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Further Evidence of the Effects of Preceding Birth Intervals on Neonatal, Infant, and Under-Five-Years Mortality and Nutritional Status in Developing Countries: Evidence from the Demographic and Health Surveys

Shea O. Rutstein

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Shea O. Rutstein

Macro International Inc.

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Address for correspondence: Shea O. Rutstein, Demographic and Health Research Division, Macro International Inc. 11785 Beltsville Drive, Calverton, MD 20705, USA; Phone: 301-572-0950; Fax: 301-572-0999; Email: shea.o.rutstein@macrointernational.com

EXECUTIVE SUMMARY

In response to my 2005 article on the effect of birth spacing on infant and child mortality, a number of suggestions were made to improve the research. This paper, which is based on a much larger, more recent set of Demographic and Health Surveys (DHS) revises that research and incorporates the suggestions for analytical improvement.

A handful of new studies have come out since the 2005 article, all of which indicate that too short intervals (either birth or pregnancy) are associated with adverse pregnancy outcomes, morbidity in pregnancy, and increased infant and child mortality. Long birth intervals were also seen as contributing to adverse pregnancy outcomes.

This study pools birth history data from all 52 DHS surveys conducted from 2000 through 2005. Utilizing life tables and Cox hazard multivariate regression, the effects of the birth-to-pregnancy interval are studied for infant and child mortality, broken down into several periods – early neonatal, neonatal, post-neonatal, infant, child (one to four years), and under-age five years. The birth-to-pregnancy interval is classified into groups that will be harmonized with those of forthcoming studies. In the analyses, intervals based on imputed dates of birth are excluded. The resulting data set includes 1,123,454 births.

Confounding relationships are statistically removed by including control variables for birth-specific characteristics (duration of the pregnancy, maternal age at birth, birth order, sex, survival of preceding child, sex of preceding child, multiplicity of the birth, use of health care service and wantedness of the birth), mother-specific characteristics (education, area of residence), and household characteristics (an index of wealth, source of drinking water, type of toilet facility and possession of a refrigerator). Birth weight, size at birth, and nutritional status at the time of the survey (stunting, wasting and underweight) are studied using means and logistic

regressions. Controls used in addition to the above were breastfeeding status and types of other child feeding.

Bivariate results indicate that 36 to 47 months between a birth and the next conception is the interval with the lowest risk of neonatal, infant, and under-five mortality. There are weak relationships of the birth-to-pregnancy interval with small size at birth and low birth weight, with children conceived in the six months following a birth most likely to be small and of low birth weight. Bivariate results show substantial declines in stunting as the birth-to-pregnancy interval increases among children conceived more than 18 months after the birth of a preceding child.

The multivariate results confirm and clarify the bivariate findings. The relationship between the preceding birth-to-pregnancy interval and under-five mortality is highly significant ($p<0.001$) and each interval group under 36 months is significantly different from the reference group of 36 to 47 months as well as from the group 60 to 96 months. For intervals of less than 36 months, the adjusted risk ratios are always substantially higher than those of the reference group.

The risk of mortality trends downwards with increasing birth interval, rapidly until 24 to 29 months and then more slowly, with longer intervals and with a final upturn for intervals of 96 or more months duration. For child mortality (one to four years), the effect of the duration of the preceding birth to pregnancy interval is almost a constant decline in mortality with an increase in interval length. The risk ratios for all interval groups are significantly different from the reference group. The risk of child death falls from 2.2 times that of the 36 to 47 month group for conceptions within six months of the preceding birth to 0.7 for conceptions at 96 months or more. There is no upturn in child mortality for the open-ended long interval as is noticed for under-five mortality.

The analysis of infant mortality is based on births that occurred 0 to 59 months prior to the survey to ensure full use of available data and control variables. Compared with a preceding birth-to-pregnancy interval of 36 to 47 months, children conceived with interval durations less than 24 months have significantly higher risks of mortality. There is little difference in mortality risk for the duration groups between 24 and 59 months. However, the mortality risk increases for births with durations of 60 months or more. The shorter the duration of the interval for intervals less than 24 months, the higher is the risk of dying during infancy.

The risk of neonatal mortality by preceding birth-to-pregnancy interval is U-shaped with the lowest point at the reference group (36-47 months). All interval groups outside the period 24 to 47 months have adjusted relative risks that are significantly higher than that of the reference group. Intervals shorter than 24 months have adjusted relative risks that are from 19 percent to 146 percent higher than the risk of the reference group's mortality. Intervals longer than the reference group have risks that are from 20 percent to 79 percent higher.

For children conceived less than six months after a prior birth, the odds of low birth weight are 42 percent greater than that of the reference group (ci=1.29-1.56). For children conceived with an interval of 6 to 11 months, the odds are 16 percent higher (ci=1.07-1.26). The relationship for small or very small size at birth is somewhat similar to that with low birth weight. One notable difference is the larger relative odds for children conceived within six months of a prior birth. The increase in the odds of being small or very small at birth for interval group 12 to 17 months is also statistically significant (rr =1.04, ci=1.01-1.07).

From the multivariate analyses, it is clear that chronic and overall undernutrition decline substantially with the longer the interval. Children conceived after an interval of 12 to 17 months are 23 percent more likely to be stunted (ci=1.19-1.26) and 19 percent more likely to be underweight (ci=1.15-1.24) than children conceived after an interval of 36 to 47 months. Children conceived after even longer durations are less likely to be stunted (up to 18 percent less, ci=0.77-0.87) and underweight (up to 18 percent less, ci=0.75-0.88) than children conceived during the reference period.

In general, the findings of this study confirm those of the author's preceding study on 17 DHS surveys. While the excess risk of mortality is highest for very short intervals (less than 12 months birth to pregnancy), there are relatively few children conceived at such intervals (14 percent). Combining both the increased risk of death for children conceived between 12 and 35 months with the great number of children with such intervals (42 percent) results in substantial declines in mortality by avoiding these intervals. The population attributable risk (PAR) for under-five mortality for avoiding conceptions at less than 24 months after a birth is 0.134. In other words, if all women would wait at least 24 months to conceive again, under-five deaths would fall by 13 percent. The effect of waiting 36 months to conceive again would avoid 25 percent of under-five deaths. The impact of avoiding these high risk intervals (less than 36 months) would be a total of 1,836,000 deaths avoided annually in less developed countries, excluding China (where there is a one child policy). Thus, parents who want their children to survive and thrive would do well to wait at least 30 months after a birth to conceive another child.

INTRODUCTION

Purpose

Parents want their children to survive and thrive. In 2005, the author published a study of the effects of birth spacing on infant and child mortality and nutritional status (Rutstein, 2005). The study was based on data collected during 17 Demographic and Health Surveys (DHSs). The purpose of this paper is to analyze a new and larger set of DHS, use analysis methodologies that make the greatest use of the information in the data, control for additional potential confounders, and use a "harmonized" definition and categorization of the birth spacing variable to allow for easy comparison with other studies.

History and Literature Review

For a review of the history and literature of studies into birth spacing, please refer to Rutstein (2005). Since that paper there have been a few new studies: Conde-Agudelo et al. (2007), on the basis of a meta-analysis of 22 studies, found evidence that long interpregnancy intervals (over five years) were associated with increased risk of preeclampsia and labor dystocia. Short intervals were associated with increased risk of uterine rupture and uteroplacental bleeding disorder, and both long and short intervals were associated with other adverse maternal outcomes of pregnancy. However, the authors concluded that more research is needed. In an earlier systematic literature review and meta-analysis (Conde-Agudelo, 2006), these authors concluded that interpregnancy intervals shorter than 18 months and longer than 59 months are significantly associated with increased risk of adverse perinatal outcomes, such as pre-term birth, low birth weight, and small for gestational age. They suggest that spacing pregnancies appropriately could help prevent such adverse perinatal outcomes. Zhu B. et al. (2006) studied the relationship between labor dystocia and interpregnancy interval using linked birth certificate-hospital discharge data for Michigan infants born between 1994 and 2002. The authors found that labor dystocia is common. In singleton births to multiparous mothers, labor dystocia increased with interpregnancy interval in a dose-response fashion, when controlled for confounding factors. Lowest levels of dystocia occurred in pregnancies occurring less than two years after a preceding pregnancy and the adjusted odd ratio for dystocia rose to 1.50 for intervals of 10 or more years. Additionally, the authors state that functional dystocia was associated more strongly with interpregnancy interval than mechanical dystocia.

DaVanzo et al. (2007) used data from the Matlab demographic surveillance system in Bangladesh to study the effects on pregnancy outcomes of the preceding interpregnancy interval and the type of pregnancy outcome that began the interval. With socioeconomic and demographic covariates controlled in multivariate analysis, interpregnancy intervals that began with a live birth and of less than six months in duration were associated with a 7.5-fold increase in the odds of an induced abortion, a 3.3-fold increase in the odds of a miscarriage, and a 1.6-fold increase in the odds of a stillbirth when compared with 27- to 50-month intervals. Interpregnancy intervals greater than or equal to 75 months were associated with increased odds of non-live-birth outcomes but were not as risky as very short intervals. Women whose pregnancies occurred between 15 and 75 months after a preceding pregnancy outcome (regardless of its type) had a lower likelihood of fetal loss than those with shorter or longer interpregnancy intervals. Razzaque et al. (2005) used data on third trimester prenatal visits to health centers in Matlab, Bangladesh, between 1996 and 2002 to study the relationship between pregnancy spacing and seven measures of maternal morbidity. The study analyzed the maternal morbidity of women who visited a health center during their third trimester of pregnancy. Adjusted odds ratios were obtained through logistic regression analysis to assess the effects of pregnancy intervals of differing lengths while holding constant other influences (six variables) on maternal morbidity. After controlling for six confounding influences with logistic regression, preeclampsia and high blood pressure were found to be significantly more likely for women with preceding interpregnancy intervals of less than six months or 75 months or more compared with those with intervals of 27 to 50 months. Premature rupture of membranes was found to be significantly more likely following interpregnancy intervals of six to 14 months, and edema was found to be significantly more likely following interpregnancy intervals over 50 months. The authors conclude that short and long interpregnancy intervals are associated with increased incidence of some maternal morbidities. Bhalotra and van Soest (2006), in an unpublished paper presented at the 2006 annual meeting of the Population Association of America, analyzed the effect of birth spacing on subsequent neonatal mortality and of mortality on the length of the next birth interval, while controlling for unobserved heterogeneity in mortality (frailty) and birth spacing (fecundity), using a dynamic panel data model. The authors found clear evidence of frailty, fecundity, and the causal effects of birth spacing on mortality and vice versa but also found that birth interval effects explained only a limited share of the correlation between neonatal mortality of successive children in a family. In a paper on inequality in infant mortality in Iran, Hosseinpoor et al. (2006) found that a "risky birth interval" of less than 24 months birth-to-birth with an adjusted odds ratio of 2.22 contributed 13 percent of inequality in infant mortality between births as measured by the concentration index. The analysis is based on data for over 108,000 live births taking place from 1990 to 1999, collected in the Iranian DHS conducted in 2000. In Côte d'Ivoire, Andoh et al. (2007) used data on almost 2,000 births in the five years preceding the 1998 DHS to study the effect of household demographic composition on child mortality. A birth-to-birth interval of less than 24 months is associated with an adjusted odds ratio of 2.0 for the proportion dead of children born in the five years preceding the survey. An insight into one of the mechanisms by which short birth intervals may adversely affect mortality is given by the finding in this article that "competition among children increased the probability of child mortality." Using DHS data for three central Asian republics (Kazakhstan, Kyrgyzstan, and Uzbekistan), Akmatov et al. (2006) found that birth intervals of 18 months or longer have an adjusted odds ratio of 0.61 for mortality of children under 36 months after controlling for 12 socioeconomic, biodemographic, reproductive health care, safe water access, religion, and place of residence factors.

In the Matlab area of Bangladesh, DaVanzo et al. (2008) in an in-press article find that shorter intervals are associated with higher mortality after controlling for other correlates of infant and child mortality. The effects after the first month appear due to sibling competition since effects of short intervals are greater if the older sibling was still alive but many relationships are found to be consistent with maternal depletion. Effects were also greater if the interval began with a live birth than with a non-live birth. When compared with inter-outcome (pregnancy to conception) intervals, significant results were found for intervals shorter than 24 months for early neonatal mortality, for intervals shorter than 36 months for late neonatal mortality, post-neonatal mortality and child (age one to four years) mortality. These effects persist when potentially confounding factors (prematurity, breastfeeding, and immunizations) and demographic and socioeconomic variables are controlled. Short *subsequent* interpregnancy intervals are also associated with a significantly higher risk of mortality for the index child. This study used a large, high-quality longitudinal dataset of 145,000 pregnancy outcomes gathered over a period of more than 20 years in an experimental setting.

In a systematic literature review of the effects of birth spacing on maternal and child nutritional status, Dewey and Cohen (2007) found 22 papers written since 1966 that dealt with children's growth indices and iron and vitamin A status in a multivariate framework. These studies indicate that a longer birth interval is associated with a lower risk of malnutrition in some populations, but not all. "In those countries in which the relationship was significant, the reduction in stunting associated with a previous birth interval ≥36 months ranged from ~ 10percent to 50percent. Some of this reduction may be due to residual confounding, i.e. to factors not included in the analysis (such as breastfeeding and maternal height)." However, they state that "Important methodological limitations were apparent in most of the studies. Thus, further research with more comprehensive control of potentially confounding variables is needed."

An earlier study (Cleland and Sathar, 1984), not mentioned in the preceding paper, investigated maternal depletion by including the average birth interval as well as the preceding birth interval in the analysis of the risk of infant and child mortality. Using data on 13,525 live births from the 1975 Pakistan Fertility Study, the authors found no significant effect of average birth interval and conclude that there is little evidence for maternal depletion. They conclude that, "The most important finding concerns the length of the preceding birth interval, which emerges as a major determinant of childhood mortality. In the neo-natal period there appears to be a threshold of about three years, above which no further advantage is conferred on the index child. For post-neo-natal and early childhood mortality ($_1q_1$), however, an approximately linear decline in probabilities of dying is found as the preceding interval lengthens. Children born after an interval of two years or less since the last birth are twice as likely to perish at these ages as those born after four or more years. After the age of two years, the relationship is less strong but nevertheless appreciable."

The majority of the studies in the literature of the relationship between pregnancy or birth spacing and infant and child mortality, birth outcome and nutritional status use relatively small datasets, wide intervals, and control for a relatively small number of confounding factors. It is a goal of the present study to overcome these shortcomings.

METHODS AND DATA

Methods

The methodology used in this study is the pooled-data analysis of retrospective survey data of the DHS program using both bivariate and multivariate analyses. The pooling of the data sets permits better estimation of effects because of the large size of the data set and, hence, better control of random sampling variation.

Dependent Variables

For infant and child mortality, the dependent variables are life table probabilities of mortality based on survival status and age at death for children who were born in the fifteen years before each survey.

For birth weight and birth size, the mother's report of the child's weight and her opinion of the child's size when born are used. The dependent variable for birth weight is whether the child weighed less than 2.5 kg when born. The dependent variable for birth size is whether the mother thought that the child was smaller than average or very small when born.

For nutritional status, the dependent variable is the percentage of young children who are stunted, wasted, or underweight. As part of the interviewing procedure, the DHSs routinely collect the height and weight of children under age 5 years. Together with the child's age, this information can be 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 with the National Center for Health Statistics (NCHS)/Centers for Disease Control and Prevention (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 median (−2 sd) on the reference standard are considered to be moderately or severely undernourished. Chronic undernutrition, or stunting, is determined by a height-for-age *z*-score below 2 standard deviations below the median; acute undernutrition, or wasting, is measured by a *z*-score of less than –2 sd for weight for height; and overall undernutrition, or underweight, is measured by a *z*-score of less than –2 sd for weight for age.

The dependent variables are summarized here:

- Early neonatal mortality, death at 0 to 6 days after birth
- Neonatal mortality, death at 0 to 30 days and less than 1 month after birth
- Postneonatal mortality, death at one to 11 months after birth
- Infant mortality, death at 0 to 11 months after birth
- Child mortality, death at 12 to 59 months after birth
- Under-five mortality, death at 0 to 59 months after birth
- Low birth weight, child weight less than 2,500 g at birth
- Small size at birth, mother stated that child was very small or smaller than average size at birth
- Chronic undernutrition (Stunted), less than −2 sd on NCHS/CDC/WHO reference for height for age
- Acute undernutrition (Wasted), less than −2 sd on NCHS/CDC/WHO reference for weight for height
- Overall undernutrition (Underweight), less than −2 sd on NCHS/CDC/WHO reference for weight for age

Independent Variables

The key independent variable is the length of the preceding birth-to-pregnancy interval, measured as the number of months between the date of the conception of the child under study (index child) and the date of the immediately preceding birth to the mother, if any. The birth-to-pregnancy interval is divided into categories that were agreed on with the WHO review team members and other researchers to provide harmonized results. Both bivariate and multivariate designs were used. The multivariate analysis is based on the pooled data for all 52 surveys together for each of the mortality age ranges. The coefficients are exponentiated to give the relative risk ratios, and the 95 percent confidence interval of the relative risk ratio is calculated by adding or subtracting 1.96 times the summary standard error from the coefficient before exponentiation.

Preceding birth-to-pregnancy interval:

- Harmonized intervals (<6, 6 to 11, 12 to 17, 18 to 23, 24 to 29, 30 to 35, 36 to 47, 48 to 59, 60 to 95, and 96+ months; first births; missing)
- Intervals for population attributable risk (PAR) calculations (<24 months, 24+ months, first births, missing) and (<36 months, 36+ months, first births, missing)

Control Variables in the Multivariate Analysis

There are a number of factors that may potentially confound the relationship between birth intervals and young child mortality. These have been cited by a number of authors (e.g., see Winikoff, 1983). Birth-specific confounders include the age of the mother at the birth, the birth order, the multiplicity of the birth, the sex of the child, use of health care services, breastfeeding, and wantedness of the birth. Mother-specific confounders include socioeconomic status and type of area of residence. To control for the potential of confounding, variables representing these factors have been used in multiple logistic regression analyses.

It is well known that the mother's age at birth and birth order are related to children's mortality (see, e.g., Hobcraft et al., 1985; Puffer and Serrano, 1975). They may also be related to birth interval length through biological and volitional linkages. Fecundability declines with age, and both older mothers and those with more children may restrict their fertility through contraception and decreases in sexual relations.

Male children have higher mortality in most cultures. In others, neglect and infanticide may invert this biological relationship. In these cultures, birth intervals may also be associated with the child's sex as families strive to meet their gender goals.

The use of health care services can be related to both mortality, through preventive and curative services, and availability and use of contraception (Potter, 1988). Information is not available for most of the births from the DHSs on the use of contraception between births. Therefore, type of prenatal care provider, delivery attendant, and number of tetanus toxoid vaccinations during pregnancy are used as measures of access to both health services for children and contraception. Moreover, these variables are more directly related to perinatal and neonatal mortality.[1]

Breastfeeding provides a potentially confounding link between mortality and birth intervals. External factors, such as household environment, can raise the mortality of both the index child and the next older sibling. The death of the older sibling will cut short the duration of

[1] To avoid reverse causality, other vaccinations cannot be used for neonatal and infant mortality because children may die before they are of age to get the vaccination. Infant deaths usually consist of about half neonatal and half postneonatal deaths, but the majority of postneonatal mortality comes in the early months, and therefore many deaths also take place before the age at which vaccinations for diphtheria, pertussis (whooping cough), and tetanus; polio; and measles are given. Indeed, in Latin America, measles vaccines are given after the first year of life. The children included in the under-five-years analyses were all born five or more years ago (to avoid censoring of mortality exposure), and the DHS does not collect vaccination information for children born more than five years ago.

breastfeeding and postpartum amenorrhea, leading to an increased risk of a short birth interval. Taking into account the survival of the preceding child controls for the breastfeeding–amenorrhea effect and for the external mortality relationships. However, the risk of death of the preceding child can also be raised by its short subsequent interval (Hobcraft et al., 1983), so that controlling for any death may result in an overcorrection. The death of the preceding child can only affect the preceding birth interval if the death occurs before the conception of the index child. To avoid overcorrection, only death of the preceding child before the index child's conception is controlled for in these analyses.

An unwanted child, especially one resulting from contraceptive failure, may suffer more neglect than wanted children. To control for these affects, the wantedness of the child and whether the child resulted from a failure of contraception are used as controls in the analyses. Because these variables are only available for births that occurred in the five years preceding the survey, they are used for the neonatal and infant and nutritional status analyses but cannot be used for under-five mortality analyses because those analyses are based on children born from five to 15 years before the surveys. Moreover, information on births resulting from a failure of contraception is not available for countries with low contraceptive prevalence and in the Bolivia and Nepal surveys.[2]

Access to health services and to contraceptives, physical and social environments, and socioeconomic status is associated with both child mortality and the spacing of births. To control for these effects, three variables are used in the analyses: mother's level of education (none, primary, secondary or higher), type of area of residence (urban or rural), wealth (quintile of

[2] There are no calendar data on failure from Benin, Bolivia, Burkina Faso, Cambodia, Cameroon, Chad, Congo, Eritrea, Ethiopia 2000, Gabon, Ghana, Guinea, Haiti, Honduras, Lesotho, Madagascar, Malawi 2000, Mali, Mauritania, Mozambique, Nepal, Nicaragua, Nigeria, Rwanda, Senegal, Uganda, or Zambia.

wealth index [Pritchett and Filmer, 2001; Rutstein and Johnson, 2004]), and type of drinking water supply and toilet facilities.[3]

Control variables include control of bias (imputation of interval), demographic controls (age of mother at birth, birth order, pregnancy duration, whether multiple birth, sex of index child, sex of preceding child, death of preceding child before the conception of the index child, age at death of preceding child if died), behavioral controls (time wanted pregnancy, pregnancy result of contraceptive failure), health care controls (prenatal care provider, prenatal initial checkup month of pregnancy, number of prenatal checks, prenatal tetanus toxoid vaccination, delivery care provider), socioeconomic and environmental controls (urban or rural residence, mother's level of education, wealth index quintile, source of drinking water, refrigerator, toilet facility), and additional data for nutritional status analyses (breastfeeding status and child feeding).[4]

Analysis Methodology

Infant and Child Mortality. Bivariate relationships are studied using life tables for each category of the independent variable for each survey separately and for all the surveys pooled together. The life tables were calculated using the Survival procedure of SPSS version 15.0.1 (2007). The resulting survival odds were converted into risk ratios by first calculating the risk of dying

[3] The absence of the father (or mother's spouse/partner) may also be related to both child mortality and birth intervals. Children whose father is absent may have lessened resources for childcare and health service utilization. Birth intervals may also be longer if the mother has less frequent sexual relations because of the absence. However, in the DHS surveys, it is not possible to ascertain the father's presence in the household at the time of death for children who have died, nor whether the child was living away from home at the time of death.

[4] The child-feeding variable is based on what the child received as food in the day and night preceding the interview. The categories are exclusive breastfeeding, feeding breast milk and just plain water, feeding breast milk and liquids other than just plain water, feeding breast milk and solid/semisolid foods but not animal protein, feeding breast milk and animal protein with or without other solids/semisolid foods, feeding liquids but no breast milk, feeding solids/semisolids but no breast milk, and feeding animal protein but no breast milk.

throughout the age interval under study and then dividing each of the interval category risk ratios by that of the reference category (36 to 47 months).

To ascertain risk ratios controlling for confounding factors, i.e. adjusted risk ratios, Cox hazard regression analysis is employed using the SPSS program, version 15.0.1. Cases are individual children, alive or not. The dependent variable is the survival of the index children during the mortality age interval of interest for children surviving to the beginning of the age interval. The principal independent variable is the preceding birth-to-pregnancy interval, calculated as the difference in birth dates (year and month) between the birth of the preceding child and of the index child, subtracting the length of gestation, and grouped according to the harmonized interval categories given above. First births are included as a separate category, as are the few intervals with missing data. The interval 36 to 47 months is used as the reference category.

The control variables given earlier are used to control for potentially confounding relationships. Missing values for each independent variable are included as separate categories. The DHSs do not permit missing data on survival or age at death. The results presented are exponentiated coefficients to obtain the adjusted risk ratios.[5]

For the analyses of birth size, birth weight, and current nutritional status, odds ratios are used as the form of the dependent variable. To ascertain adjusted risk odds ratios, binary logistic analysis is employed using the SPSS program, version 15.0.1. Cases for birth weight and size are individual children, alive or not, and cases for current nutritional status are living children.

[5] Analyses were performed on several countries including the sample design into the multivariate analysis (using svylogit in STATA 9.1). Account was taken of both the clustering of the cases by sampling units and sample stratification, with the result that a slight reduction in the estimated confidence interval ensued. Because of the laboriousness of hand-combining sample clusters required when there were no deaths in the mortality age range, the more conservative approach of ignoring sample clustering and stratification was taken. Note that although it seems that clustering would increase the estimated standard errors, appropriate stratification in the sample design and inclusion of the major differences between clusters as control variables in the model actually removes the effects of clustering.

Children with missing values on the dependent variables are omitted from that analysis. The principal independent variable is the preceding birth interval calculated as described above for the mortality analyses. The results are presented in the form of adjusted risk ratios to be consistent with the presentation of the mortality results. The adjusted risk ratios are calculated by exponentiating coefficients to obtain adjusted odds ratios, which are then converted into adjusted risk ratios using this formula:

$$\text{AdjRR} = \frac{\text{AdjOR} \times O_{\text{ref}}}{1 + \text{AdjOR} \times O_{\text{ref}}} / P_{\text{ref}},$$

Where AdjRR is the calculated adjusted relative risk, AdjOR is the adjusted odds ratio (exponentiated coefficient), O_{ref} is the odds of the reference group, and P_{ref} is the risk of the reference group.

DATA

DHS Data Used in the Study

The data used in this study come from all 52 countries surveyed in the DHS program between 2000 and 2005 (with the exception of India, whose data were not available at the time of analysis). This program of surveys in developing countries started in 1984 and is financed principally by the U.S. Agency for International Development. The DHSs are based on scientifically selected samples of households and women of reproductive age to produce nationally representative data on fertility, infant and child mortality, child and reproductive health, nutritional status, family planning, and many other health-related issues. In many countries, men of reproductive age are also interviewed. Each country survey is conducted by individual country survey organizations, with technical assistance in design, sampling, training, fieldwork, data processing, tabulation, and report generation provided by Macro International Inc.[6]

The household section of the DHS collects general household information, such as location, possessions, and services. A roster of household members collects information on sex, age, relationship to the head of the household, de facto and de jure status, and education level. Women between the ages of 15 and 49 years, inclusive, who slept in the dwelling the night before the interview are selected for interviewing with an individual questionnaire.[7]

The individual women's questionnaire contains a complete birth history with birth dates, sex, multiplicity of birth, survival status, and age at death if not surviving for each child. In some countries, a month-by-month reproductive calendar of the preceding five years gives information on pregnancies by duration and type of termination. For each child under five years of age, information is collected on prenatal and delivery care, birth weight and size, vaccinations received, feeding and breastfeeding, and morbidity status and treatment. Nutritional and anemia status of the women and of children under five years of age is ascertained through anthropometric measurement and finger pricks, respectively.

All interviews are conducted face to face by specially trained women interviewers. Anthropometric measurements are taken using internationally standard height boards and U.N. Children's Fund scales. Blood hemoglobin levels are measured using Hemocue devices. Specially trained staff (in many cases, public health nurses) carry out the anthropometric and anemia measurements.

[6] The DHS project originally began at Westinghouse Corporation's Institute for Resource Development, which was acquired by Macro Systems, Inc. later renamed Macro International, Inc. Opinion Research Corporation acquired Macro International in 1999. InfoUSA bought Macro International in 2006.

[7] In some countries of the Near East and Asia, only ever-married women are considered eligible for interview.

The quality of the DHS data is among the highest for data on births and infant and child deaths in the developing countries (see Pullum, 2006; Curtis, 1995; Sullivan et al., 1990). There is evidence for a small amount of digit preference for 12 months in the declaration of age at death, so that infant and postneonatal rates may be understated and child mortality overstated by up to 5 percent. No effect on neonatal or under-five-years mortality rates has been found. There is also evidence for some transference of births to a year earlier to avoid going over a long health section for young children. For most surveys, this boundary is at five calendar years before the survey. In other surveys, the health section eligibility boundary is three or four calendar years before the survey. Because most of the questions are for children living at the time of the survey, the effect of the transference would be to slightly lower mortality rates for short preceding birth intervals, but only for children born in the calendar year after the boundary. For a more in-depth evaluation of later DHSs, see Pullum (2006), who states that "There is virtually no evidence of heaping on age of child" and that "small deviations from a uniform distribution tend *not* to be at final digits 0 and 5." With regard to heaping on birth intervals, Pullum states, "There is no evidence of heaping on multiples of six months." The five surveys that show any irregularities took place before 2000 and are not part of the current analysis dataset. However, Pullum (2006) finds that in nine of the 52 surveys used here there was some transference from the calendar year at the start of health section eligibility to the preceding year.

The 52 DHSs selected for this analysis represent the following countries: Armenia, Bangladesh, Benin, Bolivia, Burkina Faso, Cambodia, Cameroon, Chad, Columbia, Congo (Brazzaville), the Dominican Republic, Egypt, Eritrea, Ethiopia, Gabon, Ghana, Guatemala, Guinea, Haiti, Honduras, Indonesia, Jordan, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Moldova, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Nigeria, Peru, Philippines, Rwanda, Senegal, Tanzania, Turkmenistan, Uganda, Vietnam, and Zambia. Countries represented with two surveys are Armenia (2000 and 2005), Bangladesh (2000 and 2004), Colombia (2000 and 2005), Ethiopia (2000 and 2005), Malawi (2000 and 2004), Peru (2000 and 2004-2005), and Rwanda (2000 and 2005). Egypt is represented with three surveys, 2000, 2003, and 2005. These 52 surveys are all the DHSs that took place between 2000 and 2005. No data sets have been omitted from the analysis as a result of data quality issues; that is, all available DHSs carried out between 2000 and 2005 are included in the analysis. The third India National Family Health Survey took place between 2005 and 2006, but the data are not yet available.

2005	2004	2003	2002	2001
Armenia	Bangladesh	Bolivia	Dom. Rep.	Benin
Colombia	Cameroon	Burkina Faso	Eritrea	Mali
Congo	Chad	Egypt	Jordan	Nepal
Egypt	Lesotho	Ghana	Vietnam	Nicaragua
Ethiopia	Madagascar	Indonesia	Zambia	
Guinea	Malawi	Kenya		
Honduras	Tanzania	Morocco		
Moldova		Mozambique		
Peru		Nigeria		
Senegal		Philippines		
Rwanda				

Creation of the Pooled Data Set

Child- and pregnancy-related data for births in the 15 years preceding the survey were extracted from each survey using Integrated System for Survey Analysis and entered into an SPSS .sav file. Several countries are represented by more than one survey, including Egypt (3) and Armenia, Bangladesh, Colombia, Ethiopia, Malawi, Peru, and Rwanda (2). A pooled data set was created from the individual survey .sav files with 1,123,454 cases (births).

RESULTS

Preceding Birth-to-Pregnancy Intervals

The distributions of preceding birth-to-pregnancy intervals are given in Table 1. Of all births considered, almost one quarter were first births, based on the weighted average. Among second and higher-order births, the median number of months since the preceding birth was 19.6 (from calculation based on Table 1). Very short intervals of less than 12 months between a birth and the following conception accounted for more than 19 percent of the intervals of second or higher-order births. Although more than 38 percent of birth-to-pregnancy intervals were less than 18 months in duration, almost another 30 percent occurred with durations of 18 to 30 months, resulting in more than two thirds of second and higher-order births taking place at durations of less than 30 months since the previous birth.

Analyses using the birth-to-pregnancy interval depend on the respondent's knowledge of the birth dates and lengths of gestation of her children. The DHS questionnaire requests the month and year of each birth. For living children, the child's age in years is also requested. The DHS procedures call for imputing the month and year of birth when the respondent could not give the information. The procedure depends on the type of information given in the birth history. A description of the process is given in Croft (no date). For 0.2 percent of the live births, the interval is missing. The surveys with the most missing duration of intervals are those of Egypt for 2000, 2003, and 2005, where at most 0.5 percent is missing.

Table 1. Distribution of births 0 to 179 months prior to survey by months since preceding birth to conception interval

Survey		Preceding Interval in Months													
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First births	Missing	Total	N
Armenia	2000	7.3	13.2	10.0	6.9	4.7	4.2	5.8	3.9	5.4	2.7	35.8	0.2	100.0	6,420
Armenia	2005	6.2	10.6	8.9	5.9	5.1	3.5	6.4	3.9	6.4	3.5	39.4	0.3	100.0	5,101
Bangladesh	1999/2000	4.3	6.8	13.3	9.8	10.3	6.1	9.3	5.0	5.8	1.5	27.6	0.2	100.0	20,366
Bangladesh	2004	3.2	6.2	13.1	9.4	10.2	6.2	9.5	5.6	6.6	1.8	28.0	0.2	100.0	20,855
Benin	2001	3.6	8.5	14.5	15.9	13.6	8.5	8.0	2.9	2.9	0.8	20.4	0.3	100.0	14,375
Bolivia	2003	6.3	10.7	16.3	12.4	7.9	5.2	6.4	3.6	5.0	2.4	23.7	0.1	100.0	31,091
Burkina Faso	2003	3.0	7.0	14.4	14.6	14.7	9.8	9.6	4.0	3.1	0.7	19.0	0.1	100.0	29,585
Cambodia	2000	5.6	9.4	19.1	13.1	12.0	6.3	7.2	3.4	3.2	1.0	19.6	0.1	100.0	29,493
Cameroon	2004	4.5	8.5	17.8	14.3	10.2	6.5	7.0	3.2	3.6	1.1	22.8	0.3	100.0	20,992
Chad	2004	4.9	11.0	22.3	15.7	10.1	6.0	5.9	2.7	2.3	0.6	18.5	0.2	100.0	15,316
Colombia	2000	4.5	9.1	9.8	7.1	5.7	4.5	6.6	4.9	7.8	4.1	35.7	0.2	100.0	13,521
Colombia	2005	4.0	8.2	9.5	7.9	5.8	4.6	6.9	4.9	8.1	4.7	35.0	0.2	100.0	44,312
Congo	2005	2.8	4.8	10.2	10.1	10.0	7.5	10.0	6.6	7.2	2.6	28.0	0.3	100.0	12,004
DomRep	2002	8.0	11.2	12.0	9.1	7.0	4.9	6.6	3.9	4.8	2.1	30.1	0.2	100.0	34,020
Egypt	2000	8.6	9.9	13.3	10.4	9.0	6.1	8.0	4.2	5.0	1.6	23.6	0.4	100.0	34,619
Egypt	2003	6.5	9.3	12.4	10.8	9.4	6.0	8.4	4.7	5.2	1.7	25.3	0.4	100.0	19,044
Egypt	2005	5.9	7.8	12.0	10.5	9.4	6.4	8.4	4.8	5.6	1.8	26.9	0.5	100.0	38,862
Eritrea	2002	7.8	10.4	17.0	13.9	10.1	6.1	6.7	3.0	3.1	1.0	20.8	0.1	100.0	18,755
Ethiopia	2000	6.4	9.1	15.8	13.2	12.8	7.6	8.1	3.2	3.3	1.1	19.2	0.1	100.0	30,502
Ethiopia	2005	7.0	9.9	15.5	13.6	10.6	7.4	8.0	3.7	3.5	1.0	19.7	0.1	100.0	28,542
Gabon	2000	5.8	8.1	15.9	13.1	9.9	5.8	7.3	3.9	4.4	1.6	23.9	0.3	100.0	11,822
Ghana	2003	2.6	5.9	11.1	12.6	12.5	9.0	11.2	5.1	5.8	2.1	21.8	0.2	100.0	10,592
Guinea	2005	3.0	5.4	18.2	10.5	18.2	7.3	9.2	4.5	3.9	1.1	18.6	0.2	100.0	19,107
Haiti	2000	6.4	10.7	18.1	15.3	9.3	5.5	6.1	3.0	3.3	1.0	21.0	0.2	100.0	18,938
Honduras	2005	4.7	9.6	14.8	12.8	8.2	5.7	7.2	4.3	5.1	1.8	25.7	0.2	100.0	33,619
Indonesia	2003	3.6	6.0	8.5	7.1	6.5	5.1	8.5	6.8	10.2	4.7	32.7	0.2	100.0	47,647
Jordan	2002	9.1	16.8	17.7	11.5	7.2	4.6	6.5	3.0	2.9	0.6	19.8	0.3	100.0	17,719
Kenya	2003	5.8	9.0	14.9	13.0	9.6	5.7	7.6	4.0	4.2	1.6	24.3	0.2	100.0	15,541
Lesotho	2004	1.9	3.8	8.0	9.9	11.5	8.2	9.8	6.3	7.5	2.6	30.2	0.3	100.0	9,816
Madagascar	2004	6.6	9.4	15.6	11.4	8.7	5.7	6.8	4.1	4.4	1.7	25.5	0.1	100.0	15,008
Malawi	2000	3.4	7.6	15.8	15.6	12.1	7.0	7.4	3.4	3.2	1.0	23.1	0.3	100.0	29,538
Malawi	2004	3.5	7.3	14.0	13.9	12.5	7.6	8.7	4.0	3.8	1.0	23.5	0.3	100.0	26,773

(Cont'd)

Table 1 – cont'd

Survey		Preceding Interval in Months													
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First births	Missing	Total	N
Mali	2001	6.4	10.2	20.2	14.6	10.7	6.4	7.0	3.0	2.7	0.7	18.0	0.1	100.0	36,019
Mauritania	2000	8.3	9.7	16.4	11.6	9.6	5.9	7.9	4.2	4.6	1.6	19.9	0.2	100.0	13,807
Moldova	2005	2.6	4.8	5.5	4.2	3.8	3.5	6.7	5.4	9.5	5.8	47.8	0.3	100.0	5,100
Morocco	2003	5.3	7.8	11.5	9.6	9.4	6.6	9.6	5.9	7.0	2.4	24.7	0.3	100.0	19,478
Mozambique	2003	3.3	7.4	14.7	15.2	11.3	7.1	8.0	3.9	4.3	1.4	23.2	0.2	100.0	26,629
Namibia	2000	4.1	6.0	10.7	10.1	8.5	6.3	8.7	5.7	7.3	3.1	29.2	0.1	100.0	10,702
Nepal	2001	4.7	9.1	16.5	13.8	10.7	6.5	7.5	3.4	3.0	0.7	23.9	0.1	100.0	20,142
Nicaragua	2001	8.1	11.1	13.8	10.8	7.4	5.5	6.5	4.0	5.4	2.1	25.3	0.1	100.0	21,891
Nigeria	2003	5.6	8.9	19.2	14.9	11.0	6.7	6.4	3.2	3.4	1.1	19.2	0.2	100.0	15,913
Peru	2000	5.2	9.5	13.9	11.2	8.0	5.4	7.1	4.4	6.3	2.7	26.2	0.1	100.0	43,147
Peru	2004-5	3.2	7.7	12.1	10.6	7.1	5.4	8.0	5.1	8.0	4.2	28.4	0.2	100.0	17,125
Philippines	2003	7.4	12.6	14.6	10.5	7.1	5.0	6.4	3.8	4.9	1.9	25.7	0.2	100.0	20,892
Rwanda	2000	6.7	9.9	16.3	13.6	11.2	6.9	7.9	3.3	3.0	0.6	20.5	0.1	100.0	20,577
Rwanda	2005	5.2	8.9	17.1	14.8	11.7	6.7	7.4	3.5	3.3	0.7	20.4	0.3	100.0	22,248
Senegal	2005	4.4	8.0	17.9	14.3	11.8	6.7	7.2	3.8	3.7	1.1	20.8	0.2	100.0	28,698
Tanzania	2004	3.1	7.2	15.3	15.7	12.0	7.1	8.2	4.1	3.9	1.2	21.9	0.2	100.0	21,931
Turkmenistan	2000	7.2	14.1	16.4	11.1	6.5	3.6	5.2	2.9	3.8	1.1	28.0	0.2	100.0	11,362
Uganda	2000	6.1	11.2	19.3	15.4	9.9	5.7	5.8	2.4	2.7	0.6	20.7	0.2	100.0	17,758
Vietnam	2002	2.5	5.8	11.4	10.4	6.7	4.9	7.4	5.5	7.1	2.7	35.5	0.2	100.0	8,877
Zambia	2002	3.2	6.5	15.7	17.7	13.1	7.2	7.4	3.1	3.0	0.9	22.0	0.2	100.0	17,263
Average (wtd.)		**5.3**	**8.8**	**14.6**	**12.1**	**9.8**	**6.2**	**7.6**	**4.1**	**4.9**	**1.8**	**24.6**	**0.2**	**100.0**	**1,123,454**

Table 2 shows the percentage of intervals that are based on imputation of the date of either birth or of both births. Overall, 7 percent of the intervals are based on imputed birth dates. The amount of imputation varies with how long ago the birth occurred. For the period up to five years before the survey, 3 percent were imputed; 9 percent were imputed for births in the period five to 14 years before the survey. More than four in ten intervals were imputed in surveys of Guinea (2005; 54 percent) and Benin (2001; 44 percent). Indeed, in these two surveys, over 30 percent of the intervals ending in the five years preceding the survey were imputed. In addition to Guinea 2005 and Benin 2001, the surveys with 10 percent or more of intervals imputed are Egypt 2003 (22 percent), Mauritania 2000 (21 percent); Egypt 2000 (13 percent); Senegal 2005 and Eritrea 2002 (both 12 percent); Ethiopia 2000 (11 percent); and Indonesia 2003, Morocco 2003, Madagascar 2004, and Nigeria 2003 (all 10 percent).

Table 2. Percent of preceding birth to conception interval where one or both dates are imputed

Survey		Time since birth			
		<5 years	5-14 years	Total	N
Armenia	2000	0%	0%	0%	6,420
Armenia	2005	0%	0%	0%	5,101
Bangladesh	1999	1%	4%	3%	20,366
Bangladesh	2004	0%	0%	0%	20,855
Benin	2001	31%	51%	44%	14,375
Bolivia	2003	0%	4%	3%	31,091
Burkina Faso	2003	3%	11%	8%	29,585
Cambodia	2000	0%	1%	1%	29,493
Cameroon	2004	5%	10%	8%	20,992
Chad	2004	1%	3%	2%	15,316
Colombia	2000	0%	1%	0%	13521
Colombia	2005	0%	1%	1%	44312
Congo	2005	2%	5%	4%	12,004
Dominican Rep.	2002	1%	5%	3%	34,020
Egypt	2000	3%	18%	13%	34,619
Egypt	2003	7%	31%	22%	19,044
Egypt	2005	2%	13%	9%	38,862
Eritrea	2002	7%	14%	12%	18,755

(Cont'd)

Table 2 – cont'd

Survey		Time since birth <5 years	5-14 years	Total	N
Ethiopia	2000	6%	14%	11%	30,502
Ethiopia	2005	1%	3%	2%	28,542
Gabon	2000	2%	4%	3%	11,822
Ghana	2003	1%	5%	3%	10,592
Guinea	2005	33%	64%	54%	19,107
Haiti	2000	1%	2%	2%	18,938
Honduras	2005	0%	0%	0%	33,619
Indonesia	2003	4%	14%	10%	47,647
Jordan	2002	0%	2%	1%	17,719
Kenya	2003	3%	12%	8%	15,541
Lesotho	2004	1%	2%	1%	9,816
Madagascar	2004	5%	14%	10%	15,008
Malawi	2000	1%	4%	2%	29,538
Malawi	2004	1%	2%	2%	26,773
Mali	2001	3%	9%	7%	36,019
Mauritania	2000	17%	24%	21%	13,807
Moldova	2005	0%	0%	0%	5,100
Morocco	2003	4%	14%	10%	19,478
Mozambique	2003	1%	5%	4%	26,629
Namibia	2000	2%	5%	4%	10,702
Nepal	2001	0%	0%	0%	20,142
Nicaragua	2001	1%	4%	3%	21,891
Nigeria	2003	7%	11%	10%	15,913
Peru	2000	0%	3%	2%	43,147
Peru	2004-5	0%	1%	1%	17,125
Philippines	2003	0%	1%	1%	20,892
Rwanda	2000	2%	8%	6%	20,577
Rwanda	2005	1%	5%	4%	22,248
Senegal	2005	6%	15%	12%	28,698
Tanzania	2004	1%	4%	3%	21,931
Turkmenistan	2000	0%	0%	0%	11,362
Uganda	2000	2%	10%	7%	17,758
Vietnam	2002	0%	1%	1%	8,877
Zambia	2002	1%	3%	2%	17,263
Total		**3%**	**9%**	**7%**	**1,123,454**

Imputation of the interval would normally weaken the relationships with mortality and nutritional status. Imputation intervals can be handled in a couple of ways. One way would be to include a variable in multivariate analysis that indicates whether that child had an imputed interval or not. This procedure would allow a greater number of cases (reducing standard errors) and an easy vision of the effect of the imputation. A second way is to only use nonimputed cases.

This second procedure is cleaner but may result in larger standard errors. The second procedure has been adopted for the analyses in this paper.

It has been postulated that premature births are a confounding factor in the analysis of neonatal, postneonatal, and infant mortality rates by shortening the birth-to-birth interval through a shortened length of gestation. Because premature births are known to have high rates of mortality, the mortality effects of short birth intervals (as opposed to short pregnancy intervals) may be biased upward because they would contain a disproportionately high number of premature births. The shorter the interval, the more likely it is that the proportion of premature births is higher. The analyses that have shown to be most affected are those with birth intervals of under 12 or under 15 months. The length of gestation is not available for survey data. In this case it is assumed that the gestation was nine months.[8]

Bivariate Results

Infant and Child Mortality

The DHSs collect age at death for nonsurviving children in three scales: for children who died at less than one month, age in days is collected. For nonsurviving children dying within two years of birth, age at death in number of months is collected. The number of years survived is used for children who died at an age of two or more years since birth. Dates of birth of children are given in calendar year and month. Preceding birth-to-pregnancy intervals are calculated by the

[8] The earlier article examined the potential effect on the results that adjusting for gestational length would have on the classification of birth into the birth intervals. That examination found that at most about 0.2% of births had been shifted into a longer birth interval as a result of the assumption of a nine-month gestation rather than actual gestation. For the shortest birth interval group used there, only 0.1% of births had been misclassified. Thus, even if premature births have much higher rates of mortality, the combined effect is quite small given that 99.9% will be correctly classified.

difference between the date of birth of the index child and the immediately preceding child and subtracting the duration of gestation. Only singleton births are used for the index children.

The analysis of infant and child mortality includes the following mortality rates: neonatal (deaths within first 30 days among all children born), postneonatal (deaths of children at ages one to 11 months among children surviving the neonatal period), infant (deaths of children at ages 0 to 11 months among all children born), child (deaths of children at ages one to four years among children who survive to age one year), and under-five mortality (deaths of children under 5 years of age among all children born).

The mortality rates by length of preceding birth-to-pregnancy interval are shown in Tables 3 to 5. Under-five mortality in the 52 surveys varies from 26 to 232 deaths per thousand births (Table 3). On average, children conceived after short intervals—under six months between birth and conception and six to 11 months—are, respectively, 3.0 and 2.2 times as likely to die before their fifth birthday as are children conceived after 36 to 47 months (based on unweighted averages of mortality rates from Table 3). Also, those children conceived after intervals of 18 to 23 months and 24 to 29 months have a 61 percent and 32 percent greater chance of dying, respectively, than do children conceived after 36 to 47 months. For the countries studied, the increases in the risk of dying range up to 443 percent higher for conceptions occurring less than six months since the preceding birth, up to 226 percent higher for the six to 11-month interval duration, up to 149 percent higher for the 12- to 17-month interval duration, and up to 111 percent higher for the 18- to 23-month interval duration.

Table 3. Under-five mortality rates by duration of preceding birth to conception interval, births 0 to 179 months prior to survey

Survey		Preceding Birth to Conception Interval in Months												Total	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing		
Armenia	2000	0.102	0.055	0.054	0.058	0.070	0.034	0.045	0.057	0.041	0.053	0.033	0.348	0.050	6,420
Armenia	2005	0.060	0.033	0.047	0.062	0.028	0.041	0.032	0.021	0.045	0.071	0.025	0.074	0.036	5,101
Bangladesh	1999/2000	0.219	0.159	0.145	0.122	0.086	0.068	0.066	0.066	0.055	0.072	0.128	0.505	0.118	20,366
Bangladesh	2004	0.202	0.131	0.135	0.107	0.088	0.082	0.069	0.046	0.063	0.046	0.109	0.576	0.103	20,855
Benin	2001	0.329	0.162	0.152	0.100	0.086	0.106	0.077	0.080	0.076	0.090	0.161	0.282	0.166	14,375
Bolivia	2003	0.213	0.141	0.106	0.086	0.074	0.070	0.060	0.043	0.044	0.044	0.079	0.177	0.099	31,091
Burkina Faso	2003	0.333	0.243	0.228	0.186	0.148	0.145	0.107	0.087	0.065	0.087	0.195	0.424	0.184	29,585
Cambodia	2000	0.249	0.172	0.130	0.114	0.090	0.096	0.086	0.073	0.075	0.071	0.122	0.443	0.125	29,493
Cameroon	2004	0.240	0.183	0.148	0.124	0.108	0.111	0.091	0.079	0.090	0.096	0.139	0.208	0.143	20,992
Chad	2004	0.291	0.239	0.197	0.174	0.136	0.126	0.091	0.113	0.082	0.093	0.196	0.445	0.183	15,316
Colombia	2000	0.059	0.040	0.035	0.035	0.018	0.034	0.023	0.022	0.018	0.031	0.024	0.121	0.029	13,521
Colombia	2005	0.076	0.044	0.035	0.030	0.032	0.027	0.022	0.023	0.018	0.026	0.026	0.161	0.030	44,312
Congo	2005	0.191	0.142	0.121	0.098	0.094	0.101	0.077	0.097	0.083	0.083	0.116	0.378	0.113	12,004
DomRep	2002	0.081	0.049	0.046	0.030	0.033	0.030	0.031	0.034	0.029	0.049	0.042	0.318	0.049	34,020
Egypt	2000	0.195	0.120	0.079	0.064	0.045	0.041	0.038	0.050	0.032	0.058	0.062	0.288	0.076	34,619
Egypt	2003	0.171	0.100	0.074	0.062	0.046	0.047	0.046	0.044	0.044	0.052	0.059	0.181	0.068	19,044
Egypt	2005	0.162	0.094	0.068	0.049	0.048	0.036	0.037	0.035	0.032	0.056	0.051	0.166	0.059	38,862
Eritrea	2002	0.214	0.158	0.112	0.097	0.082	0.073	0.058	0.068	0.073	0.028	0.138	0.443	0.129	18,755
Ethiopia	2000	0.315	0.274	0.209	0.195	0.160	0.135	0.119	0.078	0.087	0.083	0.200	0.569	0.191	30,502
Ethiopia	2005	0.277	0.194	0.138	0.127	0.098	0.090	0.080	0.067	0.057	0.077	0.130	0.458	0.133	28,542
Gabon	2000	0.148	0.112	0.081	0.062	0.068	0.054	0.071	0.058	0.042	0.067	0.085	0.348	0.085	11,822
Ghana	2003	0.219	0.173	0.143	0.099	0.109	0.079	0.079	0.069	0.091	0.092	0.112	0.237	0.114	10,592
Guinea	2005	0.290	0.218	0.191	0.122	0.113	0.143	0.092	0.084	0.108	0.059	0.204	0.523	0.193	19,107
Haiti	2000	0.259	0.201	0.149	0.122	0.076	0.077	0.086	0.071	0.053	0.057	0.144	0.560	0.139	18,938
Honduras	2005	0.101	0.058	0.044	0.034	0.034	0.025	0.037	0.026	0.025	0.024	0.042	0.156	0.043	33,619
Indonesia	2003	0.112	0.082	0.062	0.055	0.040	0.033	0.039	0.040	0.031	0.032	0.054	0.250	0.064	47,647
Jordan	2002	0.055	0.032	0.029	0.020	0.026	0.013	0.024	0.042	0.021	0.021	0.030	0.111	0.033	17,719
Kenya	2003	0.214	0.149	0.112	0.095	0.085	0.084	0.070	0.071	0.093	0.057	0.088	0.141	0.107	15,541
Lesotho	2004	0.233	0.164	0.114	0.091	0.085	0.069	0.068	0.069	0.108	0.094	0.100	0.428	0.100	9,816
Madagascar	2004	0.199	0.118	0.084	0.068	0.075	0.051	0.037	0.052	0.051	0.047	0.092	0.331	0.097	15,008

(Cont'd)

Table 3 – cont'd

Survey		Preceding Birth to Conception Interval in Months													
		<6	**6-11**	**12-17**	**18-23**	**24-29**	**30-35**	**36-47**	**48-59**	**60-95**	**96+**	**First birth**	**Missing**	**Total**	**N**
Malawi	2000	0.344	0.297	0.235	0.176	0.141	0.152	0.132	0.131	0.108	0.124	0.225	0.463	0.200	29,538
Malawi	2004	0.286	0.246	0.207	0.142	0.122	0.119	0.100	0.096	0.085	0.080	0.179	0.515	0.162	26,773
Mali	2001	0.368	0.319	0.247	0.207	0.164	0.152	0.127	0.112	0.107	0.109	0.265	0.568	0.232	36,019
Mauritania	2000	0.175	0.130	0.101	0.091	0.072	0.050	0.072	0.069	0.064	0.069	0.102	0.357	0.101	13,807
Moldova	2005	0.062	0.069	0.019	0.020	0.037	0.018	0.028	0.023	0.017	0.020	0.023	0.118	0.026	5,100
Morocco	2003	0.130	0.071	0.060	0.043	0.042	0.039	0.034	0.033	0.025	0.025	0.060	0.269	0.062	19,478
Mozambique	2003	0.323	0.267	0.214	0.161	0.129	0.125	0.092	0.102	0.080	0.085	0.202	0.597	0.179	26,629
Namibia	2000	0.153	0.101	0.056	0.048	0.043	0.066	0.047	0.058	0.045	0.031	0.054	0.325	0.061	10,702
Nepal	2001	0.284	0.193	0.151	0.109	0.080	0.071	0.064	0.042	0.056	0.053	0.122	0.500	0.123	20,142
Nicaragua	2001	0.106	0.061	0.046	0.033	0.045	0.034	0.034	0.021	0.026	0.022	0.048	0.412	0.052	21,891
Nigeria	2003	0.311	0.276	0.244	0.202	0.150	0.142	0.098	0.099	0.085	0.112	0.194	0.424	0.209	15,913
Peru	2000	0.211	0.116	0.092	0.070	0.059	0.045	0.044	0.045	0.042	0.037	0.058	0.308	0.075	43,147
Peru	2004-5	0.159	0.103	0.075	0.065	0.058	0.032	0.049	0.039	0.028	0.024	0.045	0.284	0.058	17,125
Philippines	2003	0.088	0.052	0.047	0.035	0.036	0.034	0.034	0.035	0.027	0.031	0.038	0.250	0.045	20,892
Rwanda	2000	0.345	0.251	0.192	0.178	0.145	0.146	0.119	0.111	0.121	0.116	0.185	0.218	0.187	20,577
Rwanda	2005	0.313	0.239	0.200	0.171	0.145	0.135	0.122	0.131	0.136	0.154	0.184	0.575	0.182	22,248
Senegal	2005	0.217	0.160	0.139	0.123	0.105	0.092	0.073	0.076	0.069	0.081	0.144	0.356	0.135	28,698
Tanzania	2004	0.215	0.193	0.137	0.119	0.097	0.107	0.101	0.085	0.097	0.095	0.139	0.303	0.131	21,931
Turkmenistan	2000	0.178	0.095	0.085	0.079	0.059	0.077	0.063	0.042	0.058	0.069	0.089	0.258	0.089	11,362
Uganda	2000	0.240	0.159	0.145	0.118	0.105	0.108	0.110	0.089	0.100	0.107	0.163	0.418	0.148	17,758
Vietnam	2002	0.103	0.063	0.034	0.041	0.038	0.021	0.019	0.025	0.021	0.031	0.035	0.119	0.036	8,877
Zambia	2002	0.268	0.252	0.180	0.147	0.121	0.130	0.118	0.143	0.146	0.150	0.178	0.447	0.167	17,263
Average (wtd.)		**0.194**	**0.144**	**0.127**	**0.105**	**0.089**	**0.081**	**0.067**	**0.059**	**0.051**	**0.051**	**0.103**	**0.320**	**0.112**	**1,123,454**

Similar patterns of excess mortality by intervals durations occur for infant mortality (Table 4) and neonatal mortality (Table 5). Compared with a preceding birth-to-pregnancy interval of 36 to 47 months, infant mortality is higher on average by 265, 140, 86, and 58 percent for intervals of less than six months, six to 11 months, 12 to 17 months, and 18 to 23 months, respectively. For neonatal mortality, the average of the excess mortality is 316, 149, 85, and 55 percent for intervals less than six months, six to 11 months, 12 to 17 months, and 18 to 23 months, respectively.

Table 4. Infant rates by duration of preceding birth interval, birth 0 to 179 months prior to survey

Survey		Preceding Birth to Conception Interval in Months													
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing	Total	N
Armenia	2000	0.097	0.051	0.050	0.053	0.060	0.026	0.036	0.049	0.038	0.053	0.030	0.348	0.045	6,420
Armenia	2005	0.057	0.030	0.042	0.050	0.024	0.035	0.025	0.015	0.038	0.057	0.023	0.074	0.032	5,101
Bangladesh	1999/2000	0.179	0.117	0.099	0.084	0.049	0.046	0.047	0.043	0.043	0.052	0.109	0.505	0.088	20,366
Bangladesh	2004	0.159	0.097	0.099	0.069	0.060	0.056	0.049	0.032	0.057	0.040	0.094	0.471	0.079	20,855
Benin	2001	0.193	0.108	0.110	0.062	0.050	0.061	0.040	0.045	0.062	0.050	0.096	0.243	0.099	14,375
Bolivia	2003	0.165	0.108	0.075	0.064	0.047	0.047	0.044	0.031	0.035	0.037	0.061	0.138	0.073	31,091
Burkina Faso	2003	0.199	0.125	0.117	0.094	0.063	0.064	0.039	0.047	0.034	0.065	0.104	0.255	0.091	29,585
Cambodia	2000	0.212	0.128	0.093	0.081	0.059	0.068	0.059	0.051	0.053	0.062	0.097	0.405	0.093	29,493
Cameroon	2004	0.170	0.117	0.080	0.062	0.055	0.046	0.041	0.055	0.055	0.059	0.081	0.184	0.081	20,992
Chad	2004	0.200	0.144	0.103	0.096	0.060	0.057	0.050	0.071	0.034	0.058	0.119	0.368	0.103	15,316
Colombia	2000	0.057	0.033	0.027	0.032	0.017	0.028	0.018	0.016	0.016	0.031	0.022	0.121	0.025	13,521
Colombia	2005	0.060	0.037	0.028	0.024	0.029	0.022	0.017	0.021	0.017	0.024	0.022	0.161	0.026	44,312
Congo	2005	0.124	0.103	0.069	0.066	0.061	0.067	0.046	0.056	0.054	0.052	0.073	0.313	0.072	12,004
DomRep	2002	0.064	0.039	0.036	0.025	0.026	0.021	0.024	0.027	0.023	0.038	0.036	0.256	0.039	34,020
Egypt	2000	0.097	0.059	0.038	0.031	0.022	0.023	0.022	0.026	0.019	0.040	0.037	0.198	0.060	34,619
Egypt	2003	0.141	0.077	0.055	0.048	0.036	0.037	0.038	0.033	0.034	0.048	0.052	0.181	0.055	19,044
Egypt	2005	0.135	0.075	0.054	0.039	0.035	0.027	0.030	0.026	0.025	0.047	0.043	0.161	0.048	38,862
Eritrea	2002	0.141	0.094	0.053	0.052	0.034	0.042	0.021	0.028	0.028	0.020	0.086	0.443	0.073	18,755
Ethiopia	2000	0.221	0.175	0.118	0.109	0.087	0.068	0.065	0.040	0.053	0.061	0.135	0.433	0.115	30,502
Ethiopia	2005	0.184	0.126	0.083	0.068	0.054	0.050	0.044	0.039	0.033	0.063	0.084	0.305	0.081	28,542
Gabon	2000	0.112	0.079	0.049	0.037	0.049	0.033	0.041	0.028	0.029	0.046	0.052	0.348	0.055	11,822
Ghana	2003	0.169	0.106	0.093	0.043	0.052	0.038	0.042	0.036	0.064	0.072	0.070	0.136	0.067	10,592
Guinea	2005	0.230	0.147	0.128	0.069	0.062	0.077	0.052	0.063	0.069	0.032	0.127	0.455	0.114	19,107
Haiti	2000	0.193	0.127	0.095	0.081	0.047	0.042	0.058	0.044	0.039	0.051	0.100	0.424	0.093	18,938
Honduras	2005	0.081	0.046	0.029	0.025	0.024	0.020	0.027	0.020	0.023	0.020	0.034	0.135	0.033	33,619
Indonesia	2003	0.093	0.063	0.047	0.041	0.031	0.024	0.030	0.029	0.025	0.029	0.044	0.250	0.049	47,647
Jordan	2002	0.050	0.027	0.024	0.016	0.021	0.011	0.022	0.033	0.018	0.021	0.025	0.111	0.028	17,719
Kenya	2003	0.169	0.111	0.068	0.055	0.052	0.047	0.054	0.056	0.071	0.040	0.061	0.111	0.072	15,541
Lesotho	2004	0.215	0.132	0.096	0.071	0.066	0.058	0.052	0.053	0.090	0.079	0.083	0.428	0.082	9,816
Madagascar	2004	0.126	0.078	0.052	0.038	0.040	0.035	0.028	0.021	0.035	0.019	0.060	0.158	0.060	15,008
Malawi	2000	0.235	0.176	0.131	0.098	0.075	0.077	0.075	0.075	0.063	0.081	0.136	0.417	0.116	29,538
Malawi	2004	0.192	0.153	0.121	0.084	0.071	0.062	0.054	0.056	0.054	0.052	0.116	0.442	0.098	26,773

(Cont'd)

Table 4 – cont'd

Survey		Preceding Birth to Conception Interval in Months												Total	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing		
Mali	2001	0.240	0.175	0.128	0.096	0.080	0.079	0.060	0.057	0.059	0.054	0.168	0.514	0.128	36,019
Mauritania	2000	0.125	0.079	0.063	0.054	0.046	0.029	0.043	0.041	0.051	0.047	0.069	0.357	0.065	13,807
Moldova	2005	0.046	0.041	0.011	0.014	0.031	0.011	0.018	0.018	0.015	0.020	0.019	0.118	0.020	5,100
Morocco	2003	0.120	0.059	0.045	0.034	0.031	0.031	0.028	0.032	0.020	0.021	0.054	0.269	0.052	19,478
Mozambique	2003	0.261	0.197	0.137	0.106	0.082	0.077	0.066	0.068	0.050	0.039	0.142	0.524	0.123	26,629
Namibia	2000	0.124	0.078	0.031	0.029	0.025	0.046	0.030	0.033	0.035	0.026	0.038	0.250	0.042	10,702
Nepal	2001	0.215	0.136	0.103	0.075	0.056	0.048	0.046	0.028	0.035	0.045	0.101	0.500	0.090	20,142
Nicaragua	2001	0.091	0.047	0.035	0.025	0.035	0.029	0.030	0.013	0.021	0.019	0.040	0.412	0.043	21,891
Nigeria	2003	0.187	0.158	0.116	0.102	0.072	0.063	0.050	0.057	0.047	0.071	0.110	0.385	0.109	15,913
Peru	2000	0.166	0.084	0.063	0.051	0.038	0.035	0.030	0.035	0.030	0.031	0.043	0.264	0.054	43,147
Peru	2004-5	0.134	0.078	0.058	0.044	0.037	0.019	0.033	0.034	0.020	0.014	0.034	0.250	0.043	17,125
Philippines	2003	0.064	0.034	0.026	0.027	0.025	0.019	0.023	0.028	0.021	0.031	0.030	0.250	0.031	20,892
Rwanda	2000	0.245	0.139	0.109	0.094	0.077	0.082	0.061	0.057	0.053	0.074	0.107	0.169	0.106	20,577
Rwanda	2005	0.222	0.138	0.106	0.094	0.076	0.074	0.065	0.065	0.079	0.128	0.109	0.519	0.104	22,248
Senegal	2005	0.141	0.085	0.071	0.061	0.049	0.047	0.040	0.042	0.034	0.047	0.089	0.298	0.072	28,698
Tanzania	2004	0.177	0.143	0.081	0.065	0.055	0.069	0.060	0.053	0.057	0.064	0.092	0.228	0.083	21,931
Turkmenistan	2000	0.145	0.079	0.067	0.070	0.044	0.063	0.052	0.031	0.045	0.069	0.075	0.258	0.074	11,362
Uganda	2000	0.148	0.097	0.083	0.057	0.047	0.056	0.058	0.046	0.067	0.060	0.104	0.352	0.085	17,758
Vietnam	2002	0.077	0.058	0.026	0.030	0.026	0.019	0.016	0.013	0.020	0.018	0.028	0.119	0.028	8,877
Zambia	2002	0.199	0.161	0.091	0.080	0.067	0.074	0.063	0.067	0.085	0.110	0.106	0.328	0.095	17,263
Average (wtd.)		**0.144**	**0.095**	**0.077**	**0.063**	**0.051**	**0.048**	**0.041**	**0.038**	**0.036**	**0.039**	**0.072**	**0.281**	**0.074**	**1,123,454**

Table 5. Neonatal rates by duration of preceding birth to conception interval, births 0 to 179 months prior to survey

Survey		Preceding Birth to Conception Interval in Months												Total	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing		
Armenia	2000	0.058	0.019	0.019	0.032	0.036	0.022	0.013	0.024	0.032	0.041	0.020	0.333	0.026	6,420
Armenia	2005	0.022	0.015	0.018	0.033	0.008	0.011	0.012	0.010	0.019	0.045	0.016	0.071	0.018	5,101
Bangladesh	1999/2000	0.110	0.069	0.057	0.049	0.033	0.024	0.023	0.025	0.027	0.038	0.077	0.455	0.054	20,366
Bangladesh	2004	0.116	0.058	0.055	0.039	0.032	0.036	0.030	0.020	0.032	0.029	0.065	0.382	0.049	20,855
Benin	2001	0.106	0.065	0.054	0.034	0.027	0.027	0.035	0.038	0.031	0.045	0.050	0.217	0.045	14,375
Bolivia	2003	0.097	0.057	0.038	0.037	0.027	0.023	0.022	0.017	0.017	0.027	0.029	0.188	0.037	31,091
Burkina Faso	2003	0.107	0.062	0.048	0.037	0.028	0.026	0.016	0.020	0.014	0.023	0.052	0.139	0.039	29,585
Cambodia	2000	0.113	0.062	0.040	0.035	0.022	0.031	0.023	0.019	0.023	0.028	0.049	0.324	0.042	29,493
Cameroon	2004	0.086	0.059	0.034	0.027	0.028	0.027	0.014	0.019	0.038	0.029	0.039	0.147	0.036	20,992
Chad	2004	0.088	0.056	0.041	0.042	0.025	0.034	0.020	0.044	0.017	0.044	0.056	0.167	0.044	15,316
Colombia	2000	0.028	0.022	0.015	0.014	0.009	0.023	0.016	0.009	0.014	0.028	0.014	0.121	0.016	13,521
Colombia	2005	0.035	0.019	0.013	0.014	0.016	0.014	0.013	0.013	0.010	0.017	0.015	0.101	0.015	44,312
Congo	2005	0.045	0.060	0.033	0.035	0.033	0.026	0.021	0.033	0.025	0.026	0.036	0.219	0.034	12,004
DomRep	2002	0.039	0.022	0.023	0.016	0.016	0.013	0.013	0.022	0.015	0.030	0.022	0.214	0.022	34,020
Egypt	2000	0.078	0.046	0.030	0.023	0.018	0.019	0.016	0.019	0.013	0.030	0.030	0.156	0.031	34,619
Egypt	2003	0.068	0.033	0.020	0.021	0.019	0.024	0.022	0.021	0.020	0.031	0.028	0.151	0.028	19,044
Egypt	2005	0.071	0.031	0.026	0.021	0.016	0.015	0.017	0.016	0.013	0.041	0.027	0.113	0.026	38,862
Eritrea	2002	0.084	0.050	0.025	0.030	0.015	0.019	0.012	0.016	0.012	0.021	0.049	0.444	0.036	18,755
Ethiopia	2000	0.119	0.084	0.056	0.050	0.042	0.029	0.031	0.020	0.022	0.024	0.073	0.295	0.057	30,502
Ethiopia	2005	0.093	0.063	0.038	0.039	0.022	0.026	0.017	0.024	0.017	0.044	0.047	0.125	0.041	28,542
Gabon	2000	0.069	0.040	0.021	0.019	0.021	0.013	0.018	0.011	0.027	0.033	0.028	0.366	0.027	11,822
Ghana	2003	0.111	0.062	0.059	0.026	0.031	0.023	0.030	0.022	0.044	0.051	0.047	0.136	0.041	10,592
Guinea	2005	0.121	0.107	0.057	0.068	0.035	0.066	0.035	0.018	0.024	0.029	0.071	0.406	0.057	19,107
Haiti	2000	0.093	0.054	0.041	0.032	0.018	0.013	0.025	0.026	0.011	0.039	0.048	0.303	0.040	18,938
Honduras	2005	0.049	0.026	0.015	0.013	0.013	0.013	0.019	0.015	0.016	0.012	0.021	0.058	0.019	33,619
Indonesia	2003	0.061	0.038	0.029	0.022	0.022	0.014	0.017	0.018	0.015	0.017	0.025	0.202	0.024	47,647
Jordan	2002	0.049	0.017	0.018	0.012	0.016	0.009	0.016	0.015	0.014	0.020	0.016	0.087	0.019	17,719
Kenya	2003	0.082	0.055	0.027	0.029	0.026	0.021	0.017	0.023	0.037	0.020	0.033	0.081	0.033	15,541
Lesotho	2004	0.159	0.093	0.059	0.042	0.034	0.034	0.025	0.032	0.041	0.036	0.044	0.300	0.045	9,816
Madagascar	2004	0.066	0.051	0.025	0.024	0.015	0.021	0.014	0.011	0.017	0.016	0.033	0.143	0.029	15,008
Malawi	2000	0.105	0.070	0.053	0.037	0.024	0.029	0.030	0.034	0.017	0.038	0.061	0.286	0.047	29,538
Malawi	2004	0.090	0.061	0.046	0.029	0.025	0.025	0.018	0.024	0.019	0.029	0.053	0.311	0.040	26,773

(Cont'd)

Table 5 – cont'd

Survey		Preceding Birth to Conception Interval in Months													
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing	Total	N
Mali	2001	0.139	0.095	0.067	0.052	0.040	0.047	0.029	0.031	0.028	0.037	0.104	0.425	0.070	36,019
Mauritania	2000	0.088	0.048	0.037	0.033	0.021	0.018	0.021	0.024	0.028	0.036	0.047	0.212	0.039	13,807
Moldova	2005	0.031	0.012	0.007	0.009	0.010	0.011	0.009	0.018	0.008	0.020	0.012	0.118	0.013	5,100
Morocco	2003	0.104	0.046	0.031	0.025	0.019	0.022	0.019	0.025	0.014	0.022	0.037	0.255	0.033	19,478
Mozambique	2003	0.133	0.077	0.050	0.040	0.033	0.024	0.021	0.021	0.016	0.022	0.058	0.292	0.046	26,629
Namibia	2000	0.083	0.058	0.017	0.019	0.012	0.021	0.015	0.016	0.015	0.021	0.021	0.250	0.023	10,702
Nepal	2001	0.146	0.077	0.059	0.044	0.031	0.029	0.026	0.017	0.015	0.037	0.064	0.500	0.054	20,142
Nicaragua	2001	0.048	0.023	0.016	0.013	0.019	0.012	0.011	0.005	0.015	0.011	0.022	0.240	0.020	21,891
Nigeria	2003	0.101	0.085	0.055	0.048	0.033	0.041	0.030	0.031	0.028	0.028	0.062	0.323	0.054	15,913
Peru	2000	0.093	0.041	0.035	0.026	0.022	0.016	0.014	0.019	0.017	0.021	0.022	0.189	0.029	43,147
Peru	2004-5	0.081	0.042	0.026	0.023	0.019	0.013	0.015	0.024	0.009	0.010	0.019	0.222	0.023	17,125
Philippines	2003	0.040	0.020	0.013	0.013	0.011	0.006	0.012	0.014	0.015	0.018	0.019	0.250	0.018	20,892
Rwanda	2000	0.132	0.064	0.043	0.042	0.031	0.038	0.018	0.031	0.018	0.024	0.052	0.167	0.048	20,577
Rwanda	2005	0.115	0.066	0.051	0.038	0.023	0.030	0.028	0.019	0.026	0.063	0.052	0.304	0.046	22,248
Senegal	2005	0.089	0.057	0.037	0.037	0.027	0.025	0.022	0.022	0.021	0.032	0.055	0.242	0.040	28,698
Tanzania	2004	0.087	0.062	0.031	0.019	0.020	0.020	0.030	0.020	0.028	0.026	0.042	0.220	0.033	21,931
Turkmenistan	2000	0.053	0.027	0.026	0.023	0.016	0.027	0.022	0.018	0.033	0.050	0.033	0.167	0.030	11,362
Uganda	2000	0.069	0.044	0.029	0.021	0.016	0.023	0.025	0.016	0.030	0.049	0.048	0.257	0.034	17,758
Vietnam	2002	0.063	0.039	0.019	0.020	0.020	0.007	0.006	0.004	0.014	0.009	0.019	0.056	0.018	8,877
Zambia	2002	0.097	0.059	0.033	0.023	0.020	0.016	0.017	0.017	0.043	0.050	0.042	0.230	0.033	17,263
Average (wtd.)		**0.077**	**0.045**	**0.035**	**0.028**	**0.023**	**0.022**	**0.019**	**0.019**	**0.018**	**0.025**	**0.039**	**0.203**	**0.037**	**1,123,454**

Birth Size and Birth Weight

The mother's estimation of the size of her baby at birth was asked about for children born in the five years before the survey in 47 surveys. Five surveys did not ask about size at birth: Bangladesh 2004, Colombia 2000 and 2005, Egypt 2003, and Peru 2000. Size was given in five categories: very small, small, average, larger than average, and very large. In this report, very small and small are combined into one category to represent the detrimental birth outcome. The other three categories are considered nondetrimental. The percentage of children who are small or very small at birth according to birth-to-pregnancy interval is shown in Table 6. Overall, 20 percent of children were so classified by their mothers. Figure 1 shows that there is a quite weak bivariate relationship between birth size and birth-to-pregnancy interval. The percentage in the categories of small or very small is highest for children conceived six months after the birth of their next oldest sibling, and intervals of 36 months or longer have lower percentages of small babies.

Four surveys did not ask about birth weight: Bangladesh 1999/2000, Bangladesh 2004, Egypt 2003, and Nepal 2001. However, not every baby is weighed at birth. Among the surveys with both birth size and birth weight information only about a third of babies were weighed at the time of birth. Overall, about 10 percent of babies are of low birth weight (Table 7), which is defined as weighing less than 2.5 kg at birth. However, the relationship of low birth weight with birth-to-pregnancy interval is quite similar to that of birth size, except that babies conceived with an interval of less than six months are the most likely to be of low birth weight (13 percent). Figure 1 indicates that the risk of being of low birth weight also rises for children conceived after very long intervals of 96 or more months.

Table 6. Small or very small size at birth by duration of preceding birth to conception interval, children born 0 to 59 months prior to the survey

Survey		Preceding Birth to Conception Interval in Months												Total	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth	Missing		
Armenia	2000	24%	19%	18%	20%	11%	17%	15%	17%	18%	18%	18%	75%	18%	1,703
Armenia	2005	18%	13%	7%	8%	15%	15%	9%	5%	12%	17%	14%	50%	13%	1,395
Bangladesh	1999/2000	22%	22%	17%	18%	19%	20%	16%	19%	19%	16%	21%	46%	19%	6,718
Bangladesh	2004	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Benin	2001	15%	12%	15%	13%	17%	14%	16%	17%	16%	16%	19%	47%	16%	5,220
Bolivia	2003	24%	24%	21%	19%	22%	21%	20%	17%	17%	22%	23%	71%	21%	10,291
Burkina Faso	2003	23%	17%	17%	15%	14%	16%	15%	17%	15%	13%	21%	21%	17%	10,364
Cambodia	2000	16%	15%	14%	13%	12%	14%	14%	13%	15%	20%	15%	44%	14%	8,398
Cameroon	2004	18%	19%	17%	16%	17%	17%	14%	19%	12%	12%	20%	26%	17%	7,933
Chad	2004	22%	33%	30%	31%	32%	36%	34%	35%	34%	28%	31%	67%	32%	5,534
Colombia	2000	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Colombia	2005	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Congo	2005	7%	4%	11%	10%	10%	10%	9%	8%	8%	11%	13%	31%	10%	4,558
DomRep	2002	30%	26%	24%	26%	23%	26%	20%	20%	18%	22%	23%	57%	23%	11,174
Egypt	2000	18%	15%	15%	15%	15%	15%	11%	14%	13%	15%	16%	49%	15%	11,295
Egypt	2003	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Egypt	2005	18%	13%	13%	14%	13%	13%	15%	14%	14%	15%	15%	46%	15%	13,622
Eritrea	2002	37%	32%	33%	32%	31%	32%	30%	26%	29%	27%	36%	100%	32%	6,151
Ethiopia	2000	31%	32%	33%	32%	33%	35%	36%	32%	30%	32%	35%	40%	34%	10,727
Ethiopia	2005	29%	27%	27%	27%	28%	26%	28%	27%	27%	26%	29%	33%	28%	9,691
Gabon	2000	11%	13%	10%	10%	9%	10%	9%	11%	10%	11%	18%	50%	12%	4,240
Ghana	2003	23%	20%	16%	16%	17%	19%	16%	20%	19%	6%	23%	50%	18%	3,772
Guinea	2005	22%	13%	16%	14%	12%	14%	15%	15%	14%	16%	17%	40%	15%	6,138
Haiti	2000	32%	34%	31%	32%	30%	33%	35%	33%	28%	36%	36%	58%	33%	6,623
Honduras	2005	29%	29%	32%	32%	27%	28%	27%	25%	21%	19%	26%	55%	27%	10,680
Indonesia	2003	14%	12%	13%	14%	13%	13%	13%	12%	13%	15%	16%	43%	14%	15,181
Jordan	2002	21%	18%	15%	17%	17%	12%	17%	13%	17%	10%	21%	55%	18%	6,002
Kenya	2003	18%	14%	15%	17%	17%	15%	17%	17%	16%	16%	18%	40%	17%	5,835
Lesotho	2004	31%	16%	16%	16%	11%	11%	11%	14%	14%	11%	13%	33%	13%	3,581
Madagascar	2004	31%	23%	26%	22%	23%	26%	21%	24%	22%	23%	26%	100%	24%	5,312

(Cont'd)

Table 6 – cont'd

Survey		Preceding Birth to Conception Interval in Months													
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth	Missing	Total	N
Malawi	2000	14%	17%	17%	14%	14%	14%	15%	16%	14%	14%	20%	44%	16%	11,721
Malawi	2004	22%	18%	15%	14%	15%	15%	14%	11%	15%	12%	18%	33%	15%	10,497
Mali	2001	20%	25%	24%	22%	23%	23%	25%	22%	25%	26%	28%	53%	24%	12,304
Mauritania	2000	52%	53%	51%	53%	51%	49%	50%	45%	53%	46%	51%	55%	51%	4,598
Moldova	2005	4%	10%	10%	13%	16%	11%	10%	7%	8%	7%	13%	60%	11%	1,532
Morocco	2003	24%	26%	21%	26%	24%	25%	22%	26%	21%	22%	26%	68%	24%	6,080
Mozambique	2003	19%	18%	19%	15%	16%	17%	18%	19%	16%	22%	26%	67%	19%	10,185
Namibia	2000	22%	17%	14%	16%	15%	18%	19%	19%	17%	19%	16%	50%	17%	3,770
Nepal	2001	30%	20%	20%	24%	22%	17%	23%	22%	21%	32%	26%	88%	23%	6,870
Nicaragua	2001	33%	32%	35%	31%	33%	29%	27%	27%	25%	26%	33%	62%	31%	6,882
Nigeria	2003	15%	14%	14%	14%	13%	16%	14%	12%	11%	16%	16%	33%	14%	5,868
Peru	2000	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Peru	2004-5	26%	20%	26%	23%	27%	20%	22%	27%	18%	20%	24%	55%	23%	5,110
Philippines	2003	19%	18%	19%	18%	21%	22%	15%	16%	18%	19%	21%	62%	19%	7,024
Rwanda	2000	11%	8%	10%	9%	12%	13%	12%	12%	11%	17%	12%	47%	11%	7,797
Rwanda	2005	10%	10%	11%	11%	12%	14%	11%	11%	15%	12%	17%	48%	13%	8,504
Senegal	2005	29%	29%	31%	28%	30%	30%	28%	31%	32%	29%	32%	73%	30%	10,731
Tanzania	2004	19%	13%	10%	11%	11%	9%	10%	11%	15%	7%	16%	63%	12%	8,456
Turkmenistan	2000	18%	9%	9%	12%	12%	8%	9%	12%	11%	8%	18%	86%	13%	3,496
Uganda	2000	19%	16%	16%	17%	18%	17%	19%	19%	17%	11%	22%	42%	18%	6,958
Vietnam	2002	6%	9%	6%	4%	4%	3%	3%	0%	6%	10%	7%	20%	6%	1,298
Zambia	2002	17%	13%	11%	11%	12%	12%	12%	10%	13%	12%	19%	56%	14%	6,796
Average (wtd.)		**23%**	**21%**	**20%**	**20%**	**20%**	**20%**	**19%**	**19%**	**18%**	**18%**	**22%**	**52%**	**20%**	**338,615**

n/a: Not available

Table 7. Low birthweight rates by duration of preceding birth to conception interval, children born age 0 to 59 months prior to survey who were weighed at birth

Survey		Preceding Birth to Conception Interval in Months												Total	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth	Missing		
Armenia	2000	9%	10%	7%	8%	1%	6%	6%	4%	4%	6%	6%	50%	6%	1,639
Armenia	2005	18%	10%	1%	3%	6%	3%	4%	2%	12%	14%	8%	71%	8%	1,398
Bangladesh	1999/2000	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bangladesh	2004	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Benin	2001	20%	13%	10%	9%	12%	11%	13%	13%	8%	11%	21%	75%	14%	2,913
Bolivia	2003	9%	6%	6%	4%	7%	7%	5%	7%	5%	6%	6%	46%	6%	6,723
Burkin/a Faso	2003	15%	12%	11%	12%	10%	16%	11%	13%	15%	13%	22%	83%	15%	3,055
Cambodia	2000	10%	0%	7%	7%	9%	9%	7%	6%	10%	3%	7%	0%	7%	1,194
Cameroon	2004	8%	12%	7%	7%	9%	8%	5%	11%	7%	10%	13%	44%	10%	4,504
Chad	2004	3%	18%	12%	10%	12%	8%	5%	20%	28%	20%	13%	33%	12%	1,029
Colombia	2000	13%	8%	6%	6%	8%	4%	6%	4%	6%	5%	8%	29%	7%	3,294
Colombia	2005	10%	6%	7%	6%	10%	7%	6%	5%	6%	7%	8%	68%	7%	10,162
Congo	2005	14%	8%	12%	11%	10%	14%	10%	8%	12%	18%	16%	42%	13%	4,150
DomRep	2002	18%	10%	12%	10%	11%	12%	10%	9%	8%	16%	11%	74%	11%	10,767
Egypt	2000	9%	7%	9%	8%	9%	13%	9%	9%	9%	10%	12%	58%	10%	2,279
Egypt	2003	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Egypt	2005	9%	11%	11%	10%	11%	13%	15%	12%	12%	16%	12%	53%	12%	4,646
Eritrea	2002	10%	10%	7%	6%	6%	2%	8%	10%	9%	14%	12%	33%	9%	1,374
Ethiopia	2000	0%	7%	5%	16%	2%	3%	6%	7%	11%	8%	7%	0%	7%	741
Ethiopia	2005	27%	0%	6%	8%	9%	13%	12%	11%	8%	14%	11%	0%	10%	731
Gabon	2000	11%	14%	10%	11%	10%	10%	10%	10%	10%	7%	19%	67%	13%	3,702
Ghana	2003	6%	0%	6%	6%	6%	5%	10%	8%	7%	4%	10%	50%	8%	972
Guinea	2005	12%	7%	13%	10%	9%	12%	9%	8%	7%	10%	13%	50%	11%	2,485
Haiti	2000	0%	20%	13%	25%	4%	21%	17%	8%	11%	0%	22%		18%	612
Honduras	2005	8%	6%	10%	9%	8%	9%	8%	8%	6%	7%	11%	50%	9%	6,838
Indonesia	2003	9%	7%	6%	6%	5%	6%	5%	5%	7%	8%	8%	57%	7%	11,723
Jordan	2002	16%	12%	11%	12%	13%	8%	13%	9%	10%	12%	12%	63%	12%	5,820
Kenya	2003	7%	4%	7%	7%	7%	8%	8%	6%	7%	11%	10%	80%	8%	2,655
Lesotho	2004	24%	11%	11%	12%	12%	8%	7%	12%	11%	9%	11%	50%	11%	2,310
Madagascar	2004	15%	7%	13%	8%	8%	13%	13%	11%	10%	13%	14%	100%	12%	2,396

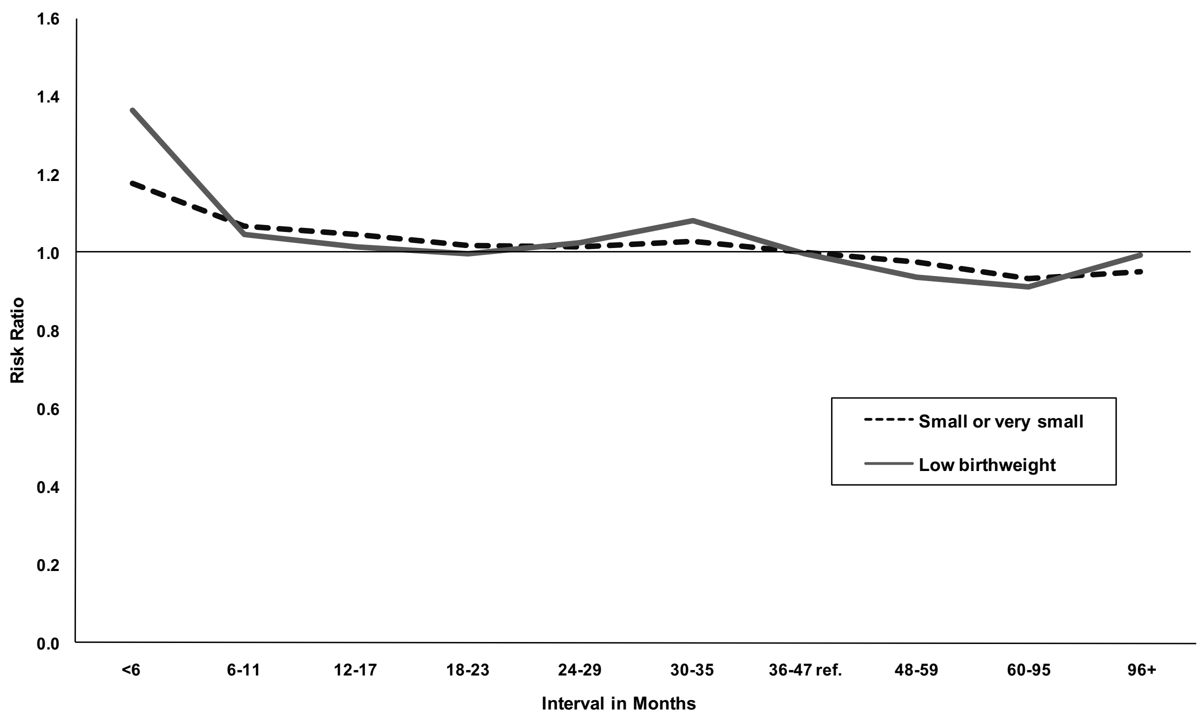
(Cont'd)

Table 7 – cont'd

Survey		Preceding Birth to Conception Interval in Months												Total	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth	Missing		
Malawi	2000	14%	11%	11%	9%	8%	8%	9%	10%	7%	2%	14%	48%	11%	5,429
Malawi	2004	14%	15%	11%	9%	11%	12%	11%	7%	11%	3%	13%	58%	11%	5,217
Mali	2001	12%	21%	12%	18%	14%	11%	17%	18%	11%	16%	19%	100%	16%	2,433
Mauritania	2000	25%	35%	31%	37%	30%	36%	31%	28%	27%	19%	30%	67%	31%	1,469
Moldova	2005	4%	7%	0%	2%	4%	6%	6%	4%	4%	5%	6%	60%	5%	1,532
Morocco	2003	11%	13%	6%	11%	12%	20%	11%	12%	8%	15%	14%	47%	12%	2,780
Mozambique	2003	20%	10%	12%	9%	11%	9%	13%	14%	9%	19%	19%	55%	13%	5,261
Namibia	2000	19%	14%	9%	14%	9%	15%	10%	14%	10%	16%	14%	80%	13%	2,550
Nepal	2001	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Nicaragua	2001	13%	12%	13%	9%	8%	14%	8%	9%	10%	9%	11%	92%	11%	4,571
Nigeria	2003	9%	7%	10%	9%	8%	14%	8%	6%	18%	27%	10%	50%	10%	825
Peru	2000	10%	10%	9%	11%	9%	11%	11%	8%	8%	9%	9%	75%	9%	9,224
Peru	2004-5	8%	10%	10%	9%	14%	9%	10%	13%	9%	7%	9%	67%	10%	4,057
Philippines	2003	21%	20%	21%	20%	17%	20%	18%	17%	17%	19%	20%	64%	20%	4,687
Rwanda	2000	11%	4%	4%	7%	6%	11%	12%	10%	3%	17%	10%	46%	8%	2,462
Rwanda	2005	6%	3%	4%	3%	4%	5%	5%	3%	8%	6%	8%	46%	5%	2,710
Senegal	2005	16%	13%	13%	13%	15%	14%	14%	16%	16%	9%	18%	60%	15%	4,705
Tanzania	2004	11%	10%	7%	7%	5%	4%	5%	6%	8%	6%	13%	63%	8%	4,105
Turkmenistan	2000	10%	4%	4%	5%	2%	2%	3%	4%	8%	4%	8%	71%	6%	3,387
Uganda	2000	13%	10%	7%	9%	10%	9%	11%	12%	12%	5%	11%	11%	10%	2,322
Vietnam	2002	0%	8%	9%	12%	6%	3%	3%	0%	8%	10%	7%	50%	7%	1,057
Zambia	2002	16%	13%	9%	7%	10%	10%	8%	9%	12%	8%	16%	75%	11%	2,674
Average (wtd.)		**13%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**9%**	**9%**	**10%**	**12%**	**58%**	**10%**	**173,569**

n/a: Not available

Figure 1 Small Size at Birth and Low Birth Weight by Preceding Birth to Conception Interval



Nutritional Status

Nutritional status was determined by anthropometric measurements on children under age five except in Indonesia, the Philippines, and Vietnam, where anthropometry was not included. Children who were born in the month of the interview were not analyzed. Tables 8, 9, and 10 present the percentage of children stunted, underweight, and wasted, respectively, according to the duration of the preceding birth-to-pregnancy interval. The averages show substantial declines in stunting as the interval increases after 18 months and for underweight after 30 months. There is a curvilinear relationship between the length of the birth-to-pregnancy interval and wasting, with increases as the interval lengthens up to an interval length of 30 to 35 months and decreases with longer intervals (Figure 2).

Table 8. Stunting rates by duration of preceding birth to conception interval, living children age 0 to 59 months

Survey		Preceding Birth to Conception Interval in Months												Total	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing		
Armenia	2000	16%	17%	14%	12%	17%	22%	11%	17%	17%	9%	9%	0%	13%	1,517
Armenia	2005	19%	13%	11%	11%	18%	8%	9%	4%	9%	14%	10%	0%	11%	1,238
Bangladesh	1999/2000	50%	54%	50%	52%	50%	45%	36%	44%	35%	26%	42%	67%	44%	5,333
Bangladesh	2004	48%	52%	51%	50%	49%	45%	40%	41%	32%	26%	38%	67%	42%	5,911
Benin	2001	24%	25%	30%	25%	29%	26%	26%	26%	23%	22%	26%	58%	27%	3,842
Bolivia	2003	36%	34%	37%	37%	32%	26%	24%	21%	13%	14%	19%	40%	27%	9,134
Burkina Faso	2003	42%	55%	43%	42%	38%	39%	34%	34%	25%	23%	36%	75%	38%	8,142
Cambodia	2000	57%	58%	56%	44%	48%	40%	42%	38%	30%	17%	43%	0%	46%	3,522
Cameroon	2004	28%	33%	39%	36%	32%	32%	29%	23%	19%	22%	27%	9%	31%	3,168
Chad	2004	40%	48%	45%	42%	40%	34%	34%	30%	32%	27%	32%	57%	39%	4,414
Colombia	2000	23%	21%	24%	20%	17%	13%	13%	11%	9%	6%	9%	11%	14%	4,180
Colombia	2005	21%	21%	21%	19%	18%	13%	9%	9%	7%	6%	8%	23%	12%	12,393
Congo	2005	24%	31%	29%	26%	25%	23%	19%	19%	18%	17%	24%	44%	23%	3,858
DomRep	2002	13%	13%	14%	12%	12%	11%	7%	4%	5%	6%	7%	0%	9%	9,288
Egypt	2000	23%	23%	21%	20%	17%	16%	17%	19%	15%	13%	17%	22%	18%	10,296
Egypt	2003	15%	18%	17%	18%	16%	13%	15%	15%	15%	17%	15%	19%	16%	6,065
Egypt	2005	24%	27%	23%	23%	22%	21%	19%	22%	18%	17%	19%	25%	21%	12,325
Eritrea	2002	47%	43%	40%	43%	40%	39%	39%	28%	30%	33%	34%	50%	39%	5,341
Ethiopia	2000	50%	52%	54%	49%	47%	48%	47%	40%	32%	41%	41%	57%	47%	8,590
Ethiopia	2005	46%	55%	49%	47%	43%	42%	41%	47%	26%	21%	36%	0%	43%	3,873
Gabon	2000	26%	30%	31%	26%	23%	20%	20%	20%	12%	17%	22%	43%	24%	3,482
Ghana	2003	37%	38%	36%	36%	32%	32%	29%	25%	25%	15%	28%	14%	31%	3,094
Guinea	2005	29%	34%	39%	35%	34%	43%	28%	32%	22%	35%	33%	50%	34%	2,595
Haiti	2000	24%	28%	29%	26%	27%	23%	22%	16%	15%	10%	14%	57%	23%	5,510
Honduras	2005	35%	40%	43%	44%	34%	33%	26%	20%	17%	9%	20%	19%	29%	9,228
Indonesia	2003	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Jordan	2002	11%	13%	13%	10%	11%	9%	8%	5%	7%	5%	8%	19%	10%	4,869
Kenya	2003	30%	31%	37%	33%	30%	28%	29%	27%	24%	16%	25%	67%	29%	4,719
Lesotho	2004	68%	59%	48%	37%	41%	35%	28%	36%	29%	31%	37%	50%	37%	1,363
Madagascar	2004	47%	46%	51%	47%	42%	41%	39%	41%	35%	39%	44%	40%	44%	4,418
Malawi	2000	52%	51%	49%	47%	47%	43%	44%	45%	44%	42%	47%	68%	47%	9,162
Malawi	2004	47%	53%	50%	48%	50%	47%	44%	49%	42%	44%	47%	71%	48%	8,045

(Cont'd)

Table 8 – cont'd

Survey		Preceding Birth to Conception Interval in Months												Total	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing		
Mali	2001	48%	49%	43%	37%	36%	33%	36%	28%	29%	30%	38%	75%	38%	9,371
Mauritania	2000	34%	38%	32%	30%	31%	28%	27%	23%	25%	21%	29%	50%	29%	3,306
Moldova	2005	0%	13%	11%	9%	12%	14%	6%	7%	9%	11%	7%	20%	8%	1,298
Morocco	2003	21%	28%	23%	21%	23%	19%	16%	16%	16%	10%	17%	21%	19%	5,356
Mozambique	2003	47%	48%	45%	41%	40%	38%	34%	35%	29%	29%	38%	63%	39%	8,031
Namibia	2000	31%	33%	24%	23%	26%	21%	19%	19%	20%	14%	20%	25%	22%	2,909
Nepal	2001	60%	57%	54%	54%	50%	49%	51%	41%	45%	42%	47%	57%	50%	6,163
Nicaragua	2001	33%	29%	31%	29%	25%	22%	20%	16%	11%	5%	16%	38%	22%	5,875
Nigeria	2003	38%	42%	41%	38%	35%	34%	33%	33%	31%	16%	37%	0%	37%	4,293
Peru	2000	45%	43%	41%	41%	35%	33%	30%	21%	18%	11%	19%	30%	29%	11,585
Peru	2004-5	56%	40%	35%	42%	42%	26%	30%	18%	16%	12%	19%	0%	26%	2,294
Philippines	2003	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rwanda	2000	38%	39%	41%	41%	43%	43%	36%	39%	38%	40%	38%	60%	40%	6,038
Rwanda	2005	44%	46%	48%	46%	39%	47%	44%	41%	45%	38%	41%	50%	44%	3,641
Senegal	2005	24%	21%	19%	19%	15%	18%	15%	12%	13%	16%	15%	25%	17%	2,847
Tanzania	2004	42%	38%	37%	35%	37%	39%	34%	34%	28%	27%	38%	57%	36%	7,132
Turkmenistan	2000	27%	26%	30%	22%	18%	23%	16%	18%	23%	29%	22%	33%	23%	2,974
Uganda	2000	43%	42%	40%	40%	40%	33%	30%	32%	30%	22%	36%	50%	38%	5,145
Vietnam	2002	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Zambia	2002	49%	58%	51%	50%	44%	46%	41%	41%	36%	37%	49%	80%	47%	5,430
Average (wtd.)		**34%**	**36%**	**38%**	**36%**	**35%**	**33%**	**29%**	**26%**	**21%**	**17%**	**26%**	**36%**	**31%**	**272,603**

n/a: Not available

Table 9. Underweight rates by duration of preceding birth to conception interval, living children age 0 to 59 months

Survey		Preceding Birth to Conception Interval in Months													
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing	Total	N
Armenia	2000	4%	3%	3%	2%	3%	6%	4%	3%	3%	2%	2%	0%	3%	1,517
Armenia	2005	6%	4%	5%	6%	5%	0%	0%	2%	3%	4%	4%	0%	4%	1,238
Bangladesh	1999/2000	55%	55%	51%	51%	53%	46%	42%	47%	41%	29%	46%	78%	47%	5,333
Bangladesh	2004	48%	58%	55%	52%	50%	51%	46%	41%	42%	32%	42%	33%	47%	5,911
Benin	2001	20%	19%	22%	18%	22%	18%	23%	20%	16%	12%	19%	50%	20%	3,842
Bolivia	2003	10%	9%	11%	11%	9%	7%	5%	7%	5%	4%	5%	30%	8%	9,134
Burkina Faso	2003	43%	51%	42%	41%	39%	39%	36%	35%	29%	30%	37%	75%	39%	8,142
Cambodia	2000	53%	56%	52%	42%	44%	42%	44%	39%	34%	36%	44%	0%	45%	3,522
Cameroon	2004	23%	20%	20%	19%	20%	19%	15%	12%	6%	7%	14%	9%	17%	3,168
Chad	2004	40%	43%	40%	39%	37%	33%	31%	35%	28%	33%	33%	43%	37%	4,414
Colombia	2000	11%	10%	12%	11%	9%	8%	5%	4%	7%	3%	4%	0%	7%	4,180
Colombia	2005	12%	12%	12%	12%	13%	8%	6%	6%	5%	5%	5%	10%	7%	12,393
Congo	2005	15%	15%	17%	15%	14%	13%	10%	15%	9%	9%	14%	22%	13%	3,858
DomRep	2002	8%	8%	9%	8%	7%	6%	4%	4%	3%	3%	4%	0%	6%	9,288
Egypt	2000	4%	7%	5%	3%	4%	5%	4%	3%	3%	2%	4%	3%	4%	10,296
Egypt	2003	11%	10%	10%	8%	9%	9%	8%	7%	7%	5%	8%	19%	9%	6,065
Egypt	2005	7%	9%	7%	6%	7%	7%	6%	7%	6%	6%	6%	5%	7%	12,325
Eritrea	2002	45%	46%	41%	44%	44%	40%	42%	37%	36%	41%	40%	50%	42%	5,341
Ethiopia	2000	45%	47%	50%	47%	45%	44%	45%	41%	33%	35%	36%	57%	43%	8,590
Ethiopia	2005	40%	45%	42%	42%	39%	37%	37%	37%	27%	19%	30%	0%	37%	3,873
Gabon	2000	19%	13%	18%	14%	12%	12%	11%	13%	8%	12%	13%	29%	14%	3,482
Ghana	2003	26%	29%	28%	24%	22%	25%	20%	24%	22%	8%	22%	29%	23%	3,094
Guinea	2005	31%	25%	28%	21%	27%	27%	25%	25%	17%	21%	26%	100%	25%	2,595
Haiti	2000	22%	23%	22%	19%	22%	20%	17%	15%	11%	10%	11%	57%	18%	5,510
Honduras	2005	17%	19%	19%	21%	16%	16%	14%	9%	7%	4%	10%	6%	14%	9,228
Indonesia	2003	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Jordan	2002	4%	7%	5%	4%	8%	5%	5%	3%	4%	5%	5%	13%	5%	4,869
Kenya	2003	25%	21%	25%	23%	21%	19%	21%	15%	14%	10%	17%	67%	20%	4,719
Lesotho	2004	47%	36%	29%	26%	25%	15%	15%	21%	11%	16%	19%	0%	20%	1,363
Madagascar	2004	42%	42%	46%	44%	38%	36%	37%	35%	30%	24%	36%	40%	38%	4,418
Malawi	2000	28%	25%	24%	24%	22%	19%	23%	24%	23%	21%	25%	53%	24%	9,162
Malawi	2004	20%	27%	23%	23%	22%	20%	19%	22%	20%	14%	21%	36%	22%	8,045

(Cont'd)

Table 9 – cont'd

Survey		Preceding Birth to Conception Interval in Months												Total	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing		
Mali	2001	40%	43%	35%	33%	33%	30%	34%	27%	27%	30%	35%	75%	34%	9,371
Mauritania	2000	31%	32%	28%	28%	27%	26%	22%	30%	24%	15%	27%	100%	27%	3,306
Moldova	2005	7%	6%	4%	4%	6%	4%	6%	3%	6%	5%	3%	20%	4%	1,298
Morocco	2003	10%	15%	15%	14%	14%	13%	10%	9%	9%	5%	9%	5%	11%	5,356
Mozambique	2003	26%	25%	24%	24%	23%	21%	19%	20%	20%	16%	22%	25%	22%	8,031
Namibia	2000	25%	30%	28%	27%	29%	20%	21%	20%	20%	16%	20%	50%	23%	2,909
Nepal	2001	48%	50%	50%	52%	48%	50%	48%	39%	49%	41%	43%	57%	48%	6,163
Nicaragua	2001	13%	14%	16%	13%	13%	12%	9%	9%	5%	6%	6%	25%	10%	5,875
Nigeria	2003	26%	33%	31%	31%	29%	26%	22%	22%	29%	7%	28%	67%	28%	4,293
Peru	2000	16%	15%	11%	12%	9%	10%	10%	5%	5%	3%	6%	10%	9%	11,585
Peru	2004-5	11%	11%	14%	16%	10%	11%	7%	3%	5%	5%	6%	0%	8%	2,294
Philippines	2003	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rwanda	2000	23%	21%	25%	25%	26%	26%	21%	28%	22%	28%	19%	53%	23%	6,038
Rwanda	2005	23%	17%	24%	24%	20%	26%	22%	17%	24%	21%	21%	17%	22%	3,641
Senegal	2005	16%	21%	23%	19%	17%	16%	15%	14%	14%	22%	16%	25%	18%	2,847
Tanzania	2004	27%	25%	24%	23%	23%	24%	20%	18%	19%	15%	22%	50%	22%	7,132
Turkmenistan	2000	17%	10%	15%	14%	11%	15%	7%	10%	12%	12%	11%	0%	12%	2,974
Uganda	2000	23%	25%	22%	23%	23%	22%	16%	23%	18%	6%	17%	17%	21%	5,145
Vietnam	2002	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Zambia	2002	33%	39%	30%	30%	29%	26%	23%	24%	23%	12%	28%	60%	28%	5,430
Average (wtd.)		**34%**	**36%**	**38%**	**36%**	**35%**	**33%**	**29%**	**26%**	**21%**	**17%**	**26%**	**36%**	**31%**	**272,603**

n/a: Not available

Table 10. Wasting rates by duration of preceding birth to conception interval, living children age 0 to 59 months

Survey		Preceding Birth to Conception Interval in Months													
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing	Total	N
Armenia	2000	3%	1%	5%	2%	3%	1%	2%	0%	3%	0%	1%	0%	2%	1,517
Armenia	2005	4%	7%	5%	8%	7%	4%	3%	10%	4%	4%	3%	0%	5%	1,238
Bangladesh	1999/2000	8%	13%	9%	13%	12%	11%	10%	8%	14%	6%	9%	56%	10%	5,333
Bangladesh	2004	8%	13%	14%	12%	12%	14%	14%	12%	12%	10%	12%	0%	12%	5,911
Benin	2001	11%	5%	6%	8%	7%	7%	11%	8%	7%	2%	7%	17%	8%	3,842
Bolivia	2003	1%	1%	2%	1%	1%	1%	1%	2%	2%	2%	1%	10%	1%	9,134
Burkina Faso	2003	20%	18%	19%	21%	19%	21%	20%	19%	17%	20%	19%	38%	20%	8,142
Cambodia	2000	9%	16%	13%	14%	14%	16%	19%	14%	12%	23%	15%	0%	15%	3,522
Cameroon	2004	4%	4%	5%	4%	5%	5%	7%	6%	3%	2%	5%	9%	5%	3,168
Chad	2004	12%	15%	12%	16%	15%	17%	16%	21%	11%	18%	15%	0%	15%	4,414
Colombia	2000	1%	1%	1%	2%	0%	1%	1%	0%	1%	1%	0%	0%	1%	4,180
Colombia	2005	1%	1%	2%	2%	2%	2%	1%	1%	1%	2%	2%	0%	2%	12,393
Congo	2005	11%	5%	5%	8%	6%	7%	5%	9%	7%	7%	7%	11%	7%	3,858
DomRep	2002	2%	2%	2%	2%	1%	1%	2%	2%	3%	1%	2%	0%	2%	9,288
Egypt	2000	2%	3%	3%	2%	2%	3%	2%	2%	2%	0%	3%	3%	2%	10,296
Egypt	2003	2%	4%	5%	3%	4%	6%	4%	3%	2%	2%	3%	0%	4%	6,065
Egypt	2005	4%	5%	4%	3%	3%	3%	5%	4%	3%	2%	4%	2%	4%	12,325
Eritrea	2002	15%	15%	14%	13%	14%	14%	16%	17%	15%	8%	15%	17%	14%	5,341
Ethiopia	2000	11%	12%	13%	11%	13%	14%	11%	13%	13%	10%	9%	14%	12%	8,590
Ethiopia	2005	13%	11%	10%	10%	11%	12%	14%	10%	13%	8%	9%	0%	11%	3,873
Gabon	2000	2%	4%	5%	3%	2%	2%	3%	1%	3%	3%	3%	0%	3%	3,482
Ghana	2003	4%	8%	8%	8%	7%	7%	8%	11%	6%	6%	8%	14%	8%	3,094
Guinea	2005	9%	6%	10%	4%	11%	9%	11%	12%	9%	15%	9%	0%	9%	2,595
Haiti	2000	7%	4%	5%	5%	6%	5%	5%	4%	6%	6%	3%	29%	5%	5,510
Honduras	2005	1%	1%	1%	2%	1%	2%	2%	0%	0%	0%	1%	0%	1%	9,228
Indonesia	2003	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Jordan	2002	1%	1%	2%	1%	2%	2%	2%	2%	2%	0%	2%	13%	2%	4,869
Kenya	2003	7%	7%	8%	8%	7%	8%	6%	4%	3%	4%	6%	0%	7%	4,719
Lesotho	2004	0%	5%	7%	6%	6%	5%	2%	2%	4%	4%	4%	0%	4%	1,363
Madagascar	2004	17%	11%	17%	13%	10%	12%	13%	13%	10%	7%	12%	20%	13%	4,418
Malawi	2000	2%	5%	5%	6%	5%	4%	6%	6%	5%	4%	5%	11%	5%	9,162
Malawi	2004	4%	7%	4%	5%	5%	5%	5%	6%	6%	3%	5%	0%	5%	8,045

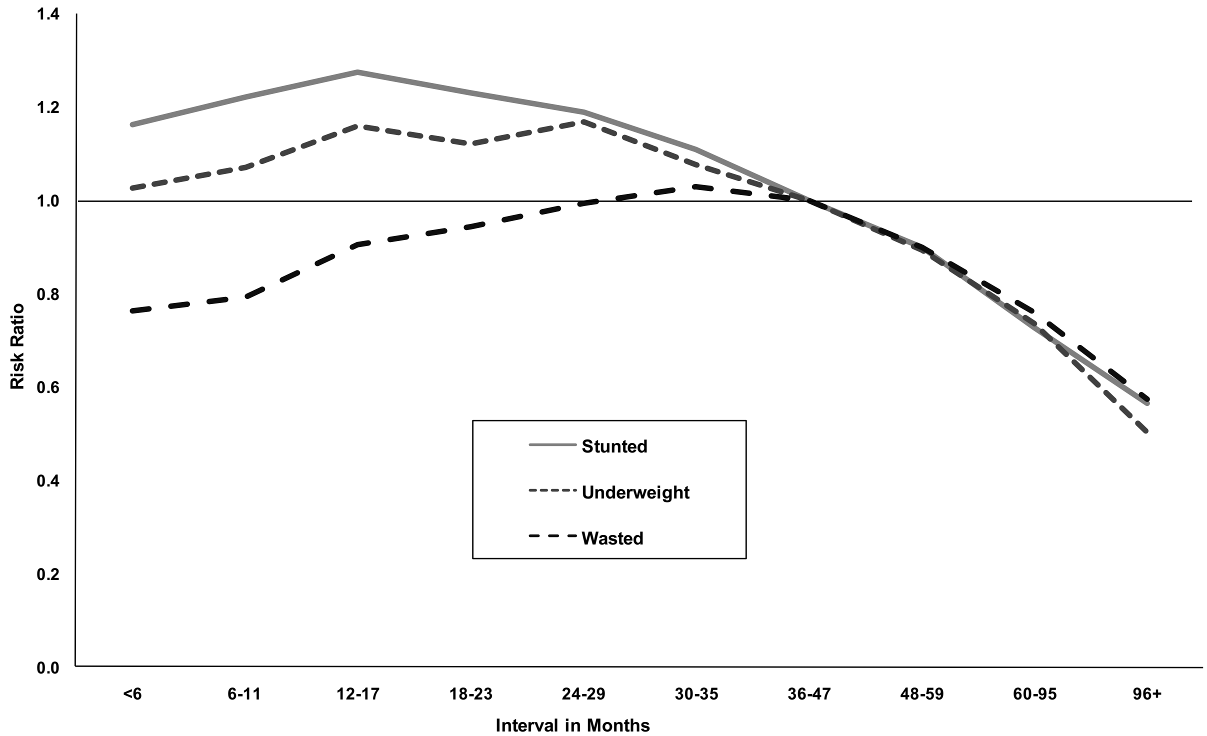
(Cont'd)

Table 10 – cont'd

Survey		Preceding Birth to Conception Interval in Months													
		<6	6-11	12-17	18-23	24-29	30-35	36-47	48-59	60-95	96+	First birth	Missing	Total	N
Mali	2001	9%	11%	10%	12%	11%	12%	12%	8%	10%	13%	11%	25%	11%	9,371
Mauritania	2000	16%	9%	13%	11%	14%	16%	14%	21%	13%	6%	12%	50%	13%	3,306
Moldova	2005	0%	2%	2%	2%	6%	11%	6%	9%	2%	4%	4%	0%	4%	1,298
Morocco	2003	7%	11%	12%	13%	8%	12%	10%	10%	9%	10%	8%	21%	10%	5,356
Mozambique	2003	3%	3%	3%	4%	4%	3%	3%	5%	4%	4%	4%	0%	4%	8,031
Namibia	2000	8%	10%	14%	10%	11%	9%	10%	11%	5%	8%	9%	25%	10%	2,909
Nepal	2001	9%	7%	8%	10%	8%	11%	11%	6%	14%	11%	9%	0%	9%	6,163
Nicaragua	2001	6%	3%	2%	2%	3%	2%	1%	1%	1%	2%	2%	0%	2%	5,875
Nigeria	2003	13%	8%	9%	8%	8%	11%	10%	10%	17%	3%	9%	33%	9%	4,293
Peru	2000	1%	2%	1%	2%	2%	1%	2%	0%	1%	1%	1%	0%	1%	11,585
Peru	2004-5	0%	1%	2%	0%	1%	1%	2%	1%	1%	1%	0%	0%	1%	2,294
Philippines	2003	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rwanda	2000	6%	7%	6%	8%	7%	6%	6%	9%	8%	4%	6%	7%	7%	6,038
Rwanda	2005	2%	2%	4%	3%	4%	5%	4%	1%	3%	2%	6%	0%	4%	3,641
Senegal	2005	4%	7%	10%	9%	7%	9%	7%	9%	6%	13%	7%	0%	8%	2,847
Tanzania	2004	2%	5%	4%	4%	4%	3%	4%	3%	4%	1%	3%	0%	4%	7,132
Turkmenistan	2000	5%	4%	5%	8%	6%	4%	5%	5%	4%	7%	5%	0%	5%	2,974
Uganda	2000	1%	5%	4%	4%	4%	4%	3%	6%	6%	6%	3%	0%	4%	5,145
Vietnam	2002	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Zambia	2002	6%	3%	4%	4%	6%	5%	4%	8%	7%	2%	5%	20%	5%	5,430
Average (wtd.)		**5%**	**6%**	**6%**	**7%**	**7%**	**7%**	**7%**	**6%**	**5%**	**4%**	**5%**	**7%**	**6%**	**272,603**

n/a: Not available

Figure 2 Risk Ratio of Malnutrition by Birth to Conception Interval
Children Under 5 Years of Age



Multivariate Results

Table 11 presents adjusted risk ratios for early neonatal, neonatal, postneonatal, and child (1one to four years) under-five mortality by the length of preceding birth-to-pregnancy interval for the pooled data from the 52 surveys. For early neonatal, neonatal, postneonatal, and infant mortality analyses, children born between 0 and 59 months before each survey interview are considered. Children born earlier than 59 months before the survey are not used because many of the control variables are not available for these children. For the child and under-five mortality analyses, children born up to 179 months before the survey are included. Children born at 180 months before the survey or earlier are excluded because of truncation of the data file.[9]

[9] Because the oldest respondents to the surveys are 49 years of age, information on births is increasingly limited to younger women as periods in the past are considered. For example, the data on births 180 months before the survey pertains to women up to the age of 34 years.

Table 11. Relative risk of mortality by duration of preceding birth to conception interval, children born 0 to 179 months prior to the survey

Indicator		Preceding Birth to Conception Interval in Months											Total rate	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth		
Early Neonatal Mortality	Risk	2.43	1.62	1.29	1.15	1.04	0.92	1.00	1.15	1.25	1.76	2.18	0.023	382,328
	CI-	2.14	1.44	1.15	1.03	0.93	0.81	1.00	0.99	1.08	1.48	1.95		
	CI+	2.76	1.83	1.44	1.29	1.17	1.05	1.00	1.33	1.43	2.09	2.44		
Neonatal Mortality	Risk	2.46	1.69	1.37	1.19	1.05	1.02	1.00	1.20	1.25	1.79	2.23	0.030	382,328
	CI-	2.21	1.52	1.24	1.08	0.95	0.91	1.00	1.06	1.11	1.54	2.03		
	CI+	2.75	1.87	1.50	1.32	1.16	1.14	1.00	1.36	1.41	2.08	2.46		
Post Neonatal Mortality	Risk	2.08	1.52	1.32	1.05	0.97	0.93	1.00	1.00	1.20	1.06	1.58	0.031	367,477
	CI-	1.86	1.38	1.21	0.96	0.88	0.83	1.00	1.00	1.06	0.87	1.44		
	CI+	2.32	1.68	1.44	1.15	1.06	1.03	1.00	1.00	1.35	1.29	1.74		
Infant Mortality	Risk	**2.27**	**1.61**	**1.35**	**1.13**	**1.01**	**0.97**	**1.00**	**1.07**	**1.22**	**1.45**	**1.89**	**0.061**	382,328
	CI-	2.10	1.50	1.27	1.05	0.94	0.90	1.00	0.98	1.12	1.29	1.77		
	CI+	2.45	1.73	1.44	1.20	1.08	1.05	1.00	1.17	1.33	1.63	2.03		
Child Mortality (1-4 yrs)	Risk	2.19	1.99	1.84	1.51	1.30	1.20	1.00	0.92	0.77	0.69	1.53	0.040	903,417
	CI-	2.05	1.88	1.74	1.43	1.22	1.12	1.00	0.85	0.70	0.59	1.44		
	CI+	2.34	2.11	1.94	1.60	1.38	1.28	1.00	1.01	0.84	0.81	1.62		
Under-Five Mortality (0-4 yrs)	Risk	**2.97**	**2.22**	**1.81**	**1.49**	**1.22**	**1.14**	**1.00**	**0.96**	**0.92**	**1.05**	**1.99**	**0.105**	1,049,196
	CI-	2.87	2.15	1.75	1.44	1.17	1.09	1.00	0.92	0.87	0.97	1.93		
	CI+	3.08	2.30	1.87	1.54	1.26	1.18	1.00	1.01	0.96	1.12	2.06		

Adjusted for:

ENN, NN PNN and Infant Mortality: Multiplicity of birth, Sex of index child, Urban-rural area of residence, Wantedness of child, Mother's Education, Whether conception was a result of contraceptive failure, outcome of preceding pregnancy (live birth, stillbirth), type of provider of prenatal care, type of provider of delivery assistance, birth order, mother's age at birth, number of prenatal tetanus injections, timing of first prenatal care visit, quintile of wealth index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, whether preceding child died before conception of index child, survey.

Child and Under-Five Mortality: Multiplicity of birth, Sex of index child, Urban-rural area of residence, Mother's Education, birth order, mother's age at birth, quintile of wealth index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, whether preceding child died before conception of index child

Age range of analysis:

ENN, NN, PNN, and Infant Mortality: 0-59 months

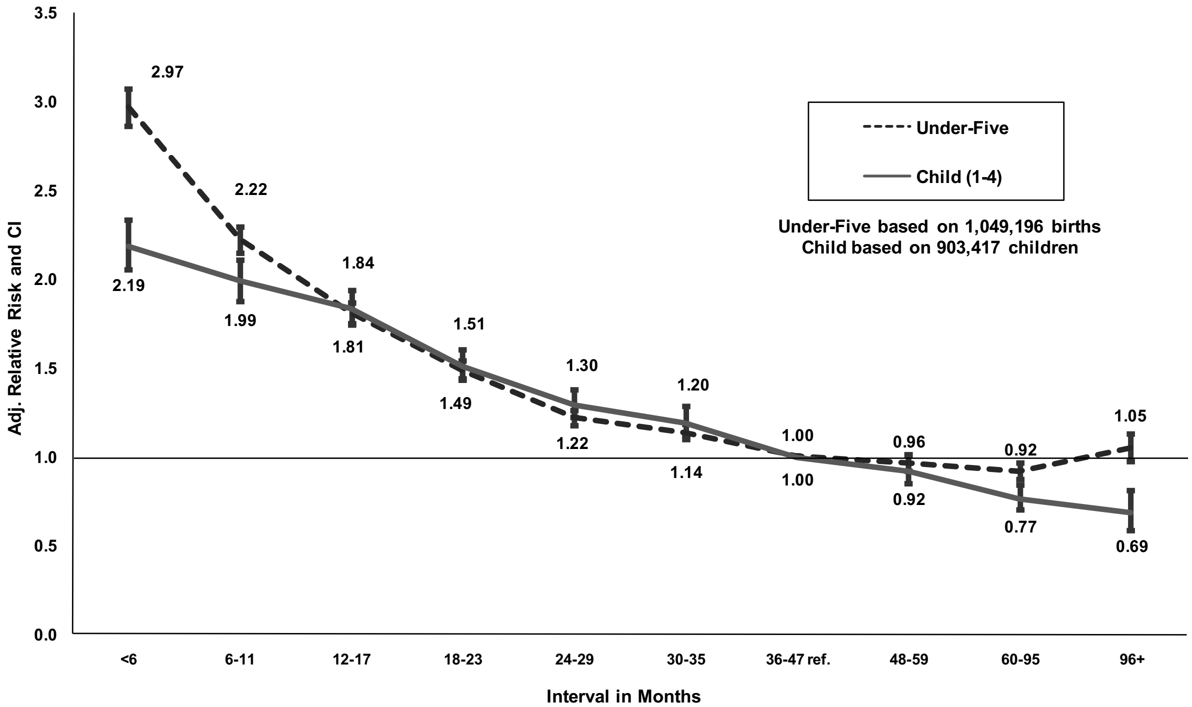
Child and Under-Five Mortality: 0-179 months

Under-Five and Child Mortality

In the multivariate analysis of under-five and child mortality, several variables that are available for all births that occurred from 0 to 179 months before the survey are used to control for the effects of spurious relationships. The demographic controls used were sex of the index child, the multiplicity of the birth of the index child (singleton, twin, triplet, quadruplet), birth order, mother's age at birth, duration of the pregnancy (assumed nine months for births occurring 60 to 179 months before survey), and whether the preceding child died before the conception of the index child. The socioeconomic controls used were type of area of residence (urban-rural), mother's education, the household's quintile on the DHS Wealth Index, type of water supply, type of toilet supply, and possession of a refrigerator. The analyses for under-five and child mortality are based on 1,049,196 births that had no imputed preceding birth-to-pregnancy interval.

The relationship between the preceding birth-to-pregnancy interval and under-five mortality is highly significant ($P < .001$), and each interval group under 36 months is significantly different from the reference group of 36 to 47 months as well as the group 60 to 96 months. For intervals less than 36 months, the adjusted risk ratios are always substantially higher than those of the reference group. Figure 3 shows the weighted average effect of the preceding birth-to-pregnancy interval on under-five mortality. The risk of mortality trends downward with increasing birth interval, rapidly until 24 to 29 months and then more slowly with longer intervals, and then a final upturn for intervals of 96 or more months' duration.

Figure 3 Adjusted Relative Risk of Under Five and Child Mortality by Birth to Conception Interval 52 DHS Surveys



For child (age one to four years) mortality, the effect of the duration of the preceding birth-to-pregnancy interval is almost a constant decline in mortality with a increase in interval length (Table 11 and Figure 3). The risk ratios for all interval groups are significantly different from the reference group. The risk of child death falls from 2.2 times that of the 36- to 47-month group for conceptions within six months of the preceding birth to 0.7 for conceptions at 96 months or more. There is no upturn in child mortality for the open-ended long interval, as is noticed for under-five mortality.

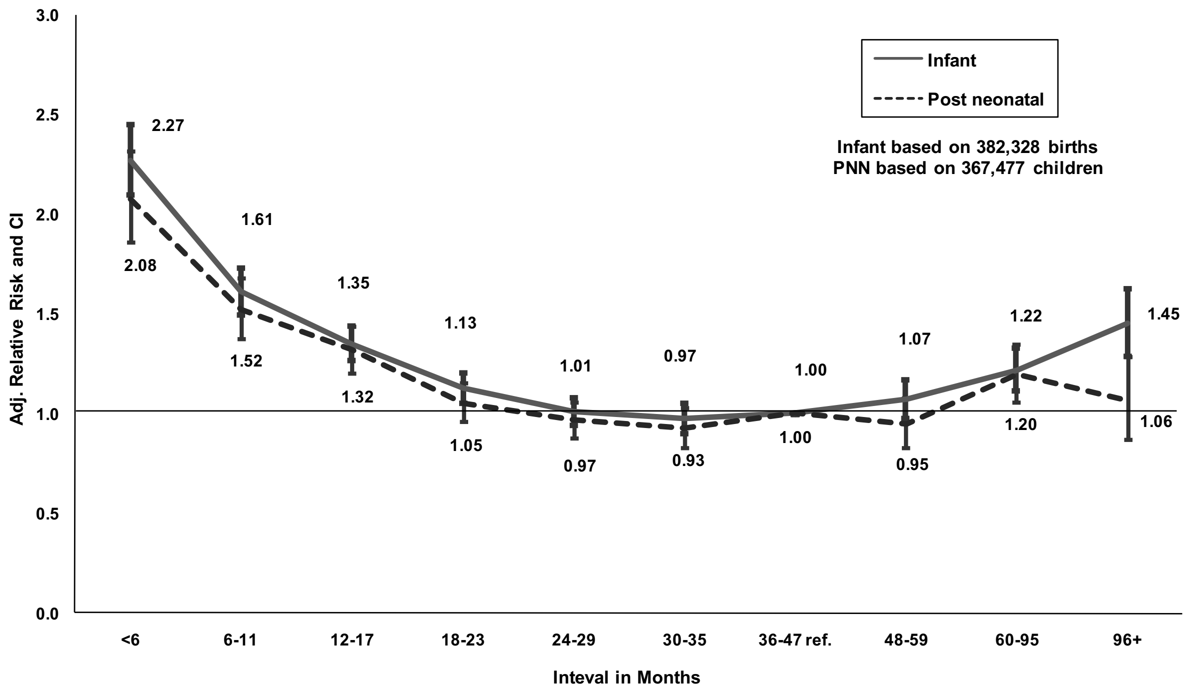
Infant and Postneonatal Mortality

The analysis of infant mortality is based on births that occurred 0 to 59 months before the survey to ensure full use of available data and control variables. In addition to the control variables included in the analysis of under-five years and child mortality, the wantedness of the birth (wanted at the time of conception, wanted later, did not want any more children) is used, as is type of provider of and timing of prenatal care, number of prenatal tetanus toxoid injections, and type of provider of delivery assistance. In addition, in the surveys with reproductive calendar data, whether or not the birth was the result of a contraceptive failure and the outcome of the preceding pregnancy (live birth or stillbirth) is included. The analyses for infant, postneonatal, neonatal, and early neonatal mortality are based on 382,328 births with no imputed preceding birth-to-pregnancy interval.

Compared with a preceding birth-to-pregnancy interval of 36 to 47 months, children conceived with interval durations of less than 24 months have significantly higher risks of mortality. There is little difference in mortality risk for the duration groups between 24 and 59 months. However, the mortality risk increases for births with durations of 60 months or more. The shorter the duration of the interval for intervals less than 24 months, the higher is the risk of the child dying during infancy. Indeed, although children conceived 18 to 23 months after a birth have 13 percent higher risk, those conceived within six months of a prior birth have 127 percent higher risk. The 52-country pooled data set indicates that children conceived 24 to 59 months after a prior birth have the lowest risk of dying in infancy (Figure 4).

The curve of relative risk of postneonatal mortality is similar to that of infant mortality with these exceptions: the excess risk is lower at each interval group, the risk of the 18- to 23-month interval is not significantly different from the reference group, and there is no indication of an upturn in risk for births conceived 96 or more months after a preceding birth (Figure 4).

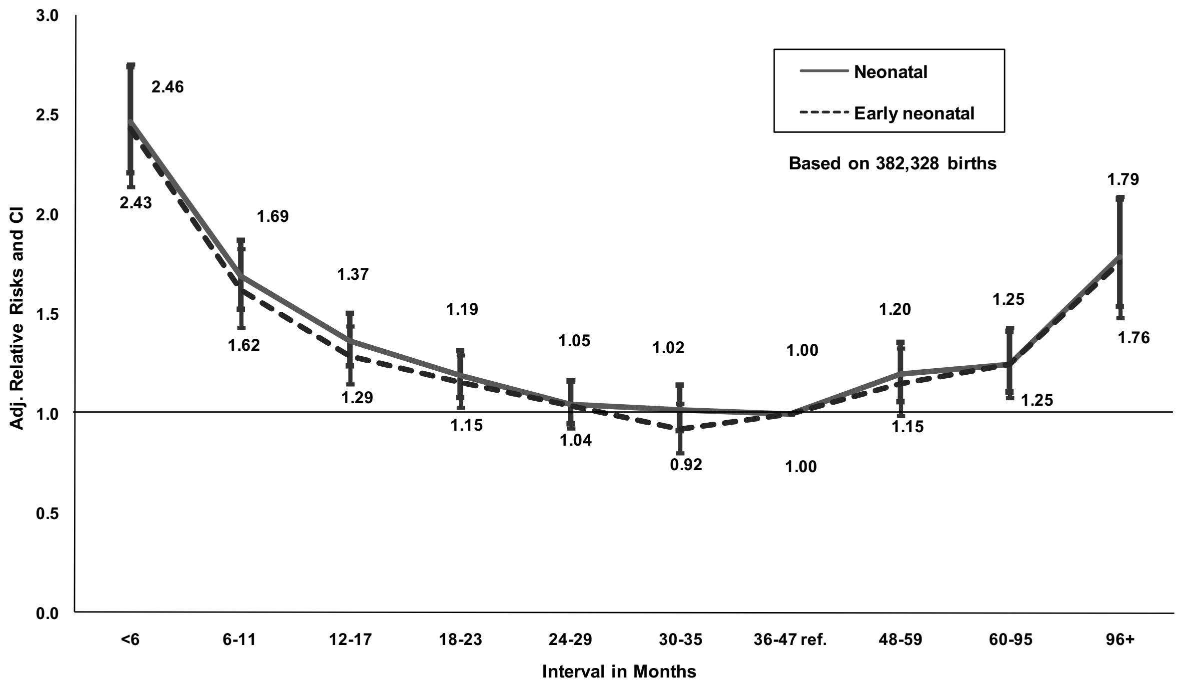
Figure 4 Adjusted Relative Risk of Infant and Post Neonatal Mortality by Birth to Conception Interval 52 DHS Surveys



Neonatal and Early Neonatal Mortality

The results for neonatal mortality are also shown in Table 11. The risk of mortality by preceding birth-to-pregnancy interval is U-shaped, with the lowest point at the reference group (36 to 47 months). All interval groups outside the period 24 to 47 months have adjusted relative risks that are significantly higher than that of the reference group. Intervals shorter than 24 months have adjusted relative risks that are from 19 percent to 146 percent higher than the risk of mortality of the reference group. Intervals longer than the reference group have risks that are from 20 percent to 79 percent higher. The curve of the adjusted relative risks is shown in Figure 5.

Figure 5 Adjusted Relative Risk of Early Neonatal and Neonatal Mortality by Birth to Conception Interval 52 DHS Surveys



It can also be seen in Figure 5 that the curve for early neonatal mortality is quite similar to that for neonatal mortality, but the confidence intervals are wider because of the smaller numbers of deaths during this shorter age range.

Interaction of Interval Length with Sex of Preceding Child

Some readers of the previous paper have suggested that the effect of the length of the birth to pregnancy interval may vary according to the sex of the preceding child. In order to determine whether there is an interaction for child mortality between the length of the birth to pregnancy interval and the sex of the child that began the interval, the Cox hazard analysis was performed separately for male and female preceding children for under-five mortality. The results shown in Table 12 and Figure 6 indicate that there was no interaction.

Table 12. Relative risk of under-five mortality by duration of preceding birth to conception interval according to sex of child and survival of preceding child, children born 0 to 179 months prior to the survey

Indicator		Preceding Birth to Conception Interval in Months											Total rate	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth		
Sex of Index Child														
Male	Risk	2.98	2.22	1.79	1.51	1.24	1.14	1.00	0.95	0.95	1.03	2.06	0.110	533,907
	CI-	2.84	2.12	1.71	1.45	1.18	1.08	1.00	0.88	0.89	0.93	1.96		
	CI+	3.13	2.33	1.87	1.59	1.31	1.21	1.00	1.01	1.01	1.14	2.16		
Female	Risk	2.96	2.22	1.83	1.45	1.19	1.13	1.00	0.98	0.89	1.06	1.92	0.100	515,215
	CI-	2.81	2.11	1.75	1.38	1.13	1.07	1.00	0.92	0.82	0.96	1.82		
	CI+	3.11	2.33	1.92	1.53	1.25	1.20	1.00	1.06	0.95	1.18	2.02		
Survival of preceding child*														
Preceding survived	Risk	3.18	2.25	1.75	1.42	1.18	1.10	1.00	0.97	0.94	1.08	1.96	0.098	981,724
	CI-	3.06	2.17	1.69	1.37	1.14	1.06	1.00	0.92	0.89	1.00	1.89		
	CI+	3.31	2.33	1.82	1.48	1.23	1.15	1.00	1.02	0.99	1.17	2.03		
Preceding died	Risk	2.57	2.17	2.15	1.93	1.45	1.40	1.00	0.91	0.79	0.85	n/a	0.200	67,398
	CI-	2.35	1.98	1.97	1.76	1.32	1.25	1.00	0.79	0.68	0.68	n/a		
	CI+	2.82	2.38	2.35	2.12	1.61	1.56	1.00	1.05	0.91	1.05	n/a		

n/a: Not available

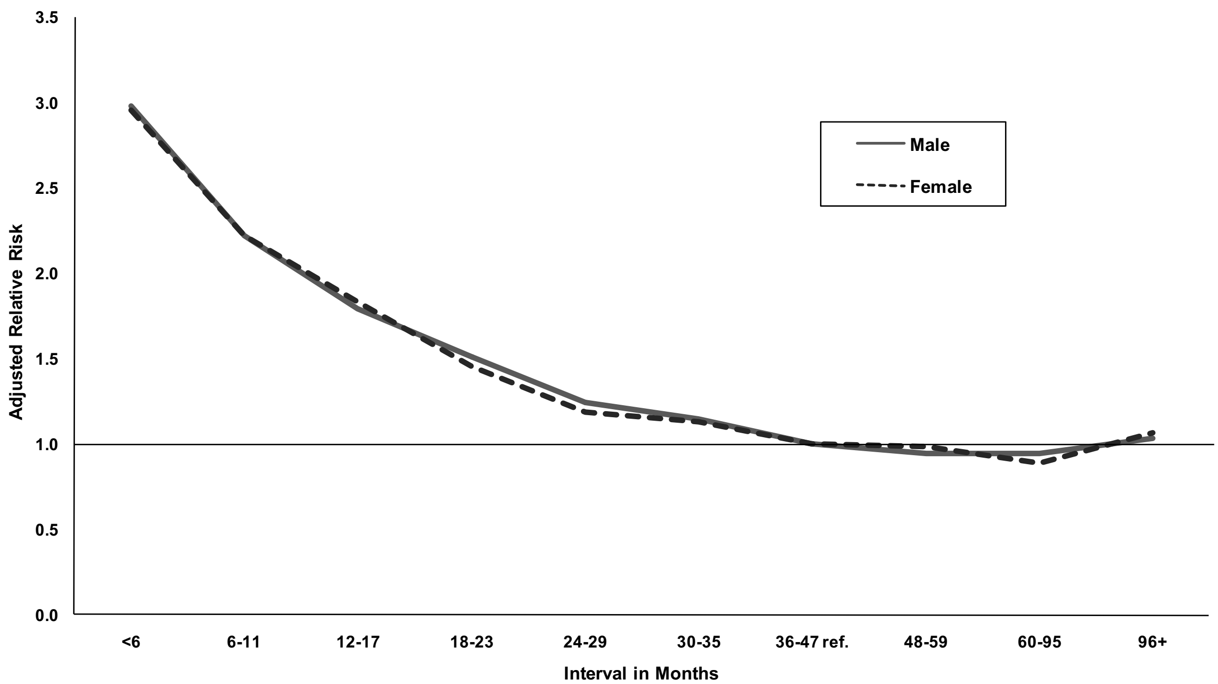
* Whether preceding child died before conception of index child

Adjusted for:

Male-Female Interaction: Multiplicity of birth, urban-rural area of residence, mother's education, birth order, mother's age at birth, quintile of wealth index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, whether preceding child died before conception of index child

Survival of Preceding Child Interaction: Multiplicity of birth, Sex of index child, urban-rural area of residence, mother's education, birth order, mother's age at birth, quintile of wealth index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy.

Figure 6 Relative Risk of Under Five Mortality for Males and Female Children by Preceding Birth to Conception Interval



A further speculation has been posed that there could also be differing effects on mortality according to the sexes of both the preceding and index children. Table 13 and Figure 7 indicate that there are no interactive effects for the combinations of sexes for under-five mortality and that the results for all combinations have confidence intervals that overlap.

Table 13. Relative risk of child(1-4) mortality by duration of preceding birth to conception interval according to sex of index and preceding child, children born 0 to 179 months prior to the survey

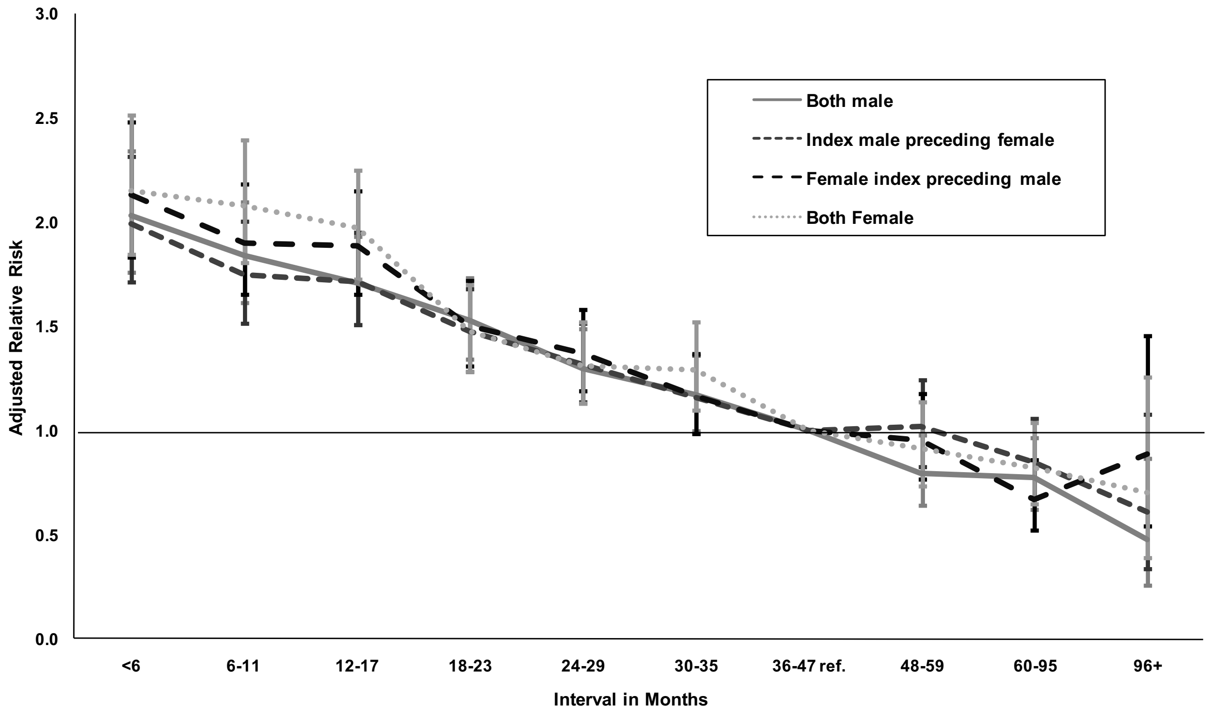
Indicator		Preceding Birth to Conception Interval in Months											N
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth	
Sex of index and preceding child													
Both male	Risk	2.03	1.84	1.71	1.53	1.30	1.17	1.00	0.79	0.78	0.48	n/a	123,031
	CI-	1.76	1.61	1.51	1.34	1.13	1.00	1.00	0.64	0.62	0.26	n/a	
	CI+	2.34	2.10	1.93	1.73	1.49	1.36	1.00	0.98	0.97	0.87	n/a	
Index male, preceding female	Risk	1.99	1.75	1.71	1.47	1.31	1.16	1.00	1.01	0.85	0.61	n/a	118,945
	CI-	1.71	1.52	1.51	1.29	1.14	0.99	1.00	0.83	0.68	0.34	n/a	
	CI+	2.32	2.00	1.95	1.68	1.51	1.36	1.00	1.24	1.06	1.08	n/a	
Index female, preceding male	Risk	2.13	1.90	1.89	1.50	1.37	1.16	1.00	0.95	0.67	0.89	n/a	118,369
	CI-	1.83	1.65	1.66	1.31	1.19	0.99	1.00	0.77	0.52	0.55	n/a	
	CI+	2.48	2.19	2.15	1.72	1.59	1.37	1.00	1.18	0.86	1.46	n/a	
Both females	Risk	2.15	2.08	1.97	1.48	1.31	1.29	1.00	0.91	0.82	0.70	n/a	117,213
	CI-	1.85	1.81	1.73	1.29	1.13	1.10	1.00	0.73	0.65	0.39	n/a	
	CI+	2.51	2.40	2.25	1.70	1.52	1.52	1.00	1.14	1.04	1.26	n/a	

n/a: Not available

Adjusted for:

Multiplicity of birth, urban-rural area of residence, mother's education, birth order, mother's age at birth, quintile of wealth index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, whether preceding child died before conception of index child

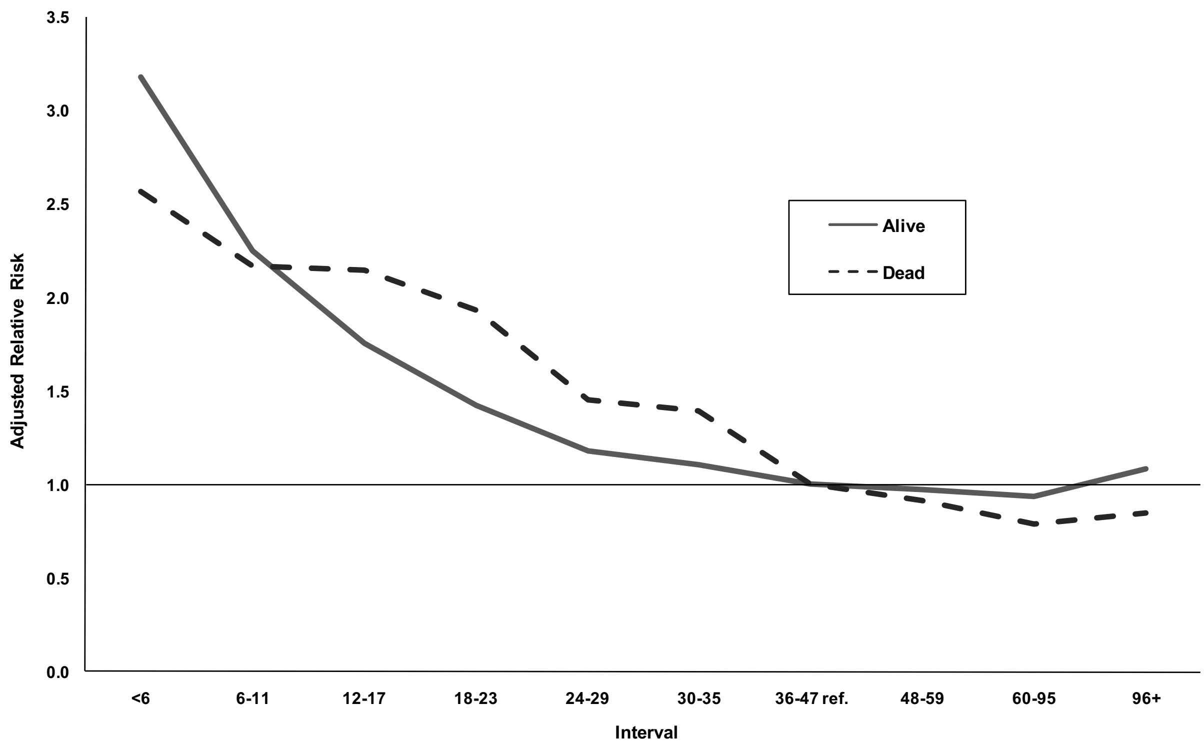
Figure 7 Adjusted Relative Risk of Child (1-4) Mortality by Preceding Birth to Conception Interval, according to Sex of Index and Preceding Child



Interaction of Interval Length with Survival Status of Preceding Child

It is expected that there may be an interaction for child mortality between birth to pregnancy interval and the survival status of the preceding child (before the conception of the next child) due to the shortening of the interval if the preceding child dies while frequently breastfeeding, which hastens the return of the mother's menses. Accordingly, the analysis was performed separately according the survival of the preceding child. Interestingly, the patterns of mortality by interval length are fairly similar, showing a decline in the risk of dying with intervals shorter than 36 months. The pattern by length of interval for non-surviving is not as smooth for dead preceding children as that for surviving preceding children due principally to the smaller number of cases in each interval group (Table 12 and Figure 8.) This lack of interaction indicates that using only the main effect of the preceding child survival variable is sufficient.

Figure 8 Relative Risk of Under-Five Mortality for Children whose Preceding Sibling is Alive or Dead



Effect of Birth to Pregnancy Interval on Under-Five Mortality by Level of Under-Five Mortality

To study whether the effect of intervals on mortality varies according to the level of mortality, the 52 surveys were grouped by level of under-five mortality: the 13 surveys with the lowest levels (average rate of 42 deaths per 1000 births); the 13 surveys with the highest levels (average of 187); and the remaining middle surveys (average of 105). The analyses were run for each group of surveys and are shown in Table 14 and Figure 9. The effect of interval does vary by level of mortality. For the middle and high surveys, the risk of dying at less than five years of age is increased for intervals shorter than 36 months. For the low surveys, the risk is increased for the intervals shorter than 18 months and is constant from thereon.

Figure 9 Adjusted Relative Risks of Under-Five Mortality by Preceding Birth to Conception Interval, According to Level of Mortality

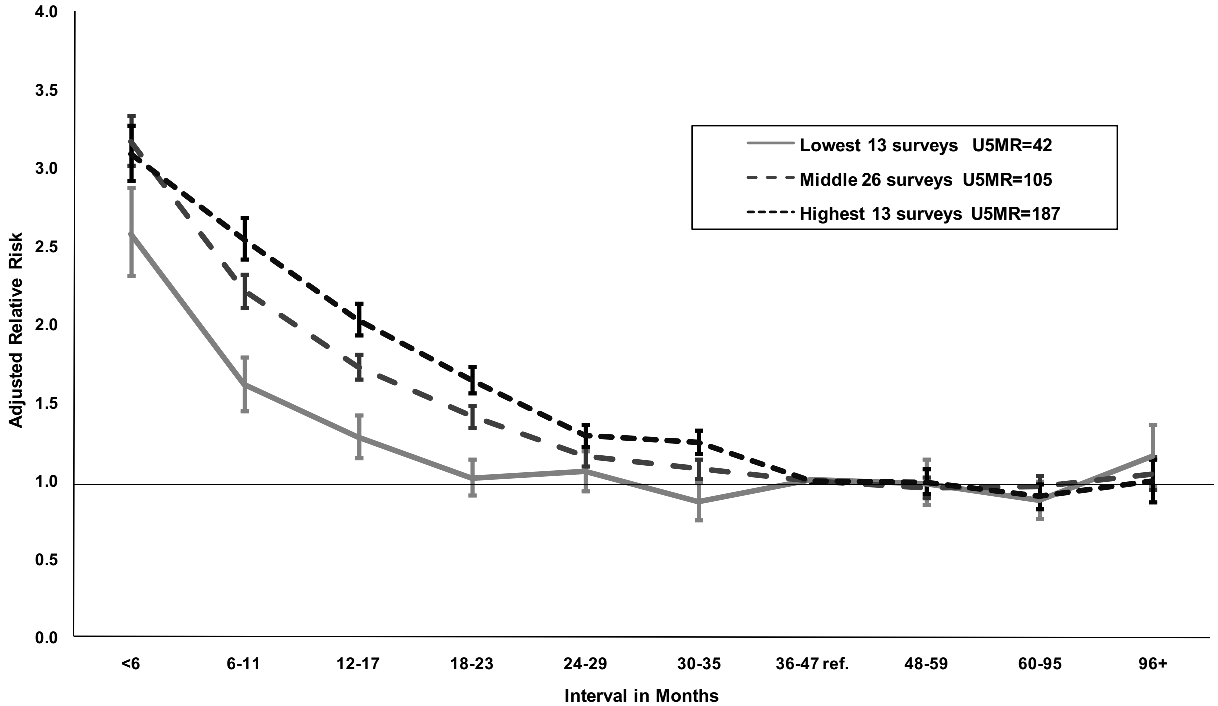


Table 14. Relative risk of under-five mortality by duration of preceding birth to conception interval according to level of mortality, children born 0 to 179 months prior to the survey

Survey mortality level		Preceding Birth to Conception Interval in Months <6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth	Total rate	N
Lowest 13 surveys	Risk	2.58	1.61	1.28	1.02	1.05	0.86	1.00	0.98	0.87	1.15	1.44	0.042	240,354
	CI-	2.32	1.45	1.15	0.91	0.93	0.75	1.00	0.85	0.76	0.97	1.29		
	CI+	2.88	1.80	1.42	1.14	1.19	0.99	1.00	1.14	1.00	1.36	1.61		
Middle 26 surveys	Risk	3.17	2.22	1.73	1.41	1.15	1.08	1.00	0.95	0.96	1.05	1.93	0.105	536,270
	CI-	3.02	2.11	1.65	1.34	1.10	1.01	1.00	0.89	0.90	0.95	1.84		
	CI+	3.34	2.33	1.81	1.48	1.22	1.14	1.00	1.02	1.03	1.16	2.03		
Highest 13 surveys	Risk	3.09	2.54	2.03	1.64	1.29	1.25	1.00	0.99	0.90	0.99	2.14	0.187	272,498
	CI-	2.92	2.42	1.94	1.56	1.22	1.17	1.00	0.91	0.83	0.86	2.03		
	CI+	3.27	2.68	2.14	1.73	1.36	1.32	1.00	1.07	0.98	1.14	2.26		

Adjusted for:

Multiplicity of birth, Sex of index child, Urban-rural area of residence, Mother's Education, birth order, mother's age at birth, quintile of wealth index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, whether preceding child died before conception of index child

Birth Size and Birth Weight

Table 15 shows the effect of the preceding birth-to-pregnancy interval on children's birth weight and the mother's estimation of the child's size at birth. The results are shown graphically in Figure 10. The only interval groups that have significant differences in the odds of low birth weight from the odds of the reference group are for children conceived within 12 months of a prior birth. For children conceived less than six months after a prior birth, the odds of low birth weight are 49 percent greater than that of the reference group, and for children conceived with an interval of six to 11 months, the odds are 18 percent higher. A bit of caution is recommended when interpreting the results because the majority of children were not weighed at birth; however, the major factors related to whether the child was weighed are included as controls in the logistic regression (type of provider of delivery assistance, urban-rural area, mother's education, and wealth quintile).

Because not all children are weighed at birth, the DHS questionnaire asks the mother to evaluate the child's size at birth. This information is available for most surveys and children. As can be seen from Figure 10, the shape of the curve for small or very small size at birth is somewhat similar to that of low birth weight. One notable difference is the larger relative odds for children conceived within six months of a prior birth. Because of the greater number of children with data on birth size, Table 15 shows that the small increases in the odds of being small or very small at birth for the interval group of 12 to 17 months are statistically significant.

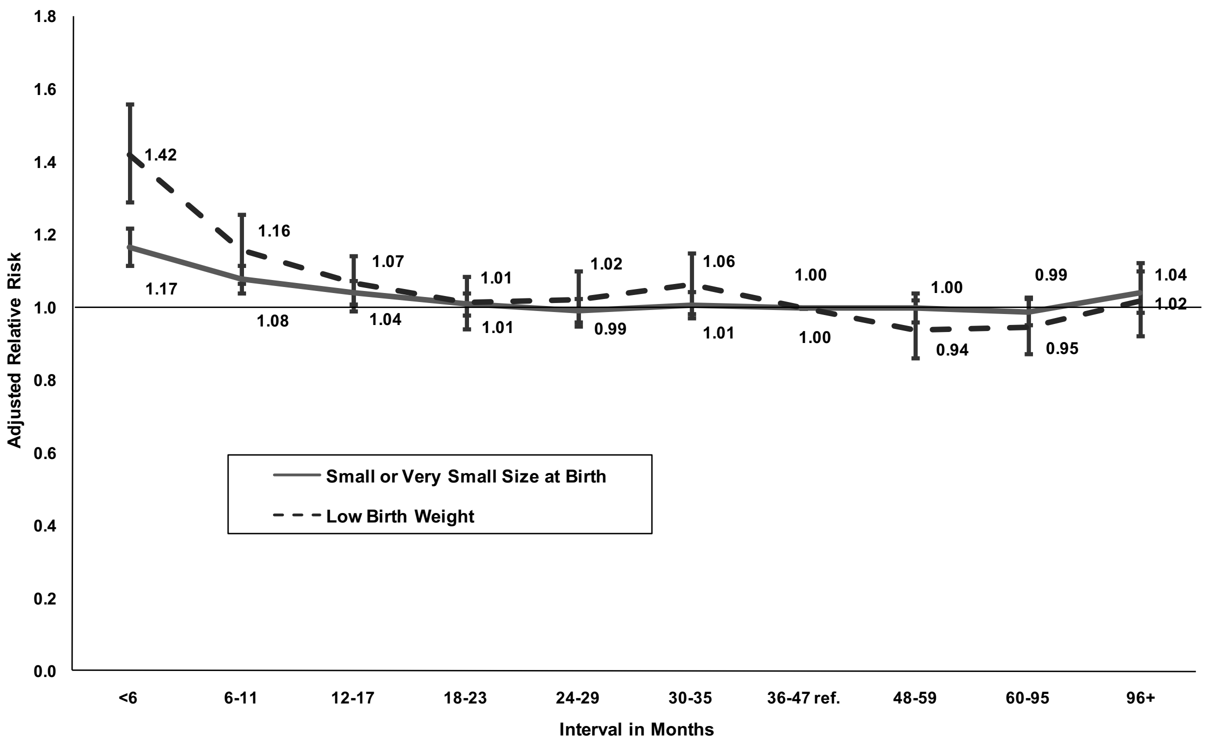
Table 15. Adjusted relative risks of small baby or low birth weight by duration of preceding birth to conception interval, children born 0 to 59 months prior to the survey

		Preceding Birth to Conception Interval in Months												
Indicator		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth	Total rate	N
Low Birth Weight	Risk	1.42	1.16	1.07	1.01	1.02	1.06	1.00	0.94	0.95	1.02	1.34	0.112	175,006
	CI-	1.29	1.07	0.99	0.94	0.95	0.98	1.00	0.86	0.87	0.92	1.26		
	CI+	1.56	1.26	1.14	1.09	1.10	1.15	1.00	1.02	1.02	1.13	1.43		
Small or Very Small Size	Risk	1.17	1.08	1.04	1.01	0.99	1.01	1.00	1.00	0.99	1.04	1.28	0.204	341,860
	CI-	1.12	1.04	1.01	0.98	0.96	0.97	1.00	0.96	0.95	0.99	1.24		
	CI+	1.22	1.12	1.07	1.04	1.02	1.04	1.00	1.04	1.03	1.10	1.31		

Adjusted for:

Multiplicity of birth, Sex of index child, Urban-rural area of residence, Wantedness of child, Mother's Education, Whether conception was a result of contraceptive failure, outcome of preceding pregnancy (live birth, stillbirth), type of provider of prenatal care, type of provider of delivery assistance, birth order, mother's age at birth, number of prenatal tetanus injections, timing of first prenatal care visit, quintile of wealth index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, whether preceding child died before conception of index child.

Figure 10 Birth Size and Weight



Nutritional Status

Logistic regressions examined the effects of the duration of preceding birth-to-pregnancy interval on the percentage of children stunted, wasted, and underweight at the time of the surveys. To control for potentially confounding factors, the following variables were included in the regressions: child's age, sex, and birth order; gestation length; mother's age at birth and education; area of residence; prenatal care provider; timing of first prenatal care visit; number of prenatal tetanus toxoid vaccinations; formation of the birth attendant; wantedness of the pregnancy; type of infant feeding received the 24 hours before interview; source of drinking water; type of toilet facility in the household; index of household wealth; and whether or not the household has a refrigerator. The results of the analyses are shown in Table 16.

Table 16. Adjusted relative risks of stunting, underweight and wasting by duration of preceding birth to conception interval, living children age 0 to 59 months at survey

Indicator		Preceding Birth to Conception Interval in Months												
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth	Total rate	N
Stunting	Risk	1.25	1.30	1.23	1.16	1.11	1.07	1.00	0.98	0.89	0.82	1.07	0.333	265,144
	CI-	1.20	1.26	1.19	1.13	1.08	1.04	1.00	0.94	0.86	0.77	1.04		
	CI+	1.30	1.34	1.26	1.20	1.14	1.10	1.00	1.01	0.93	0.87	1.10		
Underweight	Risk	1.22	1.29	1.19	1.13	1.11	1.06	1.00	0.98	0.95	0.82	1.12	0.217	265,144
	CI-	1.16	1.24	1.15	1.09	1.07	1.01	1.00	0.93	0.90	0.75	1.08		
	CI+	1.29	1.34	1.24	1.18	1.15	1.10	1.00	1.03	0.99	0.88	1.16		
Wasted	Risk	0.88	0.97	0.97	0.95	0.93	0.98	1.00	0.96	0.96	0.86	1.04	0.054	265,144
	CI-	0.78	0.90	0.91	0.89	0.87	0.91	1.00	0.88	0.88	0.75	0.98		
	CI+	0.98	1.05	1.04	1.02	0.99	1.05	1.00	1.04	1.04	0.98	1.10		

Adjusted for:

Multiplicity of birth, Sex of index child, Urban-rural area of residence, Wantedness of child, Mother's Education, Whether conception was a result of contraceptive failure, outcome of preceding pregnancy (live birth, stillbirth), type of provider of prenatal care, type of provider of delivery assistance, birth order, mother's age at birth, number of prenatal tetanus injections, timing of first prenatal care visit, quintile of wealth index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, whether preceding child died before conception of index child, type of infant feeding, child's age.

Forty-eight of the country surveys collected information on height and weight of children. The sample sizes for nutritional status range from 1,238 in Armenia 2005 to 12,393 in Colombia 2005, with a total size of 272,603, as shown in Tables 8, 9, and 10. Note that these numbers are the cases that are available for analysis after removing cases with missing or erroneous data for any of the nutritional status variables. The total number of cases for multivariate analysis (265,144) is a little lower due to missing data on some of the independent variables.

The adjusted odds ratios from the multivariate logistic regression analyses are shown graphically in Figure 11 for stunting, wasting, and underweight. It is clear that chronic and overall undernutrition declines substantially with longer intervals. Indeed, children conceived after an interval of 12 to 17 months are 25 percent more likely to be stunted and 25 percent more likely to be underweight than children conceived after an interval of 36 to 47 months. Children conceived after even longer durations are less likely to be stunted (23 percent) and underweight (22 percent) than are children conceived during the reference period. The odds of a child being wasted (acute malnutrition) do not follow the pattern of chronic and overall undernutrition. For children conceived between 6 and 23, 30 to 35, and 48 to 95 months, there is no significant difference in the odds of being wasted than with children conceived in the reference period. However, for children conceived after intervals of 24 to 29 months and 96 or more months, the odds of being wasted are somewhat less than that of the reference period. A somewhat surprising finding is that the odds of being stunted, wasted, and underweight are lower for children conceived within six months than for children conceived in the 12- to 17-months interval group.

Figure 11 Child Malnutrition by Birth to Conception Interval

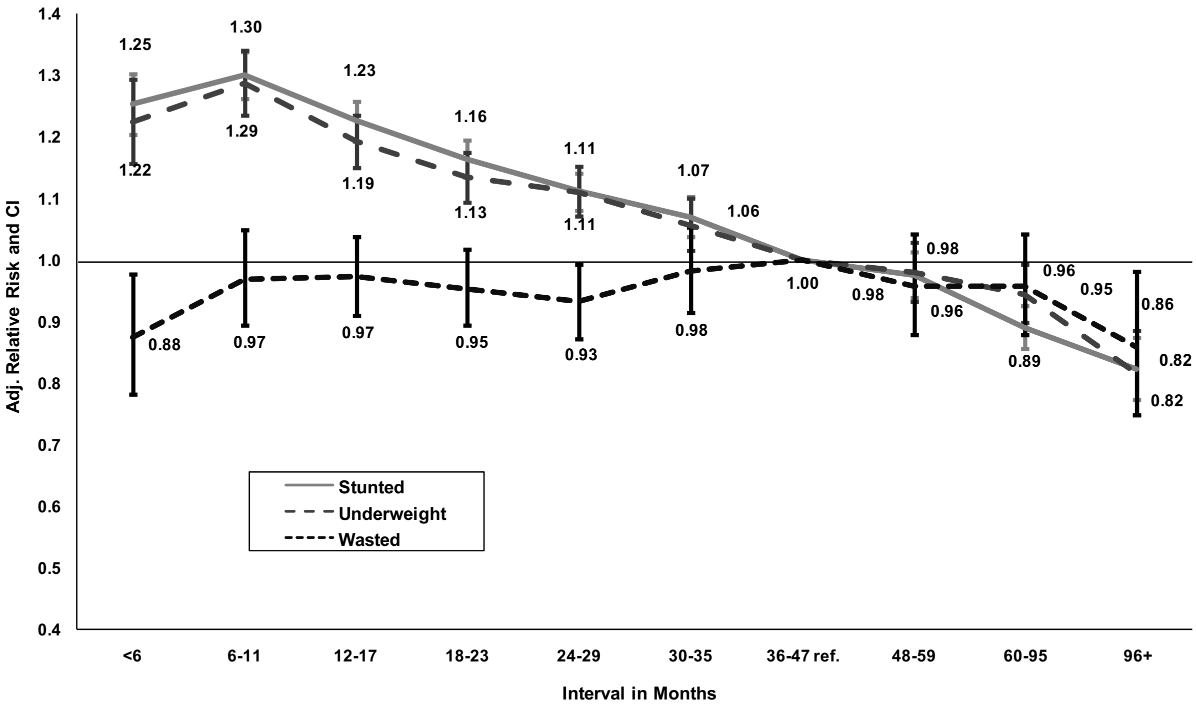


Table 17 presents the adjusted relative risks of stunting for the surveys grouped by level of mortality as given above. As can also be seen when graphed in Figure 12, there is little difference in effect on the risk of being stunted between the highest 13 surveys and the middle 26 surveys. However, the effect of birth to pregnancy interval length is greater for the 13 lowest surveys, for intervals of 12 months and longer. The results for the risk of being underweight by survey level of mortality are quite similar to those for stunting, as can be seen from Table 18 and Figure 13.

Table 17. Relative risk of stunting by duration of preceding birth to conception interval according to level of mortality, children age 0 to 179 months prior to the survey

Indicator		Preceding Birth to Conception Interval in Months											Total rate	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth		
Survey mortality level														
Lowest 13 surveys	Risk	1.20	1.31	1.34	1.35	1.25	1.11	1.00	0.90	0.82	0.73	0.98	0.161	58,258
	CI-	1.07	1.19	1.23	1.24	1.14	1.00	1.00	0.79	0.73	0.61	0.89		
	CI+	1.35	1.43	1.46	1.47	1.37	1.24	1.00	1.01	0.92	0.86	1.07		
Middle 26 surveys	Risk	1.23	1.29	1.22	1.16	1.11	1.05	1.00	0.98	0.88	0.77	1.02	0.306	133,601
	CI-	1.17	1.24	1.18	1.12	1.07	1.01	1.00	0.94	0.83	0.71	0.98		
	CI+	1.29	1.34	1.26	1.20	1.15	1.10	1.00	1.03	0.92	0.83	1.05		
Highest 13 surveys	Risk	1.16	1.23	1.17	1.13	1.09	1.07	1.00	0.97	0.93	0.92	0.99	0.412	82,707
	CI-	1.09	1.18	1.13	1.09	1.05	1.02	1.00	0.92	0.88	0.83	0.95		
	CI+	1.23	1.29	1.21	1.17	1.13	1.11	1.00	1.02	0.99	1.01	1.03		

Table 18. Relative risk of underweight by duration of preceding birth to conception interval according to level of mortality, children age 0 to 179 months prior to the survey

Indicator		Preceding Birth to Conception Interval in Months											Total rate	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth		
Survey mortality level														
Lowest 13 surveys	Risk	1.24	1.36	1.37	1.34	1.31	1.16	1.00	0.88	0.80	0.78	0.97	0.081	58,258
	CI-	1.04	1.19	1.21	1.17	1.14	1.00	1.00	0.73	0.68	0.62	0.86		
	CI+	1.47	1.55	1.56	1.52	1.50	1.36	1.00	1.05	0.95	0.97	1.10		
Middle 26 surveys	Risk	1.24	1.29	1.21	1.12	1.12	1.07	1.00	0.96	0.90	0.72	0.98	0.213	133,601
	CI-	1.16	1.22	1.16	1.07	1.07	1.01	1.00	0.90	0.84	0.65	0.93		
	CI+	1.33	1.36	1.27	1.17	1.18	1.13	1.00	1.02	0.96	0.80	1.03		
Highest 13 surveys	Risk	1.24	1.27	1.18	1.15	1.10	1.04	1.00	0.97	0.94	0.84	1.04	0.291	82,707
	CI-	1.15	1.20	1.12	1.10	1.05	0.99	1.00	0.90	0.88	0.73	0.98		
	CI+	1.34	1.34	1.23	1.21	1.15	1.10	1.00	1.03	1.02	0.96	1.09		

Figure 12 Adjusted Relative Risk of Stunting by Preceding Birth to Conception Interval, According to Level of Mortality

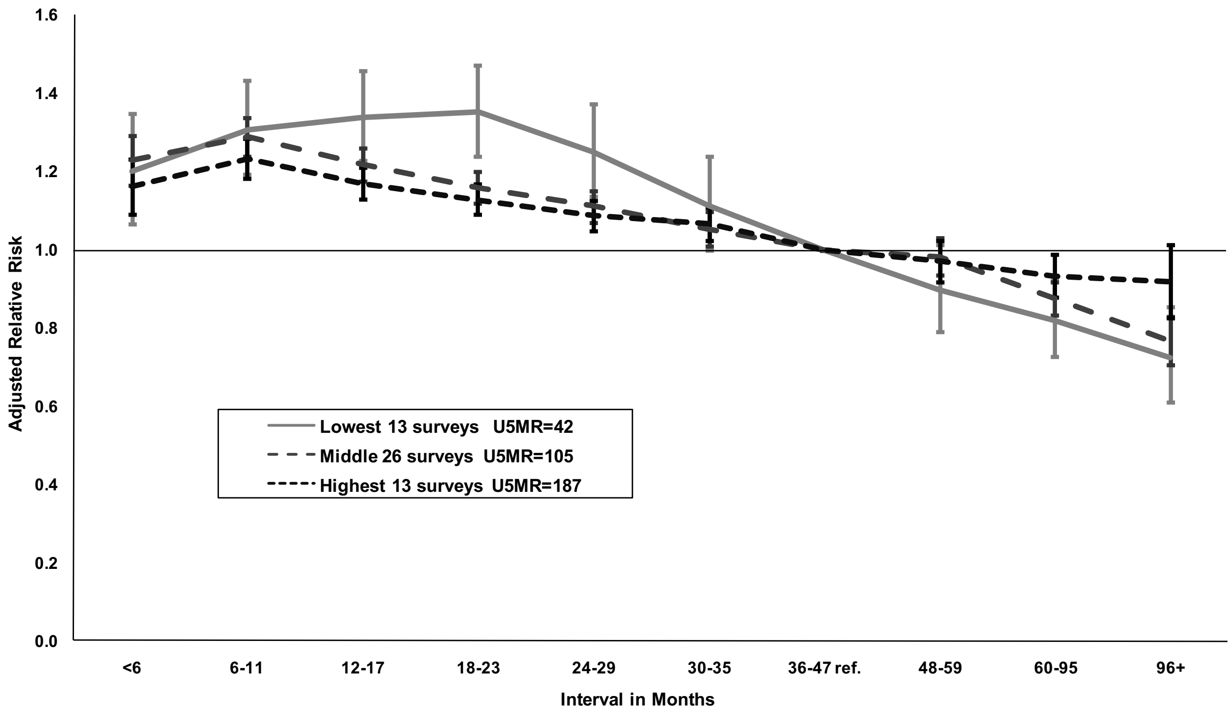
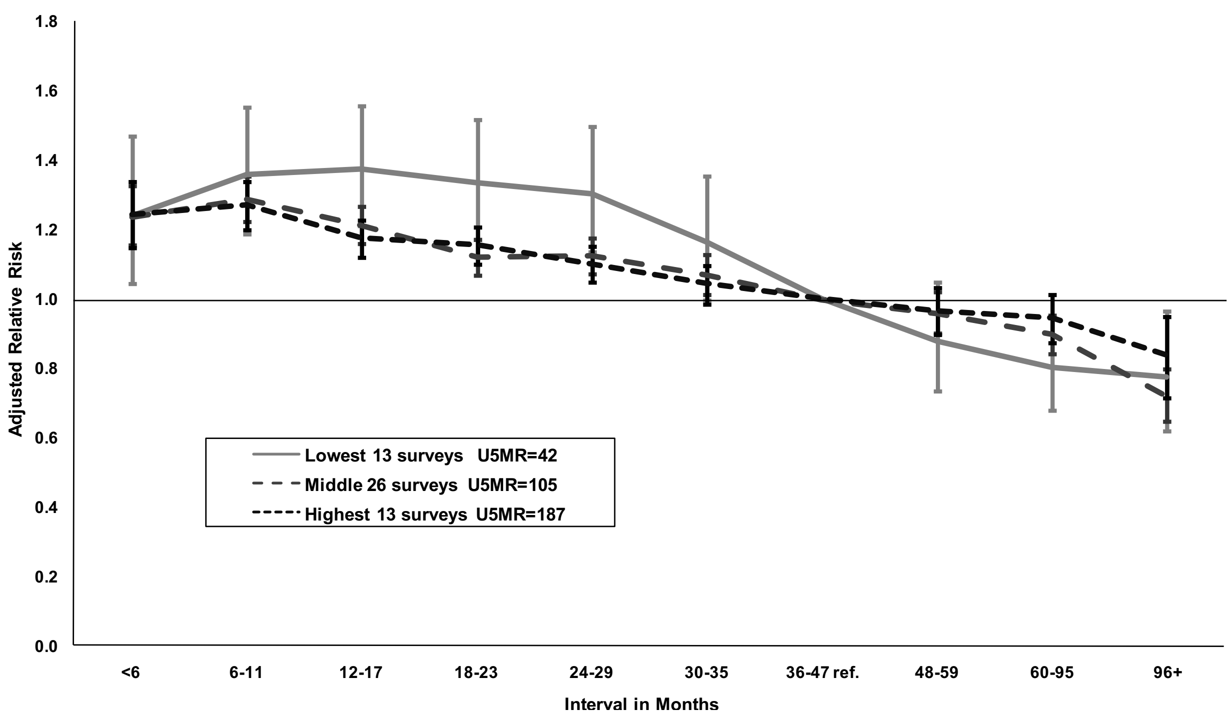


Figure 13 Adjusted Relative Risk of Underweight by Preceding Birth to Conception Interval, According to Level of Mortality



DISCUSSION

Previous studies have well established that there is an important effect of the length of the preceding birth interval on the survival chances of a child through the neonatal, infant and under-five years periods of life. The previous paper by the author indicated that there was an optimal length of birth interval. The current study extends and strengthens the analyses presented in that paper by:

- Analyzing a much larger data set, with 1,123,000 births (382,000 for neonatal and infant mortality; 367,000 for post-neonatal; 903,000 for child and 1,049,000 multivariate analyses of mortality; and 265,000 living children under age five for stunting);
- Using all 52 surveys in the DHS program that took place between 2000 and 2005 for mortality analysis; the previous paper used 17 surveys from 17 selected countries.
- Using all 48 surveys with data on nutritional status; the previous paper had nutritional status data for 14 countries.
- Changing the focus of the principal dependent variable to the preceding birth to pregnancy interval with groupings that are harmonized with other studies currently being undertaken.
- Utilizing length of gestation information, the previous DHS study did not control for length of gestation due to lack of data in many earlier surveys but did do an analysis of the potential impact, which found 99.9% of births to be correctly classified. In the current paper, 40 surveys had reproductive calendar or pregnancy history information while 12 did not.

- Adding additional controls variables for multiplicity of the birth, sex of the preceding child, age at death of the preceding child (if died), source of drinking water, household possession of a refrigerator and the type of toilet facilities.
- Using only unimputed data on birth to pregnancy interval.
- For mortality analyses, using Cox proportional hazards regression used instead of logistic regression to be able to include additional data for children only partially exposed to the risk of mortality. And, using a direct analysis of a pooled data set rather than meta-analysis of the results from separate data sets.[10]

In general, the findings of this current study confirm those of the author's preceding study on 17 different surveys. For neonatal mortality, the adjusted risk ratios indicate that risk of dying decreases with increasing birth to pregnancy interval lengths up to 36 months and rises for conceptions after 48 or more months. This rise was indicated in the previous study for birth intervals of five and more years but the increase was not statistically significant. The larger data set now confirms that this rise is statistically significant.

As in the 17-survey paper, the results for infant mortality are similar to those of neonatal mortality. For post-neonatal mortality, the decrease of the risk of dying with increasing interval is again similar to those of early neonatal, neonatal and infant mortality. However, there is no corresponding increase with duration of interval for children conceived after the reference group (i.e. after an interval of 48 or more months).

For the risk of dying between ages one and four years, also known as child mortality, the adjusted risk ratios indicate that the longer the birth interval, the lower the risk, even for intervals

[10] A comparison of meta analysis of half of the surveys and the pooled data show almost identical results.

of 48 or more months. Cleland and Sathar (1984) found similar results for wider intervals in Pakistan data.

In their prospective study involving a large number of pregnancies in Matlab, Bangladesh, DaVanzo et al. also found significantly increased risks of mortality with all inter-outcome and inter-birth intervals of less than 36 months duration for the neonatal, post-neonatal and 1 to 4 years periods of life. Only for the early neonatal (first week of life) period did that study not find an increased risk for intervals of 24 to 35 months. Their study differs somewhat from the present study in that it uses prospective information for a small area of one country and takes into account five types of termination of the preceding interval (surviving live birth, non-surviving live birth, stillbirth, miscarriage, induced abortion). The current study combines stillbirths, miscarriages and induced abortions so that three categories are used. However, the results between the two studies are quite similar.

For under-five mortality, which includes the effects of neonatal, post-neonatal, and child mortality, there are significant declines in risk as interval increases up to the 60 to 95 month duration group. A small rise in risk (close to being statistically significant at the 5 percent level) is seen for conceptions occurring 96 or more months after a prior birth.

The increased risk of low birth weight and small size at birth due to a short birth to pregnancy interval is limited to intervals of less than 18 months. This result is congruent with the finding of DaVanzo et al. (2007) for fetal loss and is also congruent with the Conde-Agudelo et .al. perinatal meta-analysis (2006).

The risk of being chronically malnourished (stunted and/or underweight) decreases with increasing time between the preceding birth and the conception of the child under study. In contrast with the effects on mortality, there is no leveling or increase in the risk of being stunted or underweight for long birth intervals. There is no observable relationship between birth interval length and wasting. This lack of association is not surprising given that wasting is an indicator of acute malnutrition and is more likely to occur because of a recent shortage of food or a recent illness. The results for stunting and underweight are similar to those found for some studies in the systematic literature review by Dewey and Cohen. Other studies in their review focused on different measures of nutritional status and some may not have had enough cases to produce significant results. The large pooled data set used here provides the necessary statistical power.[11]

Boerma and Bicego (1992) concluded that in the 17 early surveys studied (none of those included here) there was only a moderate effect of length of birth interval on stunting and underweight.[12] They used a "tri-mean" of individual survey results to summarize their overall findings. From their Table 5, the risk of stunting based on the tri-means is 33 percent higher for children born with a birth to birth interval of less than 24 months and 22 percent higher for children born with an birth to birth interval of 24 to 25 months, when compared to children born after an interval of 36 or more months. Similarly, children with birth to birth intervals of less than 24 months and of 24 to 35 months are 37 percent and 12 percent more likely to be underweight, respectively, than are children born after a birth to birth interval of at least 36 months. Their results are, therefore, consistent with those presented here.

There was concern from members of the WHO meeting who reviewed the previous 17 survey article about the mechanisms by which the length intergenesic intervals could affect child

[11] Meta-analysis of several studies can also provide that power even if the individual studies do not produce significant results.

[12] In contrast with the measurement of nutritional status used in this paper, the surveys analyzed by Boerma and Bicego were based on children 3 to 36 or 6 to 36 months of age. Weight in these early surveys was measured using a hanging mechanical scale, which has been found to be less accurate than the non-hanging electronic scale used by recent and current DHS surveys.

mortality. The results shown here for stunting and underweight (chronic and overall undernutrition) indicate one pathway may be through children's nutritional status and could indicate that the ability to properly care for closely spaced children is a key factor. Even the pattern of acute malnutrition (wasting) may be the result of the joint impact of undernutrition and mortality since children who were more severely wasted (with odds of wasting higher than those of the reference group) may have passed away and were, therefore, not around to be measured.

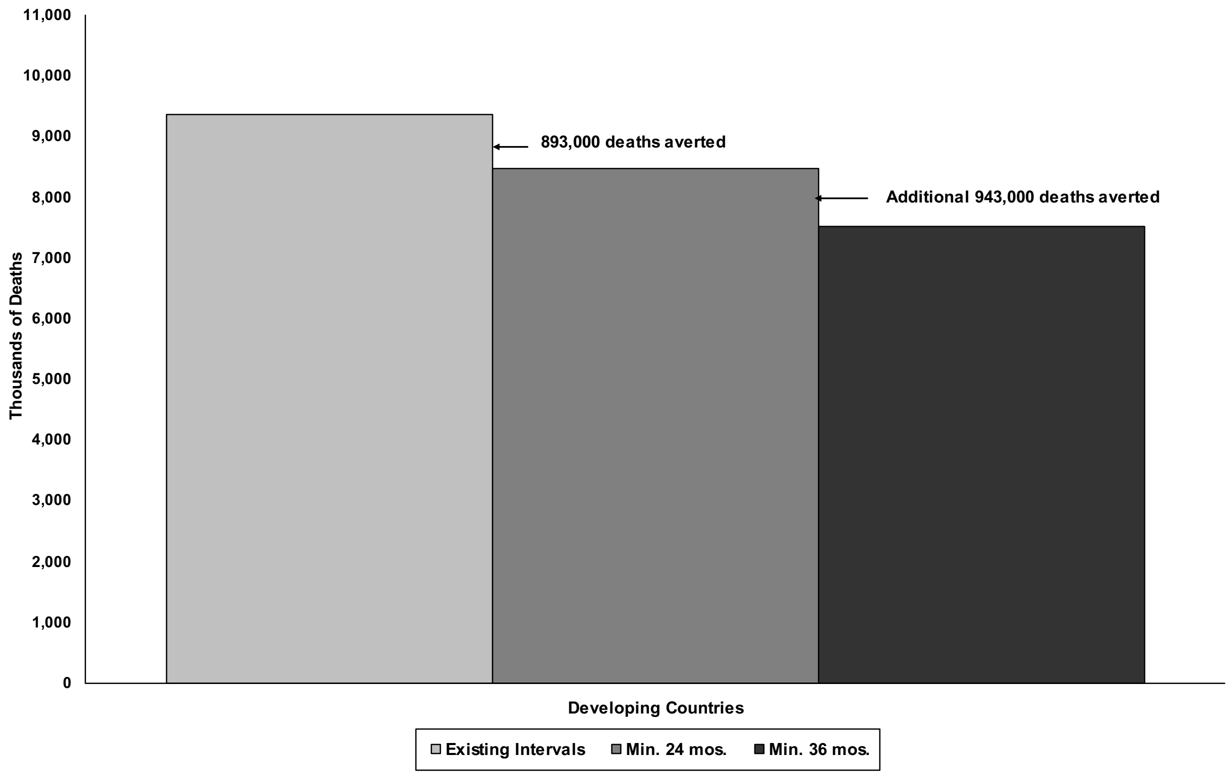
The current large dataset indicates that intervals longer than those traditionally acknowledged as having high risk (less than 24 months between births or less than 15 months birth to pregnancy) have substantial impacts on the risks of mortality and of undernutrition. In this study, intervals of 18 to 23 months between the prior birth and the conception of the index child (equivalent to 27 to 32 month birth to birth intervals) have statistically significant elevated risks for early neonatal, neonatal, infant, child, and under-five mortality. Intervals through 35 months birth to pregnancy (through 44 months birth to birth) have significant elevated risks of child and under-five mortality.

While the excess risk of mortality is highest for very short intervals (less than 12 months birth to pregnancy), there are relatively few children conceived at such intervals (14 percent). Combining both the increased risk of death for children conceived between 12 and 35 months with the great number of children with such intervals (42 percent) results in substantial declines in mortality by avoiding these intervals. Population attributable risks (PAR) of infant and under-five mortality are shown in Table 19 for intervals of less than 24 months and less than 36 months between conception and the prior birth. The PAR for under-five mortality for avoiding conceptions at less than 24 months after a birth is 0.134. Said another way, if all women would wait at least 24 months to conceive again, under-five deaths would fall by 13 percent. However, the effect of waiting 36 months to conceive again would avoid 25 percent of under-five deaths. Figure 14 shows the impact of avoiding these high risk intervals on the numbers of deaths per year in developing countries (excluding China). In 2007, over nine million deaths are projected to occur in the developing countries, excluding China. If women would delay conceiving again until at least 24 months after giving birth, it is estimated using the PARs that under-five deaths would fall by over 893,000. If they would further delay conception until 36 months, another 943,000 deaths would be avoided, resulting in a total of 1,836,000 deaths avoided annually.

Table 19. Population attributable risks for infant and under-five mortality by length of interval

	Interval avoided	
	< 24 months	< 36 months
Infant Mortality	0.075	0.118
Under-Five Mortality	0.134	0.251

Figure 14 Annual Number of Under Five Deaths with Existing Birth to Conception Intervals and with Minimum Intervals of 24 and 36 months



Finally, Table 20 and Figure 15 show the effects of the preceding birth to pregnancy interval on the likelihood of having a living and thriving child. The table and figure show the percent of children who are both alive and not undernourished. It is clear that the percent of children who survive and are not undernourished is lowest for birth to pregnancy intervals of less than 12 months and increases rapidly as the duration of the interval increases. Parents who want their children to survive and thrive would do well to wait at least 30 months after a birth to conceive another child.

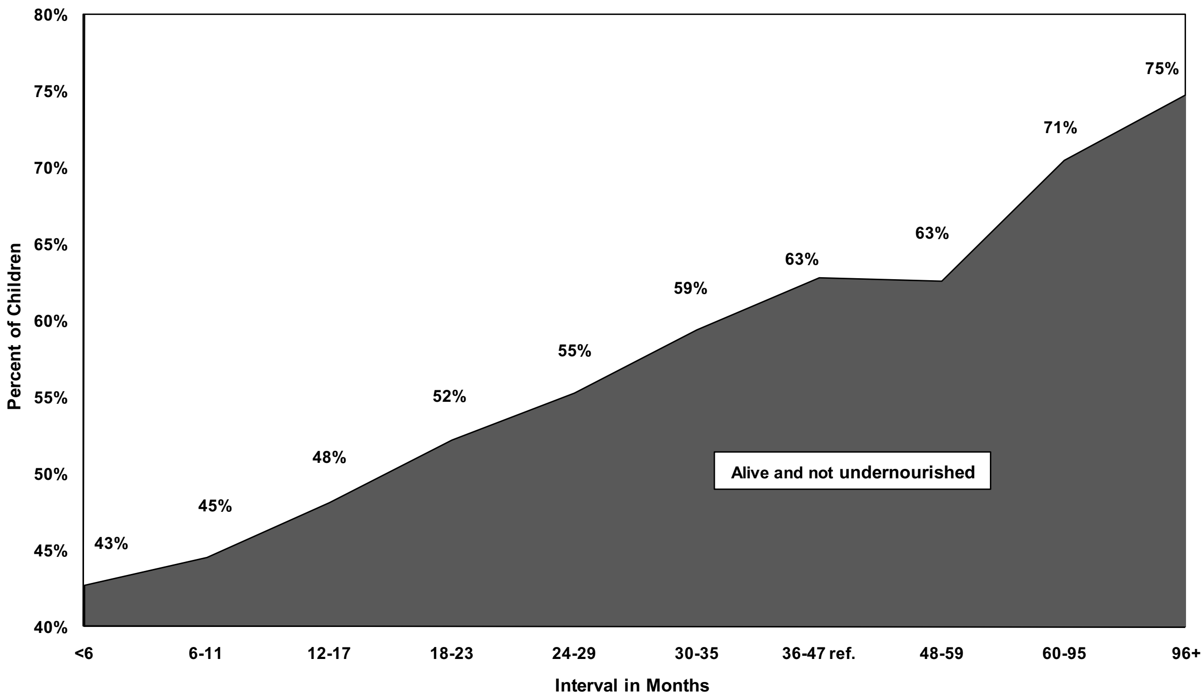
Table 20. Adjusted relative odds of being alive and not undernourished by duration of preceding birth to conception interval, living children age 0 to 59 months at survey

Indicator		Preceding Birth to Conception Interval in Months											Total rate	N
		<6	6-11	12-17	18-23	24-29	30-35	36-47 ref.	48-59	60-95	96+	First birth		
Alive and Not Undernourished	Risk	0.85	0.87	0.90	0.93	0.95	0.98	1.00	1.00	1.04	1.06	0.96	61.1%	352,447
	CI-	0.83	0.85	0.89	0.92	0.94	0.97	1.00	0.98	1.03	1.04	0.95		
	CI+	0.87	0.88	0.91	0.94	0.96	0.99	1.00	1.01	1.06	1.08	0.97		

Adjusted for:

Multiplicity of birth, Sex of index child, Urban-rural area of residence, Wantedness of child, Mother's Education, Whether conception was a result of contraceptive failure, outcome of preceding pregnancy (live birth, stillbirth), type of provider of prenatal care, type of provider of delivery assistance, birth order, mother's age at birth, number of prenatal tetanus injections, timing of first prenatal care visit, quintile of wealth index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, whether preceding child died before conception of index child.

Figure 15 Percent of Children Alive and Not Undernourished by Duration of Preceding Birth to Conception Interval



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