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THE EFFECTS OF FERTILITY BEHAVIOR ON CHILD SURVIVAL AND CHILD NUTRITIONAL STATUS: EVIDENCE FROM THE DEMOGRAPHIC AND HEALTH SURVEYS, 2006 TO 2012

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The Effects of Fertility Behavior on Child Survival and Child Nutritional Status: Evidence from the Demographic and Health Surveys, 2006 to 2012

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Preface

One of the most significant contributions of The DHS Program is the creation of an internationally comparable body of data on the demographic and health characteristics of populations in developing countries.

The *DHS Comparative Reports* series examines these data across countries in a comparative framework. The *DHS Analytical Studies* series focuses on analysis of specific topics. The principal objectives of both series are to provide information for policy formulation at the international level and to examine individual country results in an international context.

While *Comparative Reports* are primarily descriptive, *Analytical Studies* provide in–depth, focused studies on a variety of substantive topics. The studies are based on a varying number of data sets, depending on the topic being examined. These studies employ a range of methodologies, including multivariate statistical techniques.

The staff of The DHS Program, in conjunction with the U.S. Agency for International Development (USAID), selects the topics covered in *Analytical Studies.*

It is anticipated that the *DHS Analytical Studies* will enhance the understanding of analysts and policymakers regarding significant issues in the fields of international population and health.

Sunita Kishor
Director, The DHS Program

Executive Summary

The current study is the latest in a series of three based on DHS surveys that examine the relationship between spacing between births or pregnancies and infant and child mortality and nutritional status. The first study used data from 17 DHS surveys between 1990 and 1997. The second study used data from 52 different DHS surveys from 2000 to 2005. The present study includes data from 45 DHS surveys between 2006 and 2012 and extends the analysis by reporting on mother's age at birth and child's birth order in addition to the preceding birth–to–conception interval reported in the previous two studies.

More than 1.1 million births that occurred in the 15 years prior to the surveys are included in the analyses of mortality under age five years and at ages one to five years. More than 420,000 births in the five years preceding the surveys are included for the analyses of mortality in infancy. Nutritional status is analyzed for more than 340,000 living children under age five years. The analysis methodology includes bivariate and multivariate Cox hazard regression for mortality and multivariate logistic regression for nutritional status.

The results for spacing are quite similar to those found in the preceding studies, confirming the importance of waiting a period of time to conceive again after a birth. While birth–to–conception intervals of fewer than 18 months (i.e., a birth–to–birth interval of 27 months) incur an increased risk of neonatal mortality, intervals of fewer than 36 months birth to conception incur an increased risk of mortality at ages one to four years. Risks of mortality increase during infancy for birth–to–conception intervals longer than 60 months. Population–attributable risk calculations indicate 26 percent excess under–five mortality due to birth–to–conception intervals shorter than 36 months. The analysis of nutritional status indicates that the longer the preceding birth–to–conception interval, the less likely a child is to be stunted (chronically malnourished) and underweight for his or her age. However, the likelihood of wasting, being a measure of acute malnutrition, is not affected.

Mother's young age at birth (less than 18 years) increases the risk of dying for children at all ages under five years, and a mother's being 35 years or older increases the child's risk of dying during infancy. After infancy, however, the chances of dying for children of older mothers are slightly lower than the chances for children whose mothers were 18–24 years when the child was born. Children of older mothers are also less likely to be stunted and underweight. Being born to a mother under age 18 years increases a child's likelihood of being stunted and underweight.

First–born children have a substantially higher risk of mortality at all ages under age five years, even when a young mother's age at birth is taken into account. Higher birth order does not affect neonatal mortality but increases post–neonatal, ages one to four, and all under–five mortality, and slightly increases rates of stunting but not underweight or wasting.

The study indicates that the more fertility behavioral risk factors a child faces, the greater are the chances of dying and being malnourished. A child with three risk factors is twice as likely to die before reaching age five as a child with no risk factors, and if the child survives, she or he is 30 percent more likely to be suffering from chronic malnutrition.

Glossary of Terms

Acute undernutrition (wasted): Defined as a child whose weight for height is below –2 standard deviations from the median of the National Center for Health Statistics, Centers for Disease Control and Prevention (NCHS/CDC) reference for weight for height.

Birth order: A count of all live births the mother had before the index child.

Child mortality: Refers to deaths to children at ages one to four years among children who survive to age one year.

Chronic undernutrition (stunted): Defined as a child whose height for age is below –2 standard deviations from the median of the NCHS/CDC reference for height for age.

Early neonatal mortality (ENN): Refers to deaths that occur 0 to 6 days after live birth.

Neonatal mortality (NN): Refers to deaths within the first 30 days among all children born alive.

Infant mortality: Refers to deaths to children at ages 0–11 months among all children born alive.

Odds ratio (OR): Defined as the ratio of the odds of an event occurring in one group relative to the odds of it occurring in another group.

Overall undernutrition (underweight): Defined as a child whose weight for age is below –2 standard deviations from the median of the NCHS/CDC reference for weight for age.

Population–attributable risk (PAR): Defined as the proportion of cases (e.g., deaths) that would not occur if a given risk factor were eliminated. The attributable risk in a population depends on the prevalence of this risk factor and the strength of its association (relative risk) with the outcome.

Post–neonatal mortality (PNN): Refers to deaths at 1–11 months after live birth.

Preceding birth–to–conception interval: Refers to 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.

Preceding birth–to–birth interval: Refers to the number of months between the date of birth of the child under study (index child) and the date of the immediately preceding birth to the mother, if any.

Risk ratio (RR): A measure of the risk of a certain event (i.e., infant mortality) happening in one group compared with the risk of the same event happening in another group.

Singleton birth: A birth that is not a twin or other multiple birth.

Under–five mortality: Refers to deaths to children less than five years of age among all children born alive.

Introduction and Rationale

This study examines three fertility–related behavioral factors that are known to affect child survival and health, namely, the length of the preceding birth–to–conception interval, maternal age at the child's birth, and the child's birth order. Numerous studies have examined the effects of these three maternal characteristics on child survival and health outcomes. However, the challenge has been disentangling the separate effects of each of these characteristics, because they are closely related to one another. This study takes advantage of data from all recent DHS surveys between 2006 and 2012 and examines the effects of each characteristic on child survival and nutritional status while holding the other two constant and controlling for an extensive set of potential confounding variables. This study is intended to contribute to understanding the relative importance of each characteristic and to inform child survival and nutrition policies.

Literature Review

Preceding birth–to–conception interval

The harmful effects of a short or long preceding birth–to–conception interval[1] for maternal and child health have been studied extensively, with consistent findings dating back to as early as the 1920s. Various causal mechanisms could explain the effect of the length of the preceding birth interval on the risk of child mortality. In a review of 58 observational studies, Conde–Agudelo and colleagues identified several plausible causal mechanisms, including folic acid deficiency, cervical insufficiency, vertical transmission of infections, inadequate breastfeeding, and sibling competition (Conde–Agudelo, Rosas–Bermúdez, and Kafury–Goeta 2006). For an in–depth discussion of the literature on this relationship, see previous studies by Rutstein (Rutstein 2005; Rutstein 2008).

In brief, the effect of short intervals has been shown repeatedly to be one of the most important factors affecting the mortality of infants and young children under age five years. Early studies identified a U–shaped pattern between the length of the preceding birth–to–conception interval and infant mortality (Hughes, Hunter, and Woodbury 1923; Woodbury 1925). Subsequent studies demonstrated that even after adjusting for a variety of confounding factors, the effect of birth interval on young child mortality persists (Alam 1995; Alam and David 1998; Bhalotra and van Soest 2006; Conde–Agudelo, Rosas–Bermúdez, and Kafury–Goeta 2006; DaVanzo et al. 2008; Hosseinpoor et al. 2006; Koenig et al. 1990; Miller et al. 1992; Mozumder et al. 1998; Zenger 1993). Studies have found that the harmful effects of a non–optimal preceding birth interval are concentrated in early infancy (Koenig et al. 1990), suggesting that prenatal conditions, rather than household factors like sibling competition, are likely to explain the effect of birth interval (Boerma and Bicego 1992). However, studies have also found that the effect of a short–preceding birth interval on child mortality are stronger if the preceding child is still alive, suggesting that sibling completion does play a role (DaVanzo et al. 2008). In recent years, multi–country studies have sought to identify the optimal birth interval for child survival. Rutstein (2005 and 2008) found that for neonatal mortality and infant mortality the risk of dying was lowest for children with a preceding birth–to–birth interval of 36–47 months, while for child mortality risk continued to decrease with increasing length of the preceding birth interval.

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[1] While this study uses birth to next conception of live birth intervals, many studies have used birth-to-birth intervals, the difference being the length of gestation, taken as nine months where data for gestation length do not exist.

In addition to the effects of birth interval on child survival, studies have documented a strong relationship between the length of the preceding birth interval and chronic and general undernutrition such that nutrition outcomes are poorer for children with shorter preceding birth intervals (Dewey and Cohen 2007; Rutstein 2005). In a systematic literature review of the effects of birth spacing on maternal and child nutritional status, Dewey and Cohen (2007) found that among 22 studies on this topic identified since 1966, the longer the birth interval, the lower the risk of malnutrition in some but not all populations. In countries with significant results, a previous birth–to–birth interval of at least 36 months was associated with a 10 to 50 percent reduction in stunting.

Maternal age

The effects of maternal age on infant and early child survival and health have been studied extensively, but with mixed findings. Children born to very young women and to older women have often been observed to have higher levels of mortality. However, some authors provide evidence that this association can be explained away by young women's social disadvantage and other confounding factors (Geronimus 1987; Reichman and Pagnini 1997). Others provide evidence that the observed maternal–age effect persists after adjusting for social factors (Finlay, Özaltin, and Canning 2011; Fraser, Brockert, and Ward 1995; Kumar et al. 2013), suggesting a biological effect. Several plausible biological explanations could explain the excess mortality observed among young mothers. Young teenage mothers have often not yet reached full physiological and reproductive maturity, thereby increasing their risk of complications during pregnancy and birth as well as the likelihood of inadequate weight gain during pregnancy. Young mothers who are still growing themselves also may compete for nutrients with the fetus (Fraser, Brockert, and Ward. 1995). Young teenage mothers' psychological immaturity also could impact the child's care. However, the observed association also could be explained by social factors or by collinearity between maternal age and birth order.

Much of the literature exploring the effect of young maternal age on birth outcomes has relied on United States–based data (Fraser, Brockert, and Ward 1995; Geronimus 1987; Reichman and Pagnini 1997). Within the context of the United States, teenage pregnancy is associated with social and economic disadvantage, and teenage mothers have been shown to use prenatal care and health services at a lower rate (Reichman and Pagnini 1997). Some studies have found that after controlling for socioeconomic circumstances and health status and care–seeking–such as the mother's education, insurance status, marital status, use of prenatal care, reproductive history, smoking and alcohol use, and the mother's health status–young age itself was no longer associated with additional risk (Reichman and Pagnini 1997).

Several studies in less developed countries have also found that adjusting for sociodemographic factors eliminates the bivariate U–shaped association between maternal age and early child mortality (Akinyemi, Bamgboye, and Ayeni 2013). Akinyemi and colleagues (2013), for example, found no evidence of an association between maternal age (< 18, 18–34, 35+ years) and under–five mortality in Nigeria, in a hazard model that adjusted for a range of socioeconomic, behavioral and health, environmental, and biodemographic factors. Handa and colleagues found that the risk of under–five mortality was lower for women who had their first birth at 16 years of age or older compared with women who gave birth at a younger age in only one of four countries in Southern Africa (Mozambique but not in Malawi, Tanzania, or Zambia), in an adjusted Cox regression model (Handa, Koch, and Ng 2010).

However, other studies in less developed countries have found an independent, persistent association between maternal age and early child mortality, suggesting underlying physiological causal pathways (Finlay, Özaltin, and Canning 2011; Ikamari 2013; Kumar et al. 2013; van der Klaauw and Wang 2011). Van der Klaauw and Wang (2011) found that the expected U–shaped relationship between maternal age and neonatal, post–neonatal, and child (years one to four) mortality persisted after adjusting for an array of sociodemographic characteristics among children in rural India, including state, sex of child, preceding birth interval, first –birth order, ethnicity, mother's marital status, education, wealth decile, and various household and village characteristics. For example, the risk of neonatal mortality was lower among mothers who were 20–25 and 26–31 than for women under age 20, and was highest for women of at least 32 years. Ikamari (2013) also found that neonatal and post–neonatal mortality varied significantly according to maternal age at birth, in adjusted Cox regression models. However, rather than follow the U–shaped risk pattern, the risk of both neonatal and post–neonatal mortality increased incrementally with age, such that the risk was lowest in the < 20 age group, higher in the 20–34 group, and highest in the 35+ group. Similarly, Kumar and colleagues (2013) found that the adjusted probability of early neonatal death was highest among women under age 20 at the child's birth and lowest among women at least 25 years old at the child's birth.

Some studies have focused specifically on the association between the mother's older age and birth outcomes (Lisonkova et al. 2010). In a study of a representative sample of women with singleton births in British Columbia, Lisonkova and colleagues (2010) examined whether older maternal age was associated with three outcomes–stillbirth, neonatal death, and preterm birth. They found that older age (being 35–39, and 40 or older) was associated with the risk of stillbirth and preterm birth after adjusting for parity, marital status, neighborhood income, rural residence, smoking, alcohol and drug use during pregnancy, prenatal care, infant's sex, ethnicity, previous induced abortion, and previous spontaneous abortion. The association between maternal age and neonatal mortality was not significant in the adjusted model. They also found that parity significantly modified the associations between maternal age and preterm birth and between maternal age and being small for gestational age, such that the effect was stronger among primiparous women.

Several of the aforementioned studies that have found a positive, independent effect of maternal age on child survival have been limited to women's first birth in order to better isolate the effect of maternal age from the effect of birth order (Finlay, Özaltin, and Canning 2011; Fraser, Brockert, and Ward 1995). For example, in a sample of singleton first births to women in the United States, Fraser (1995) found that children born to mothers between the ages of 13 and 17 years had a higher risk of being born with a low birth weight, being delivered prematurely, or being small for gestational age than children whose mothers were between the ages of 20–24 years at the time of their birth, after adjusting for educational attainment, marital status, and prenatal care. The risk of these three outcomes was also elevated among mothers age 18–19 compared with women age 20–24. More recently, Finlay and colleagues (2011) conducted a multi–country analysis of DHS data from 55 countries to investigate the association between maternal age and infant mortality, child nutritional status, diarrhea, and anemia. They found that even after controlling for a range of socioeconomic factors, the U–shaped association between maternal age and infant mortality persisted, with optimal outcomes to women in the 27–29 year range.

Although studies limited to first births are informative in helping to isolate the effect of age versus the effect of birth order, they are not generalizable to all births, because the effect of a woman's age at first birth could differ from the effect of her age at later births. The current study will include all births as well as measures of all three fertility–related characteristics–maternal age, preceding birth interval, and birth order–in order to provide additional evidence on the independent effects of each.

Studies have also found maternal age to be significantly associated with measures of child health and nutrition (Finlay, Özaltin, and Canning 2011; Vitolo et al. 2008). Using cross–sectional data on children age one month to five years in southern Brazil, Vitolo and colleagues (2008) found that young maternal age is associated with being born with a low birth weight and with wasting. Using DHS data from 55 countries, Finlay and colleagues (2011) found that among women's first births, maternal age was associated with children's being underweight, stunted, and having had diarrhea. The relationship with these outcomes was linear, such that the risk of each outcome decreased with increasing age, after adjusting for sociodemographic factors.

Birth order

The association between birth order and child mortality is often described as U–shaped, with higher mortality levels among first births and high–order births. However, studies exploring determinants of child mortality have not consistently found birth order to retain significance in adjusted models (Saha and van Soest 2013).

Some studies have found a significant association between birth order and child mortality, even after controlling for potential confounders (Handa, Koch, and Ng 2010). Handa and colleagues (2010) examined trends in determinants of under–five and under–two mortality over time in four countries in Southern Africa. In their full Cox regression models, they included a measure of the mother's parity (total number of live births, measured continuously) as well as a categorical measure of the child's birth order (first, second, and third or higher). They interpret parity as a measure of maternal depletion and categorical birth order as a measure of the child's lived experience in the home. In the adjusted model, they found that the mother's parity was positively associated with the risk of under–five and under–two mortality in Malawi, Mozambique, Tanzania, and Zambia, indicating the expected effect of maternal depletion. Higher birth order, on the other hand, was negatively associated with the risk of under–five and under–two mortality, such that in all four countries, children of third or higher birth order had a roughly 30 percent lower risk of dying by age five than first and second births. Uddin and colleagues (2009) found that the child mortality rate increased steadily with increasing birth order. They concluded that this finding reflects a "more intense competition faced by higher birth order children in terms of care givers time, medical resources, and nutritious food" (Uddin, Hossain, and Ullah 2009).

Other studies have not found birth order to be an important determinant of child survival (Saha and van Soest 2013). Saha and van Soest (2013) did not find a significant association between birth order and infant mortality, after adjusting for a range of factors, among births in the Matlab area of Bangladesh. In this study, birth order was included as a continuous variable with a quadratic term. They did, however, find that birth order was significantly associated with birth interval (another outcome that was examined in the study), such that higher order births tend to have shorter preceding intervals.

As mentioned earlier, separating the effects of maternal age from the effects of the child's birth order is challenging. Depending on the study design, it is not always possible to determine how much excess risk can be attributed to first birth order beyond the risk of young maternal age, or to high birth order, beyond the risk of older maternal age. Rather than attempt to measure separate effects, Rossiter and colleagues (1985) examined the combined effects of these factors, finding that among singleton births, perinatal survival is poorest among first births to mothers age 15 or younger and to high–order births to women age 30 or older (Rossiter et al. 1985).

Some useful studies have investigated the interaction between birth order and maternal age. In a study using data from a Demographic Surveillance System site in Matlab, Bangladesh, Alam (2000) found that among teenage mothers, the risk of neonatal mortality was higher for their second birth than for their first birth in an adjusted logistic regression model. Among women age 20–24, the risk of neonatal and post–neonatal mortality was higher for first births than for second births. Alam interprets this finding as evidence of a depletion effect among young teenage mothers with multiple births.

Children's nutritional status has been found to depend on the child's birth order, perhaps more consistently than their survival. The number of siblings a child has increases his or her odds of poor nutritional outcomes, possibly through sibling competition, the mother's availability for child care, or the correlation between large family size and lower socioeconomic status (Magvanjav et al. 2013; Vitolo et al. 2008). In a study using a cross–sectional sample of children in Sao Leopoldo, Brazil, Vitolo (2008) found the number of siblings to be positively associated with children's odds of being stunted, after controlling for socio–demographic factors. Similarly, a recent study of children in Bolivia found that the presence of each additional older brother or younger sister was negatively associated with arm measures in girls (Magvanjav et al. 2013).

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 techniques. The pooling of the data sets permits better estimation of effects due to the large size of the data set and, hence, better control of random sampling variation.

Dependent variables

The study examines nine outcomes: six young childhood mortality outcomes (early neonatal, neonatal, post–neonatal, infant, child, and under–five mortality) and three nutrition–related outcomes (stunting, wasting, and underweight). For early neonatal, neonatal, post–neonatal, and infant 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 five years prior to each survey. For child and under–five 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 15 years prior to each survey.[2] Analyses of mortality at the youngest ages are restricted to the five years prior to each survey in order to take advantage of information on maternal and birth–related care that is only available for these births. Because birth care is a less important determinant of older child mortality, this restriction was not necessary.

For nutritional status, the dependent variable is the percentage of young children who are stunted, wasted, or underweight among living children under age five years. As part of the interviewing procedure, the DHS surveys routinely collect the height and weight of children under age five 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 to the NCHS/CDC international reference standards for height for age, weight for age, and weight for height. Children whose z–scores are below minus two standard deviations from the median (–2 sd) on the reference standard are considered 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 less than –2 sd for weight for height; overall undernutrition, or underweight, is measured by a z–score less than –2 sd for weight for age.

The dependent variables are summarized below:

- ENN–Early neonatal mortality, death at 0–6 days after birth
- NN–Neonatal mortality, death at 0–30 days and <1 month after birth
- PNN–Post–neonatal mortality, death at 1–11 months after birth
- IMR–Infant mortality, death at 0–11 months after birth
- Child mortality, death at 12–59 months after birth
- Under–five mortality, death at 0–59 months after birth
- Chronic undernutrition (stunted), <–2 sd on NCHS/CDC reference for height for age

[2] Because the age range of interviewed women is 15-49 years at the time of the survey, data on births occurring earlier than 15 years prior to the survey are limited to mothers ages 15-34 years. To avoid substantial bias due to this age restriction, the 15-year window is used in the analyses here.

- Acute undernutrition (wasted), <–2 sd on NCHS/CDC reference for weight for height
- Overall undernutrition (underweight), <–2 sd on NCHS/CDC reference for weight for age

Key independent variables

The key independent variables are the length of the preceding birth–to–conception interval, the mother's age at the child's birth, and the child's birth order.

The length of the preceding birth–to–conception interval is 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, if any, to the mother. The interval is calculated as the difference in birth dates (year and month) between the birth of the preceding child and of the index child, subtracting the duration of gestation of the index child where available. Where not available, nine months of gestation were assumed. These categories correspond to the categories that were agreed upon by the World Health Organization (WHO) review team members and other researchers to provide harmonized results (< 6, 6–11, 12–17, 18–23, 24–29, 30–35, 36–47, 48–59, 60–95, 96+ months, first births, and missing). For the calculation of the population attributable risk (PAR), the following condensed categories are used: <36 months, 36+ months, first births, and missing.

Maternal age at the child's birth is calculated using the mother's age at the time of interview and the date of the child's birth. Maternal age is then grouped into five categories: < 18, 18–24, 25–34, 35–39, and 40 years or older. For the calculation of the PAR, the following two sets of condensed categories are used: < 18 or 40+ years and 18–39 years; <18 or 35+ years and 18–34 years.

Birth order is examined using five categories in the univariate and bivariate analyses: first, second, third–fourth, fifth–sixth, and seventh and higher. Note that this variable is a count of all live births the mother had before the index child rather than a count of all pregnancies, since the standard DHS does not include a full pregnancy history. For the multivariate analysis, first and second order births are combined into a single category, because the model also includes preceding birth interval, which has a separate category for first births. For the calculation of PAR, the following condensed categories are used: first–third birth order and fourth–plus order.

To examine potential interactions between the three key independent variables, two additional summary indicators are used. The first indicator examines each possible combination of the three exposure variables, separately: no extra risk; unavoidable first–birth risk; single risk spacing < 24 months; single risk spacing 24–35 months; single risk age < 18; single risk age 40+; single risk order 4+; double risk spacing < 24 months and order 4+; double risk spacing 24–35 months and order 4+; double risk first birth and age < 18; double risk first birth and age 40+; double risk order 4+ and age < 18; double risk order 4+ and age 40+; double risk spacing < 24 months and age < 18; double risk spacing 24–35 months and age < 18; double risk spacing < 24 months and age 40+; double risk spacing 24–35 months and age 40+; 3–way risk spacing < 24 months, order 4+ and age < 18; 3–way risk spacing < 24 months, order 4+, and age 40+; 3–way risk spacing 24–35 months, order 4+, and age < 18; 3–way risk spacing 24–35 months, order 4+, and age 40+; and missing. The second indicator is a summary of the first, with six categories: no extra risk, unavoidable first–birth risk, any single risk, any double risk, any 3–way risk, and missing.

Both bivariate and multivariate designs are used. The multivariate analysis is based on the pooled data for all 45 surveys together for each of the mortality age ranges. The coefficients are exponentiated to give the relative risk ratios. 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.

Control variables in the multivariate analysis

A number of factors could potentially confound the relationship between the three key independent variables (preceding birth–to–conception interval, maternal age, and birth order) and young child mortality. These have been cited by a number of authors [for example, see (Winikoff 1983)]. Birth–specific confounders include 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 any potential confounding due to multiplicity of birth, the study population is restricted to singleton births. To control for potential confounding by other characteristics of the birth and mother, variables representing these factors have been used in the multiple regression analyses. A slightly modified list of controls are included in multivariate models for the different outcomes. As mentioned above, models examining death within the first year include variables on maternal and birth care; models examining child mortality, under–five mortality, and nutritional status do not.

Male children have higher mortality in most cultures. In others, neglect and infanticide may invert this biological relationship. In these cultures, birth intervals also may 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 surveys 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.[3]

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 breastfeeding and postpartum amenorrhea, leading to an increased risk of a short birth interval. Taking account of 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, McDonald, and Rutstein 1983) so that controlling for any death may result in an over–correction. 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 over–correction, only deaths of the preceding child before the index child's conception will be controlled in these analyses.

An unwanted child, especially one due to contraceptive failure, may suffer more neglect than wanted children. To control for these effects, the wantedness of the child[4] 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 they cannot be used for under–five mortality analyses because those analyses are based on children born in the 15 years prior to the surveys. Moreover, information on births

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[3] 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 post-neonatal deaths, but the majority of post-neonatal mortality comes in the early months and, therefore, many deaths occur before the age at which vaccinations for DPT, polio, and measles are given. Indeed, in Latin America, measles vaccinations are given after the first year of life.

[4] Whether the mother wanted the pregnancy to occur at the time it did, wanted the pregnancy later, or wanted no more pregnancies.

resulting from a failure of contraception is not available for countries with low contraceptive prevalence nor in several other surveys.[5]

Access to health services and to contraceptives, physical and social environments, and socioeconomic status are associated with both child mortality and the spacing of births. To control for these effects, five 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 DHS Wealth Index [Filmer and Pritchett 2001; Rutstein and Johnson 2004)], and type of drinking water supply and type of toilet facility.[6] Appendix Table 1 shows the distribution of births by control variables used in the multivariate analyses.

Control variables:

Demographic controls

- Pregnancy duration
- Sex of index child
- Death of the preceding child prior to the conception of the index child
- Outcome of preceding pregnancy (live birth or stillbirth)

Behavioral controls

- Wantedness (time wanted pregnancy or whether birth wanted at all)
- Pregnancy result of contraceptive failure of any method

Health care controls

- Prenatal care provider
- Prenatal initial checkup month of pregnancy
- Number of prenatal tetanus toxoid vaccinations
- Delivery care provider

Socioeconomic and environmental controls

- Urban–rural residence
- Mother's level of education
- DHS Wealth Index quintile

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[5] There are no calendar data on failure from Albania, Benin, Bolivia, Cameroon, Congo DR, Dominican Republic, Ghana, Guyana, Liberia, Lesotho, Madagascar, Mali, Namibia, Niger, Nigeria, Pakistan, Philippines, Sao Tome and Principe, Sierra Leone, Swaziland, Timor-Leste, and Zambia.

[6] The absence of the father (or mother's spouse/partner) also may be related to both child mortality and birth intervals. Children whose father is absent may have lessened resources for child care and health service utilization. Birth intervals also may be longer if the mother has less frequent sexual relations due to the absence. However, in 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 is it possible to determine whether the child was living away from home at the time of death.

- Source of drinking water
- Refrigerator
- Toilet facility

Analysis methodology

The analyses were performed using SPSS 20.0.0 software.

<u>Infant and child mortality</u>

Bivariate relationships are studied using life tables for each category of the independent variables for each survey separately and for all the surveys pooled together. The life tables were calculated using the Survival procedure of SPSS. (These results will be available in a separate appendix upon request.) Unadjusted risk ratios for the pooled data set were calculated using the Cox regression procedure.

To ascertain risk ratios controlling for confounding factors, i.e., adjusted risk ratios, Cox regression analysis is employed. 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 variables are the preceding birth–to–conception interval, the mother's age at the child's birth, and the child's birth order. First births are included as a separate category in the birth interval variable as are the few intervals with missing data. The interval 36–47 months is used as the reference category. For maternal age, women ages 18 to 24 years are used as the reference category, and for birth order, first and second births are used as the reference category.

The control variables given above are used to control for potentially confounding relationships. Missing values for each independent variable are included as separate categories. The DHS surveys do not permit missing data on survival or age at death. The results presented are exponentiated coefficients to obtain the adjusted risk ratios.[7]

For the analyses of current nutritional status, odds ratios are used as the form of the dependent variable. To ascertain adjusted odds ratios, binary logistic analysis is employed. Cases for current nutritional status are living children. Children with missing values on the dependent variables are omitted from that analysis. The principal independent variables are the preceding birth interval, the mother's age at the child's birth, and the child's birth order, calculated as described above for the mortality analyses. The results are presented in the form of unadjusted and adjusted odds ratios.

DHS Data Used in the Study

The data used in this study come from all 45 national surveys in The DHS Program with field work that took place between 2006 and 2012. This program of surveys in developing countries started in 1984 and is financed principally by USAID. The surveys in The DHS Program are based on scientifically selected

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[7] In the 52-country study (Rutstein 2008), analyses were performed on several countries, incorporating 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. Due to the laboriousness of hand-combining sample clusters when there were no deaths in the mortality age range, the more conservative approach of ignoring sample clustering and stratification was taken in the current study. Note that although clustering would seem to 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 removed the effects of clustering.

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 are 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 ICF International.[8]

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, de facto and de jure status, and educational level. Women between the ages of 15–49 years, inclusive, who slept in the dwelling the night before interview, are selected for interviewing with an individual questionnaire.[9]

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 children under five years 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 UNICEF scales. Specially trained staff members–in many cases, public health nurses–carry out the anthropometric measurements.

The quality of the DHS data is among the highest for data on births and infant and child deaths in the developing countries [see (Curtis 1995; Pullum 2006; Sullivan, Bicego, and Rutstein 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 post–neonatal rates may be understated and child mortality may be overstated by up to 5 percent. No effect on neonatal or under–five–years mortality rates has been found. Some evidence exists for transference of births to a year earlier in order to avoid asking a long health section for young children. For most surveys, this boundary is at five calendar years prior to the survey. In other surveys, the health section eligibility boundary is three or four calendar years prior to 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 DHS surveys, 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 data set.

The 45 surveys selected for this analysis represent the following countries: Albania, Armenia, Azerbaijan, Bangladesh, Benin, Bolivia, Burkina Faso, Burundi, Cambodia, Cameroon, Colombia, Congo DR, Dominican Republic, Egypt, Ethiopia, Ghana, Guyana, India, Indonesia, Jordan, Kenya, Lesotho, Liberia,

[8] 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 and subsequently sold the company to ICF International, and the Macro International name was abandoned.

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

Madagascar, Malawi, Mali, Mozambique, Namibia, Nepal, Niger, Nigeria, Pakistan, Peru, Philippines, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Swaziland, Tanzania, Timor–Leste, Uganda, Ukraine, Zambia, and Zimbabwe (Table 1). These 45 surveys are all those that took place between 2006 and 2012. All available surveys in the DHS program carried out between 2006 and 2012 are included in the analysis. However, three surveys did not include anthropometry and will not be used in the nutrition status analysis: Indonesia, Philippines, and Ukraine.

Table 1. List of surveys, by year

Year	Countries
2005–06	India
2006	Azerbaijan, Benin, Mali, Niger
2006–07	Namibia, Pakistan, Swaziland
2007	Congo DR, Dominican Republic, Indonesia, Jordan, Liberia, Ukraine, Zambia
2008	Bolivia, Egypt, Ghana, Nigeria, Philippines, Sierra Leone
2008–09	Albania, Kenya, Madagascar, Sao Tome and Principe
2009	Guyana, Lesotho, Timor–Leste
2010	Armenia, Burkina Faso, Burundi, Cambodia, Colombia, Malawi, Rwanda, Tanzania
2010–11	Senegal, Zimbabwe
2011	Bangladesh, Cameroon, Ethiopia, Mozambique, Nepal, Uganda
2012	Peru

Creation of the Pooled Data Set

Child and pregnancy–related data for singleton births in the 15 years preceding the survey were extracted from each survey using ISSA and entered into an SPSS .sav file. A pooled data set was created from the individual survey .sav files with 1,227,161 cases (births).

Results

Univariate Results

Table 2 shows the distributions of preceding birth–to–conception intervals of births in the period 0–179 months prior to the surveys. Because of the large sample sizes, 15 percent of the births are from India and nearly one in three (30 percent) is from India, Colombia, Indonesia, Malawi, and Burkina Faso. Of all the births considered, slightly more than one quarter were first births, based on the unweighted average. Among second and higher order births, the mean number of months since the preceding birth was 37.8 months with a median of 31 months. Very short intervals of fewer than 12 months between a birth and the following conception accounted for more than 17 percent of the intervals of second or higher order births. While more than 37 percent of birth–to–conception intervals were fewer than 18 months in duration, more than another 28 percent occurred with durations of 18 to 30 months, resulting in about two thirds of second and higher order births being at durations of fewer than 30 months.

Analyses using the birth–to–conception interval depend on the respondent's knowledge of the birth dates and length 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. Croft [no date] provides a description of the process. For 0.1 percent of the live births, the interval is missing. The survey with the most missing data on duration of intervals is Senegal 2010–11 where, at most, 0.04 percent is missing.

The accuracy of birth spacing intervals depends on the accuracy of the birth dates of children. For all births 0 to 179 months prior to the surveys, almost 97 percent had a birth date reported in years and months, and for 2 percent, the month needed to be imputed. Only four countries had less than 90 percent of births with year and month of birth: Benin (20 percent), Niger (20 percent), Pakistan (36 percent), and Senegal (25 percent). Imputation of the interval would normally weaken the relationships with mortality and nutritional status because the interval is randomly assigned within specified limits. For example, births with true shorter intervals and thus higher mortality and malnutrition proportions would then be imputed to have both short and long intervals, reducing the observed strength of the relationships.

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 for a greater number of cases (reducing standard errors) and an easy vision of the effect of the imputation. Another way is to use only non–imputed cases, which, although a cleaner procedure, 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, post–neonatal, 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 upwards, since they would contain a disproportionately high number of premature births. The shorter the interval, the more likely 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.[10]

[10] The earlier article examined the potential effect on the results that adjusting for gestational length would have on the classification of births into birth interval categories. That examination found that, at most, about 0.2 percent of births had been shifted into a longer birth interval due to the assumption of a nine-month gestation rather than actual gestation. In the shortest birth interval, only 0.1 percent 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 percent will be correctly classified.

Table 2. Distribution of births 0 to 179 months prior to survey by duration of preceding birth–to–conception interval, 45 DHS surveys, 2006–2012

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 births	Total	Mean	Median	N
Albania	2008-09	2.3	6.2	8.5	7.5	7.7	6.0	10.5	7.3	8.3	2.5	33.1	100.0	45.7	40.0	6,867
Armenia	2010	4.4	9.5	6.9	5.9	4.7	4.0	6.1	3.9	5.4	3.7	45.5	100.0	43.6	33.0	4,167
Azerbaijan	2006	7.2	12.6	10.3	8.1	5.4	3.5	5.0	3.0	4.7	1.5	38.8	100.0	35.0	27.0	7,564
Bangladesh	2011	2.8	5.0	8.7	7.6	7.7	5.6	9.5	6.9	9.3	3.4	33.3	100.0	47.7	40.0	27,377
Benin	2006	2.8	7.1	15.1	15.5	13.4	8.2	8.2	3.7	3.1	1.0	22.0	100.0	35.9	32.0	39,544
Bolivia	2008	5.1	9.5	15.6	11.5	7.4	4.9	6.7	4.3	6.2	3.1	25.9	100.0	39.5	30.0	26,730
Burkina Faso	2010	2.0	6.9	14.4	15.8	13.7	9.8	9.2	3.9	3.1	0.6	20.5	100.0	36.2	33.0	40,092
Burundi	2010	4.8	8.0	16.6	15.2	12.8	7.3	8.1	3.1	2.3	0.5	21.3	100.0	33.5	30.0	18,799
Cambodia	2010	3.5	5.8	11.8	9.7	9.1	6.3	9.6	5.4	6.8	2.5	29.4	100.0	42.4	35.0	23,438
Cameroon	2011	5.3	8.7	15.7	14.0	9.4	6.5	7.7	3.8	3.9	1.3	23.7	100.0	35.7	30.0	28,932
Colombia	2010	3.1	6.6	8.1	6.5	5.3	4.0	6.6	5.3	9.4	6.5	38.4	100.0	52.6	40.0	49,404
Congo DR	2007	5.7	8.1	18.0	14.5	11.5	6.3	7.1	3.0	3.1	1.2	21.5	100.0	34.2	29.0	21,330
Dominican Republic	2007	6.3	9.6	9.9	8.2	6.3	5.0	7.2	4.9	6.5	3.0	33.0	100.0	41.3	32.0	33,076
Egypt	2008	4.6	6.9	10.6	9.8	9.2	6.2	8.8	5.4	6.2	1.8	30.6	100.0	40.4	34.0	29,213
Ethiopia	2011	6.3	8.6	15.9	14.0	11.7	7.2	8.3	3.7	3.5	1.0	20.0	100.0	34.6	30.0	33,168
Ghana	2008	2.6	5.7	11.7	10.9	9.1	7.9	11.6	6.0	6.9	2.3	25.2	100.0	43.0	37.0	7,547
Guyana	2009	6.5	9.1	10.7	8.7	6.7	5.0	6.7	4.1	8.0	4.0	30.4	100.0	43.2	32.0	6,025
India	2005–06	6.5	9.6	16.3	10.8	8.7	5.4	6.7	3.3	3.1	0.8	28.7	100.0	33.3	28.0	177,993
Indonesia	2007	2.8	4.6	6.9	6.0	5.5	4.4	8.4	6.9	12.8	6.4	35.2	100.0	55.9	48.0	48,014
Jordan	2007	7.6	14.0	15.1	10.5	7.9	5.7	7.1	4.4	4.5	1.0	22.0	100.0	33.9	28.0	27,230
Kenya	2008–09	4.6	8.6	14.5	12.6	9.7	6.0	7.9	4.3	5.2	1.7	24.9	100.0	37.6	31.0	15,448
Lesotho	2009	2.0	3.0	6.6	8.3	9.3	6.7	10.4	6.0	8.3	3.1	36.3	100.0	48.3	41.0	9,124
Liberia	2007	4.7	7.3	13.3	12.2	9.1	6.9	9.2	5.0	6.6	2.3	23.5	100.0	40.2	33.0	14,573
Madagascar	2008–09	5.8	10.1	16.9	12.5	8.4	6.1	7.4	3.8	4.5	1.4	23.3	100.0	35.4	29.0	35,352

(Continued...)

Table 2. – *Continued*

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 births	Total	Mean	Median	N
Malawi	2010	3.3	6.3	13.4	13.7	12.7	8.0	9.9	4.4	3.7	1.0	23.5	100.0	37.3	33.0	49,925
Mali	2006	5.4	9.9	21.2	15.1	10.4	5.9	6.5	3.0	2.6	0.7	19.4	100.0	32.3	28.0	37,501
Mozambique	2011	3.3	5.9	14.0	14.6	11.6	7.3	8.4	4.3	4.6	1.7	24.3	100.0	38.4	32.0	28,435
Namibia	2006–07	3.0	4.7	9.7	10.2	8.0	6.1	8.9	6.0	8.1	3.4	32.1	100.0	45.7	37.0	12,955
Nepal	2011	3.3	7.7	13.8	10.7	8.9	6.1	8.4	4.3	4.4	1.2	31.1	100.0	37.6	32.0	17,031
Niger	2006	6.5	10.1	22.0	14.4	11.1	5.8	6.7	3.1	2.2	0.6	17.6	100.0	31.7	27.0	26,808
Nigeria	2008	5.8	9.6	19.3	13.9	10.2	6.2	6.7	3.2	3.4	1.2	20.6	100.0	33.8	28.0	70,621
Pakistan	2006–07	12.1	12.7	18.7	11.1	8.2	4.8	6.2	3.3	2.6	0.6	19.8	100.0	30.2	25.0	26,513
Peru	2012	1.4	4.8	8.5	7.9	6.0	4.7	7.9	6.0	11.1	7.1	34.7	100.0	55.3	44.0	25,753
Philippines	2008	6.3	11.5	13.0	9.6	7.1	4.9	6.6	4.0	5.9	2.5	28.7	100.0	38.0	29.0	18,233
Rwanda	2010	4.0	8.3	16.4	14.8	11.3	7.0	7.4	3.3	3.3	1.0	23.1	100.0	34.9	30.0	23,921
Sao Tome and Principe	2008–09	2.3	4.7	10.4	10.5	9.2	7.7	11.4	6.6	8.2	3.0	25.9	100.0	45.4	38.0	4,652
Senegal	2010–11	4.2	8.3	15.3	14.0	10.5	6.3	8.1	4.2	3.9	1.3	23.8	100.0	36.2	31.0	28,149
Sierra Leone	2008	4.6	7.0	16.0	11.5	10.1	5.9	8.3	4.8	5.3	2.1	24.3	100.0	38.5	32.0	16,041
Swaziland	2006–07	2.6	5.8	12.2	11.1	7.6	6.3	9.2	5.6	7.2	2.6	29.7	100.0	43.1	35.0	7,300
Tanzania	2010	2.6	6.1	14.8	14.9	11.6	7.7	8.7	4.5	4.6	1.5	22.9	100.0	38.2	33.0	20,454
Timor-Leste	2009	5.3	12.1	20.3	15.8	9.5	5.6	6.0	3.2	2.8	1.0	18.3	100.0	32.4	27.0	26,507
Uganda	2011	6.1	10.4	19.2	16.3	10.1	6.1	6.1	2.9	3.1	0.8	18.7	100.0	32.6	28.0	20,733
Ukraine	2007	1.7	3.6	3.2	3.0	2.4	2.3	4.3	4.1	8.7	7.1	59.7	100.0	65.4	55.0	3,855
Zambia	2007	3.4	6.4	14.2	16.6	13.2	6.9	8.4	3.6	3.5	1.0	22.8	100.0	36.1	32.0	15,484
Zimbabwe	2010–11	1.6	3.1	6.1	8.1	8.5	7.5	11.7	8.0	8.7	2.9	33.7	100.0	48.8	43.0	13,405
Total N		4.9	8.3	14.4	11.9	9.4	6.1	7.8	4.3	5.0	1.9	26.2	100.0	37.8	31.0	1,227,151

Note: Percent distributions are based on weighted cases for all individual countries. The total percent distribution, however, is based on unweighted cases, because the application of standard individual country weights is not meaningful in the pooled sample and analyses using the pooled data are unweighted. Ten unweighted cases with missing information on the length of preceding interval are excluded.

Table 3 lists the distributions of mother's age at child's birth in grouped ages in the period 0–179 months prior to the surveys. Of all births considered, slightly more than 8 percent occurred to mothers of less than 18 years of age, based on the unweighted average. Countries with10 percent or more births in the age group less than 18 years include Bangladesh, Cameroon, Colombia, the Dominican Republic, India, Madagascar, Mali, Mozambique, Niger, Sierra Leone, and Swaziland. Almost 10 percent of births occurred to mothers ages 35 and older. Countries with 3 percent or more births in ages 40 and older include Burundi, Congo DR, Ghana, Liberia, Nigeria, Rwanda, and Timor–Leste. Overall, almost one in five births occurred at less favorable mothers' ages. The mean age at birth was 25.5 years. In 16 of the 45 countries, one fifth or more of births occurred at less favorable ages of the mother.

Table 3. Distribution of births 0 to 179 months prior to survey by the mother's age at child's birth, 45 DHS surveys, 2006–2012

		Mother's age at child's birth in years (%)								
Survey		**< 18**	**18-24**	**25-34**	**35-39**	**40+**	**Total**	**Mean**	**Median**	**N**
Albania	2008–09	1.4	36.5	55.5	6.0	0.6	100.0	26.4	26.0	6,867
Armenia	2010	1.8	57.8	36.3	3.5	0.6	100.0	24.4	23.0	4,167
Azerbaijan	2006	3.0	49.1	43.3	4.2	0.4	100.0	25.0	24.0	7,564
Bangladesh	2011	19.7	45.9	29.8	3.9	0.6	100.0	22.8	22.0	27,377
Benin	2006	8.2	39.4	42.2	8.0	2.2	100.0	25.7	25.0	39,544
Bolivia	2008	7.4	37.0	43.4	9.7	2.5	100.0	26.2	26.0	26,730
Burkina Faso	2010	7.2	38.8	41.6	9.7	2.7	100.0	26.1	25.0	40,092
Burundi	2010	3.4	35.1	45.9	11.9	3.7	100.0	27.3	27.0	18,799
Cambodia	2010	3.3	37.6	46.5	10.2	2.4	100.0	26.7	26.0	23,438
Cameroon	2011	11.3	40.0	38.8	7.9	2.0	100.0	25.1	24.0	28,932
Colombia	2010	10.9	41.5	39.1	7.1	1.5	100.0	24.9	24.0	49,404
Congo DR	2007	7.9	37.7	41.2	10.0	3.2	100.0	26.2	25.0	21,330
Dominican Republic	2007	12.0	45.7	37.0	4.6	0.7	100.0	24.0	23.0	33,076
Egypt	2008	4.1	41.8	45.8	7.1	1.2	100.0	25.8	25.0	29,213
Ethiopia	2011	9.0	38.5	41.1	8.9	2.6	100.0	25.8	25.0	33,168
Ghana	2008	6.3	34.4	46.4	9.8	3.1	100.0	26.6	26.0	7,547
Guyana	2009	9.0	42.4	39.3	8.0	1.3	100.0	25.2	24.0	6,025
India	2005–06	10.9	51.9	33.4	3.3	0.5	100.0	23.5	23.0	177,993
Indonesia	2007	4.7	36.7	47.8	8.9	1.9	100.0	26.4	26.0	48,014
Jordan	2007	1.7	32.8	53.3	10.4	1.8	100.0	27.3	27.0	27,230
Kenya	2008–09	9.3	41.8	39.2	7.7	2.1	100.0	25.2	24.0	15,448
Lesotho	2009	7.3	45.1	37.1	8.2	2.3	100.0	25.3	24.0	9,124
Liberia	2007	9.8	37.2	39.4	10.2	3.4	100.0	26.0	25.0	14,573
Madagascar	2008–09	10.7	37.9	39.8	9.1	2.6	100.0	25.6	25.0	35,352
Malawi	2010	9.9	44.2	36.3	7.2	2.3	100.0	24.9	24.0	49,927
Mali	2006	12.4	38.1	38.5	8.6	2.4	100.0	25.2	24.0	37,501
Mozambique	2011	11.9	38.7	37.8	8.6	2.9	100.0	25.3	24.0	28,435

(Continued...)

Table 3. – *Continued*

Survey		Mother's age at child's birth in years (%)								
		< 18	18-24	25-34	35-39	40+	Total	Mean	Median	N
Namibia	2006–07	7.1	38.0	43.2	9.2	2.4	100.0	26.1	25.0	12,955
Nepal	2011	8.8	50.5	35.1	4.6	1.0	100.0	24.1	23.0	17,031
Niger	2006	13.2	38.7	37.8	8.1	2.2	100.0	25.1	24.0	26,808
Nigeria	2008	9.9	35.4	42.5	9.1	3.1	100.0	26.0	25.0	70,621
Pakistan	2006–07	5.1	36.9	47.2	8.8	2.1	100.0	26.4	26.0	26,513
Peru	2012	6.7	35.9	44.5	10.3	2.6	100.0	26.4	26.0	25,753
Philippines	2008	3.2	35.5	48.4	10.1	2.7	100.0	27.0	26.0	18,233
Rwanda	2010	2.0	33.8	48.3	11.9	4.0	100.0	27.6	27.0	23,921
Sao Tome and Principe	2008–09	7.5	41.5	38.2	10.0	2.8	100.0	25.8	25.0	4,652
Senegal	2010–11	9.0	36.7	43.3	8.8	2.2	100.0	25.9	25.0	28,157
Sierra Leone	2008	13.0	38.3	38.9	7.7	2.1	100.0	25.0	24.0	16,041
Swaziland	2006–07	11.1	41.0	37.9	8.3	1.7	100.0	25.1	24.0	7,300
Tanzania	2010	8.0	40.1	40.5	8.9	2.4	100.0	25.8	25.0	20,454
Timor-Leste	2009	2.8	30.1	49.2	13.5	4.4	100.0	28.1	28.0	26,507
Uganda	2011	9.7	40.3	39.4	8.4	2.2	100.0	25.4	24.0	20,733
Ukraine	2007	3.7	55.3	37.0	3.5	0.4	100.0	24.3	23.0	3,855
Zambia	2007	9.7	42.1	38.1	7.7	2.4	100.0	25.2	24.0	15,484
Zimbabwe	2010–11	8.5	45.5	38.0	6.5	1.5	100.0	24.8	24.0	13,405
Total N		8.6	40.6	40.9	7.8	2.1	100.0	25.5	25.0	1,227,161

Note: Percent distributions are based on weighted cases for all individual countries. The total percent distribution, however, is based on unweighted cases, because the application of standard individual country weights is not meaningful in the pooled sample and analyses using the pooled data are unweighted.

Analyses using mother's age at birth depend on the respondent's knowledge of her and her child's birth dates and/or current ages. The DHS questionnaire requests the month and year of birth of the individual respondent as well as her age. If either the year or month of her birth is not known, then an imputation procedure is used to estimate the missing data. In the recode data sets, all women are required to have a birth date either by response or imputation. A description of the process is given in Croft [no date]. Based on the weighted data, for 69 percent of the live births, the mother gave her age as month and year; 17 percent had the mother's month of birth missing; and for 12 percent the month and year of the mother's birth were imputed from age. The survey with the most missing mother's birth date is Bangladesh 2011 where almost 93 percent of birth dates were based on age alone. In Azerbaijan, Colombia, and Peru no imputation was needed.

First births are considered to have additional risks for both the child and the mother, compared with second or third births. Likewise, higher order births invoke higher risks. Table 4 shows the distribution of births in months 0–179 prior to the survey by their birth order. As noted above, slightly more than one in four births was firstborn, an unavoidable risk if there are to be any children. However, almost one in four births was of order five or greater. In 6 of the 45 surveys, more than one third of births are of order five or higher. In five surveys, less than 10 percent are so. For all the surveys together, the median birth order is three.

Table 4. Distribution of births 0 to 179 months prior to survey by the child's birth order, 45 DHS surveys, 2006–2012

		Birth order (%)								
Survey		**1**	**2**	**3-4**	**5-6**	**7+**	**Total**	**Mean**	**Median**	**N**
Albania	2008–09	33.1	34.9	27.2	3.9	0.9	100.0	2.2	2.0	6,867
Armenia	2010	45.5	36.3	16.5	1.3	0.4	100.0	1.8	2.0	4,167
Azerbaijan	2006	38.8	33.8	23.5	3.3	0.6	100.0	2.1	2.0	7,564
Bangladesh	2011	33.3	26.8	27.2	9.0	3.6	100.0	2.6	2.0	27,377
Benin	2006	22.0	19.4	29.4	17.7	11.6	100.0	3.5	3.0	39,544
Bolivia	2008	25.9	21.5	27.2	14.5	10.9	100.0	3.3	3.0	26,730
Burkina Faso	2010	20.5	18.3	29.1	19.1	12.8	100.0	3.7	3.0	40,092
Burundi	2010	21.3	18.3	28.9	18.3	13.2	100.0	3.6	3.0	18,799
Cambodia	2010	29.4	24.2	28.3	12.2	6.0	100.0	2.9	2.0	23,438
Cameroon	2011	23.7	19.1	27.7	16.8	12.6	100.0	3.5	3.0	28,932
Colombia	2010	38.4	28.5	24.1	6.2	2.8	100.0	2.3	2.0	49,404
Congo DR	2007	21.5	18.0	28.0	18.1	14.5	100.0	3.7	3.0	21,330
Dominican Republic	2007	33.0	27.3	29.7	7.2	2.7	100.0	2.5	2.0	33,076
Egypt	2008	30.6	25.8	29.5	9.7	4.4	100.0	2.7	2.0	29,213
Ethiopia	2011	20.0	17.6	27.5	18.6	16.3	100.0	3.9	3.0	33,168
Ghana	2008	25.2	21.4	30.2	14.9	8.2	100.0	3.2	3.0	7,547
Guyana	2009	30.4	24.8	28.4	10.7	5.7	100.0	2.8	2.0	6,025
India	2005–06	28.7	25.6	28.7	11.6	5.4	100.0	2.8	2.0	177,993
Indonesia	2007	35.2	27.4	25.4	8.0	4.0	100.0	2.5	2.0	48,014
Jordan	2007	22.0	20.2	31.0	16.7	10.2	100.0	3.4	3.0	27,230
Kenya	2008–09	24.9	20.9	28.4	15.3	10.5	100.0	3.3	3.0	15,448
Lesotho	2009	36.3	24.4	25.4	9.9	3.9	100.0	2.6	2.0	9,124
Liberia	2007	23.5	19.4	27.6	16.5	13.1	100.0	3.5	3.0	14,573
Madagascar	2008–09	23.3	20.0	28.4	15.9	12.4	100.0	3.5	3.0	35,352
Malawi	2010	23.5	20.5	29.3	16.2	10.5	100.0	3.4	3.0	49,927
Mali	2006	19.4	17.2	27.1	18.8	17.5	100.0	4.0	3.0	37,501
Mozambique	2011	24.3	20.4	29.6	16.2	9.4	100.0	3.3	3.0	28,435
Namibia	2006–07	32.1	23.8	27.0	11.5	5.7	100.0	2.8	2.0	12,955
Nepal	2011	31.1	26.3	27.9	10.1	4.6	100.0	2.7	2.0	17,031
Niger	2006	17.6	16.1	27.0	19.7	19.6	100.0	4.2	4.0	26,808
Nigeria	2008	20.6	18.2	28.4	17.5	15.3	100.0	3.8	3.0	70,621
Pakistan	2006–07	19.8	17.9	29.1	18.6	14.7	100.0	3.8	3.0	26,513
Peru	2012	34.7	26.3	25.1	8.9	5.0	100.0	2.6	2.0	25,753
Philippines	2008	28.7	22.5	28.1	12.6	8.1	100.0	3.0	2.0	18,233
Rwanda	2010	23.1	19.4	28.9	17.5	11.1	100.0	3.5	3.0	23,921
Sao Tome and Principe	2008–09	25.9	22.0	29.0	13.9	9.2	100.0	3.2	3.0	4,652
Senegal	2010–11	23.8	19.4	28.1	17.3	11.6	100.0	3.5	3.0	28,157

(Continued...)

Table 4. – *Continued*

Survey		Birth order (%) 1	2	3-4	5-6	7+	Total	Mean	Median	N
Sierra Leone	2008	24.3	21.3	29.8	15.7	8.9	100.0	3.3	3.0	16,041
Swaziland	2006–07	29.7	21.2	25.5	13.8	9.8	100.0	3.2	2.0	7,300
Tanzania	2010	22.9	19.8	28.6	16.7	12.0	100.0	3.5	3.0	20,454
Timor-Leste	2009	18.3	17.3	30.0	20.3	14.1	100.0	3.8	3.0	26,507
Uganda	2011	18.7	17.0	27.5	19.3	17.5	100.0	4.0	3.0	20,733
Ukraine	2007	59.7	31.1	8.0	0.9	0.3	100.0	1.6	1.0	3,855
Zambia	2007	22.8	19.4	28.6	16.6	12.6	100.0	3.5	3.0	15,484
Zimbabwe	2010–11	33.7	26.2	27.1	9.3	3.7	100.0	2.6	2.0	13,405
Total N		26.2	22.0	28.0	14.2	9.6	100.0	3.2	3.0	1,227,161

Note: Percent distributions are based on weighted cases for all individual countries. The total percent distribution, however, is based on unweighted cases, because the application of standard individual country weights is not meaningful in the pooled sample and analyses using the pooled data are unweighted.

Children may be subject to multiple fertility behavior risk factors at the same time. Table 5 presents the distribution of births in the 15 years preceding the survey by each combination of additional risk. Table 6 presents a summarization of Table 5 through five categories: no additional risk factors, an unavoidable additional risk factor (i.e., a first birth), one additional risk factor, two additional risk factors, and three additional risk factors.

From Table 5, 16 percent of children faced no extra risk and another 19 percent had only the unavoidable risk of being firstborn. Other extra–risk categories with substantial percentages of births are a single–risk factor for inadequate spacing (fewer than 24 months and 24–35 months), a single–risk factor for births of order four or greater, and a double–risk factor for both inadequate spacing and high birth order, each of which has about 12 percent of the births.

Table 5. Distribution of births 0 to 179 months prior to survey by maternal fertility–related risk factors, 45 DHS surveys, 2006–2012

Survey		No extra risk	Extra risk due to fertility pattern (%): Unavoid-able first-birth risk	Single risk spacing <24 mos.	Single risk spacing 24-35 mos.	Single risk age <18	Single risk age 40+	Single risk order 4+	Double risk spacing <24, order 4+	Double risk spacing 24-35, order 4+	Double risk first-birth, age <18	Double risk order 4+, age 40+	Double risk spacing <24 and age <18	Double risk spacing 24-35 and age <18	3-way risk spacing <24, order 4+, age <18	3-way risk spacing <24, order 4+, age 40+	3-way risk, spacing 24-35, order 4+, age 40+	Total	N
Albania	2008–09	31.8	31.7	10.2	12.5	0.0	0.1	6.1	2.9	2.7	1.3	0.4	0.1	0.0	0.0	0.0	0.0	100.0	6,867
Armenia	2010	21.8	44.0	16.6	10.2	0.0	0.3	3.2	0.9	1.0	1.5	0.1	0.2	0.0	0.0	0.1	0.1	100.0	4,167
Azerbaijan	2006	15.5	36.0	22.0	13.1	0.0	0.1	4.4	2.8	2.7	2.6	0.1	0.3	0.0	0.0	0.0	0.1	100.0	7,564
Bangladesh	2011	26.5	17.1	5.5	8.7	0.5	0.0	11.3	4.6	6.0	16.2	0.4	1.6	1.4	0.0	0.1	0.1	100.0	27,377
Benin	2006	13.8	15.7	6.6	13.3	0.2	0.1	15.1	9.4	15.7	6.2	1.2	0.9	0.8	0.0	0.2	0.7	100.0	39,544
Bolivia	2008	15.3	19.7	10.1	10.3	0.1	0.2	11.6	10.5	12.6	6.2	1.4	0.9	0.3	0.0	0.3	0.5	100.0	26,730
Burkina Faso	2010	14.2	14.3	6.0	13.0	0.1	0.0	16.8	9.1	16.8	6.2	1.7	0.4	0.5	0.0	0.3	0.7	100.0	40,092
Burundi	2010	11.3	18.4	9.1	13.2	0.0	0.0	14.2	10.4	16.4	2.9	2.1	0.3	0.2	0.0	0.6	1.0	100.0	18,799
Cambodia	2010	20.6	26.3	8.1	11.7	0.0	0.3	13.1	5.9	8.6	3.0	1.3	0.2	0.1	0.0	0.2	0.5	100.0	23,438
Cameroon	2011	12.3	15.1	7.7	11.8	0.2	0.1	13.7	11.9	14.2	8.6	1.1	1.3	1.1	0.1	0.4	0.5	100.0	28,932
Colombia	2010	26.0	28.8	8.5	8.3	0.1	0.5	7.2	4.4	4.4	9.5	0.7	0.9	0.4	0.0	0.1	0.1	100.0	49,404
Congo DR	2007	11.5	15.3	8.2	11.7	0.3	0.1	12.9	12.7	16.6	6.2	1.4	0.8	0.6	0.1	0.6	1.0	100.0	21,330
Dominican Republic	2007	21.5	23.4	12.5	10.8	0.2	0.2	7.6	6.5	5.0	9.6	0.3	1.7	0.6	0.0	0.1	0.1	100.0	33,076
Egypt	2008	19.5	27.3	10.8	13.5	0.0	0.1	12.4	5.0	6.3	3.3	0.8	0.5	0.2	0.0	0.1	0.1	100.0	29,213
Ethiopia	2011	11.8	13.3	7.9	10.6	0.3	0.0	15.7	12.9	16.4	6.7	1.4	1.1	0.8	0.0	0.4	0.8	100.0	33,168
Ghana	2008	21.0	19.7	6.2	10.4	0.1	0.1	16.0	6.9	10.4	5.5	2.1	0.4	0.2	0.0	0.3	0.5	100.0	7,547
Guyana	2009	18.9	23.2	11.5	10.2	0.1	0.2	11.1	7.9	6.9	7.2	0.6	1.2	0.5	0.0	0.1	0.2	100.0	6,025
India	2005–06	14.7	20.6	12.3	13.4	0.2	0.0	8.5	9.7	9.5	8.1	0.3	1.7	0.8	0.0	0.1	0.1	100.0	177,993
Indonesia	2007	29.3	31.0	6.2	7.4	0.0	0.3	10.9	3.9	4.7	4.2	1.1	0.3	0.2	0.0	0.1	0.3	100.0	48,014
Jordan	2007	9.1	20.4	17.6	10.5	0.0	0.0	16.1	11.0	11.8	1.5	1.2	0.2	0.1	0.0	0.2	0.3	100.0	27,230
Kenya	2008–09	15.2	17.4	8.6	11.6	0.3	0.1	13.6	9.7	12.5	7.5	1.0	0.9	0.6	0.0	0.4	0.5	100.0	15,448
Lesotho	2009	24.4	29.4	4.9	10.0	0.1	0.2	13.2	2.6	5.7	6.9	1.7	0.3	0.1	0.0	0.1	0.4	100.0	9,124

(Continued...)

Table 5. – *Continued*

Survey		No extra risk	Unavoidable first-birth risk	Single risk spacing <24 mos.	Single risk spacing 24-35 mos.	Single risk age <18	Single risk age 40+	Single risk order 4+	Double risk spacing <24, order 4+	Double risk spacing 24-35, order 4+	Double risk first birth, age <18	Double risk order 4+, age 40+	Double risk spacing <24 and age <18	Double risk spacing 24-35 and age <18	3-way risk spacing <24, order 4+, age <18	3-way risk spacing <24, order 4+, age 40+	3-way risk, spacing 24-35, order 4+, age 40+	Total	N
			Extra risk due to fertility pattern (%)																
Liberia	2007	16.4	15.1	6.8	10.2	0.2	0.0	15.4	10.2	12.6	8.4	2.1	0.8	0.5	0.0	0.6	0.7	100.0	14,573
Madagascar	2008–09	13.2	15.1	9.2	11.0	0.2	0.1	12.0	12.8	13.4	8.2	1.4	1.3	0.9	0.0	0.4	0.6	100.0	35,352
Malawi	2010	15.2	15.2	6.7	13.5	0.2	0.0	16.4	7.7	13.1	8.3	1.3	0.7	0.6	0.0	0.3	0.7	100.0	49,927
Mali	2006	8.7	10.3	8.3	11.5	0.3	0.0	12.9	15.1	18.5	9.1	1.1	1.7	1.3	0.1	0.5	0.8	100.0	37,501
Mozambique	2011	15.5	14.6	5.9	13.3	0.3	0.1	14.3	8.1	13.5	9.7	1.6	0.9	0.9	0.1	0.3	0.9	100.0	28,435
Namibia	2006–07	22.7	25.5	5.9	10.6	0.1	0.2	11.7	5.5	8.5	6.5	1.5	0.3	0.2	0.0	0.3	0.4	100.0	12,955
Nepal	2011	18.6	23.4	10.2	13.6	0.1	0.0	9.2	6.5	8.7	7.7	0.6	0.7	0.3	0.0	0.1	0.3	100.0	17,031
Niger	2006	7.9	8.4	7.7	10.8	0.2	0.0	14.2	16.2	19.4	9.2	1.1	2.3	1.3	0.1	0.3	0.7	100.0	26,808
Nigeria	2008	10.3	13.6	8.7	11.8	0.3	0.1	13.3	13.7	15.7	7.0	1.5	1.5	1.0	0.1	0.6	0.9	100.0	70,621
Pakistan	2006–07	8.1	16.1	13.3	10.8	0.1	0.0	11.8	18.7	13.9	3.7	1.0	0.9	0.4	0.1	0.5	0.5	100.0	26,513
Peru	2012	26.6	28.4	6.1	8.4	0.1	0.6	10.9	3.5	6.9	6.2	1.3	0.3	0.2	0.0	0.1	0.3	100.0	25,753
Philippines	2008	14.6	25.8	14.0	10.0	0.0	0.3	10.9	9.6	9.1	2.8	1.3	0.4	0.1	0.0	0.4	0.5	100.0	18,233
Rwanda	2010	11.6	21.3	10.1	13.3	0.0	0.1	13.2	9.2	15.3	1.8	2.4	0.1	0.1	0.0	0.4	1.1	100.0	23,921
Sao Tome and Principe	2008–09	20.0	19.0	5.8	12.1	0.1	0.2	18.4	5.3	9.1	6.9	2.2	0.3	0.2	0.0	0.1	0.3	100.0	4,652
Senegal	2010–11	13.1	17.1	7.5	11.9	0.4	0.1	14.0	10.4	14.7	6.6	1.2	1.1	0.8	0.1	0.3	0.6	100.0	28,157
Sierra Leone	2008	15.8	14.8	7.9	11.1	0.5	0.1	13.4	9.6	12.3	9.5	1.1	1.6	1.2	0.1	0.4	0.4	100.0	16,041
Swaziland	2006–07	18.7	19.6	6.2	10.2	0.2	0.0	15.0	7.1	10.4	10.1	0.9	0.4	0.4	0.0	0.2	0.5	100.0	7,300
Tanzania	2010	15.3	15.9	6.5	12.9	0.1	0.0	15.4	7.7	15.9	7.0	1.5	0.4	0.4	0.0	0.3	0.6	100.0	20,454
Timor-Leste	2009	8.6	16.0	11.6	12.3	0.0	0.1	12.6	14.6	17.1	2.3	1.9	0.3	0.1	0.0	0.9	1.4	100.0	26,507
Uganda	2011	9.1	11.4	8.8	11.6	0.3	0.0	13.3	14.8	19.1	7.3	1.2	1.1	0.9	0.0	0.4	0.6	100.0	20,733
Ukraine	2007	26.0	55.9	5.8	5.3	0.0	0.2	1.3	1.0	0.4	3.6	0.1	0.1	0.0	0.0	0.0	0.0	100.0	3,855
Zambia	2007	13.2	14.5	6.6	14.1	0.1	0.0	14.9	8.1	16.5	8.3	1.5	0.8	0.5	0.0	0.2	0.6	100.0	15,484

(Continued...)

Table 5. – *Continued*

Survey		No extra risk	Extra risk due to fertility pattern (%)															Total	N
			Unavoid-able first-birth risk	Single risk spacing <24 mos.	Single risk spacing 24-35 mos.	Single risk age <18	Single risk age 40+	Single risk order 4+	Double risk spacing <24, order 4+	Double risk spacing 24-35, order 4+	Double risk first-birth, age <18	Double risk order 4+, age 40+	Double risk spacing <24 and age <18	Double risk spacing 24-35 and age <18	3-way risk spacing <24, order 4+, age <18	3-way risk spacing <24, order 4+, age 40+	3-way risk, spacing 24-35, order 4+, age 40+		
Zimbabwe	2010–11	28.3	25.7	4.3	9.8	0.1	0.1	13.5	2.6	5.8	8.0	1.1	0.3	0.2	0.0	0.1	0.2	100.0	13,405
Total N		15.8	19.3	9.2	11.5	0.2	0.1	12.3	9.4	11.8	6.9	1.1	1.0	0.6	0.0	0.3	0.5	100.0	1,227,161

Note: Percent distributions are based on weighted cases for all individual countries. The total percent distribution, however, is based on unweighted cases, because the application of standard individual country weights is not meaningful in the pooled sample and analyses using the pooled data are unweighted.

Table 6 shows that one in three births has a single extra–risk factor and almost one in three has two risk factors, other than being a first birth. Very few births have three risk factors. The countries that have more than90 percent of births with additional risk are Jordan, Mali, Niger, Pakistan, Timor–Leste, and Uganda. Four countries have more than 60 percent of births with no avoidable risk (no extra risk or are first births): Albania, Armenia, Indonesia, and the Ukraine.

Table 6. Distribution of births 0 to 179 months prior to survey by maternal fertility–related risk factors, 45 DHS surveys, 2006–2012

		Summary measure of extra risk (%)						
Survey		No extra risk	Unavoid-able first-birth risk	Any single risk	Any double risk	Any 3-way risk	Total	N
Albania	2008–09	31.8	31.7	28.9	7.6	0.0	100.0	6,867
Armenia	2010	21.8	44.0	30.3	3.7	0.1	100.0	4,167
Azerbaijan	2006	15.5	36.0	39.6	8.8	0.1	100.0	7,564
Bangladesh	2011	26.5	17.1	26.0	30.2	0.2	100.0	27,377
Benin	2006	13.8	15.7	35.3	34.2	1.0	100.0	39,544
Bolivia	2008	15.3	19.7	32.3	31.8	0.9	100.0	26,730
Burkina Faso	2010	14.2	14.3	35.8	34.8	0.9	100.0	40,092
Burundi	2010	11.3	18.4	36.5	32.3	1.6	100.0	18,799
Cambodia	2010	20.6	26.3	33.2	19.2	0.7	100.0	23,438
Cameroon	2011	12.3	15.1	33.5	38.2	0.9	100.0	28,932
Colombia	2010	26.0	28.8	24.6	20.4	0.2	100.0	49,404
Congo DR	2007	11.5	15.3	33.2	38.3	1.6	100.0	21,330
Dominican Republic	2007	21.5	23.4	31.2	23.8	0.2	100.0	33,076
Egypt	2008	19.5	27.3	36.8	16.2	0.2	100.0	29,213
Ethiopia	2011	11.8	13.3	34.4	39.3	1.2	100.0	33,168
Ghana	2008	21.0	19.7	32.8	25.6	0.9	100.0	7,547
Guyana	2009	18.9	23.2	33.1	24.4	0.4	100.0	6,025
India	2005–06	14.7	20.6	34.4	30.1	0.2	100.0	177,993
Indonesia	2007	29.3	31.0	25.0	14.4	0.4	100.0	48,014
Jordan	2007	9.1	20.4	44.2	25.8	0.5	100.0	27,230
Kenya	2008–09	15.2	17.4	34.1	32.2	1.0	100.0	15,448
Lesotho	2009	24.4	29.4	28.4	17.3	0.4	100.0	9,124
Liberia	2007	16.4	15.1	32.7	34.6	1.3	100.0	14,573
Madagascar	2008–09	13.2	15.1	32.6	38.0	1.1	100.0	35,352
Malawi	2010	15.2	15.2	36.8	31.8	1.0	100.0	49,927
Mali	2006	8.7	10.3	33.0	46.7	1.3	100.0	37,501
Mozambique	2011	15.5	14.6	33.9	34.8	1.3	100.0	28,435
Namibia	2006–07	22.7	25.5	28.5	22.6	0.7	100.0	12,955

(Continued...)

Table 6. – *Continued*

Survey		Summary measure of extra risk (%) No extra risk	Unavoid-able first-birth risk	Any single risk	Any double risk	Any 3-way risk	Total	N
Nepal	2011	18.6	23.4	33.2	24.5	0.4	100.0	17,031
Niger	2006	7.9	8.4	33.0	49.6	1.1	100.0	26,808
Nigeria	2008	10.3	13.6	34.2	40.4	1.5	100.0	70,621
Pakistan	2006–07	8.1	16.1	36.1	38.6	1.1	100.0	26,513
Peru	2012	26.6	28.4	26.0	18.5	0.5	100.0	25,753
Philippines	2008	14.6	25.8	35.2	23.5	1.0	100.0	18,233
Rwanda	2010	11.6	21.3	36.7	28.8	1.5	100.0	23,921
Sao Tome and Principe	2008–09	20.0	19.0	36.6	23.9	0.5	100.0	4,652
Senegal	2010–11	13.1	17.1	33.8	34.9	1.0	100.0	28,157
Sierra Leone	2008	15.8	14.8	33.0	35.5	1.0	100.0	16,041
Swaziland	2006–07	18.7	19.6	31.6	29.4	0.7	100.0	7,300
Tanzania	2010	15.3	15.9	35.0	33.0	0.9	100.0	20,454
Timor-Leste	2009	8.6	16.0	36.6	36.5	2.3	100.0	26,507
Uganda	2011	9.1	11.4	34.0	44.4	1.2	100.0	20,733
Ukraine	2007	26.0	55.9	12.7	5.3	0.0	100.0	3,855
Zambia	2007	13.2	14.5	35.8	35.7	0.9	100.0	15,484
Zimbabwe	2010–11	28.3	25.7	27.7	18.0	0.3	100.0	13,405
Total N		15.8	19.3	33.3	30.8	0.8	100.0	1,227,161

Note: Percent distributions are based on weighted cases for all individual countries. The total percent distribution, however, is based on unweighted cases, because the application of standard individual country weights is not meaningful in the pooled sample and analyses using the pooled data are unweighted.

Bivariate Results

Infant and child mortality

The DHS surveys collect age at death for non–surviving children in three scales. For children who died at less than one month, age is collected in days. For non–surviving children dying within two years of birth, age at death is collected in number of months. Number of years is used for children who died at an age of two or more years. Dates of birth of children are given in calendar year and month. Preceding birth–to–conception intervals are calculated by the 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.

Infant and child mortality by spacing interval

The analysis of infant and child mortality includes the following mortality rates: early neonatal (deaths that occur 0–6 days after a live birth), neonatal (deaths within the first 30 days among all children born alive), post–neonatal (deaths to children at ages 1–11 months among children surviving the neonatal period), infant (deaths to children at ages 0–11 months among all children born alive), child mortality (deaths to children at ages one to four years among children who survive to age one year) and under–five mortality (deaths to children under five years of age among all children born alive).

The first panel of Table 7 shows the mortality rates by length of preceding birth–to–conception interval. From the pooled data set for the 45 surveys, on average, children conceived after short intervals–under 6 months between birth and conception and 6–11 months–are respectively 3.8 and 2.6 times as likely to die before their fifth birthday, as are children conceived after 36–47 months. Also, those children conceived after intervals of 12–17 months, 18–23 months, and 24–29 months have a 112 percent, 69 percent, and 34 percent, respectively, greater chance of dying, than do children conceived after 36–47 months. These results are very similar to those found in the preceding 52–country study.

Similar patterns of excess mortality by interval durations occur for infant mortality and neonatal mortality. Compared with a preceding birth–to–conception interval of 36–47 months, infant mortality is higher on average by 246 percent, 122 percent, 71 percent, and 34 percent for intervals of fewer than 6 months, 6–11 months, 12–17 months, and 18–23 months, respectively. For neonatal mortality the average excess mortality is 287 percent, 118 percent, 60 percent, and 26 percent for intervals of fewer than 6 months, 6–11 months, 12–17 months, and 18–23 months, respectively. The pattern of excess post–neonatal mortality is similar to that of neonatal mortality for intervals of fewer than 36–47 months but has a non–significant declining level for intervals of 48 months or longer.

Infant and child mortality by mother's age at birth

A U–shaped pattern exists for neonatal, post–neonatal, infant, and child mortality with respect to the mother's age at birth (second panel of Table 7). Relative to the risk of dying for births that occurred when the mother was 18–24 years of age, births to mothers under 18 years of age had a 41 to 60 percent increased risk of mortality at all ages of exposure. The risk of mortality also increased for children born to mothers 40 years of age or older–around 30 percent greater mortality risk in the neonatal, post–neonatal, and infant age groups, and a 17 percent greater risk for under–five mortality. Being born when the mother is between 25 and 34 years of age had a lower risk of dying for all ages under five years.

Infant and child mortality by birth order

Being a firstborn child carries a greater risk of mortality than being a second–born child, a 47 percent greater risk of dying during the neonatal period, 29 percent during infancy, and 21 percent at all ages under five years (third panel of Table 7). For the post–neonatal and child periods, being a firstborn does not have a significantly different risk of dying than being second born. However, births of order five or higher do incur higher risks of dying during all periods under age five, with the extra risk increasing in the post–neonatal and child periods.

Table 7. Unadjusted relative risk of mortality by duration of preceding birth–to–conception interval, mother's age at child's birth, and the birth order, children born 0 to 179 months prior to the survey, 45 DHS surveys, 2006–2012

	Early neonatal			Neonatal			Post-neonatal			Infant			Child			Under five		
	uRR	**CI-**	**CI+**	**uRR**	**CI-**	**CI+**	**uRR**	**CI-**	**CI+**	**uRR**	**CI-**	**CI+**	**uRR**	**CI-**	**CI+**	**uRR**	**CI-**	**CI+**
Birth-to-conception interval (months)																		
<6	3.87	3.42	4.37	3.99	3.58	4.44	2.93	2.61	3.29	3.46	3.20	3.75	2.90	2.73	3.09	3.81	3.67	3.95
6-11	2.18	1.94	2.45	2.28	2.06	2.53	2.16	1.94	2.39	2.22	2.06	2.38	2.31	2.18	2.44	2.55	2.46	2.64
12-17	1.60	1.43	1.78	1.67	1.52	1.84	1.75	1.59	1.93	1.71	1.60	1.83	2.26	2.14	2.38	2.12	2.05	2.19
18-23	1.26	1.12	1.42	1.30	1.17	1.44	1.38	1.25	1.53	1.34	1.25	1.44	1.87	1.77	1.98	1.69	1.63	1.75
24-29	1.02	0.90	1.16	1.08	0.97	1.20	1.18	1.06	1.32	1.13	1.05	1.22	1.48	1.39	1.57	1.34	1.29	1.39
30-35	1.08	0.94	1.24	1.13	1.00	1.27	1.03	0.92	1.17	1.08	0.99	1.18	1.28	1.19	1.37	1.16	1.12	1.22
36-47 (ref.)	**1.00**			**1.00**			**1.00**			**1.00**			**1.00**			**1.00**		
48-59	1.08	0.93	1.26	1.04	0.91	1.19	0.98	0.86	1.13	1.01	0.92	1.12	0.77	0.71	0.84	0.87	0.83	0.92
60-95	1.20	1.04	1.38	1.18	1.04	1.33	0.89	0.78	1.01	1.03	0.94	1.13	0.63	0.57	0.68	0.83	0.79	0.87
96+	1.56	1.31	1.85	1.44	1.24	1.68	0.83	0.69	1.00	1.14	1.01	1.28	0.53	0.46	0.61	0.87	0.81	0.93
First births	2.04	1.85	2.26	1.98	1.81	2.16	1.21	1.10	1.32	1.59	1.50	1.70	1.27	1.21	1.34	1.72	1.67	1.77
Total N		424,907			424,907			424,907			424,907			1,176,384			1,176,384	
Mother's age at child's birth																		
<18	1.59	1.48	1.71	1.57	1.47	1.67	1.41	1.31	1.52	1.50	1.43	1.57	1.46	1.41	1.51	1.60	1.57	1.63
18-24 (ref.)	**1.00**			**1.00**			**1.00**			**1.00**			**1.00**			**1.00**		
25-34	0.79	0.75	0.83	0.79	0.76	0.83	0.95	0.90	0.99	0.86	0.83	0.89	0.97	0.95	1.00	0.91	0.89	0.92
35-39	1.02	0.94	1.10	1.01	0.94	1.08	1.08	1.00	1.16	1.04	0.99	1.10	1.05	1.01	1.10	1.04	1.02	1.07
40+	1.31	1.18	1.46	1.28	1.17	1.40	1.32	1.19	1.46	1.30	1.21	1.39	1.16	1.07	1.25	1.17	1.12	1.22
Total N		424,948			424,948			424,948			424,948			1,176,388			1,176,388	
Birth order																		
1	1.55	1.45	1.65	1.47	1.39	1.55	1.07	1.00	1.14	1.29	1.24	1.34	0.97	0.94	1.00	**1.21**	**1.19**	**1.23**
2 (ref.)	**1.00**			**1.00**			**1.00**			**1.00**			**1.00**			**1.00**		
3-4	0.97	0.90	1.03	0.96	0.91	1.02	1.15	1.08	1.23	1.05	1.01	1.10	1.20	1.16	1.24	1.11	1.09	1.14
5-6	1.14	1.06	1.24	1.16	1.08	1.24	1.40	1.31	1.51	1.27	1.21	1.33	1.50	1.45	1.56	1.36	1.33	1.39
7+	1.43	1.32	1.55	1.45	1.36	1.56	1.70	1.58	1.83	1.56	1.49	1.65	1.92	1.85	2.00	1.71	1.67	1.75
Total N		424,948			424,948			424,948			424,948			1,176,388			1,176,388	

Note: Age range of analysis:

ENN (early neonatal), NN (neonatal), PNN (post–neonatal), and Infant Mortality: births in 0–59 months prior to survey.

Child and Under–Five Mortality: births in 0–179 months prior to survey.

Infant and child mortality by multiple fertility extra risk factors

As seen in Tables 5 and 6, a child may be subject to one extra risk factor or two or three factors simultaneously. Tables 8 and 9 show their combined effects on infant and child mortality in full combinations and by number of risk factors, respectively. Beyond no extra risk and the unavoidable risk of first birth, Table 8 lists 19 combinations of extra risk. As shown in Table 5, some combinations are rare while others are frequent. Fifteen of the combinations have significant relationships with under–five mortality, all of which increase the risk of dying under age five.

The greatest increases have relative risks of more than six and four times that of children not in any extra–risk category and are made up of children with spacing intervals of fewer than 24 months, birth order four or higher, and ages at birth of less than 18 years or 40 years or more, respectively. However, very few births occur with these combinations of risk factors. Among those with 1 percent or more of the births, single risks of spacing fewer than 24 months, spacing 24–35 months, and maternal age 40 years or more carry extra risks of 25 to 133 percent. For double risks, children born with the combinations of birth order four or higher with spacing of fewer than 24 months or maternal age 40 years or more carry extra risks of dying under age five years of 255 percent and 53 percent greater than those born with no extra risk. Similarly, children born to mothers under age 18 and who are either first births or with a spacing of fewer than 24 months have increased risks of dying under age five years of 184 percent and 303 percent, respectively.

Table 9 demonstrates that the risk of dying under five years of age relative to that of children with no extra fertility risk factor increases with the number of factors from 55 percent extra risk for first births alone to 67 percent for one avoidable risk factor, 174 percent for two risk factors, and 227 percent for three risk factors. For all age at death intervals and all categories, the increased risk of dying is significant.

Table 8. Unadjusted relative risk of mortality by the mother's fertility–related risk, children born 0 to 179 months prior to the survey, 45 DHS surveys, 2006–2012

	Early neonatal			Neonatal			Post-neonatal			Infant			Child			Under five		
	uRR	**CI-**	**CI+**	**uRR**	**CI-**	**CI+**	**uRR**	**CI-**	**CI+**	**uRR**	**CI-**	**CI+**	**uRR**	**CI-**	**CI+**	**uRR**	**CI-**	**CI+**
Extra risk due to fertility pattern																		
No extra risk (ref.)	**1.00**			**1.00**			**1.00**			**1.00**			**1.00**			**1.00**		
Unavoidable first-birth risk	1.81	1.68	1.96	1.76	1.64	1.89	1.16	1.07	1.25	1.48	1.40	1.56	1.19	1.14	1.25	1.55	1.51	1.60
Single risk spacing <24 months	1.89	1.72	13.41	1.93	1.78	2.10	1.86	1.69	2.03	1.90	1.78	2.02	2.12	2.02	2.23	2.33	2.27	2.40
Single risk spacing 24-35 months	1.04	0.94	7.41	1.12	1.02	1.22	1.32	1.20	1.44	1.21	1.14	1.29	1.85	1.76	1.94	1.61	1.56	1.66
Single risk age <18	0.84	0.37	5.94	0.87	0.43	1.74	1.19	0.64	2.22	1.02	0.64	1.62	1.86	1.44	2.40	1.46	1.23	1.74
Single risk age 40+	2.39	1.60	16.95	2.15	1.49	3.11	1.39	0.85	2.27	1.80	1.34	2.41	0.63	0.35	1.14	1.45	1.16	1.81
Single risk order 4+	1.06	0.96	7.49	1.08	1.00	1.18	1.21	1.11	1.32	1.14	1.07	1.21	1.36	1.30	1.44	1.25	1.21	1.28
Double risk spacing <24, order 4+	2.49	2.27	17.66	2.69	2.48	2.91	2.95	2.71	3.20	2.81	2.65	2.97	3.60	3.44	3.76	3.55	3.46	3.65
Double risk spacing 24-35, order 4+	1.30	1.19	9.26	1.37	1.26	1.48	1.76	1.62	1.91	1.55	1.46	1.64	2.52	2.41	2.64	2.10	2.04	2.16
Double risk first birth, age <18	2.52	2.29	17.91	2.52	2.31	2.74	1.98	1.80	2.18	2.27	2.13	2.42	2.38	2.26	2.50	2.84	2.76	2.92
Double risk first birth, age 40+	1.29	0.42	9.18	1.00	0.32	3.12	1.12	0.36	3.49	1.06	0.48	2.36	nc	nc	nc	0.87	0.48	1.56
Double risk order 4+, age <18	40.53	5.73	287.74	31.30	4.41	222.20	nc	nc	nc	20.82	2.93	147.67	nc	nc	nc	3.90	0.55	27.68
Double risk order 4+, age 40+	1.65	1.40	11.71	1.61	1.39	1.85	1.44	1.23	1.70	1.53	1.38	1.70	1.46	1.28	1.66	1.53	1.42	1.65
Double risk spacing <24 and age <18	3.30	2.68	23.41	3.27	2.72	3.94	2.90	2.35	3.57	3.10	2.70	3.56	3.78	3.46	4.12	4.03	3.83	4.24
Double risk spacing 24-35 and age <18	1.67	1.20	11.86	1.87	1.42	2.47	2.06	1.56	2.73	1.96	1.61	2.39	3.52	3.16	3.91	2.78	2.59	2.99
Double risk spacing <24 and age 40+	1.17	0.16	8.29	0.91	0.13	6.44	3.06	0.98	9.50	1.92	0.72	5.12	0.99	0.25	3.96	2.02	1.15	3.56
Double risk spacing 24-35 and age 40+	2.60	0.84	18.46	2.02	0.65	6.26	nc	nc	nc	1.08	0.35	3.35	1.09	0.35	3.38	1.25	0.67	2.32
3-way risk spacing<24, order 4+, age<18	8.96	3.72	63.58	6.95	2.89	16.73	3.35	0.84	13.42	5.31	2.53	11.16	6.66	4.65	9.54	6.14	4.92	7.67
3-way risk spacing <24, order 4+, age 40+	3.66	2.90	25.99	3.73	3.04	4.57	4.03	3.26	4.99	3.87	3.34	4.48	4.05	3.48	4.71	4.16	3.82	4.54
3-way risk spacing 24-35, order 4+, age<18	0.01	0.00	0.05	4.47	0.63	31.74	nc	nc	nc	2.34	0.33	16.60	2.87	0.93	8.92	1.80	0.75	4.32
3-way risk, spacing 24-35, order 4+, age 40+	2.31	1.89	16.43	2.41	2.02	2.87	2.25	1.85	2.74	2.33	2.05	2.66	2.73	2.38	3.14	2.63	2.43	2.85
Total N	424,907			424,907			424,907			424,907			1,176,388			1,176,388		

Note: Age range of analysis:

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

Child and Under-Five Mortality: 0-179 months

Table 9. Unadjusted relative risk of mortality by the mother's fertility-related risk, children born 0 to 179 months prior to the survey, 45 DHS surveys, 2006–2012

	Early neonatal			Neonatal			Post-neonatal			Infant			Child			Under five		
	aRR	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**
Extra risk due to fertility pattern																		
No extra risk (ref.)	**1.00**			**1.00**			**1.00**			1.00			1.00			1.00		
Unavoidable first-birth risk	1.81	1.68	1.96	1.76	1.64	1.89	1.16	1.07	1.25	1.48	1.40	1.52	1.19	1.14	1.25	1.55	1.51	1.60
Any single risk	1.25	1.16	1.35	1.29	1.21	1.38	1.39	1.30	1.50	1.34	1.28	1.37	1.75	1.68	1.82	1.67	1.63	1.71
Any double risk	1.93	1.79	2.08	2.00	1.87	2.13	2.10	1.96	2.25	2.05	1.95	2.10	2.82	2.71	2.94	2.74	2.68	2.81
Any 3-way risk	2.79	2.38	3.27	2.87	2.50	3.29	2.81	2.42	3.27	2.84	2.57	2.99	3.33	3.01	3.69	3.27	3.08	3.47
Missing													0.03	0.00	>1000	0.03	0.00	>1000
Total N	424,907			424,907			424,907			424,907			1,176,388			1,176,388		

Note: Age range of analysis:

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

Child and Under-Five Mortality: 0-179 months

Nutritional status

Nutritional status was determined by anthropometric measurements on children under age five at the time of the survey except in Indonesia, the Philippines, and Ukraine, where anthropometry was not included. Children who were born in the month of interview were not analyzed. Table 10 presents the unadjusted odds of children being stunted, underweight, and wasted according to the duration of the preceding birth–to–conception interval, the mother's age at birth, and the child's birth order for the pool of the 45 latest DHS surveys.

Table 10. Unadjusted odds ratios for stunting, underweight, and wasting by duration of preceding birth–to–conception interval, mother's age at child's birth, and birth order, living children age 0 to 59 months at survey, 42 DHS surveys, 2006–2012

	Stunting			Underweight			Wasting		
	uOR	**CI-**	**CI+**	**uOR**	**CI-**	**CI+**	**uOR**	**CI-**	**CI+**
Birth-to-conception interval (months)									
<6	1.47	1.39	1.55	1.46	1.38	1.54	1.05	0.95	1.15
6-11	1.43	1.37	1.49	1.37	1.31	1.43	1.08	1.01	1.16
12-17	1.44	1.39	1.49	1.39	1.33	1.44	1.13	1.06	1.19
18-23	1.27	1.23	1.31	1.20	1.16	1.25	1.06	1.00	1.13
24-29	1.22	1.18	1.26	1.18	1.13	1.22	1.03	0.97	1.10
30-35	1.09	1.04	1.13	1.05	1.00	1.10	1.04	0.97	1.11
36-47 (ref.)	**1.00**			**1.00**			**1.00**		
48-59	0.90	0.86	0.94	0.93	0.88	0.98	0.98	0.90	1.06
60-95	0.75	0.72	0.79	0.76	0.73	0.80	0.89	0.83	0.96
96+	0.62	0.58	0.66	0.64	0.59	0.69	0.69	0.61	0.77
First births	0.89	0.86	0.92	0.90	0.87	0.93	0.89	0.84	0.94
Total N		348,122			348,122			348,740	
Mother's age at child's birth									
<18	1.09	1.06	1.13	1.09	1.05	1.13	0.95	0.89	1.00
18-24 (ref.)	**1.00**			**1.00**			**1.00**		
25-34	0.95	0.93	0.97	0.93	0.91	0.95	0.97	0.94	1.00
35-39	0.98	0.95	1.01	0.89	0.87	0.93	0.92	0.87	0.97
40+	1.08	1.04	1.13	1.03	0.98	1.08	1.01	0.94	1.09
Total N		348,151			348,151			348,769	
Birth order									
1	0.88	0.86	0.90	0.88	0.86	0.91	0.91	0.87	0.95
2 (ref.)	**1.00**			**1.00**			**1.00**		
3-4	1.13	1.10	1.15	1.09	1.06	1.12	1.02	0.98	1.06
5-6	1.29	1.26	1.33	1.22	1.19	1.26	1.12	1.07	1.17
7+	1.38	1.34	1.42	1.30	1.26	1.35	1.17	1.11	1.23
Total N		348,151			348,151			348,769	

Note: p-values for the three exposure variables are <0.000 for all models with the following exception: in the model for stunting, mother's age at birth (p=.010).

Nutritional status by spacing interval

The averages show substantial declines in the odds of being stunted and underweight as the birth–to–conception interval increases after 18 months. The odds of being wasted are significantly a little higher for births with an interval of 6–17 months and significantly lower for 60+ months, compared with births with a 36–47–month spacing interval.

Nutritional status by mother's age at birth and birth order

Table 10 shows a U–shaped relationship between mother's age at birth and the odds of being stunted and underweight. The odds of being wasted are lower for births to mothers ages 25–39 years than for births to mothers ages 18–24 years, and surprisingly are lower for births to mothers ages less than 18 years. However, this latter result is on the cusp of significance. The odds of stunting, underweight, and wasting all increase with birth order, as shown in Table 10, although the result for wasting for orders three and four is not significantly different from that for births of order two.

Nutritional status by risk category combinations

Table 11 shows the odds of children being stunted, underweight, and wasted according to combinations of extra risk due to fertility behavior. Compared with children not in any extra–risk category, all risk categories with significant relationships have increased odds of being stunted except for the single–risk categories of first births with a slightly lowered risk and births to women ages 40 and older with 40 percent lower odds. The results for underweight are similar to those for stunting, with the exception that first births to women 40 and older also are less likely to be underweight. Among the significant results for wasting, all combinations of risk categories show increased odds of being wasted relative to children in no extra–risk category.

Table 12 indicates that the odds of being stunted, underweight, and wasted increase as the number of fertility extra–risk factors increases. There is an 80 percent increase in the odds of being stunted for children with three risk factors, compared with those with no risk factor. All results are significant except for first births for wasting which is close to that of children with no risk factors.

Table 11. Unadjusted odds ratios for stunting, underweight, and wasting by the mother's fertility–related risk, living children age 0 to 59 months at survey, 45 DHS surveys, 2006–2012

	Stunting			Underweight			Wasting			Any malnourished		
	uOR	**CI-**	**CI+**	**uOR**	**CI-**	**CI+**	**uOR**	**CI-**	**CI+**	**uOR**	**CI-**	**CI+**
Extra risk due to fertility pattern												
No extra risk (ref.)	**1.00**			**1.00**			**1.00**			**1.00**		
Unavoidable first-birth risk	0.95	0.92	0.98	0.96	0.93	0.99	0.98	0.93	1.03	0.96	0.94	0.98
Single risk spacing <24 months	1.48	1.43	1.53	1.46	1.40	1.52	1.18	1.11	1.25	1.43	1.38	1.48
Single risk spacing 24-35 months	1.35	1.31	1.39	1.32	1.27	1.36	1.11	1.05	1.17	1.31	1.27	1.35
Single risk age <18	1.40	1.14	1.72	1.47	1.19	1.83	1.31	0.94	1.84	1.34	1.11	1.62
Single risk age 40+	0.60	0.47	0.76	0.67	0.52	0.87	0.89	0.62	1.27	0.64	0.52	0.79
Single risk order 4+	1.24	1.20	1.28	1.22	1.18	1.26	1.15	1.10	1.21	1.23	1.19	1.26
Double risk spacing <24, order 4+	1.92	1.86	1.99	1.77	1.71	1.84	1.25	1.17	1.33	1.75	1.69	1.81
Double risk spacing 24-35, order 4+	1.64	1.59	1.69	1.53	1.48	1.58	1.25	1.19	1.32	1.55	1.51	1.59
Double risk first birth, age <18	1.32	1.28	1.38	1.32	1.27	1.38	1.01	0.94	1.08	1.26	1.21	1.30
Double risk first birth, age 40+	0.79	0.51	1.24	0.56	0.32	0.99	0.34	0.11	1.07	0.72	0.48	1.08
Double risk order 4+, age <18	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
Double risk order 4+, age 40+	1.26	1.19	1.34	1.21	1.13	1.29	1.09	0.99	1.21	1.23	1.17	1.30
Double risk spacing <24 and age <18	1.95	1.77	2.16	2.03	1.83	2.26	1.41	1.19	1.67	1.83	1.66	2.01
Double risk spacing 24-35 and age <18	1.74	1.55	1.95	1.61	1.42	1.83	1.30	1.06	1.59	1.64	1.47	1.83
Double risk spacing <24 and age 40+	1.83	1.04	3.23	1.90	1.04	3.47	1.96	0.84	4.57	1.72	1.00	2.94
Double risk spacing 24-35 and age 40+	0.88	0.47	1.63	1.18	0.64	2.21	0.74	0.23	2.34	0.86	0.49	1.49
3-way risk spacing <24, order 4+, age<18	3.77	1.84	7.72	1.77	0.76	4.13	0.57	0.08	4.22	2.94	1.44	6.02
3-way risk spacing <24, order 4+, age 40+	1.87	1.66	2.12	1.64	1.43	1.89	1.28	1.03	1.59	1.65	1.47	1.86
3-way risk spacing 24-35, order 4+, age<18	1.85	0.48	7.14	1.46	0.31	6.86	nc	nc	nc	1.26	0.33	4.88
3-way risk spacing 24-35, order 4+, age 40+	1.76	1.62	1.91	1.65	1.51	1.81	1.29	1.12	1.49	1.67	1.54	1.80
Total N	348,122			348,122			348,740			348,115		

Table 12. Unadjusted odds ratios for stunting, underweight, and wasting by the mother's fertility–related risk, living children age 0 to 59 months at survey, 45 DHS surveys, 2006–2012

	Stunting			Underweight			Wasting			Any malnourished		
	uOR	**CI-**	**CI+**	**uOR**	**CI-**	**CI+**	**uOR**	**CI-**	**CI+**	**uOR**	**CI-**	**CI+**
Extra risk due to fertility pattern												
No extra risk (ref.)	**1.00**			**1.00**			**1.00**			1.00		
Unavoidable first-birth risk	0.95	0.92	0.98	0.96	0.93	0.99	0.98	0.93	1.03	0.96	0.94	0.98
Any single risk	1.33	1.29	1.36	1.30	1.27	1.34	1.14	1.10	1.19	1.30	1.27	1.32
Any double risk	1.60	1.56	1.64	1.52	1.48	1.56	1.19	1.14	1.24	1.51	1.47	1.54
Any 3-way risk	1.80	1.68	1.93	1.65	1.53	1.78	1.28	1.13	1.45	1.67	1.56	1.78
Total N	348,122			348,122			348,740			348,115		

Multivariate Results

The first panel of Table 13 presents adjusted risk ratios for early neonatal, neonatal, post–neonatal, child (one to four years), and under–five mortality by the length of the preceding birth–to–conception interval for the pooled data from the 45 surveys. For early neonatal, neonatal, post–neonatal, and infant mortality analyses, children born between 0–59 months prior to each survey interview are considered. Children born earlier than 59 months prior to 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 prior to the survey are included. Children born at 180 months prior to the survey or earlier are excluded due to truncation of the data file.[11]

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 0–179 months prior to the survey are used to control for the effects of spurious relationships. The demographic controls used were sex of the index child, duration of the pregnancy (assumed 9 months for births occurring 60–179 months prior to 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 1,176,384 singleton births that had no imputed preceding birth–to–conception interval.[12]

The relationship between the preceding birth–to–conception interval and under–five mortality is highly significant ($p < 0.001$), and each interval group under 36 months is significantly higher than the reference group of 36–47 months as well as the group of 96 or more months. Figure 1 shows the weighted average effect of the preceding birth–to–conception interval on under–five mortality. The risk of mortality trends downward with each increasing birth–to–conception interval–rapidly until 24–29 months, then more slowly with longer intervals, and with a final upturn for intervals of 96 or more months' duration.

For child (ages one to four years) mortality, the effect of the duration of the preceding birth–to–conception interval is almost a constant decline in mortality with an increase in interval length (Table 13 and Figure 1). The risk ratios for all interval groups are significantly different from the reference group. The risk of child death falls from 2.5 times that of the 36–47–month group for conceptions within 6 months of the preceding birth to 0.8 for conceptions at 60 months or more. There is no upturn in child mortality for the open–ended long interval as is noticed for under–five mortality.

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[11] 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 prior to the survey pertain to women up to the age of 34 years at the child's birth.

[12] Four births had missing birth interval information.

Table 13. Adjusted relative risk of mortality by duration of preceding birth–to–conception interval, mother's age at child's birth, and the birth order, children born 0 to 179 months prior to the survey, 45 DHS surveys, 2006–2012

	Early neonatal			Neonatal			Post-neonatal			Infant			Child			Under five		
	aRR	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**
Birth-to-conception interval (months)																		
<6	2.25	1.97	2.57	2.29	2.04	2.56	1.97	1.74	2.22	2.15	1.97	2.33	2.53	2.38	2.70	3.24	3.12	3.36
6-11	1.65	1.46	1.87	1.69	1.52	1.88	1.64	1.47	1.83	1.67	1.54	1.80	2.10	1.99	2.23	2.33	2.25	2.42
12-17	1.28	1.15	1.44	1.31	1.19	1.45	1.31	1.19	1.45	1.32	1.23	1.41	1.89	1.79	2.00	1.86	1.80	1.92
18-23	1.09	0.97	1.23	1.10	0.99	1.22	1.10	0.99	1.22	1.11	1.03	1.19	1.60	1.51	1.69	1.52	1.47	1.57
24-29	0.92	0.81	1.04	0.95	0.86	1.07	0.99	0.89	1.10	0.98	0.90	1.05	1.30	1.22	1.38	1.22	1.18	1.27
30-35	1.03	0.90	1.18	1.06	0.94	1.20	0.93	0.82	1.05	1.00	0.91	1.08	1.17	1.09	1.25	1.10	1.05	1.15
36-47 (ref.)	**1.00**			**1.00**			**1.00**			**1.00**			**1.00**			**1.00**		
48-59	1.18	1.02	1.38	1.16	1.01	1.32	1.13	0.99	1.30	1.14	1.04	1.26	0.86	0.79	0.94	0.94	0.89	0.99
60-95	1.39	1.21	1.60	1.40	1.24	1.59	1.17	1.02	1.34	1.28	1.17	1.41	0.80	0.73	0.87	0.98	0.93	1.03
96+	1.77	1.48	2.11	1.72	1.47	2.01	1.25	1.03	1.52	1.50	1.33	1.70	0.81	0.70	0.93	1.13	1.05	1.22
First births	2.22	1.98	2.49	2.16	1.95	2.38	1.47	1.32	1.63	1.83	1.70	1.96	1.49	1.41	1.58	2.01	1.94	2.09
Mother's age at child's birth																		
<18	1.19	1.10	1.28	1.18	1.10	1.26	1.23	1.14	1.33	1.20	1.14	1.26	1.33	1.28	1.38	1.35	1.32	1.38
18-24 (ref.)	**1.00**			**1.00**			**1.00**			**1.00**			**1.00**			**1.00**		
25-34	1.03	0.97	1.10	1.01	0.96	1.07	1.00	0.95	1.07	1.01	0.97	1.05	0.91	0.88	0.94	0.96	0.94	0.97
35-39	1.38	1.24	1.53	1.31	1.20	1.44	1.10	0.99	1.21	1.20	1.12	1.29	0.81	0.77	0.86	0.98	0.95	1.02
40+	1.85	1.62	2.12	1.71	1.52	1.92	1.31	1.15	1.49	1.51	1.38	1.64	0.80	0.74	0.88	1.03	0.98	1.09
Birth order																		
1-2 (ref.)	**1.00**			**1.00**			**1.00**			**1.00**			**1.00**			**1.00**		
3-4	0.95	0.88	1.02	0.95	0.89	1.01	1.07	1.00	1.14	1.01	0.96	1.05	1.10	1.07	1.14	1.07	1.04	1.09
5-6	1.00	0.91	1.10	1.01	0.93	1.10	1.13	1.04	1.22	1.07	1.01	1.13	1.22	1.17	1.28	1.15	1.12	1.18
7+	1.00	0.90	1.12	1.03	0.94	1.13	1.20	1.08	1.32	1.11	1.04	1.19	1.44	1.37	1.51	1.28	1.24	1.32
Total N	424,907			424,907			424,907			424,907			1,176,384			1,176,384		

(Continued...)

Table 13. – *Continued*

Note: In addition to the three key fertility risk behavior characteristics, adjusted models included the following variables:

ENN, NN, PNN, and Infant Mortality: 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 or stillbirth), type of provider of prenatal care, type of provider of delivery assistance, number of prenatal tetanus injections, timing of first prenatal care visit, quintile of DHS Wealth Index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, and whether preceding child died before conception of index child.

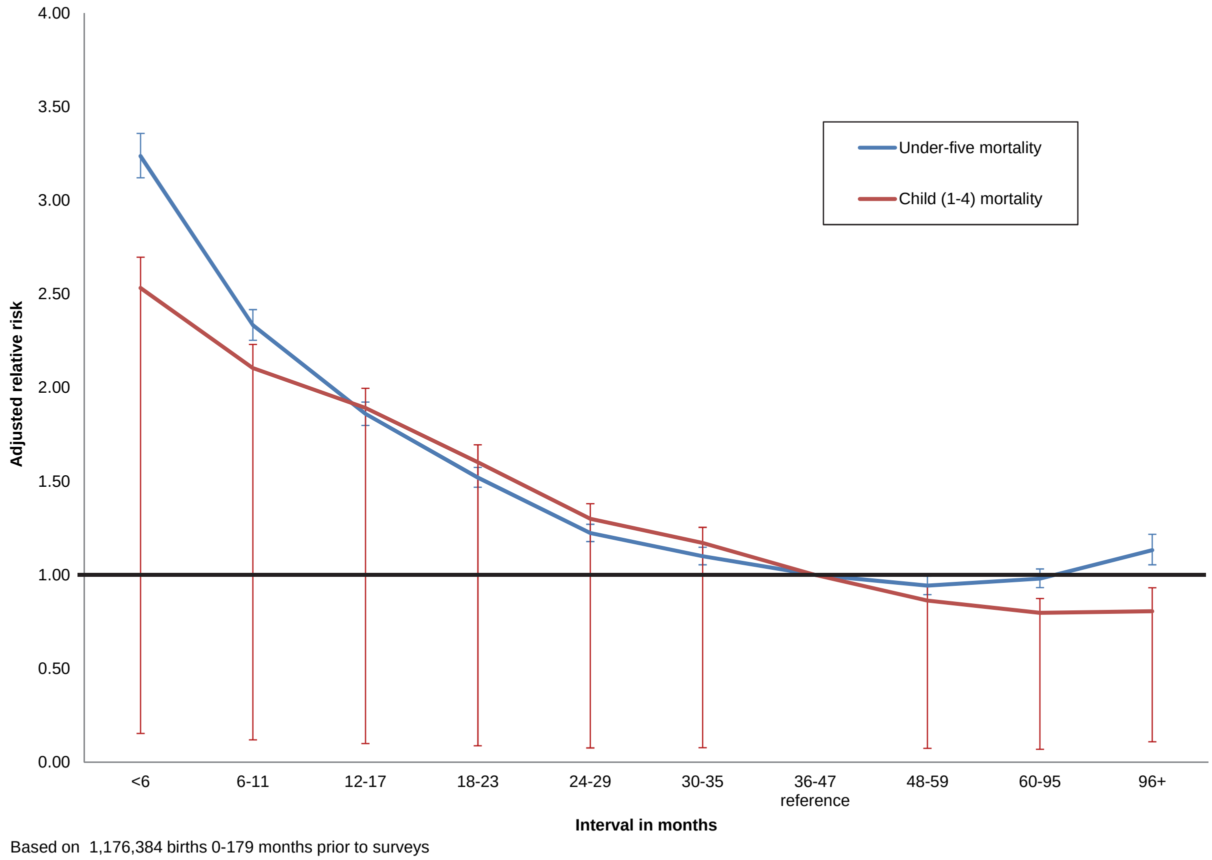
Child and Under–Five Mortality: Sex of index child, urban–rural area of residence, mother's education, quintile of Wealth Index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, and whether preceding child died before conception of index child.

Age range of analysis:

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

Child and Under–Five Mortality: 0–179 months

Figure 1. Adjusted relative risks of under–five and child (one to four years) mortality by length of birth–to–conception interval, 45 DHS surveys between 2006 and 2012

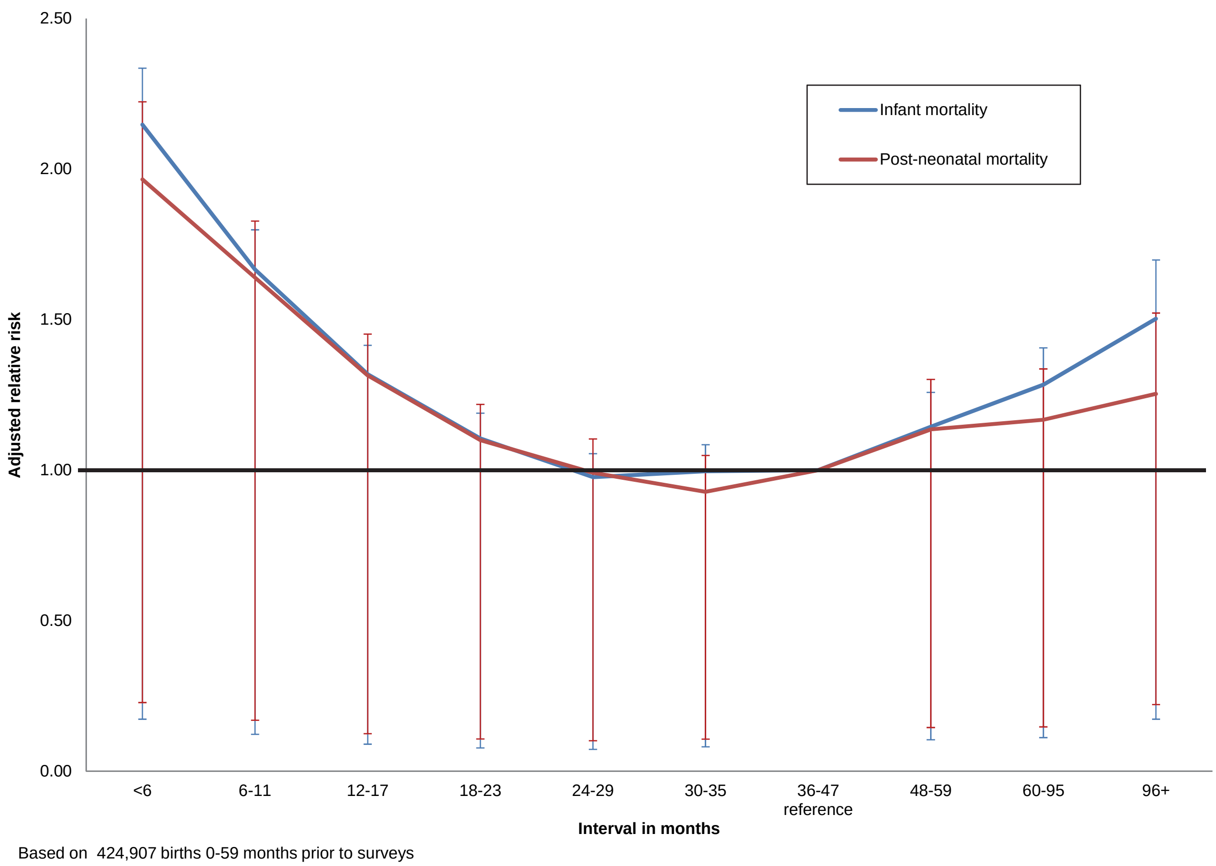


Infant and post–neonatal mortality

The analysis of infant mortality is based on births that occurred 0–59 months prior to 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, and did not want any more children) is used, together with type of provider of and timing of prenatal care, number of prenatal tetanus toxoid injections, and type of provider of delivery assistance. Also included in the surveys with reproductive calendar data is whether the birth was the result of a contraceptive failure and the outcome of the preceding pregnancy (live birth or stillbirth). The analyses for infant, post–neonatal, neonatal, and early neonatal mortality are based on 424,907 singleton births with no imputed preceding birth–to–conception interval.

Compared with a preceding birth–to–conception interval of 36–47 months, children conceived with interval durations of fewer than 24 months have significantly higher risks of mortality. There is little difference in mortality risk for the duration groups between 24–47 months. However, the mortality risk increases for births with durations of 48 months or more. The shorter the duration of the interval for intervals of fewer than 24 months, the higher the risk of dying during infancy. Indeed, while children conceived 18–23 months after a birth have an 11 percent higher risk, those conceived within 6 months of a prior birth have a 115 percent higher risk. The 45–country pooled data set indicates that children conceived 24–47 months after a prior birth have the lowest risk of dying in infancy (Figure 2).

Figure 2. Adjusted relative risks of infant and post–neonatal mortality by length of birth–to–conception interval, 45 DHS surveys between 2006 and 2012

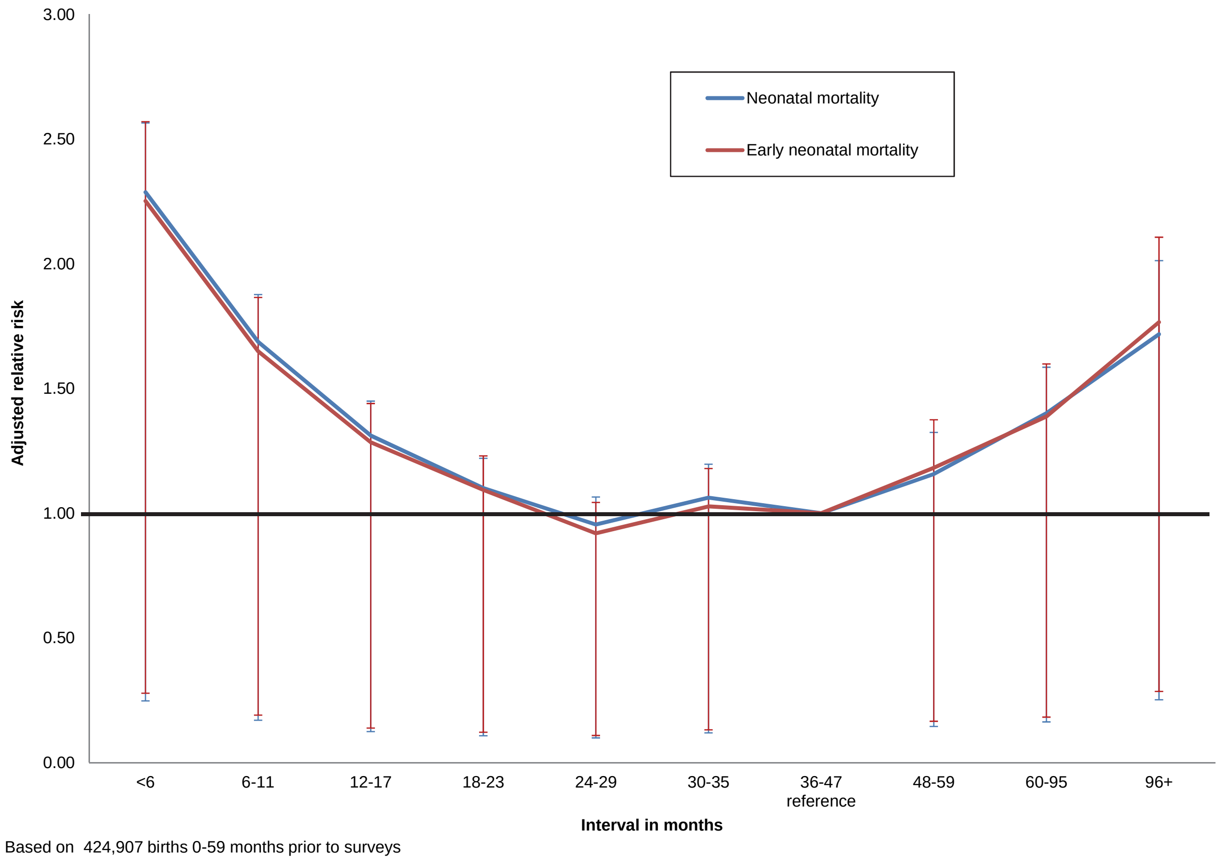


Neonatal and early neonatal mortality

Table 13 also shows the results for neonatal mortality. The risk of mortality by preceding birth–to–conception interval is U–shaped with the lowest points at 24–47 months, including the reference group (36–47 months). All interval groups outside the period 24–47 months have adjusted relative risks that are significantly higher than those of the reference group. Intervals shorter than 24 months have adjusted relative risks that are from 10 percent to 129 percent higher than the risk of mortality of the reference group. Intervals longer than the reference group have risks that are from 16 percent to 72 percent higher. Figure 3 shows the curve of the adjusted relative risks.

Figure 3 also shows that the curve for early neonatal mortality is quite similar to that for neonatal mortality, but the confidence intervals are a little wider because of the smaller number of deaths during this shorter age range.

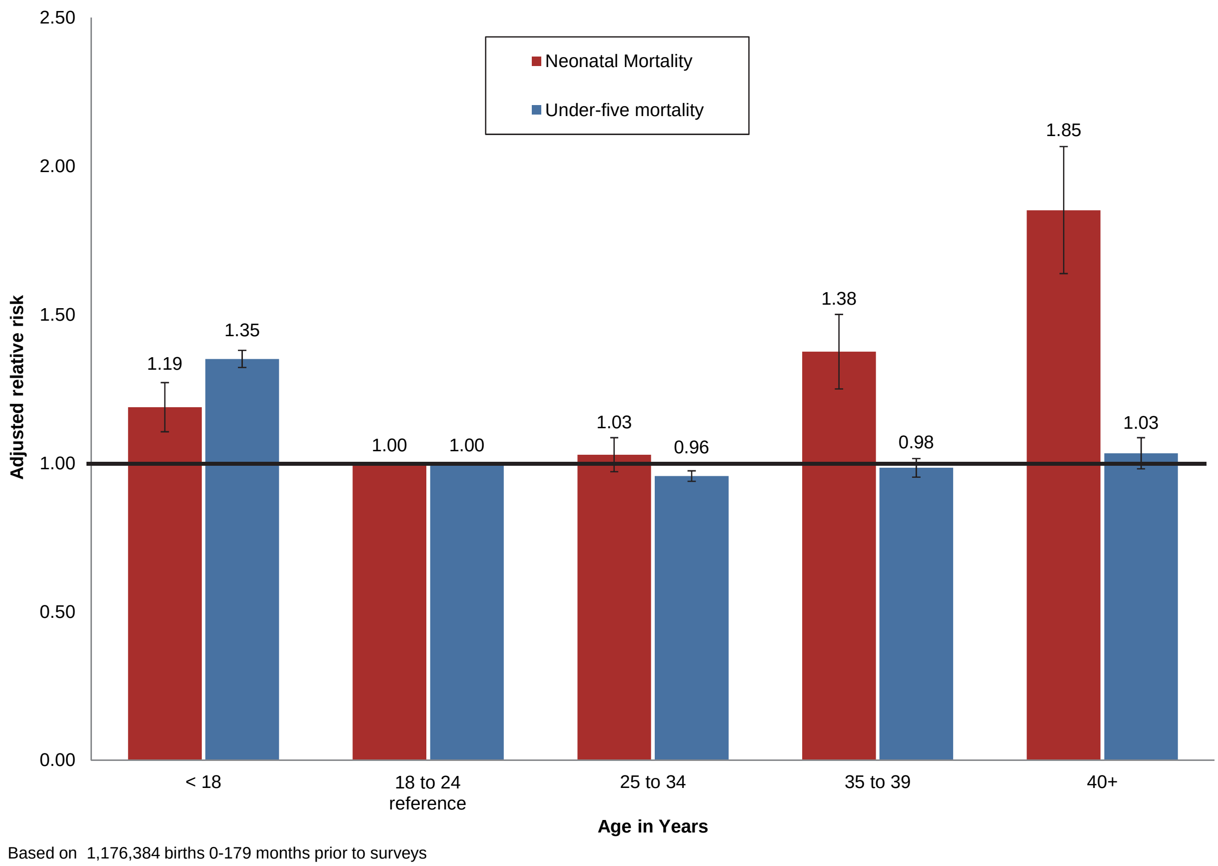
Figure 3. Adjusted relative risks of neonatal and early neonatal mortality by length of birth–to–conception interval, 45 DHS surveys between 2006 and 2012



Mother's age at birth and infant and child mortality

Compared with births to mothers aged 18–24 years, those born to mothers under age 18 years have significantly higher risks of dying in all the mortality age groups after taking account of a number of confounding factors (second panel of Table 13). The excess risk varies from 18 percent in the neonatal period to 35 percent for all ages under five years. Children born to mothers ages 25–34 years do not have significantly higher risks of dying during infancy but have about a 9 percent lower risk of dying during ages one to four years. Children born to mothers 35 years of age or over are significantly more likely to die than children in the reference group in the neonatal period but are significantly less likely to die when they are one to four years. The change from more to less risk as the child ages causes the risk of under–five mortality to be not significantly different from the reference group for children of mothers 35 years or over. Figure 4 shows the change in this pattern.

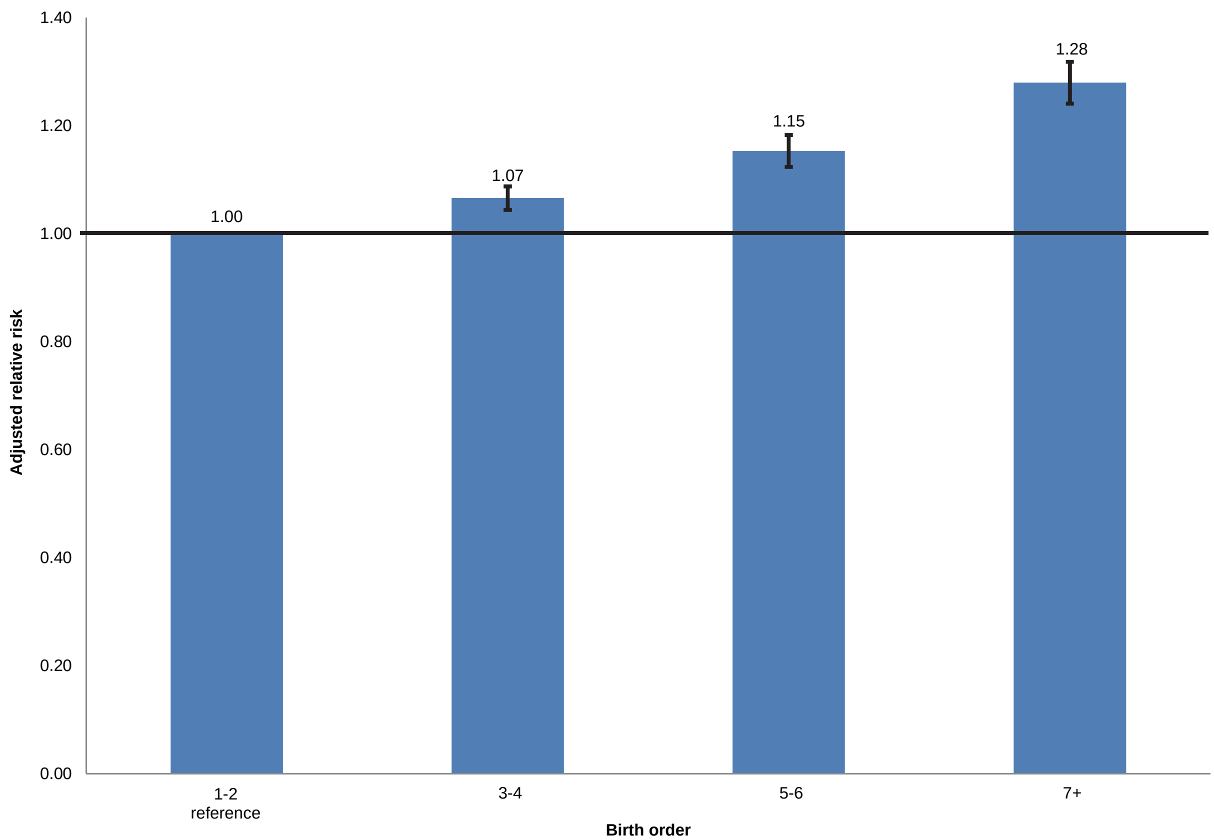
Figure 4. Adjusted relative risks of neonatal and under–five mortality by mother's age at birth, 45 DHS surveys between 2006 and 2012



Birth order and infant and child mortality

Birth order of the child is not significantly related to the risk of dying in the neonatal period after taking account of confounding factors (third panel of Table 13). However, for children ages 1–59 months, children with birth orders three or higher have greater risks of dying than do first– and second–born children, the reference group (the increased risk for third– and fourth–born children in the post–neonatal period is almost significant). For all under–five mortality, the higher the birth order, the higher the mortality risk (Figure 5).

Figure 5. Adjusted relative risks of under–five mortality by birth order, 45, DHS surveys between 2006 and 2012



Based on 1,176,384 births 0-179 months prior to surveys

Combined risk categories and infant and child mortality

Children can have more than one fertility behavior risk factor at the same time. Table 14 shows the adjusted relative risk of dying at various age intervals according to single risk factors and combinations of risk factors, adjusted for confounding characteristics. For under–five mortality compared with children with no extra risk factor, 14 combinations of risk factors have relative risks that are significantly different from the reference category (Figure 6). They vary from a high of 251 percent extra risk for the combination of spacing of fewer than 24 months, birth order four or higher, and maternal age at birth of less than 18 years (a very rare category) to 15 percent greater risk for fourth or higher order births to women age 40 years or over. During infancy, two of the combinations do not show significantly higher risks of mortality, compared with no extra risk: children born with a spacing of fewer than 24 months to women ages 40 years or over and children born with a spacing of 24–35 months to women under 18 years of age. During ages one to four years, the combination of a birth order of four or higher to women ages 40 years or over is not significant.

Table 14. Adjusted relative risk of mortality by the mother's fertility–related risk, children born 0 to 179 months prior to the survey, 45 DHS surveys, 2006–2012

	Early neonatal			Neonatal			Post-neonatal			Infant			Child			Under five		
	aRR	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**
Extra risk due to fertility pattern																		
No extra risk (ref.)	**1.00**			**1.00**			**1.00**			**1.00**			**1.00**			**1.00**		
Unavoidable first-birth risk	1.83	1.69	1.99	1.80	1.68	1.94	1.24	1.14	1.35	1.54	1.46	1.63	1.35	1.29	1.42	1.77	1.72	1.81
Single risk spacing <24 months	1.34	1.21	9.51	1.34	1.23	1.47	1.33	1.21	1.46	1.34	1.26	1.43	1.92	1.82	2.01	2.08	2.02	2.14
Single risk spacing 24-35 months	0.84	0.76	6.00	0.89	0.81	0.97	0.97	0.88	1.06	0.93	0.87	0.99	1.53	1.45	1.60	1.38	1.34	1.43
Single risk age <18	0.60	0.27	4.28	0.60	0.30	1.21	0.69	0.37	1.29	0.66	0.41	1.04	1.19	0.92	1.54	1.02	0.86	1.21
Single risk age 40+	3.05	2.05	21.68	2.79	1.93	4.04	2.04	1.24	3.34	2.47	1.83	3.31	0.78	0.43	1.41	1.71	1.37	2.14
Single risk order 4+	0.95	0.86	6.75	0.96	0.88	1.04	0.96	0.88	1.05	0.96	0.91	1.02	1.00	0.95	1.06	0.99	0.96	1.02
Double risk spacing <24, order 4+	1.53	1.38	10.85	1.59	1.46	1.73	1.64	1.50	1.79	1.62	1.53	1.73	2.40	2.29	2.51	2.54	2.47	2.61
Double risk spacing 24-35, order 4+	0.99	0.90	7.06	1.01	0.92	1.10	1.11	1.02	1.21	1.07	1.00	1.13	1.68	1.60	1.76	1.55	1.51	1.59
Double risk first birth, age <18	2.18	1.98	15.49	2.16	1.98	2.35	1.61	1.46	1.77	1.90	1.78	2.02	1.88	1.79	1.98	2.51	2.43	2.58
Double risk first birth, age 40+	1.75	0.56	12.45	1.37	0.44	4.26	1.89	0.61	5.87	1.56	0.70	3.47	0.01	0.00	>1000	1.23	0.68	2.22
Double risk order 4+, age <18	21.93	3.02	155.72	14.63	2.03	105.67	nc	nc	nc	10.04	1.41	71.74	nc	nc	nc	2.05	0.29	14.52
Double risk order 4+, age 40+	1.65	1.40	11.74	1.58	1.36	1.83	1.26	1.07	1.49	1.43	1.28	1.59	0.99	0.87	1.13	1.15	1.07	1.24
Double risk spacing <24 and age <18	1.72	1.39	12.25	1.66	1.37	2.00	1.52	1.23	1.88	1.61	1.40	1.85	2.46	2.25	2.68	2.72	2.58	2.86
Double risk spacing 24-35 and age <18	1.05	0.75	7.47	1.14	0.86	1.51	1.13	0.85	1.49	1.14	0.93	1.39	2.15	1.93	2.39	1.88	1.75	2.01
Double risk spacing <24 and age 40+	0.86	0.12	6.11	0.66	0.09	4.70	2.43	0.78	7.54	1.46	0.55	3.90	0.92	0.23	3.70	1.91	1.08	3.36
Double risk spacing 24-35 and age 40+	2.53	0.81	17.97	1.94	0.63	6.03	nc	nc	nc	1.05	0.34	3.25	0.99	0.32	3.06	1.19	0.64	2.21
3-way risk spacing <24, order 4+, age<18	3.81	1.58	27.04	2.85	1.18	6.88	1.43	0.36	5.74	2.28	1.09	4.79	3.41	2.38	4.89	3.51	2.81	4.38
3-way risk spacing <24, order 4+, age 40+	2.41	1.90	17.13	2.35	1.91	2.89	2.29	1.84	2.84	2.33	2.00	2.70	2.37	2.04	2.76	2.69	2.47	2.93
3-way risk spacing 24-35, order 4+, age <18	0.00	0.00	0.01	2.34	0.33	16.66	nc	nc	nc	1.10	0.15	7.81	1.37	0.44	4.24	0.98	0.41	2.36
3-way risk spacing 24-35, order 4+, age 40+	1.88	1.53	13.31	1.88	1.57	2.25	1.52	1.25	1.86	1.71	1.50	1.96	1.64	1.43	1.88	1.79	1.65	1.94
Total N	424,907			424,907			424,907			424,907			1,176,388			1,176,388		

Note: Adjusted models included the following variables:

ENN, NN, PNN, and Infant Mortality: 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 or stillbirth), type of provider of prenatal care, type of provider of delivery assistance, number of prenatal tetanus injections, timing of first prenatal care visit, quintile of DHS Wealth Index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, and whether preceding child died before conception of index child.

(Continued...)

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Table 14. – *Continued*

Child and Under–Five Mortality: Sex of index child, urban–rural area of residence, mother's education, quintile of Wealth Index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, and 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

nc: no cases stunted, underweight, or wasted

Figure 6. Adjusted relative risk of under–five mortality by combinations of extra–risk fertility behavior

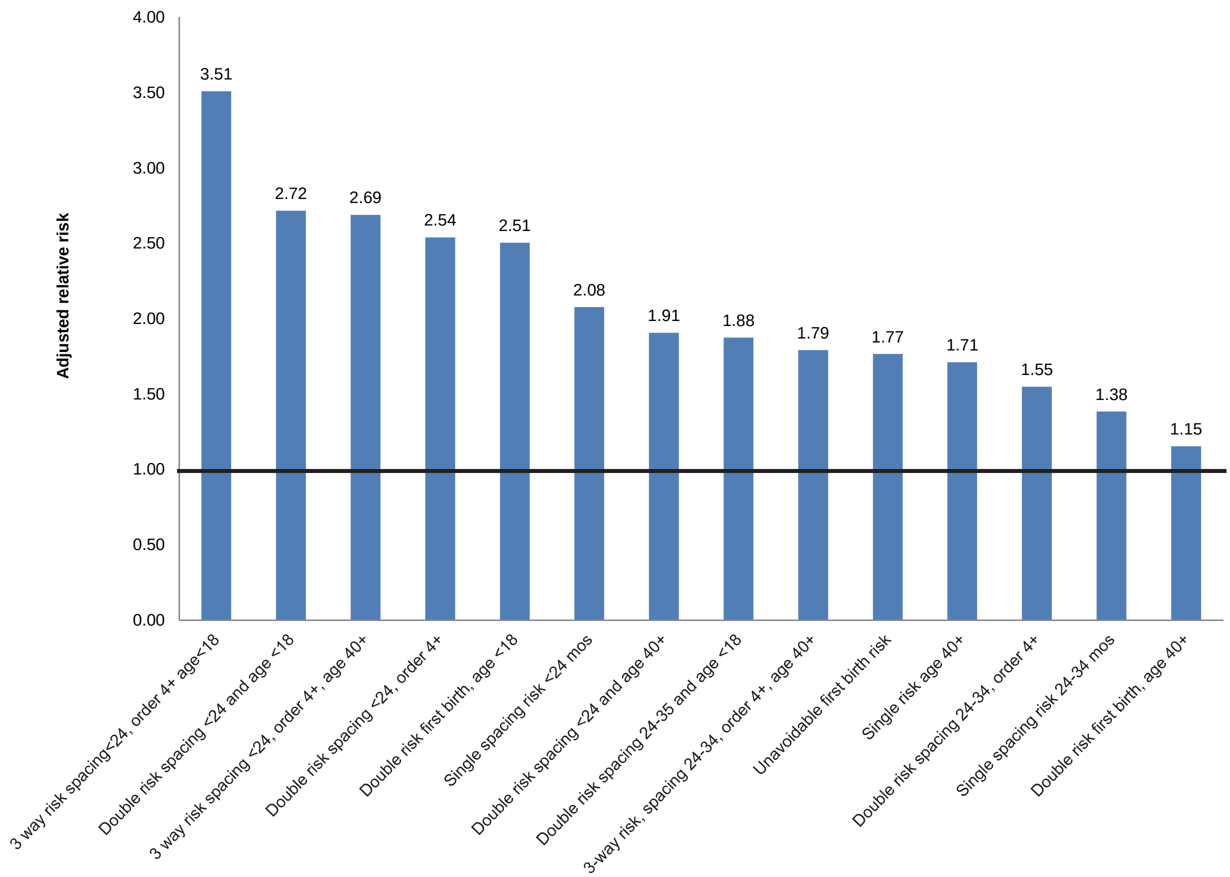


Table 15 shows the effects of the number of risk factors on infant and child mortality after controlling for the effects of confounders. For under–five, child, and infant mortality, the greater the number of behavioral risk factors, the higher the level of risk. First births alone also have higher risks at all ages. However, children with only one risk factor do not have significantly higher risks of dying during the early neonatal, neonatal, and post–neonatal periods when taken separately. They do have significantly higher mortality, however, when taken over infancy as a whole.

Table 15. Adjusted relative risk of mortality by the mother's fertility–related risk, children born 0 to 179 months prior to the survey, 45 DHS surveys, 2006–2012

	Early neonatal			Neonatal			Post-neonatal			Infant			Child			Under five		
	aRR	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**	**aRR**	**CI-**	**CI+**
Extra risk due to fertility pattern																		
No extra risk (ref.)	**1.00**			**1.00**			**1.00**			**1.00**			**1.00**			**1.00**		
Unavoidable first-birth risk	1.79	1.65	1.94	1.76	1.64	1.89	1.24	1.14	1.34	1.53	1.45	1.57	1.36	1.29	1.42	1.77	1.72	1.81
Any single risk	1.05	0.97	1.13	1.06	0.99	1.13	1.05	0.97	1.12	1.06	1.01	1.08	1.41	1.35	1.47	1.41	1.38	1.45
Any double risk	1.47	1.36	1.59	1.47	1.38	1.58	1.36	1.27	1.46	1.43	1.36	1.46	1.95	1.88	2.03	2.09	2.04	2.14
Any 3-way risk	2.20	1.87	2.59	2.16	1.88	2.49	1.79	1.53	2.08	1.99	1.79	2.09	1.97	1.78	2.18	2.19	2.06	2.32
Total N	424,907			424,907			424,907			424,907			1,176,388			1,176,388		

Note: Adjusted models included the following variables:

ENN, NN, PNN, and Infant Mortality: 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 or stillbirth), type of provider of prenatal care, type of provider of delivery assistance, number of prenatal tetanus injections, timing of first prenatal care visit, quintile of DHS Wealth Index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, and whether preceding child died before conception of index child.

Child and Under–Five Mortality: Sex of index child, urban–rural area of residence, mother's education, quintile of Wealth Index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, and 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

Nutritional status

Logistic regressions examined the effects of the duration of preceding birth to conception, mother's age at birth, and birth order on the percentage of children stunted, underweight, and wasted at the time of the surveys. To control for potentially confounding factors, the following variables were included in the regressions: child's age, sex, gestation length, 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, source of drinking water, type of toilet facility in the household, an index of household wealth, and whether the household has a refrigerator. All three independent variables of interest were also included in the logistic regressions. Table 16 shows the results of the analyses.

Table 16. Adjusted odds ratios for stunting, underweight, and wasting by duration of preceding birth–to–conception interval, mother's age at child's birth, and birth order, living children age 0 to 59 months at survey, 45 DHS surveys, 2006–2012

	Stunting			Underweight			Wasting		
	aOR	**CI-**	**CI+**	**aOR**	**CI-**	**CI+**	**aOR**	**CI-**	**CI+**
Birth-to-conception interval (months)									
<6	1.39	1.31	1.47	1.38	1.29	1.47	1.01	0.91	1.11
6-11	1.35	1.29	1.41	1.29	1.23	1.36	1.06	0.98	1.14
12-17	1.27	1.23	1.32	1.23	1.18	1.28	1.06	0.99	1.12
18-23	1.15	1.11	1.19	1.10	1.06	1.15	1.01	0.95	1.07
24-29	1.13	1.09	1.17	1.09	1.05	1.14	0.97	0.91	1.04
30-35	1.03	0.99	1.08	0.99	0.95	1.04	1.00	0.93	1.07
36-47 (ref.)	**1.00**			**1.00**			**1.00**		
48-59	0.96	0.92	1.01	1.00	0.95	1.06	1.02	0.94	1.10
60-95	0.92	0.88	0.97	0.96	0.91	1.01	1.04	0.96	1.13
96+	0.86	0.80	0.93	0.96	0.89	1.04	0.93	0.82	1.05
First births	1.04	1.01	1.09	1.06	1.01	1.10	1.01	0.95	1.08
Mother's age at child's birth									
<18	1.08	1.04	1.11	1.09	1.05	1.13	0.98	0.93	1.05
18-24 (ref.)	**1.00**			**1.00**			**1.00**		
25-34	0.95	0.93	0.98	0.96	0.93	0.98	1.00	0.96	1.04
35-39	0.92	0.89	0.96	0.89	0.85	0.93	0.95	0.88	1.01
40+	0.95	0.90	1.00	0.95	0.89	1.01	1.00	0.91	1.10
Birth order									
1-2 (ref.)	**1.00**			**1.00**			**1.00**		
3-4	1.03	1.01	1.06	1.01	0.98	1.03	0.97	0.93	1.02
5-6	1.08	1.04	1.11	1.04	1.00	1.08	1.01	0.95	1.06
7+	1.07	1.03	1.12	1.05	1.00	1.10	1.01	0.94	1.08
Total N	348,122			348,122			348,740		

Note: In addition to the three key fertility risk behavior characteristics, adjusted models included the following variables:

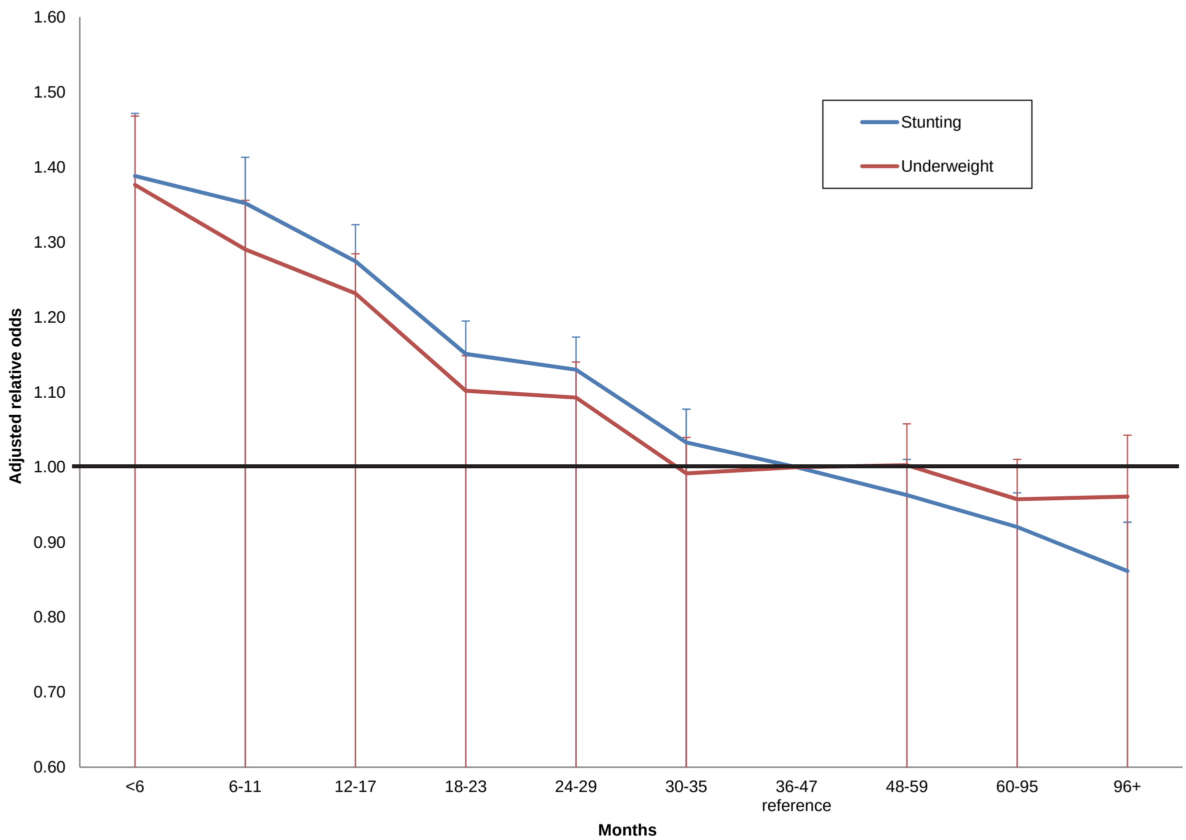
Sex of index child, urban–rural area of residence, wantedness of child, mother's education, whether conception was a result of contraceptive failure, outcome of preceding pregnancy (live birth or stillbirth), type of provider of prenatal care, type of provider of delivery assistance, number of prenatal tetanus injections, timing of first prenatal care visit, quintile of DHS Wealth Index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, and whether preceding child died before conception of index child.

Note that in the model predicting underweight, birth order was not a significant variable (p=.053). In the model predicting wasting, preceding birth to pregnancy interval (p=0.20), mother's age at child's birth (0.38), and birth order (0.40) were not significant.

Forty–two of the country surveys collected information on height and weight of children. The sample size from the pooled data set for nutritional status is 348,122. Note that these are the cases available for analysis after removing those with missing or erroneous data for any of the nutritional status variables. The total number of cases for multivariate analysis is a little lower than that for the unadjusted analysis due to missing data on some of the independent variables.

Figure 7 shows the adjusted odds ratios for birth–to–conception interval from the multivariate logistic regression analyses for stunting and underweight. Wasting is not shown as none of the results is significantly different from the reference category (Table 16, first panel). It is clear that chronic and overall undernutrition declines substantially with longer intervals. Indeed, children conceived after an interval of 12–17 months are 27 percent more likely to be stunted and 23 percent more likely to be underweight than children conceived after an interval of 36–47 months. Children conceived after even longer durations are less likely to be stunted 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 as the spacing interval is not significantly related once confounding factors have been taken into account.

Figure 7. Adjusted relative odds of stunting and underweight by birth–to–conception interval, 42 DHS surveys between 2006 and 2012



Based on 348,122 living children of age 0-59 months

Mother's age at birth and birth order are significantly related to stunting (second and third panels of Table 16). Although mother's age at birth is significantly related to underweight, birth order is not, and neither characteristic is related to wasting. Children whose mothers were older (through age 39) at their birth are less likely to be stunted and underweight. For children born to mothers of ages 40 years or over, there is no significant difference in the odds ratios with children born to mothers age 18–24 years. Increases in birth order increase the odds of being stunted but not underweight or wasted. The effects of both mother's age at birth and birth order are not large, being at most 8 percent different from those of the reference category. In contrast, children born with a birth–to–conception interval of fewer than 6 months are 39 percent more likely to be stunted than children of the reference, and children conceived 96 or more months after the preceding birth are 14 percent less likely to be stunted.

Table 17. Adjusted odds ratios for stunting, underweight, and wasting, by the mother's fertility–related risk, living children age 0 to 59 months at survey, 45 DHS surveys, 2006–2012

	Stunting			Underweight			Wasting		
	aOR	CI-	CI+	aOR	CI-	CI+	aOR	CI-	CI+
Extra risk due to fertility pattern									
No extra risk (ref.)	**1.00**			**1.00**			**1.00**		
Unavoidable first-birth risk	1.00	0.97	1.03	1.05	1.01	1.08	1.12	1.06	1.17
Single risk spacing <24 months	1.45	1.39	1.50	1.40	1.34	1.46	1.04	0.98	1.11
Single risk spacing 24-35 months	1.20	1.16	1.24	1.17	1.13	1.21	0.97	0.92	1.03
Single risk age <18	1.05	0.85	1.29	1.12	0.90	1.41	1.12	0.80	1.58
Single risk age 40+	0.77	0.61	0.99	0.94	0.72	1.22	1.12	0.78	1.61
Single risk order 4+	1.00	0.97	1.03	0.99	0.96	1.03	1.01	0.96	1.07
Double risk spacing <24, order 4+	1.50	1.44	1.56	1.37	1.32	1.43	0.98	0.92	1.05
Double risk spacing 24-35, order 4+	1.25	1.21	1.29	1.17	1.13	1.22	1.01	0.95	1.06
Double risk first birth, age <18	1.11	1.07	1.16	1.18	1.13	1.23	1.07	0.99	1.14
Double risk first birth, age 40+	1.11	0.70	1.76	0.81	0.45	1.45	0.43	0.14	1.35
Double risk order 4+, age <18	nc	nc	nc	nc	nc	nc	nc	nc	nc
Double risk order 4+, age 40+	1.02	0.96	1.09	1.02	0.95	1.10	1.00	0.90	1.11
Double risk spacing <24 and age <18	1.53	1.38	1.70	1.61	1.44	1.80	1.13	0.95	1.35
Double risk spacing 24-35 and age <18	1.26	1.12	1.42	1.16	1.02	1.32	1.01	0.82	1.24
Double risk spacing <24 and age 40+	1.99	1.10	3.60	2.09	1.11	3.95	1.86	0.79	4.40
Double risk spacing 24-35 and age 40+	1.04	0.55	1.97	1.46	0.77	2.79	0.78	0.24	2.50
3-way risk spacing <24, order 4+, age<18	2.55	1.23	5.30	1.15	0.48	2.73	0.40	0.05	2.97
3-way risk spacing <24, order 4+, age 40+	1.39	1.22	1.58	1.22	1.06	1.41	0.97	0.77	1.21
3-way risk spacing 24-35, order 4+, age<18	1.16	0.29	4.60	0.93	0.19	4.48	nc	nc	nc
3-way risk, spacing 24-35, order 4+, age 40+	1.31	1.20	1.43	1.24	1.13	1.37	1.00	0.86	1.16
Total N	348,122			348,122			348,740		

(Continued...)

Table 17. – *Continued*

Note: The adjusted models included the following variables:

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 or stillbirth), type of provider of prenatal care, type of provider of delivery assistance, number of prenatal tetanus injections, timing of first prenatal care visit, quintile of DHS Wealth Index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, and whether preceding child died before conception of index child.

nc: no cases stunted, underweight, or wasted

The effects on children's nutritional status of having more than one risk factor at a time are shown in Table 17 for individual combinations, in Table 18 for the number of combinations, and in Figure 8 for stunting by significant combinations of risk factors. Children were most likely to be stunted if the preceding birth–to–conception interval was fewer than 24 months, the birth order was four or more, and the mother was under 18 years of age at the time of birth (as noted above, a very rare combination). Children who were born to mothers age 40 or over and with a spacing interval of fewer than 24 months had almost twice the odds of being stunted as children with no extra risk factor. On the other hand, children whose mothers were 40 or over at the time of their birth and with no other risk factor had a 23 percent lower likelihood of being stunted than children in the reference category. Most of the common combinations, those with 1 percent or more of births, had increased risks of stunting: single risks of intervals less than 24 months (45 percent greater risk of stunting) and intervals of 24–35 months (20 percent greater); and double risks of intervals of fewer than 24 months with a birth order four or higher (50 percent greater), intervals of 24–35 months with a birth order four or higher (25 percent greater), first births to mothers under 18 years of age (11 percent greater), and births with an interval of fewer than 24 months to mothers under 18 years of age (53 percent greater risk of stunting).

The effects of the combinations for underweight are very similar to those for stunting. None of the combinations are significantly related to wasting except for the unavoidable first–birth category that has 5 percent greater odds of being stunted than the reference category.

The odds of being stunted, underweight, and wasted increase with the number of risk factors, even after controlling for confounding variables (Table 18). Having three risk factors increases the odds of stunting by 80 percent, the odds of underweight by 65 percent, and the odds of wasting by 28 percent in comparison to the reference group of having no extra risk factor. However, just being a first birth does not significantly change the odds of being wasted compared with no risk factors.

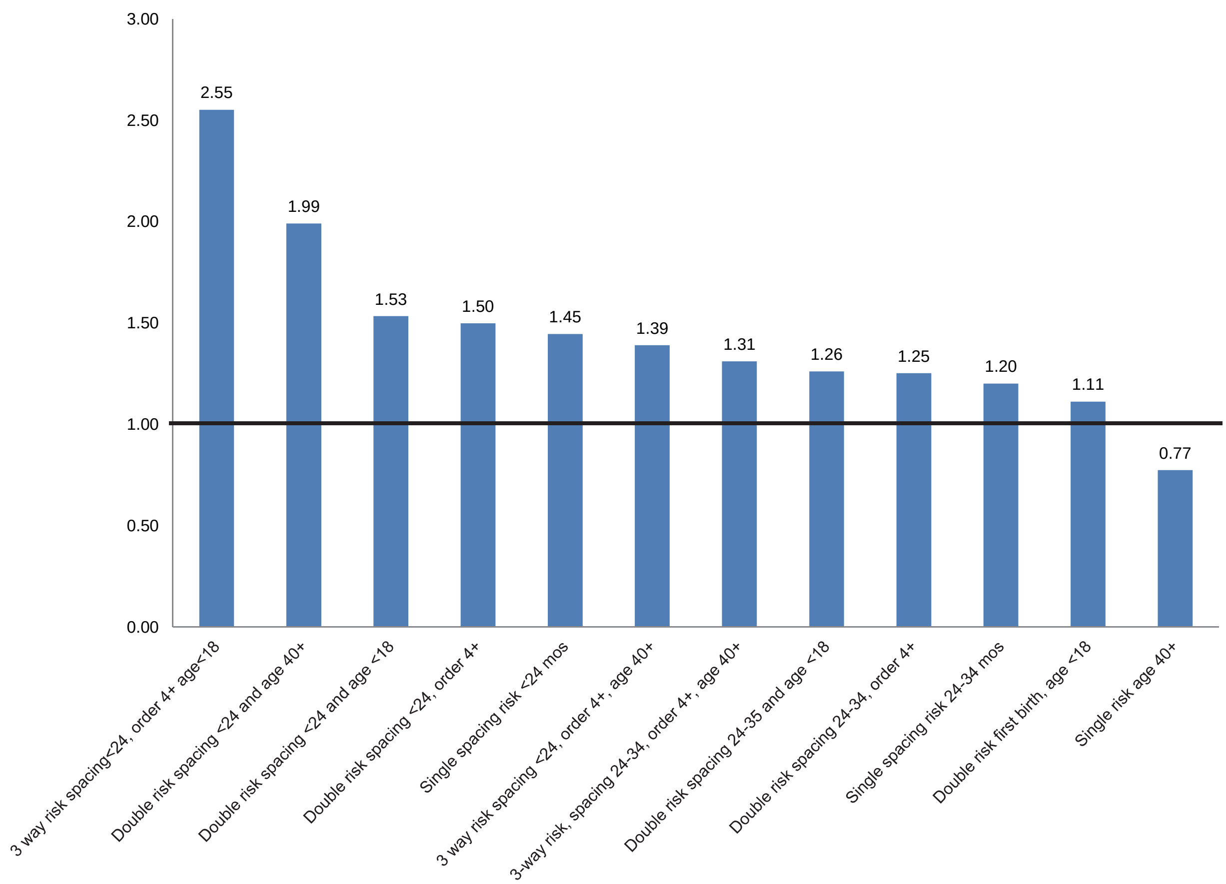
Table 18. Adjusted odds ratios for stunting, underweight, and wasting by the mother's fertility–related risk, living children age 0 to 59 months at survey, 45 DHS surveys, 2006–2012

	Stunting			Underweight			Wasting		
	aOR	CI-	CI+	aOR	CI-	CI+	aOR	CI-	CI+
Extra risk due to fertility pattern									
No extra risk (ref.)	**1.00**			**1.00**			**1.00**		
Unavoidable first-birth risk	1.01	0.99	1.04	1.06	1.02	1.09	1.11	1.06	1.17
Any single risk	1.13	1.10	1.16	1.12	1.09	1.15	1.01	0.97	1.05
Any double risk	1.24	1.21	1.27	1.20	1.17	1.24	1.01	0.97	1.06
Any 3-way risk	1.31	1.22	1.41	1.22	1.13	1.33	0.99	0.87	1.12
Total N	348,122			348,122			348,740		

Note: The adjusted models included the following variables:

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 or stillbirth), type of provider of prenatal care, type of provider of delivery assistance, number of prenatal tetanus injections, timing of first prenatal care visit, quintile of DHS Wealth Index, type of water supply, type of toilet facility, possession of refrigerator, duration of pregnancy, and whether preceding child died before conception of index child.

Figure 8. Adjusted relative odds of stunting by combinations of fertility behavior risk factors, 42 DHS surveys between 2006 and 2012



Discussion

Previous studies have well established the importance of the length of the preceding birth interval to the survival chances of a child through the neonatal, infant, and under–five years periods of life. The previous papers by the first author indicated that there is an optimal length of birth interval, namely, 36–59 months birth to birth. The current study extends and strengthens the analyses presented in those papers by:

- Adding analyses of two other fertility risk behavior characteristics: the mother's age at the child's birth and the birth order of the child;
- Analyzing a newer large data set, with 1,227,151 births (424,948 for neonatal and infant mortality, 1,176,384 for under age five multivariate analyses of mortality, and 348,769 living children under age five for stunting);
- Using all 45 surveys in the DHS program that took place between 2006 and 2012 for mortality analysis; using all 42 surveys with data on nutritional status;
- Using only unimputed data on birth–to–conception interval and singleton births; and
- As in the 52–country study (Rutstein 2008), for mortality analyses, using Cox proportional hazards regression to include additional data for children only partially exposed to the risk of mortality.

In general, the findings of this study confirm those of the first author's prior studies based on 17 and 52 different surveys (Rutstein 2008; Rutstein 2005). For neonatal mortality, the adjusted risk ratios indicate that risk of dying decreases with increasing birth–to–conception interval lengths up to 18 months[13] and rises again for conceptions after 48 or more months. This rise was indicated in the previous studies for birth intervals of five and more years, but the increase was not statistically significant in the 17–country study. The larger data sets now confirm that this rise is statistically significant for intervals of four or more years.

As in the 17–survey and 52–survey papers, the results for infant mortality are similar to those of neonatal mortality with the exception that the spacing interval of 18–23 months also has increased risk that is significant. For post–neonatal mortality, the fall of the risk of dying with increasing interval is again similar to those of early neonatal, neonatal, and infant mortality. Unlike the previous studies, however, there is an increase with duration of interval for children conceived 60 or more months after a preceding birth with 48–59 months being close to significant.

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 of 48 or more months. Similar results were found in the 52–country study.

For under–five mortality, which includes the effects of neonatal, post–neonatal, and child mortality, there are significant declines in risk as the interval increases up to the 60–95–month duration group. A significant small rise in risk is seen for conceptions occurring 96 or more months after a prior birth, shown by the 52–survey study as well.

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[13] The risk of dying decreases up to 29 months, but the decreases are not significant at the 95 percent level between 18-29 months.

Mother's age at birth has a U–shaped relationship with early neonatal, neonatal, post–neonatal, and infant mortality. This relationship persists even after adjusting for the preceding birth–to–conception interval, the child's birth order, and other potential confounders. Children born to young mothers (under age 18), for example, have a 20 percent greater risk of dying in the first year of life, and children born to mothers ages 35–39 and 40 or older have a 20 percent and 50 percent greater risk of dying in the first year of life, respectively. A different relationship is evident for mortality at age one to four years as the risk of dying decreases with increasing maternal age. It may be that the greater life experience of older mothers overcomes the biological effects of older age at birth for children older than 12 months.

Birth order is not significantly related to mortality during the neonatal period. After the neonatal period, however, increasing birth order results in increasing risk of dying, once confounding factors have been taken into account.

The more risk factors a child faces, the greater the risk of mortality, and certain combinations are especially deleterious to survival. The risk of being chronically malnourished (stunted 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, no leveling or increase occurs in the risk of being stunted or underweight for long birth intervals. No significant relationship exists 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 in the earlier 17–survey and 52–survey studies and for some studies in the systematic literature review by Dewey and Cohen (2007).

Increasing mother's age at birth lowers a child's risk of being stunted, but increasing birth order increases the risk. The risk of being underweight also decreases with mother's age at birth. Birth order is not related to being underweight once confounding factors have been taken into account. The number of risk factors a child faces increases the risk of chronic malnutrition (stunting and underweight) but is unrelated to wasting, similar to that found for the risk factors considered individually.

Members of the World Health Organization meeting who reviewed the previous 17–country article expressed concern about the mechanisms by which the length of intergenesic intervals could affect child mortality. The results shown for stunting and underweight (chronic and overall undernutrition) in the previous 52–survey study and those shown here 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 data set indicates that intervals longer than those traditionally acknowledged as having high risk, fewer than 24 months between births or fewer than 15 months birth–to–conception, have substantial impacts on the risks of mortality and of undernutrition. In this study, intervals of 18–23 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 of 18–23 months have elevated risks for post–neonatal mortality as well but the result is not quite at the 5 percent significance level. Intervals up through 35 months birth–to–conception (up through 44 months birth–to–birth) have significant elevated risks of child and under–five mortality.

Although the excess risk of mortality is highest for very short intervals (fewer than 12 months birth–to–conception), relatively few children are conceived at such intervals (13 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 potential declines in mortality by avoiding these intervals. Population–attributable risks (PARs) of under–five mortality are shown in Table 19 for intervals of fewer than 36 months between conception and the prior birth, for mother's age at birth under 18 years or 40 years or over, and for births of order four or higher.

The PAR for under–five mortality for avoiding conceptions at fewer than 36 months after a birth is 0.26. In other words, if all women would wait at least 36 months to conceive again, under–five deaths would fall by 26 percent. The PAR for mother's age at birth under age 18 or 40 or over is 0.03 and 0.04 for birth order four or higher. **Taken together, under–five mortality could be reduced by one third if women would wait at least 36 months to conceive again, have their children between ages 18–39 years, and not have more than three children.**

Finally, Figures 7, 8, and 9 show the effects of the preceding birth–to–conception interval, mother's age at the child's birth, and the child's birth order on the likelihood of having a living and thriving child. The figures show the relative risks for children to be both alive and not stunted. Clearly, the likelihood for children to survive and not be stunted is lowest for birth–to–conception intervals of fewer 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. Similarly, the optimal age for a mother to have her children born is between 25–39 years of age, and births before 18 years of age should be avoided.** The likelihood of being alive and not stunted decreases as birth order increases, becoming worse for children with orders higher than four.

Table 19. Calculation of population–attributable risks for infant and under–five mortality by duration of preceding birth–to–conception interval, mother's age at child's birth, and the birth order, 45 DHS surveys, 2006–2012

	Under–five mortality among children born 60 to 179 months prior to interview						
			Pooled*				
	Average U5MR	Total births	b	se	RR	PAR	Total deaths
Preceding birth–to–conception interval							
<36 months	0.111	509,421	0.59	0.01	1.80	0.26	56,546
36+ months (ref.)	0.054	345,800	0.00	0.00	1.00	0.00	18,673
first births	0.088	321,163	0.63	0.01	1.88	0.19	28,262
Total**	0.088	1,176,384					103,481
Mother's age at birth							
<18 or 40+ years	0.128	127,866	0.26	0.01	1.30	0.03	16,367
18–39 years (ref.)	0.083	1,048,518	0.00	0.00	1.00	0.00	87,027
Total	0.088	1,176,384					103,394
Birth order							
1–3 birth order (ref.)	0.081	771,608	0.00	0.00	1.00	0.00	62,500
4+ birth order	0.103	404,776	0.12	0.01	1.13	0.04	41,692
Total	0.089	1,176,384					104,192

U5MR: under–five mortality rate
b: weighted average coefficient; se: weighted average standard error of b
RR: adjusted relative risk; PAR: Population–attributable risk
* Weighted average using inverse of square of standard error as weights
** Total excludes 2770 births with missing birth interval data

Figure 9. Adjusted relative risk of being alive and not stunted at five years of age, by duration of preceding birth–to–conception interval

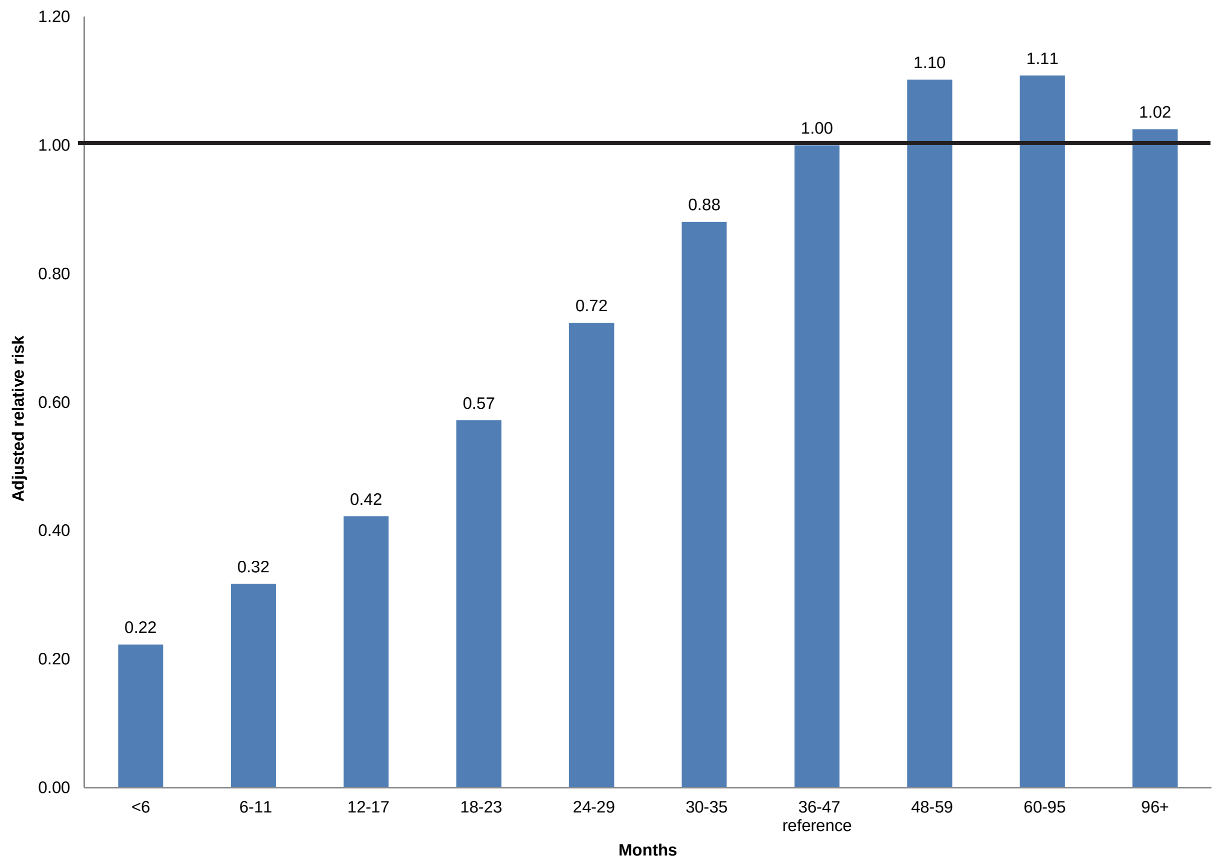


Figure 10. Adjusted relative risk of being alive and not stunted at five years of age, by mother's age at child's birth

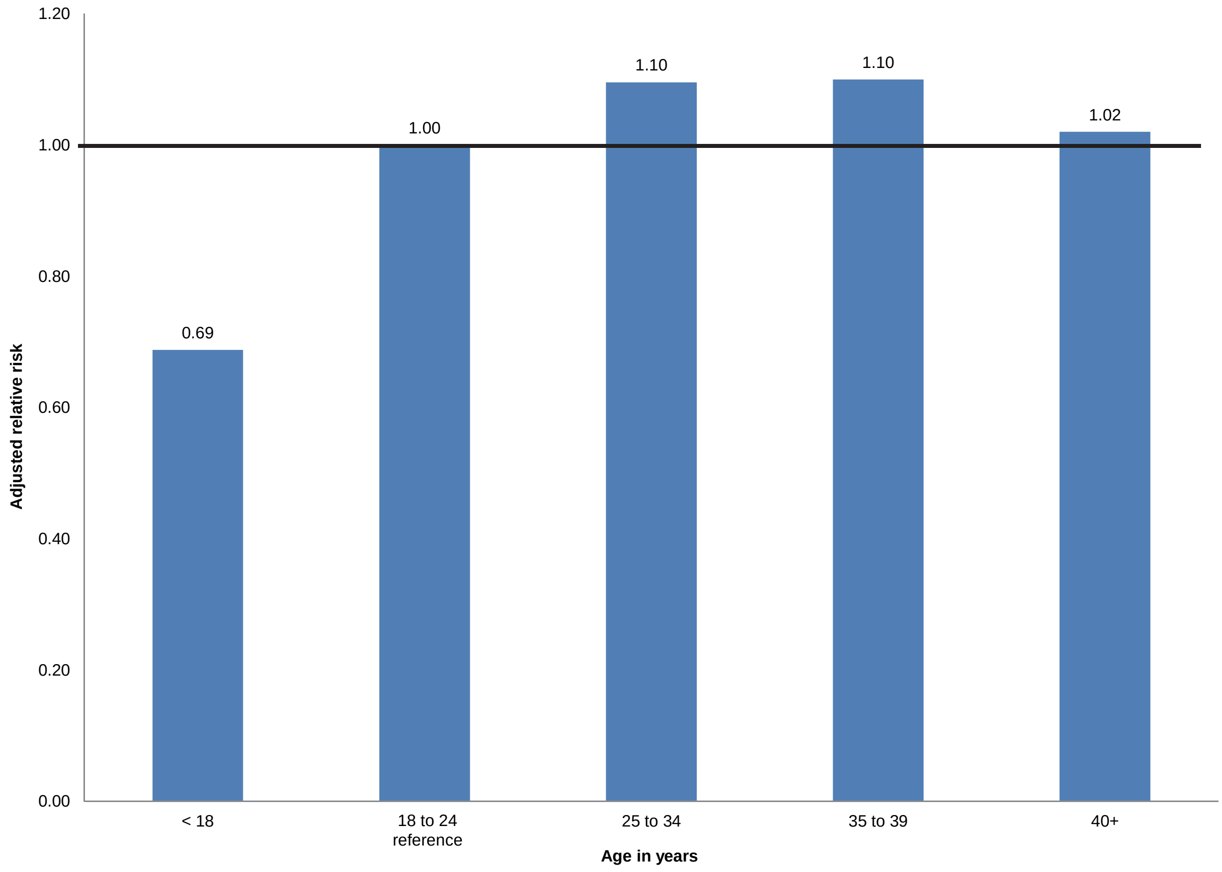
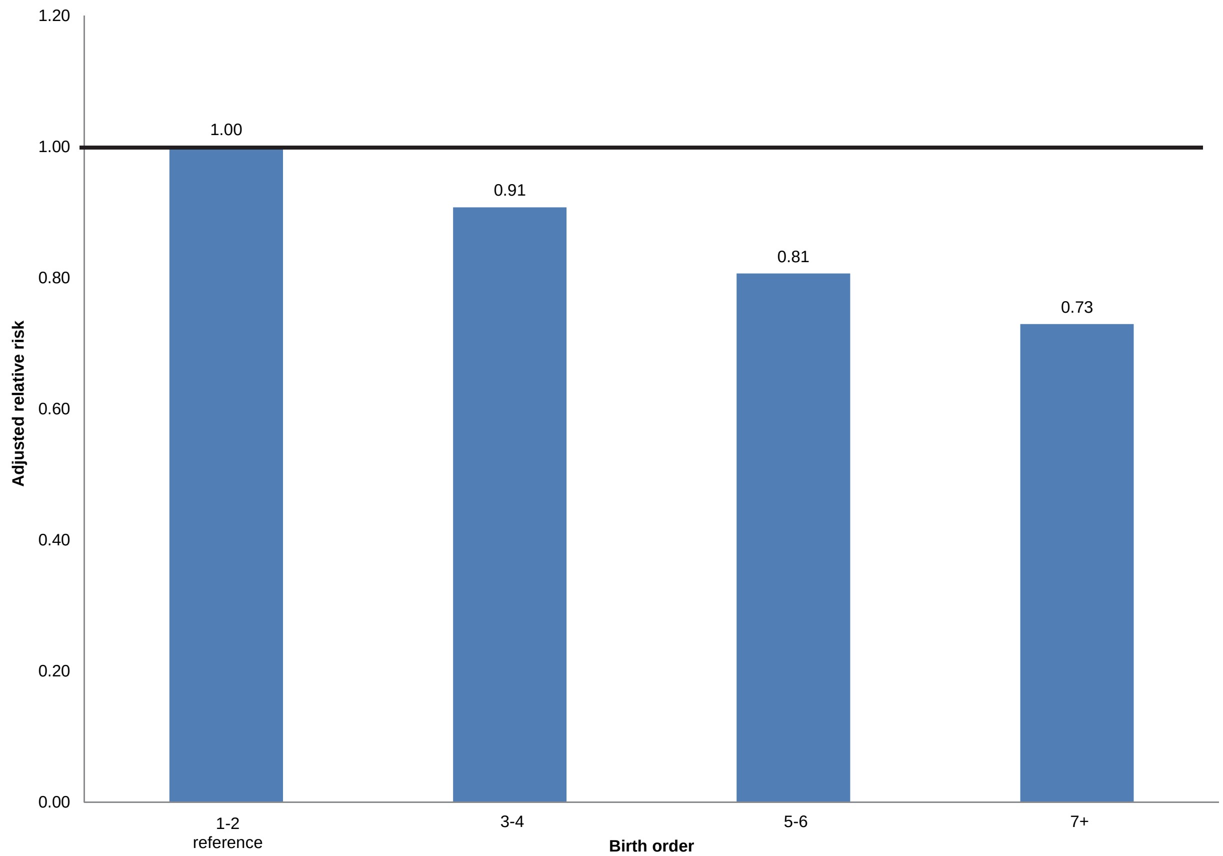


Figure 11. Adjusted relative risk of being alive and not stunted at five years of age, by child's birth order



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Appendix

Appendix Table A1. Distribution of births 0 to 179 months and 0 to 59 months prior to survey by control variables used in multivariate analyses, 45 DHS surveys, 2006-2012

	Births 0 to 179 months prior to the survey		Births 0 to 59 months prior to the survey	
Control variables	**Percent**	**Frequency**	**Percent**	**Frequency**
Control variables included in all multivariate models				
Sex of index child				
Male	51.2	628,039	51.1	217,328
Female	48.8	599,122	48.9	207,620
Type of place of residence				
Urban	33.5	411,419	33.3	141,657
Rural	66.5	815,742	66.7	283,291
Mother's highest educational level				
No education	38.1	466,938	34.1	144,766
Primary	32.2	395,385	32.2	136,621
Secondary	24.3	297,976	27.6	117,426
Higher	5.4	66,819	6.1	26,123
Wealth index quintiles				
Poorest quintile	24.9	305,817	24.8	105,404
Second quintile	21.5	263,481	21.4	90,928
Middle quintile	19.8	242,885	19.8	84,253
Fourth quintile	18.2	223,120	18.2	77,274
Wealthiest quintile	15.6	191,858	15.8	67,089
Household has refrigerator				
No	77.4	950,149	77.9	330,994
Yes	20.7	254,142	19.4	82,310
Missing	1.9	22,870	2.7	11,644
Type of toilet/latrine				
Flush toilet	27.0	331,922	25.4	107,990
Pit latrine	37.5	460,583	38.8	164,854
None	29.5	362,191	29.2	124,102
Other, missing	5.9	72,465	6.6	28,002
Source of drinking water				
Piped	35.6	437,419	34.7	147,246
Open well	17.8	218,486	17.1	72,702

(Continued...)

Appendix Table A1. – *Continued*

	Births 0 to 179 months prior to the survey		Births 0 to 59 months prior to the survey	
Control variables	**Percent**	**Frequency**	**Percent**	**Frequency**
Protected well	18.4	225,511	18.7	79,652
Surface	16.2	198,721	16.8	71,187
Rain	1.5	18,931	1.5	6,344
Tanker truck	1.1	13,825	1.1	4,638
Bottled	2.8	34,145	2.8	11,730
Other, missing	6.5	80,123	7.4	3,931
Length of gestation (months)				
7	.9	10,601	0.6	2,610
8	1.7	21,380	2.2	9,374
9	92.3	1,132,069	90.9	386,251
10 or more	5.1	63,111	6.3	26,713
Survival of preceding child				
Did not die	93.6	1,148,574	94.4	401,045
Preceding child died	6.4	78,587	5.6	23,903
Additional control variables included in models predicting early neonatal, neonatal, post-neonatal, and infant mortality				
Outcome of preceding pregnancy				
Live birth			62.5	265,752.0
Not a live birth			33.9	143,990.0
Not available			3.6	15,206.0
Time wanted pregnancy				
Then			73.0	310,405.0
Later			16.0	67,907.0
No more			10.5	44,793.0
NA			0.4	1,843.0
Pregnancy was result of contraceptive failure				
No			95.6	406,136.0
Yes			2.4	10,272.0
Not asked			2.0	8,540.0
Prenatal care provider				
Doctor			14.9	63,264
Nurse/Midwife			30.4	129,359
Other Medical			13.7	58,245
TBA			2.4	10,199

(Continued...)

Appendix Table A1. – *Continued*

Control variables	Births 0 to 179 months prior to the survey		Births 0 to 59 months prior to the survey	
	Percent	Frequency	Percent	Frequency
Other Person			28.7	122,128
No One			9.8	41,753
Delivery care provider				
Doctor			9.1	38,863
Nurse/Midwife			33.7	143,056
Other Medical			14.7	62,425
TBA			21.3	90,442
Other Person			17.5	74,253
No One			3.7	15,909
Prenatal tetanus injections				
None			17.4	74,111
One			14.3	60,617
2+			39.1	166,226
Missing, DK			29.2	123,994
Timing of first antenatal check				
No antenatal check			39.4	167,464
< 3 months			15.5	65,661
3-4 months			24.8	105,217
5-6 months			15.5	65,987
7-8 months			4.2	17,688
Ninth month			0.3	1,245
Doesn't know			0.4	1,645
Total	**100.0**	**1,227,161**	**100.0**	**424,948**

Note: Distributions and percentages are based on unweighted cases, since the application of standard individual country weights is not meaningful in the merged sample. Forty-three cases had missing information on maternal education, and 41 cases had missing information on timing of first antenatal check.