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ABSTRACT

Introduction: Every year millions of children die before reaching their fifth birthday. While the effect of the length of birth interval on child health and survival is well established, there has been little exploration of the links between birth intervals and causes of under-five mortality at either global or regional levels. The purpose of this study is to explore the association between birth intervals and specific causes of death for children under age 5 years in Afghanistan.

Method: This study is a retrospective analysis of data from the 2010 Afghanistan Mortality Survey (AMS 2010). The analysis is limited to deaths of children under age 5 years that occurred in the three years before the survey. The dependent variable is the cause-specific mortality rate (CSMR) among children under age 5. 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 and the immediately preceding birth to the mother, if any. The analysis used both bivariate and multivariate designs.

Results: After adjusting for socio-demographic characteristics, children with a previous birth interval of less than 18 months have a higher risk of dying from certain causes of death, including sepsis and diarrhea, than children with a previous birth interval of 24-35 months (the reference category). Children with a previous birth interval of at least 60 months also have a higher risk of dying from certain causes, including diarrhea and low birth weight, than children with a previous birth interval of 24-35 months.

Conclusion: The AMS 2010 provides a rich dataset that can be analyzed and used to generate new information for planners, program managers, and policymakers. This study, which combines data from the survey on causes of death with other covariates of the risk of death of children under age 5, has shown mechanisms by which the length of birth intervals may be related to the risks of dying in childhood. In particular, the length of birth intervals is significantly related to mortality risk from diarrhea, sepsis, and low birth weight. Further analyses in other settings are needed to confirm the generalizability of these conclusions and to establish whether children with non-optimal birth intervals are more likely to contract these diseases or to have higher case fatalities, or both.

INTRODUCTION

Every year millions of children die before reaching their fifth birthday. While the effect of the length of birth interval on child health and survival is well established, there has been little exploration of the links between birth intervals and causes of under-five mortality at either global or regional levels.

The purpose of this study is to explore the association between birth intervals and specific causes of death for children under age 5 years in Afghanistan. By comparing the association between the length of birth intervals and various causes of death, we hope to better understand the pathways through which non-optimal birth intervals contribute to child mortality. The findings can help to introduce effective interventions to enhance child survival in Afghanistan.

CONTEXT AND LITERATURE REVIEW

Although under-five mortality remains a major public health problem, levels have dropped worldwide, from 12.0 million under-five deaths in 1990 to 6.9 million in 2011, of which 3.0 million were neonatal deaths, 2.0 million post-neonatal deaths, and 1.9 million deaths among children age 1–4 (UNICEF et al. 2012). In Afghanistan, levels of under-five mortality have decreased, from an estimated 287 deaths per 1,000 live births in 1970 to 121 deaths per 1,000 live births in 2010 (Rajaratnam et al. 2010). The Afghanistan Mortality Survey 2010 (AMS 2010) indicates that the under-five mortality rate is 97 deaths per 1,000 live births, the child mortality rate is 23, and the infant mortality rate is 76 deaths per 1,000 live births (Afghan Public Health Institute et al. 2011).

Findings from the AMS 2010 show that access to maternal health services has improved markedly. The percentage of women who received antenatal care (ANC) from a skilled provider for their most recent birth increased from 16%, as estimated by the 2003 Multiple Indicator Cluster Survey (MICS 2003), to 60%, as reported by the AMS 2010. In addition, the proportion of births attended by medically skilled providers rose from 14% in 2003 to 34% in 2010. Prevalence of modern contraceptive use has also doubled, from 10% in 2003 to 20 % in 2010 (Afghan Public Health Institute et al. 2011, CSO and UNICEF 2004). Despite these improvements, rates of maternal and child mortality in Afghanistan are still higher than in other countries in the region.

One effective intervention for improving child survival is to promote optimal birth spacing. The research literature documents a close association between birth spacing and child mortality. A meta-analysis by Conde-Agudelo and colleagues in 2006 found that both short birth intervals (6-17 months) and long birth intervals (59 months or more) were associated with significantly greater risk for adverse perinatal outcomes, such as preterm birth, low birth weight, and small size for gestational age (Conde-Agudelo et al. 2006). The authors suggested that spacing pregnancies appropriately could help to prevent such adverse outcomes. Earlier evidence from Pakistan in 1984 showed a strong relationship between preceding birth intervals of less than two years and childhood mortality rates. After age 2 the relationship was weaker, but nevertheless appreciable. The effects of birth spacing were not changed when controls were introduced for residence, education, sex, and family size (Cleland and Sathar 1984). A 2008

study by Rutstein using DHS data found that the risk of mortality rapidly decreases as the birth interval increases up to 24-29 months and then decreases more slowly with longer birth intervals, but increases again for intervals of 96 or more months (Rutstein 2008). Other studies in India, Malawi, Bangladesh and other settings have established similar associations between birth intervals and child mortality (Whitworth and Stephenson 2002, St George et al. 2000, Manda 1999, Kuate Defo 1997, DaVanzo et al. 2004, Ronsmans 1996, Boerma and Bicego 1992, Yigzaw and Enquselassie 2010).

A number of causal mechanisms could explain the effect of the length of birth intervals on the risk of child mortality. In a systematic review of 58 observational studies, Conde-Agudelo and colleagues identified several mechanisms as links between short birth intervals and adverse health consequences, including folic acid deficiency, cervical insufficiency, vertical transmission of infections, inadequate breastfeeding, and sibling competition (Conde-Agudelo et al. 2012).

According to a systematic analysis done in 2008 by Black, the main causes of child mortality at age 1-59 months were infectious diseases, particularly pneumonia, diarrhea, and malaria. Forty-one percent of child deaths occurred during the first 28 days of life, mainly due to preterm birth complications, followed by birth asphyxia, sepsis, and pneumonia (Black 2010). In addition, a 2010 study in India showed that prematurity and low birth weight, followed by neonatal infections and birth asphyxia, were responsible for most neonatal deaths (The Million Death Study Collaborators 2010). Similarly, WHO estimated in 2005 that pneumonia, diarrhea, malaria, and neonatal sepsis accounted for more than half of all child deaths (Bryce 2005). A retrospective cohort study in 2003 found that the probability of complications such as intrauterine growth retardation, preterm birth, and perinatal death were most likely to occur with birth intervals of less than six months (Smith et al. 2003).

Despite such findings, the literature contains little information about the effect of the length of birth interval on causes of child mortality. The purpose of this study is to help fill this knowledge gap.

DATA AND METHODS

This study is a retrospective analysis of data from the 2010 Afghanistan Mortality Survey (AMS 2010). The analysis is limited to deaths of children under age 5 years that occurred in the three years before the survey.

The dependent variable is the cause-specific mortality rate (CSMR) among children under age 5. 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 and the immediately preceding birth to the mother, if any. The analysis used both bivariate and multivariate designs. A multivariate logistic regression model was applied to take into account the confounding effects of other factors affecting child mortality, such as age of mother at birth, birth order, age at death, type of residence, and economic status as measured by the DHS wealth index.

The AMS 2010 applied the standard procedures of the Demographic and Health Surveys (DHS). The AMS 2010 was implemented by the Afghanistan National Public Health Institute (ANPHI) and the Central Statistics Organization (CSO), with technical support from ICF International, the Indian Institute of Health Management Research (IIHMR), and WHO/EMRO. The main objectives of the AMS 2010 included collecting up-to-date information on the levels and causes of child, maternal, and adult mortality, fertility, family planning, and use of maternal health services such as antenatal care, institutional delivery, skilled birth attendants, and postnatal care. These indicators were estimated for the country as whole, for urban and rural areas separately, and for each of three survey domains (North, Central, and South).

The survey used a stratified two-stage cluster sampling design. The survey sample was selected from the 2011 Population and Housing Census (PHC) preparatory frame obtained from CSO. Overall, the survey was implemented in 22,351 households in all 34 provinces of the country. Due to security issues, however, the design of the survey excluded the rural areas of Kandahar, Helmand, and Zabul provinces. Also, 32 of the 751 clusters that were initially selected could not be covered due to insecurity. As a result, the survey covered 87% of the population of the country.

The AMS 2010 applied three types of questionnaires: a household questionnaire, a woman's questionnaire, and a verbal autopsy (VA) questionnaire. The household questionnaire

collected general household information, such as location, household possessions, deaths, migration in and out of the household, and out-of-pocket expenditures for outpatient and in-patient services. A roster of household members collected information on the sex, age, relationship to the head of the household, and de-facto and de-jure household status.

For the individual woman's questionnaire, a sample of women age 12-49 who stayed in the household the night before the survey were selected for interviewing. Questions were asked of 47,848 women and included a complete birth history for each child, with birth dates, sex, multiplicity of births, survival status, and age at death if not surviving, as well as data on the women's marital status and knowledge and use of family planning. Also, the individual woman's questionnaire collected information about antenatal, delivery, and postnatal care received by married women for their last birth in the five years before the survey. A demographic history of the respondent's siblings was included, in which women provided information about the number of children of their mother and the survival status of brothers and sisters, as well as age of surviving siblings or age at death and time since death of non-surviving siblings. Further information obtained by the questionnaire concerned the death of a sister, as to whether she died during pregnancy, during delivery, or in the two months after birth, to ascertain whether the death was pregnancy related.

The verbal autopsy (VA) used three forms and collected information from households about deaths that occurred in the three years preceding the interview, including the history of illness, signs and symptoms, and care received by the deceased before death. Fifteen physicians trained on the International Statistical Classification of Diseases and Related Health Problems (ICD-10) classification of cause of death reviewed all death records and filled out standard WHO death certificates noting the cause of death.

The data collected from the 22,351 households identified 6,044 deaths that occurred in the five-year calendar period prior to the survey, of which 2,904 were deaths of children under age 5. The VA questionnaire was completed for 3,933 of the deaths that occurred in the three-year calendar period prior to the survey, of which 1,927 deaths were to children under age 5, including those declared as born dead (Table 1).

Table 1. Number of records of various types, Afghanistan Mortality Survey, 2010

	Unweighted number	Weighted number
Households	22,351	22,351
Members		
De jure	177,810	175,438
De facto	177,392	175,079
Individual interviews		
Live births in history	116,360	115,770
Live births in preceding eight years	47,661	47,182
Stillbirths in history	2,554	2,493
Stillbirths in preceding three years	574	563
Deaths to children in pregnancy history		
Deaths of all ages	9,288	9,698
Deaths to children under age 5	8,547	8,963
Household deaths since 1 Hammal 1384*		
Deaths to household members of all ages**	6,044	6,212
Deaths to children under age 5	2,904	3,019
Verbal autopsies for deaths since 1 Hammal 1386*	3,933	3,951
Deaths to children under 5 and still births[#]	1,927	1,980
Matched verbal autopsy (VA) records		
Matched VA records for deaths under age 5[##]	1,618	1,679

* Deaths to usual household residents in the five calendar years prior to fieldwork were recorded (since 1 Hammal 1384 in the Afghan calendar, or 21 March 2005 in the Gregorian calendar). All recorded household deaths that occurred in the three calendar years prior to field work (since 1 Hammal 1386 in the Afghan calendar) were followed up with Verbal Autopsy questionnaires.

** Includes deaths with missing or unknown age: 14 (unweighted) and 125 (weighted).

[#] Excludes nine deaths in VA form 1 and one death in VA form 2 with missing age at death.

[##] Among the matched VA records for children who died under age 5, 88 (unweighted) and 90 (weighted) were declared "born dead" and this information was missing for 2 (unweighted and weighted) on VA form 1. These children are excluded.

This study linked information on each child's cause of death from the VA with information on the woman's birth history from the women's questionnaire. Of the 1,927 VA death reports for children under age 5, 1,618 were successfully matched to children listed in the women's birth histories. The two files were matched using the child's sex and date of birth,

allowing for a discrepancy in the date of birth between files of one day in either direction. The final analytic sample for this study contained matched information for 1,618 deaths in the three years preceding the survey.

To derive overall estimates of the probability of dying in the first five years of life, this study also used the birth cohort corresponding to the period captured in the verbal autopsy. The VA included deaths to children in the three years before the interview, so these under-five deaths could correspond to births up to eight years before the interview. Thus, estimates of under-five mortality were generated using the 47,661 live births in the eight years before the interview.

The analysis begins with an assessment of the percent distribution of cause of death, separately for each category of birth interval. Logistic regression models were run to calculate adjusted percent distributions of cause of death, so that the distribution of causes of death could be examined within birth interval categories, after adjusting for levels of other key background characteristics that could also affect cause of death. The logistic regression models adjusted for the mother's age at birth, the survival status of the preceding pregnancy, maternal education, residence, wealth, and geographic remoteness. To derive adjusted percentages, the unadjusted percentages were multiplied by the adjusted risk ratios for birth intervals generated in the logistic models.

In order to calculate adjusted cause-specific mortality rates, first the all-cause under-five mortality rates were calculated among live births in the eight years preceding the interview. Cox proportional hazard models were used to calculate the differential probability of dying in each birth interval category (see Appendix Table 1 for unadjusted all-cause early child mortality rates disaggregated by birth interval category). The overall risk of dying by age 5 in the reference birth interval category (24-35 months) was multiplied by the adjusted relative risk of dying in each birth interval category, in order to generate the adjusted risk of dying by age 5, controlling for the key background characteristics listed above. These all-cause mortality estimates were then multiplied by the adjusted distributions of cause of death (presented in Table 3) in order to calculate cause-specific under-five mortality rates. To generate standard errors for these estimates, the standard errors associated with beta coefficients from the logistic regression model estimating the odds of dying from specific causes were combined with the standard errors

associated with beta coefficients from the Cox proportional hazards model estimating the overall risk of death. SPSS Version 19 was used for this study.

RESULTS

Table 2 shows the distribution of births and matched deaths to children under age 5 by their preceding birth interval. Among all births in the eight years preceding the interview, 17% were first births. Short intervals of under 24 months accounted for 33% of the births. Slightly less than one-third of the births occurred 24-35 months after the preceding birth, and the remaining 21% of births occurred more than 35 months after the preceding birth.

Of all deaths among children under age 5 that took place in the eight years before the survey (3,015), 18% were among first–born children. A higher proportion of children who died had a short birth interval of 0-23 months, at 42% compared with 33% among all children. For children who died, just over one-fifth of the preceding birth intervals were 24-35 months, and 18% had a previous birth interval of 36 or more months.

The distribution of birth intervals within the sample of VA-matched deaths is similar to the distribution of birth intervals among all deaths to children under age 5 in the eight years preceding the survey, although a somewhat smaller percentage of matched children who died had a birth interval of less than two years compared with all dead children (36% versus 42%).

Table 2. Percent distribution of births in the preceding eight years by duration of preceding birth interval, according to survival status, and percent distribution of matched verbal autopsy (VA) records by preceding birth interval, according to age at death, unweighted

	Preceding birth interval						Total	
	0-23 months	24-35 months	36-47 months	48-59 months	60+ months	First births		
	%	%	%	%	%	%	%	N
Births in the preceding eight years								
All births	33.1	29.3	11.5	4.8	4.3	16.9	100.0	47,521
Living children	32.5	29.8	11.7	4.8	4.3	16.9	100.0	44,455
Dead children under age 5	42.3	21.5	9.3	4.1	5.0	17.7	100.0	3,015
VA matched deaths to children under age 5								
All deaths to children under age 5	36.2	21.9	12.1	5.8	6.6	17.5	100.0	1,618
Neonatal	34.9	22.4	10.3	4.8	5.7	21.8	100.0	682
Post-neonatal	34.9	21.3	12.7	6.0	8.9	16.2	100.0	582
Infant	34.9	21.9	11.4	5.4	7.2	19.2	100.0	1,264
Toddler (12-23 months)	41.2	22.7	13.9	6.2	4.1	11.9	100.0	194
Age 24-59 months	40.0	20.6	15.6	8.8	4.4	10.6	100.0	160

Table 3 presents the percent distribution of deaths by specific causes, separately within each birth interval group. In the full sample of 1,618 VA matched deaths to children under age 5, acute respiratory infection caused more than one-fifth of the deaths, while just under one-fifth of the deaths resulted from perinatal conditions. Diarrhea and sepsis were each the primary causes of 10% of the deaths, and injury was the primary cause for an additional 7%. Congenital conditions, low birth weight/being born preterm, and malnourishment were each the primary cause for under 5% of deaths; the remaining 20% of deaths had other causes.

Several causes of death, including sepsis, low birth weight/preterm birth, and diarrhea, appear to be a more prevalent cause of death for children with either a short or long birth interval compared with children with the optimal birth interval of 24-35 months. The percentage of deaths due to sepsis, for example, is highest among births in both the shortest and longest birth interval range and lowest in the optimal birth interval of 24-35 months. In contrast, perinatal conditions appear to be a slightly more common cause of death for children with a birth interval in the optimal range compared with children with either short or long birth intervals.

Table 3. Unadjusted and adjusted percentages of children dying by specific causes and birth intervals among children dying before age 5 in the three years preceding the survey, Afghanistan 2010

	Cause of death																			
	ARI		Diarrhea		Sepsis		Perinatal conditions		Injury		Congenital		Low birth weight/ preterm		Mal-nourished		Other causes		Total	
	%	Adj %	%	Adj %	%	Adj %	%	Adj %	%	Adj %	%	Adj %	%	Adj %	%	Adj %	%	Adj %	%	Adj %	N
Birth interval																					
<18 months	19.6	19.0	11.4	12.6	12.0	12.6	18.7	17.3	6.1	6.6	4.1	3.9	5.6	5.8	3.8	3.6	18.7	18.6	100.0	100.0	342
18-23 months	22.2	21.9	15.6	16.4	7.8	7.9	12.8	13.1	9.1	9.0	4.9	4.9	2.9	2.4	5.3	4.7	19.3	20.3	100.0	100.0	243
24-35 months*	**20.9**	**20.9**	**7.6**	**7.6**	**10.7**	**10.7**	**18.6**	**18.6**	**8.8**	**8.8**	**3.4**	**3.4**	**4.8**	**4.8**	**4.2**	**4.2**	**20.9**	**20.9**	100.0	100.0	354
36-47 months	28.1	27.7	11.2	11.6	7.7	8.1	13.3	11.6	7.1	8.1	3.1	3.5	5.6	6.2	3.6	3.6	20.4	19.9	100.0	100.0	196
48-59 months	25.5	25.8	11.7	11.5	7.4	7.4	18.1	16.9	9.6	10.5	2.1	2.2	4.3	5.3	3.2	3.2	18.1	17.6	100.0	100.0	94
60+ months	15.1	16.7	11.3	11.9	12.3	13.9	19.8	16.4	4.7	5.6	3.8	3.3	6.6	7.9	3.8	4.6	22.6	20.4	100.0	100.0	106
First births	20.8	18.5	6.7	8.7	11.0	12.4	23.3	24.2	4.2	3.8	4.2	3.4	4.2	4.2	6.0	5.6	19.4	20.0	100.0	100.0	283
Total	21.6		10.4		10.1		18.0		7.0		3.8		4.8		4.4		19.8		100.0		1,618

Note: Sample size and percentages are presented unweighted. Adjusted percentages were calculated using logistic regression models which adjust for mother's age at birth, the survival status of the preceding pregnancy, maternal education, residence, wealth, and geographic remoteness.

*This interval was used as the reference category in the logistic regression models used to calculate adjusted percentages.

Multivariate Analysis

Table 4 presents the adjusted risk of dying of specific causes by birth interval, for children dying under age 5. The relationship between the preceding birth interval and the causes of mortality is considered statistically significant for p-values less than 0.05. For example, among children whose preceding birth interval was <18 months, the adjusted risk of dying from ARI before reaching age 5 is 19 deaths per 1,000 live births (risk ratio = 0.019). In other words, of each 1,000 live births with a preceding birth interval shorter than 18 months, an estimated 19 children will die from ARI before reaching their fifth birthday.

After adjusting for birth order, mother's age at birth, survival status of the preceding pregnancy, maternal education, residence, wealth, and geographic remoteness, children with a previous birth interval of less than 18 months have a higher risk of dying from some causes of death than children with a previous birth interval of 24-35 months (the reference category). The rate of dying from sepsis by age 5 is significantly higher (p=0.036) among children with a preceding birth interval <18 months than among children with a preceding birth interval of 24-35 months. Similarly, the risk of dying before reaching age 5 due to diarrhea is significantly higher among children with a preceding birth interval <18 months than among children with a birth interval of 24-35 months (p=0.003), after adjusting for background characteristics. Overall, the risk of dying from causes in later young childhood is more than twice as high among children with a preceding birth interval of less than 18 months as among children with a preceding birth interval of 24-35 months.

Children also have an elevated risk of dying from some specific causes of death if the preceding birth interval was at least 60 months. This pattern is significant for the diarrhea-specific adjusted mortality risk (p=0.037) and the low birth weight/preterm-specific adjusted mortality risk (p=0.039), such that the adjusted risk of dying due to diarrhea and low birth weight is significantly greater among children with a preceding birth interval of 60+ months than among children with a preceding birth interval of 24-35 months.

Table 4. Adjusted risk of dying by specific causes and birth interval among children dying before age 5, Afghanistan 2010

	Cause-specific mortality risk (p-value in parentheses)											
Birth interval	**ARI**	**Diarrhea**	**Sepsis**	**Perinatal conditions**	**Injury**	**Congenital**	**Low birth-weight / preterm**	**Mal-nourished**	**Other causes**	**Early in life causes***	**Causes in later young childhood***	**N**
<18 months	0.019	0.012	0.012	0.017	0.006	0.004	0.006	0.004	0.018	0.026	0.053	342
	(0.107)	(0.003)	(0.036)	(0.100)	(0.219)	(0.080)	(0.052)	(0.186)	(0.117)	(0.066)	(0.042)	
18-23 months	0.013	0.010	0.005	0.008	0.005	0.003	0.001	0.003	0.012	0.012	0.035	243
	(0.207)	(0.007)	(0.408)	(0.440)	(0.232)	(0.096)	(0.587)	(0.204)	(0.252)	(0.411)	(0.106)	
24-35 months (Reference)	**0.010**	**0.004**	**0.005**	**0.009**	**0.004**	**0.002**	**0.002**	**0.002**	**0.010**	**0.013**	**0.024**	354
36-47 months	0.015	0.006	0.005	0.006	0.005	0.002	0.003	0.002	0.011	0.012	0.033	196
	(0.103)	(0.080)	(0.413)	(0.525)	(0.306)	(0.269)	(0.151)	(0.366)	(0.286)	(0.411)	(0.135)	
48-59 months	0.015	0.007	0.004	0.010	0.006	0.001	0.003	0.002	0.010	0.014	0.034	94
	(0.131)	(0.081)	(0.461)	(0.308)	(0.171)	(0.509)	(0.234)	(0.439)	(0.352)	(0.304)	(0.141)	
60+ months	0.012	0.009	0.010	0.012	0.004	0.002	0.006	0.003	0.015	0.019	0.038	106
	(0.311)	(0.037)	(0.080)	(0.249)	(0.449)	(0.257)	(0.040)	(0.196)	(0.189)	(0.169)	(0.160)	
First births	0.015	0.007	0.010	0.020	0.003	0.003	0.003	0.005	0.016	0.026	0.040	283
	(0.192)	(0.105)	(0.088)	(0.037)	(0.578)	(0.186)	(0.246)	(0.076)	(0.153)	(0.054)	(0.180)	
Total												**1,618**

*Causes early in life include perinatal conditions, congenital, low birth weight/preterm; causes in later young childhood include ARI, diarrhea, sepsis, and malnutrition.

DISCUSSION

The 2010 Afghanistan Mortality Survey (AMS 2010) indicates that more children in Afghanistan are living past their fifth birthday than at any time in the past. Fewer women are dying during pregnancy and childbirth than previously reported. Despite these improvements, one Afghan child in every 10 dies before age 5, and one in every 13 dies within the first year after birth.

The survey shows that fertility rates have declined and more women are using family planning. Still, Afghanistan has higher fertility and lower levels of contraceptive use than neighboring countries such as Bangladesh, India, and Pakistan. Afghan women now give birth to about five children, on average, over the course of their reproductive years. As we might expect, given that most Afghan women have many births, short birth intervals are common: one-third of all births in the eight years preceding the 2010 AMS occurred after a birth interval of less than two years, while 42% of all children who died before reaching age 5 were born within two years of a preceding birth.

Surveillance reports in the country have shown that acute respiratory infection (ARI) and diarrheal diseases are the leading causes of death among children under age 5 (DEWS 2011). The present study, however, using AMS data found that ARI and perinatal conditions are the leading causes of death for children under age 5 (at 22% and 18%, respectively), followed by diarrheal disease and sepsis (at 10% each) (Rasella et al. 2010).

For the first time, the current study establishes a relationship between birth intervals and cause-specific child mortality. The findings suggest that children born with non-optimal birth intervals (<18 months or 60+ months) may be particularly vulnerable to certain causes of death, including diarrhea, sepsis, low birth weight, perinatal conditions, and ARI (for ARI and perinatal conditions, the pattern is visible but not statistically significant). Avoiding births with very short or long birth intervals would likely reduce the risk of dying due to such health problems.

Children with a birth interval less than 18 months have a significantly higher risk of dying due to sepsis than children born an optimal 24-35 months after a preceding birth. Sepsis is a major problem among children in Afghanistan, which could be reduced by achieving or coming closer to the optimal interval. The significant relationship between short birth intervals

and under-five mortality from diarrheal diseases and low-birth weight/preterm causes is a trigger point for program managers and policymakers to align efforts to reduce child mortality with efforts to encourage optimal birth spacing.

According to findings of this study, long birth intervals also present a higher risk of under-five mortality, significantly so for diarrhea-specific adjusted mortality risk and low-birth weight/preterm-specific adjusted mortality risk. That is, both extremely short and long intervals between pregnancies put children at a higher risk of dying young. Studies on child mortality and its causes support such findings (Ghosh 2012). Policymakers should focus on control and prevention of sepsis, which could lead to considerable reductions in child and newborn mortality. This focus, and particularly better care for infants born at home, has been shown to avert most deaths among newborns in rural India (Bang et al. 1999).

The AMS 2010 provides a rich dataset that can be analyzed and used to generate new information for planners, program managers, and policymakers. This study, which combines data from the survey on causes of death with other covariates of the risk of death of children under age 5, has shown mechanisms by which the length of birth intervals may be related to the risks of dying in childhood. In particular, the length of birth intervals is significantly related to mortality risk from diarrhea, sepsis, and low birth weight. Further analyses in other settings are needed to confirm the generalizability of these conclusions and to establish whether children with non-optimal birth intervals are more likely to contract these diseases or to have higher case fatalities, or both.

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APPENDIX

Table A1. Neonatal, postneonatal, infant, toddler (12-23 months), child (24-59 months), child (12-59 months), and under-five mortality rates* for the eight-year period preceding the survey, Afghanistan 2010

	N	Neonatal mortality	Post-neonatal mortality	Infant mortality	Toddler (12-23 months) mortality	Child (24-59 months) mortality	Child (12-59 months) mortality	Under-five mortality
Birth interval								
< 18 months	1,979	35.8	45.5	81.9	8.5	9.6	17.8	99.2
18-23 months	13,547	17.6	25.5	43.3	7.8	8.4	15.9	58.6
24-35 months	13,542	16.1	19.9	36.3	5.6	5.1	10.7	46.6
36-47 months	5,540	14.3	26.0	40.1	7.7	9.3	16.7	56.0
48-59 months	2,264	15.9	26.8	42.5	7.6	11.3	18.4	60.0
60+ months	2,122	23.1	37.5	60.5	5.9	7.7	13.3	73.4
First births	8,082	32.4	29.9	63.5	5.3	4.5	9.8	73.2
Total	**47,076**	**20.3**	**26.2**	**46.7**	**6.7**	**7.0**	**13.5**	**59.8**

* Rates may not match those presented in the 2010 Afghanistan Mortality Survey due to the non-standard eight-year reference period used in this study.