Figure 1). These inappropriate intervals were observed among 40.9% (3,668) of all the women followed. On average, each of the women who spaced any of her births inappropriately had 2.0 inter-birth intervals that were below the minimum recommendation of WHO.

### ***Inter-birth interval by background characteristics***

Figure 2 presents inter-birth spacing levels by background characteristics of the mother and the child. The results show that maternal age was inversely related with non-adherence to the recommended minimum length between two live births. The proportion of inter-birth intervals that were poorly spaced was highest (76%) among youngest (15-19) women and declined rapidly with increasing age to as low as 30% among the oldest (45-49) women ( $P < 0.001$ ). In terms of marital status, the highest proportion (50%) of births that were poorly spaced were observed among married/in-union women and the lowest (37%) was observed among ever married (divorced or widowed) women ( $P < 0.001$ ). Regarding maternal education, levels of poor spacing of births were 52%, 46% and 38% among women who had no education, primary education and at least secondary education respectively ( $P < 0.001$ ). Likewise, poorly spaced intervals were highest (53%) among women who had no job, dropped to 48% among women who were self-employed and lowest (45%) among women with formal employment ( $P = 0.058$ ). Considering place of residence, poor spacing of births was higher among women that resided in rural areas than their urban counterparts (50% versus 45%), and the difference was statistically significant ( $P < 0.001$ ). Moreover, parity (birth order) of at least four presented a highest proportion (61%) of inter-birth intervals that were below the minimum recommendation ( $P < 0.001$ ).

It was observed that 49% of the inter-birth intervals corresponding to singleton birth of the index child being poorly spaced. This proportion was 40% for births of the index children that were

multiple (i.e. twins triplet etc) and the difference was significant ( $P = 0.002$ ). In addition, while 43% of the inter-birth intervals whose index child was born at a health facility were below the recommended minimum length, it was 57% for index births that did not occur in health facilities ( $P < 0.001$ ). We also observed a higher proportion (55%) of poorly spaced births among women who became members of the study area through in-migration than that observed among women who became members through enumeration (47%) and the difference was significant ( $P < 0.001$ ). Finally, the proportion of poorly spaced births was similar for male and female sexes of the index children (48% versus 49%) ( $P = 0.215$ ).

### ***Regression results of correlates of inappropriate birth spacing***

Results of the multivariate (adjusted) logistic regression model of the factors associated with non-adherence to the WHO recommended minimum inter-birth interval length are presented in Table 2.

Findings show that the younger the maternal age the higher was the likelihood of poor spacing of births and vice versa. Women aged between 15 and 19 years were twelve times more likely to have poorly spaced inter-birth intervals compared with women aged 45-49 (OR = 11.82, 95% CI 8.56-16.33). This trend continued but with declining magnitude of the odds ratios for subsequent age categories, except the age category 40-44 in which the likelihood of spacing poorly was low and not different from that for the 45-49 age category (OR = 1.28, 95% CI 0.94-1.76). In terms of marital status, the likelihood that the inter-birth interval was less than the recommended minimum length was less likely among ever married and single women compared with married/in-union women (OR = 0.67, 95% CI 0.59-0.75 and OR = 0.60, 95% CI 0.51-0.70) respectively. On the other hand, women who had no formal education (never been to school) were 26% more likely to be non-adherent to the recommended minimum inter-birth interval compared with those with secondary education and higher (OR = 1.26, 95% CI 1.00 -1.57). Poor spacing of births was also significantly associated with increasing birth order (Para 3: OR = 1.30, 95% CI 1.20-1.40; Para  $\geq 4$ : OR = 2.64, 95% CI 2.37-2.93).

Furthermore, the inter-birth intervals corresponding to multiple births (i.e. twins, triplet etc) of the index child were less likely to be poorly spaced compared with those corresponding to singleton birth of the index child (OR = 0.76, 95% CI 0.59-0.97). We also observed that the inter-birth intervals for which the index child was born elsewhere other than in a health facility were more likely to be less than the recommended minimum length compared with those for which the index child was born in a health facility (OR = 1.81, 95% CI 1.68-1.94). Likewise, the inter-birth intervals of women who became members of the HDSS through in-migration were more likely to be poorly spaced compared with that for women who became members through enumeration (OR = 1.31, 95% CI 1.20-1.42).

Finally, having adjusted for all variables in the multivariate model, we observed no association between non-adherence to the recommended minimum inter-birth interval length and place of residence (OR = 1.03, 95% CI 0.95-1.11) and maternal occupation (no job: OR = 0.85, 95% CI 0.70-1.03; formal employment: OR = 1.03, 95% CI 0.72-1.49).

## Discussion

Our findings reveal that close to half (48.8%) of the inter-birth intervals in Rufiji district were below the WHO recommended minimum length of 33 months for better maternal and child health outcomes. This corresponded to more than two in every five women in the study area not adhering to the recommended minimum inter-birth interval. This implies that a pronounceable proportion of mothers in the study area are at risk of maternal complications and poor health outcomes of their babies due to improper spacing of their births. The median inter-birth interval of 33.4 months observed in this study is similar to that reported in the Tanzanian DHS [16] and Ethiopia, one of the country with the highest fertility rate in Africa [26].

This study identified a good number of factors associated with non-adherence to the minimum recommendation of the WHO on birth spacing. Maternal age and non-adherence to the recommendation were inversely related, such that the younger the maternal age the higher was the likelihood of non-adherence to the recommendation and vice versa. We also observed that the higher the parity the more was the likelihood of non-adherence to the recommendation. However, there were no statistical interaction between maternal age and parity in the prediction of non-adherence to the recommended minimum inter-birth interval. Several other studies have similarly shown that older mothers tend to have longer birth intervals[27;28]. This is likely because older women may have already achieved their desired family sizes compared with the younger ones hence likely to have longer birth intervals [21]. It may also be due to the fact that older women are less fertile compared with the younger women thus leading to longer inter-birth intervals [21;29].

Regarding marital status, inter-birth intervals of women who were single and ever married were less likely than intervals of women in marriage/in-union to be non-adherent (shorter), implying that the latter category of women space births poorly. This observation was expected and there are obvious reasons for it such as frequency of sexual intercourse is higher in marriage than in any other category of marital status [30;31]. However, low utilization of contraceptives methods in Tanzania might be also a contributing factor in the married group although, contraceptive use has been noticed to increase in recent years [16]. This is one of the possibilities why women in marriage may space their births poorly, and has also been reported to be the same in Asia [5]. Given that people marry due to, among other reasons, desire for children, unmarried women will perhaps have less of this desire and will get pregnancies most likely mistakenly (unplanned) thus, likely to have long intervals.

Inter-birth intervals of women with no education (never been to school) were more likely to be shorter compared with that for women with secondary education and higher. Although some studies such as one conducted in Korea in the 80's showed that better educated women space births poorly [32], our finding is consistent with recent findings [28;33]. This may be partly attributable to transformational role that education plays as a catalyst for change that influences decisions and choices [34;35]. Although the contemporary literatures in this field seem to agree about the relationship between the maternal education and birth spacing, a reason for the diversity remains less clear.



Inter-birth intervals beginning with multiple births (twins, triplets and so on) were less likely to be shorter than those whose preceding birth was a singleton. This may be partly due to double or even more logistical difficulties and financial expenses that the family has to incur in the process of upbringing two or more babies simultaneously. It may also be due to parents' satisfaction as far as their desired number of children or family size is concerned, thus likely to delay the next birth. A qualitative study with health service providers in Egypt reports that "... *postponing pregnancy for longer periods usually occurs following the second child ...*" [36].

Considering place of delivery, inter-birth intervals whose index births occurred in the health facilities were less likely to be shorter. It is possible that during antenatal or delivery care seeking from health facilities, women – among other things – are educated on optimum birth spacing, breastfeeding, the use of family planning and risks for adverse pregnancy outcome. The latter is thought to have a greater role in influencing pregnancy preparedness and care [36]. Therefore, it is important to promote and encourage health care seeking from the health facilities during antenatal, childbirth, postnatal and throughout childrearing period.

Finally, evidence of in-migrant women being more likely to space births poorly compared with original residents of the study area indicates the possibility of cultural differences, beliefs and practices of birth spacing [37]. Similarly, it may be that original residents of the study area were better informed on optimal birth spacing from different sources including presence of the Rufiji HDSS in particular than the in-migrants who may not have had a longer duration of exposure to the HDSS.

### **Limitations**

No data was available regarding duration of breastfeeding, contraceptive use, religion, biological and genetic factors which would have alighted more on the question posed.

### **Conclusion and recommendations**

Nearly half of the inter-birth intervals in Rufiji district are poorly spaced. Young maternal age, low maternal education, multiple births to the index, non-health facility delivery of the index child, being an in-migrant resident, increasing parity and being married are associated with non-adherence to the WHO recommended minimum inter-birth interval of 33 months. This calls for Maternal and Newborn Health Services (MNCH) interventions that can integrate birth spacing issues into their programmes. Community- and health facility-based optimum birth spacing education is urgently required for better health outcomes of our mothers and babies.

### **Acknowledgements**

We acknowledge comments received from participants of the Bagamoyo II workshop that was organized by the Ifakara Health Institute (IHI) in which the idea of this paper was first presented. A version of this paper was presented as a poster at the Population Association of America (PAA) meeting which was held in San Francisco, CA, USA, 3-5 May 2012. Comments received are specially acknowledged.

## Authors' contributions

AE conceptualized the research question and wrote the first draft of the manuscript. AE, KB, SM and AS designed the study and analyzed the data. DM, GM and HM participated in designing the study and reviewed critically the manuscript drafts. All the authors read and approved the final manuscript.

## Conflict of interest

None.

## References

1. Davanzo J, Razzaque A, Rahman M, and Hale L, with Ahmed K, Khan MA, Mustafa G, and Gausia K. The Effects of Birth Spacing on Infant and Child Mortality, Pregnancy Outcomes, and Maternal Morbidity and Mortality in Matlab, Bangladesh. 2004. Labour and Population. 9-9-2011.
2. UNICEF. The State of the World's Children, 2004. <http://www.unicef.org/sowc07/docs/sowc07.pdf> . 2003. UNICEF. 9-9-2011.
3. Klerman LV, Cliver SP, Goldenberg RL: **The Impact of Short Interpregnancy Intervals on Pregnancy Outcomes in Low-Income Population.** *American Journal of Public Health* 1998, **88**:1182-1185.
4. Miller JE: **Birth intervals and perinatal health: an investigation of three hypotheses.** *Family Planning Perspectives* 1991, **23**:62-70.
5. Miller JE, Trussell J, Pebley AR, Vaughan B: **Birth spacing and child mortality in Bangladesh and the Philippines.** *Demography* 1992, **29**:305-318.
6. Rutstein S. Effect of birth intervals on mortality and health: Multivariate crosscountry analysis. 2000. MACRO International.
7. Rutstein S. Effect of Birth intervals on Mortality and Health: Multivariate Cross Country Analyses. USAID-sponsored Conference on Optimal Birth spacing for Central America. 2003. Antigua, Guatemala.
8. Rutstein S. Effects of Preceding Birth and Pregnancy Intervals on Child Mortality and Nutritional Status in Less Developed Countries: Evidence from the Demographic and Health Surveys. 2003. ORC Macro.
9. Winikoff B: **The effects of birth spacing on child and maternal health.** *Studies in Family Planning Perspectives* 1983, **14**:231-245.

10. Puffer PR, Serrano CY. Birth Weight, Maternal age and birth orders: Three Important Determinants in infant mortality. Scientific Publication No. 294. 1975. Washington, DC, Pan American Health Organization.
11. Zhu B-P: **Effect of interpregnancy interval on birth outcomes: findings from three recent US studies.** *International Journal of Gynaecology and Obstetrics* 2005, **89**:S25-S33.
12. Yohannes S, Wondafrash M, Abera M, Girma E: **Duration and determinants of birth interval among women of child bearing age in Southern Ethiopia.** *Pregnancy & Childbirth* 2011, **11**:38.
13. Jelliffe DB: **The Assessment of the Nutritional Status of the Community.** *Monogr Ser World Health Organ* 1966, **53**:3-271.
14. Winkvist A, Rasmussen KM, Habicht J-P: **A new definition of maternal depletion syndrome.** *Am J Public Health* 1992, **82**:691-694.
15. Aaby P. Malnutrition Versus Overcrowding in Child Survival. Proceedings of the 21<sup>st</sup> International Population Conference. 351-362. 1989. New Delhi, International Union for the Scientific Study of Population.
16. National Bureau of Statistics (NBS) [Tanzania], ICF Macro. Tanzania Demographic and Health Survey 2010. 2011. Dar es Salaam, Tanzania, NBS and ICF Macro.
17. Mturi AJ: **The Determinants of Birth Intervals Among Non-Contracepting Tanzanian Women.** *African population Studies* 1997, **12**.
18. Trussell J, Martin LG, Feldman R, Palmore JA, Concepcion M, Abu Bajer DN: **Determinants of birth interval length in the Philippines, Malaysia and Indonesia: A hazard model analysis.** *Demography* 1985, **22**:145-168.
19. Rasekh A, Momtaz M: **The Determinants of Birth Interval in Ahvaz-Iran: A Graphical Chain Modelling Approach.** *Journal of Data Science* 2007, **5**:555-576.
20. Orji E, Shittu A, Makinde O, Sule S: **Effect of prolonged birth spacing on maternal and perinatal outcome.** *East Afr Med J* 2004, **81**:388-391.
21. Saumya R, John T, Ian A. Correlates of Inter-birth Intervals: Implications of Optimal Birth Spacing Strategies in Mozambique. *Population Council.* 2006.  
[http://www.popcouncil.org/pdfs/frontiers/FR\\_FinalReports/Mozam\\_OBSI.pdf](http://www.popcouncil.org/pdfs/frontiers/FR_FinalReports/Mozam_OBSI.pdf) . 5-26-2012.
22. Ayanaw A. Proximate determinants of birth interval length in Amhara region: the case of Fagita Lekoma district, Awi- zone. Addis Ababa, Ethiopia. 2008.

23. Yohannis F, Yemane B, Alemayehu W: **Differentials of fertility in rural Butajira.** *Ethiop J Health Dev* 2003, **17**:17-25.
24. WHO. Report of a WHO Technical Consultation on Birth Spacing. 2007. Geneva, Switzerland, WHO. 9-9-2011.
25. Millennium Development Goals Report: Mid-Way Evaluation: 2000-2008. <http://www.tz.undp.org/docs/mdgprogressreport.pdf> . 2012. 5-26-2012.
26. Yohannes S, Wondafrash M, Abera M, Girma E: **Duration and determinants of birth interval among women of child bearing age in Southern Ethiopia.** *BMC Pregnancy & Childbirth* 2011, **11**:38.
27. Chakraborty N, Sharmin S, Islam MA: **Differential pattern of birth intervals in Bangladesh.** *Asia-Pacific Population Journal* 1996, **11**:73-86.
28. Setty-Venugopal V, Upadhyay UD. Birth Spacing: Three to Five Saves Lives. No. 13. 2002. Baltimore, Johns Hopkins Bloomberg School of Public Health, Population Information Program. Population Reports, Series L.
29. Larsen U, Vaupel JW: **Hutterite Fecundability by Age and Parity: Strategies for Frailty Modeling of Event Histories.** *Demography* 1993, **30**:81-102.
30. The Audacious Epigone. Sex frequency by age and marital status. <http://anepigone.blogspot.com/2009/10/sex-frequency-by-age-and-marital-status.html> . 2009. 5-26-2012.
31. Karraker A, DeLamater J, Schwartz CR: **Sexual frequency decline from midlife to later life.** *The Journals of Gerontology, Series B* 2011, **10.1093/geronb/gbr058**.
32. Bumpass LL, Ronald RR, James AP: **Determinants of Korean birth intervals: The confrontation of theory and data.** *Population Studies* 1996, **40**:403-423.
33. Rutstein SO. Trends in Birth Spacing. <http://www.measuredhs.com/pubs/pdf/CR28/CR28.pdf> DHS Comparative Reports No. 28. 2011. Calverton, Maryland, USA, ICF Macro.
34. Dominic B: **Women's Education a Tool of Social Transformation'-A Historical Study Based on Kerala Society.** *International Journal of Scientific & Engineering Research* 2011, **2**.
35. Lopez-Claros A, Zahidi S. Women's Empowerment: Measuring the Global Gender Gap. [https://members.weforum.org/pdf/Global\\_Competitiveness\\_Reports/Reports/gender\\_gap.pdf](https://members.weforum.org/pdf/Global_Competitiveness_Reports/Reports/gender_gap.pdf) . 2005. 2-29-2012.

36. The CATALYST Consortium. Optimal Birth Spacing: An In-depth Study of Knowledge, Attitudes and Practices. <http://www.pathfind.org/site/DocServer?docID=2421> . 2004. 5-29-2012.
37. Riessman CK. **Birth Control, Culture and the Poor.** <http://www.eric.ed.gov/PDFS/ED020209.pdf> . 2012. 5-26-2012.

**Figures**

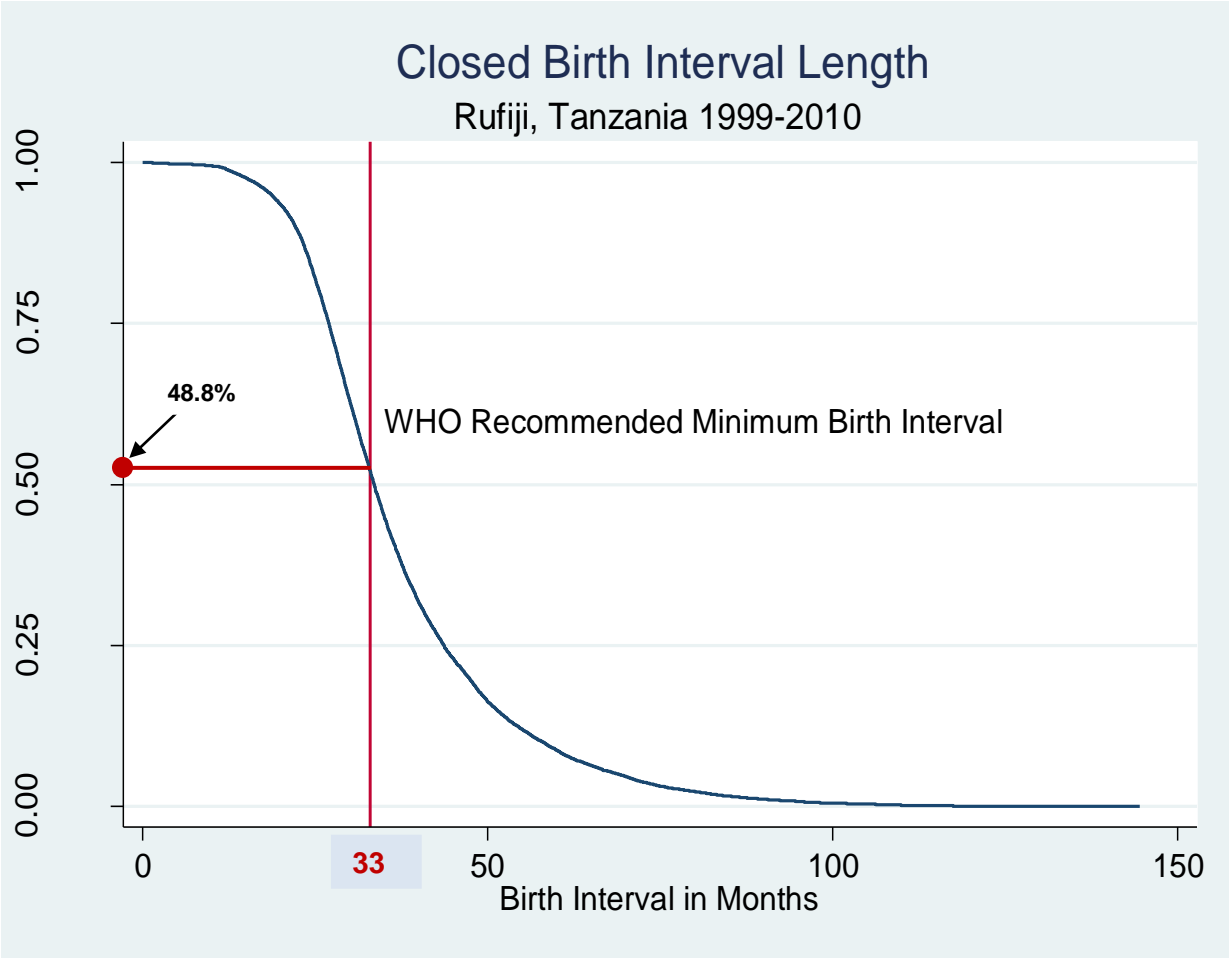


Figure 1. Proportion of inter-birth intervals below (non-adherence) the WHO recommended length of  $\geq 33$  months between two live births for better maternal and child health outcome in Rufiji, Tanzania (n = 15,373)

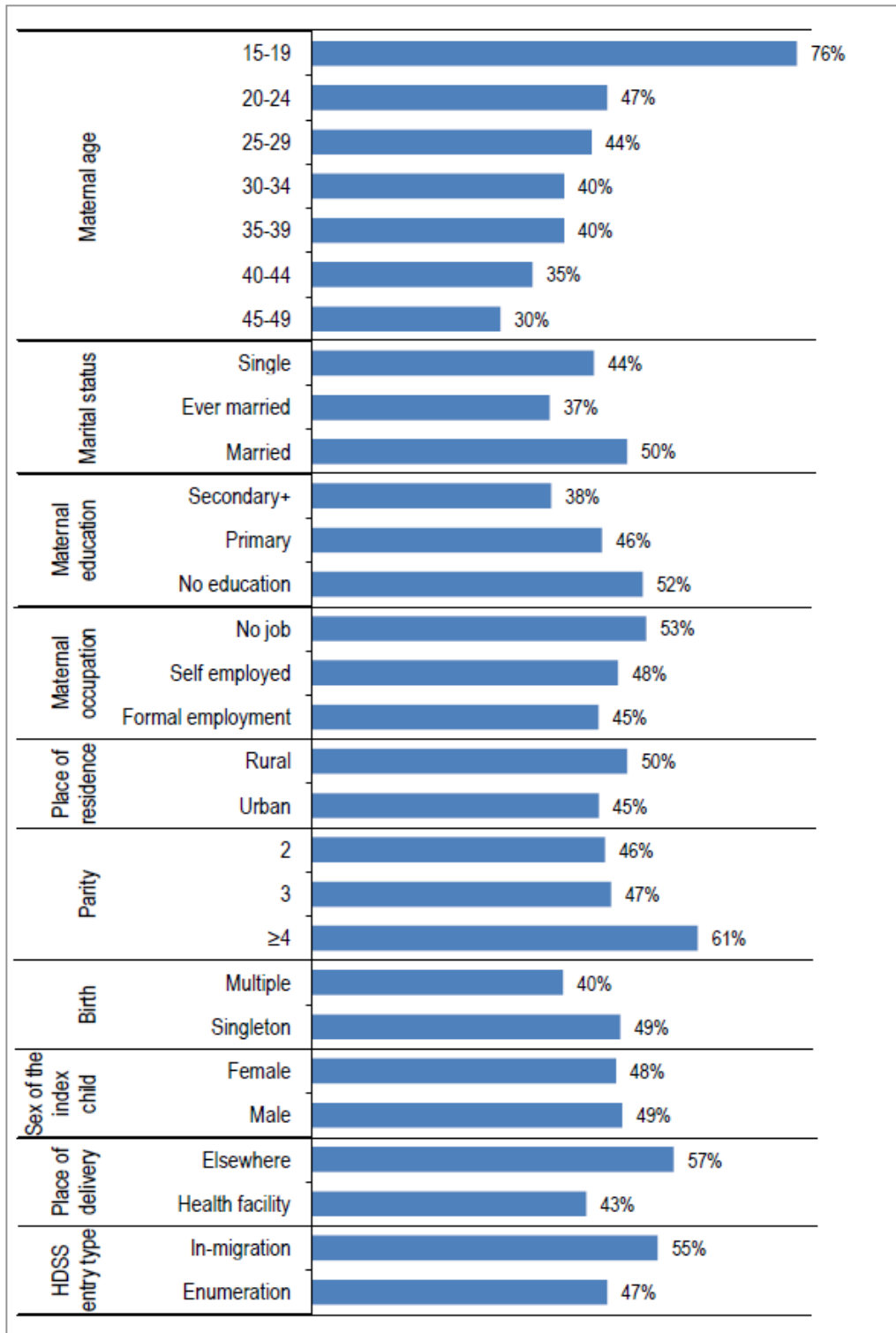


Figure 2. Percent distribution of poorly spaced (<33 months) inter-birth intervals by characteristics of the mother and the child in Rufiji, Tanzania, 1999-2010 (n = 15,373)

## Tables

Table 1. Multivariate logistic regression model of factors associated with shorter inter-birth intervals (<33 months) in Rufiji, Tanzania: 1999-2010 (n = 15,158)

Variable	Odds ratio (OR)	95% Confidence Interval (CI)	P-Value
<b>Maternal age (years)</b>			
15-19	11.82	8.56-16.33	<0.001
20-24	3.87	2.90-5.16	<0.001
25-29	2.22	1.67-2.96	<0.001
30-34	1.95	1.46-2.60	<0.001
35-39	1.58	1.18-2.11	0.002
40-44	1.28	0.94-1.76	0.117
45-49 (ref.)	1.00	--	--
<b>Marital status of mother</b>			
Married (ref.)	1.00	--	--
Ever married (widowed or divorced)	0.67	0.59-0.75	<0.001
Single	0.60	0.51-0.70	<0.001
<b>Maternal education</b>			
Secondary+ (ref.)	1.00	--	--
Primary	1.09	0.87-1.36	0.455
Never been to school	1.26	1.00-1.57	0.045
<b>Maternal occupation</b>			
No job	0.85	0.70-1.03	0.102
Self employed (ref.)	1.00	--	--
Formal employment	1.03	0.72-1.49	0.862
<b>Place of residence</b>			
Urban (ref.)	1.00	--	--
Rural	1.03	0.95-1.11	0.419
<b>Parity</b>			
2 (ref.)	1.00	--	--
3	1.30	1.20-1.40	<0.001
≥4	2.64	2.37-2.93	<0.001
<b>Birth</b>			
Singleton (ref.)	1.00	--	--
Multiple	0.76	0.59-0.97	0.034
<b>Place of delivery of the index child</b>			
Health facility (ref.)	1.00	--	--
Elsewhere	1.81	1.68-1.94	<0.001
<b>HDSS entry type</b>			
Enumeration (ref.)	1.00	--	--
In-migration	1.31	1.20-1.42	<0.001

Goodness-of-fit test, P = 0.071. ref. = reference category. HDSS = Health and Demographic Surveillance System. All variables herein are adjusted for each other.