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Abstract

Evidence shows a strong relationship between child mortality and fertility at the aggregate level but the relationship at the individual level is less clear. Data from the 1993 Ghana DHS are used to examine the impact of infant death on a woman's subsequent fertility behaviour. Birth interval analysis, parity progression ratios, and multilevel discrete-time hazard models are used. Child replacement after infant death is found to be taking place in Ghana. On average, birth intervals are shortened by about 15 months if a child dies in the neonatal stage, and by about 11 months for postneonatal death. Progression to the next parity is higher if an infant dies than if it survives; the probability of progression is about 32% higher if a male child dies than if a female dies. A sustained decline in child mortality in Ghana is likely to result in further reduction in fertility.

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Child Loss and Fertility Behaviour in Ghana

by

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Introduction

The relationship between childhood mortality and fertility is of great interest particularly for countries currently experiencing a demographic transition. According to demographic transition theory, there is a strong correlation between childhood mortality and fertility. Empirical evidence has shown that a fall in child mortality is generally followed by a fall in fertility (Mondot-Bernard 1977; Knodel 1978; Vallin and Lery 1978). The recent demographic and health surveys (DHS) conducted between 1990 and 1995 indicate that under-five mortality in sub-Saharan Africa is now lower than three or four decades ago. Childhood mortality declined steadily between the 1950s and the early 1980s from levels as high as 400 deaths per 1000 live births (Hill 1993). Currently, under-five mortality averages about 170 deaths per 1000 live births in the region but varies substantially from about 77 in Zimbabwe to 318 deaths per 1000 births in Niger (Bicego and Ahmad 1996). However, there are indications that the decline in childhood mortality has slowed down in some countries; in others there is even a reversal. These trends are thought to be a result of unfavourable socio-economic conditions and recent epidemiological developments (Hill 1993; Brockerhoff and Derose 1996).

Improvements in child survival within the sub-continent have been associated with many factors. Better access to health services, expanded coverage of immunization, the use of oral rehydration therapy, access to potable water, and improved female literacy have contributed to reductions in childhood mortality (Brockerhoff 1995; Defo 1996; Lalou and LeGrande 1996). Other factors that may have contributed to better child survival are better sanitation and nutrition, and demographic factors such as longer birth spacing, lower parities, and childbearing at low-risk maternal ages.

Within the past two decades, fertility in a number of sub-Saharan African countries has declined although the region as a whole has registered only a minimal fall in total fertility, declining from an average of 6.6 children per woman in 1960 to 6.4 children per woman in 1994 (Lutz 1994). Notable among the countries participating in this recent fertility transition are Zimbabwe, Botswana, Kenya, and to a lesser extent, Ghana, Tanzania, Zambia, Cameroon, and Senegal. This marked fall in the rate of childbearing has been attributed to various factors including economic changes, a decline in childhood mortality, improvements in female literacy, and increased use of modern methods of contraception. Fertility reduction in these countries has been preceded by a long period of slow but fairly consistent child mortality decline. Data from the DHS for the early 1990s suggest that, with the exception of Zambia and Tanzania, none of the countries cited above had infant mortality rates above 70 deaths per 1000 live births.

Ghana's current population growth rate of 3.1 per cent per annum has been described as one of the highest in the world whilst GDP per caput continues to grow at a very slow rate of less than 0.5 per cent per annum (Republic of Ghana 1995). The total fertility in Ghana remained high and constant at about 7 children per woman until the late 1980s when it started to decline. Estimates for the past two decades put the levels at 6.7 children per woman for 1979/80, 6.4 for 1988 and 5.5 for 1993. Although fertility in Ghana is still high, the 14 per cent decline between 1988 and 1993 is quite remarkable and exceeds, by a modest margin, the 10 per cent fall suggested by many commentators to indicate the onset of irreversible demographic transition. A plausible explanation for this decline may be the continued improvement in child survival. The level of under-five mortality in Ghana has fallen from a high level of around 160 deaths per 1000 live births in the mid 1970s to about 120 in the early 1990s. Similarly, infant mortality declined from about 80 to 66 deaths per 1000 live births.

While there is no doubt about the relationship between child mortality and fertility at the aggregate level, the relationship at the individual woman-level is less clear, in particular, whether there is voluntary adjustment of subsequent childbearing in response to child survival or loss. Another area of uncertainty is that of son preference particularly for African communities. Do couples respond to male child loss differently from female child loss? The objective of this paper is to examine the extent to which the death of an infant in Ghana affects a woman's fertility through subsequent childbearing. In particular, the analysis will focus on the probability of having another child given the current family structure and the survival status of previous children. The possibility of son preference in Ghana will also be explored to see if there is a relationship between male child loss and subsequent fertility.

The Link between Child Mortality and Fertility

A comparison of recent under-five mortality and fertility rates for selected sub-Saharan African countries shows a positive correlation (Pearson's correlation coefficient = 0.76) confirming that in countries with high childhood mortality fertility is also high (see Figure 1). A similar relationship (not shown) was observed for infant mortality and total fertility.

[Figure 1 about here]

At an individual level, the association between the death of a child and the risk of childbearing has been attributed to two main strategies of reproductive behaviour: replacement and hoarding (Wolpin, 1998). Hoarding refers to the fertility response to expected mortality of offspring while replacement is the response to the experience of child mortality. Ben-Porath (1976, p.165) suggests that "where the age profile of deaths is such that replacement can reconstitute the family life cycle, replacement is superior to hoarding as a reaction since the latter involves deviations from what would be the optimum family life cycle in the absence of mortality". On the other hand, when the risk of mortality is significant beyond infancy, replacement may be biologically impossible or undesirable since the fertile period is finite (Ben-Porath, 1976). Thus, the reaction to mortality that is expected late in the family life cycle may be partly achieved through hoarding. Ben-Porath (1976) recognizes that hoarding and replacement are substitutes and, therefore, if couples have learnt to expect high mortality and respond to it by hoarding, then fertility should not respond strongly to actual mortality. Furthermore, the fertility decision making is a sequential process in which one child is born at a time, and in which there is time to respond to realized deaths (O'Hara 1975 cited in Wolpin, 1998; Ben-Porath 1976;Williams 1977).

Generally, women who experience infant deaths may go on to bear more children than those whose children survive through involuntary physiological or voluntary replacement mechanisms (Aaby 1992; Miller *et al.* 1992). The death of an infant results in an increase in parity, which is linked to the discontinuation of breastfeeding as well as the parent's desire to replace the dead child. Mondot-Bernard (1977) argues that the early death of an infant leads to a shorter interval to the next birth. This is brought about as a result of the abrupt weaning of the child and thus the premature return of the menstrual cycle. In their study, Choe *et al.* (1998) also found that the parity progression ratios among women whose index child died were much higher than for those whose index child survived. In situations where the child died in infancy, the ratio increased to over 90 per cent.

Breastfeeding is known to cause temporary infertility by prolonging the period of postpartum amenorrhoea but a child's death interrupts the process and allows ovulation to resume sooner (Van Ginneken 1974; Mondot-Bernard 1977; Knodel 1978). Thus, in the absence of contraception, an earlier subsequent pregnancy may occur. In 1978, Knodel examined the influence of infant mortality on fertility by comparing the birth intervals of a breastfeeding with that of a non-breastfeeding village. On average, women who did not breastfeed their children became pregnant sooner than those who did. He concluded that the effect of child mortality on birth intervals is closely linked to the influence of breastfeeding on fertility (Knodel 1978). In non-lactating women, the duration of amenorrhoea varies little and is estimated to be around 60 days; in lactating women the period varies and can extend up to 10 months (Van Ginneken 1974).

Partial breastfeeding is, however, less effective in suppressing ovulation so that the duration of amenorrhoea is longer when an infant is being fully breastfed compared to when the infant receives mixed feeding (Van Ginneken 1974). Knodel (1978) argues that in situations where deliberate attempts to control fertility are absent and where there is prolonged breastfeeding, the physiological effect of infant mortality on fertility should be apparent in a comparison of birth intervals following infant deaths with normal birth intervals (i.e. those in which the child survives the period of infancy).

The voluntary child replacement mechanism, on the other hand, applies to situations where couples make a conscious effort to replace children who die young until they arrive at some satisfactory number of surviving children. This desire to replace the child may be accomplished through increased coital frequency. The implicit assumption here is that couples are able to practice some means of family limitation once the desired number of children is achieved. If couples replace children who die young, one would expect those who experience the loss of a child at the start of their childbearing years to bear more children than those whose first few children survive. This relationship is, however, not entirely independent of the physiological effect of infant mortality on fertility. Women with more infant deaths would experience shorter birth intervals, and hence be able to bear more children in a given span of time.

The issue of son preference in Ghana has not been given much attention because earlier studies could not establish any gender discriminatory patterns among couples (Goody *et al.* 1981; Alderman 1990). However, there is a wealth of evidence to suggest that son preference still exists in some societies, particularly where there are strong patrilineal family systems. Choe *et al.* (1998) demonstrate that in some parts of Asia and Northern Africa, sons who belong to patrilineal societies are valued for their roles in providing economic and social support and sustaining the family lineage. In Ghana, preference for sons is covert in both patrilineal and matrilineal systems; for example, when resources are limited, boys rather than girls are sent to school.

In a recent study of the influence of traditional religion on fertility regulation among the Kassena-Nankana of Northern Ghana (a strong patrilineal community), Adongo *et al.* (1998)

found that lineage heads typically expressed a strong preference for sons because of the patrilocal system of inheritance. In matrilineal communities, although inheritance is through the female line, males are still considered to be the household heads and are responsible for making major decisions about the family (Republic of Ghana/UNICEF 1990). It is therefore likely that a preference for sons, though subtle, might exist within the Ghanaian population such that a couple may want to have another child soon after the death of a son until the required number of sons is achieved.

The preceding discussion can be summarized into the following testable hypotheses relating child loss to fertility behaviour:

- H_1 Mothers who lose their children in infancy have, on average, a higher probability of having a subsequent child.
- H_2 The earlier an infant's death occurs, the more quickly subsequent childbearing will be resumed.
- H_3 The effect of the death of a male child on subsequent fertility will be stronger than that of a female child.
- H_4 The number of surviving siblings will be negatively associated with subsequent fertility.

Data and Methods

The study uses data from the 1993 Ghana Demographic and Health Survey (GDHS) to examine the link between infant mortality and fertility. The 1993 GDHS was a nationally representative sample survey, which provided information on birth history, contraception, and other maternal and child health indicators for 4562 women aged 15-49 years. The drawback of these data is that the characteristics of the respondents including the use of contraception relate to the time of the interview and not to the date of birth of each reported child. Data on relevant child health indicators such as breastfeeding are also limited to births in the last three years. However, the three-year sample is too small to undertake any meaningful analyses, and in addition, the time interval is too short to expect any significant subsequent childbearing. As such, the analyses are confined to births occurring in the last ten years. It is assumed that the characteristics of the women did not change much during that period. The choice of the ten-year as opposed to a wider window is to ensure that the data are not seriously biased by recall errors of dates. The accuracy of the demographic parameters that need to be estimated in this paper depends on the reliability of the reported birth and death dates of these children.

The main analytical procedures used in this study to examine the link between infant mortality and fertility are median birth intervals (using life table techniques), parity progression ratios and discrete-time hazards models. The median birth intervals and parity progression ratios are used to examine the association between the sex and survival status of the index child and subsequent fertility without controlling for confounders. A parity progression ratio (PPR) is the probability that a woman will go on to have another child, given that she already has a certain number. Thus, replacement behaviour is measured as the difference between the PPR when there is no death and the PPR when there is a death (Vallin and Lery 1978; Wolpin 1998). PPRs are calculated for currently married women aged 35 years and over, that is women who have experienced much of their childbearing. Time to the next birth is truncated at 72 months in order to minimize errors in date reporting and to allow a sufficiently large proportion of the women to be included in the analysis. The median birth intervals are also calculated for births that occurred in the last 10 years to currently married women using a progression period of 72 months. This birth interval approach is used to measure the difference between birth durations conditional on having an additional birth under alternative mortality experiences (Knodel 1978; Defo 1998).

To examine how the survival status of the index child affects the timing of a subsequent birth, discrete-time hazards models are used. The dependent variable is whether or not the birth interval is closed by a subsequent live birth. In this analysis, the sex of the index child, the number of previous siblings and their sex composition are included to find out if they have an association with the probability that the subsequent birth interval is closed. The time to the next birth is considered as the survival time and variables such as the mother's age, type of union, ethnicity, religion, region, and the area of residence are included in the model as confounders. The year of birth of the child is also included as a dummy variable to account for changing trends in mortality. Since a short subsequent birth interval can contribute to the premature death of the index child, the possibility of reverse causality is controlled for by ensuring that only deaths which occur before the conception of the child who closes the interval are included. The effect of mortality in the model is thus represented by whether or not the index child died during its first year of life and before the conception date of the subsequent child.

The hierarchical nature of the data suggests that multilevel modelling is appropriate since some women have more than one birth in the 10-year period and it is possible that fertility behaviour may be correlated for births to the same woman. Evidence of clustering of mortality in Ghana was shown by Madise (1993) using the 1988 Demographic and Health Survey data. Other evidence of death clustering in African countries has been reported by Madise and Diamond (1995), Curtis and Steele (1996), and Manda (1998). Similarly, the sampling procedure for the 1993 GDHS was such that clusters of households were sampled and this introduces another level in the hierarchy. If the pace of childbearing is similar among women of the same cluster then failure to account for this would result in erroneous inferences. Thus, a three-level model will be used in the analysis.

The hazard rate is the conditional probability that an event occurs at time t, given that it has not already occurred. Assuming a logit link between the hazard rate and the explanatory variables, the three-level discrete-time hazards model can be expressed as:

$$\log\left(\frac{\mathrm{P}_{\mathrm{tijk}}}{1-\mathrm{P}_{\mathrm{tijk}}}\right) = a_t + \mathrm{x}'_{\mathrm{tijk}}\, b + w_{jk} + u_k$$

where

$\mathrm{P}_{\mathrm{tijk}}$	is the probability that the subsequent birth interval of the i^{th} child belonging to the j^{th} mother in the k^{th} cluster is closed,
$\mathrm{x}'_{\mathrm{tijk}}$	is a vector of covariates corresponding to the i^{th} child of the j^{th} mother in the k^{th} cluster which may take on different values at different discrete times,
a_t	is a function of time and is defined for birth intervals of 9-23 months, 24-35 months, 36-47 months, 48-59 months and 60-72 months,
b	is a vector of unknown regression parameters associated with the explanatory variables,
w_{jk}	is a residual error term associated with the j^{th} mother in the k^{th} cluster, and
u_k	is a residual error term associated with the k^{th} cluster.

The family-level error term, w_{jk}, is mother-specific and may stem from differences between women in potential fertility-limiting characteristics such as nutritional status, breastfeeding practices, or contraception. These factors are either unobserved or unobservable but they are likely to have an influence on a woman's reproductive behaviour and outcome. Similarly, the cluster effect, u_k, may arise as a result of similarities within a cluster of fertility behaviour such as taboos relating to sexual intercourse.

Multiple births have been excluded from all the analyses because the death of one twin may not significantly affect the length of the succeeding interval, as the other twin may still be breastfeeding. In any case, such births are rare in Ghana. Similarly, premarital births are not included since the interval between a premarital birth and the next birth tends to be long. The analyses also exclude children born to women who have ever been married but are currently not in a union because their exposure to the risk of pregnancy is not comparable to that experienced by those who are currently in union. For the discrete time hazards model, the analysis is limited to singleton children born in the last 10 years to currently married women aged 15-49 years. Births occurring 0-9 months prior to the survey are excluded as the mothers of these children are not yet exposed to the risk of a subsequent birth.

Bivariate Results

Effect of infant mortality on succeeding birth intervals

The variation in the median birth interval associated with an infant's death is examined by selected characteristics including parity, the sex of the child, the mother's education, ethnic affiliation, urban/rural place of residence, religion and marital history. Table 1 suggests that, overall, the median succeeding birth interval associated with a child who died in the first year of life was shorter by 14 months (or 36 per cent) compared with that of a child who survived the first year. The reduction was much larger if the child died at the neonatal stage (38 per cent) than at the postneonatal stage (28 per cent). This result supports the hypothesis that children are replaced more quickly if they die early in life than those who die at a later stage. This pattern is repeated for sub-groups of women. The reduction in the length of the succeeding birth interval after the death of the index child varies little according to the sex of the child, the mother's marital history, and the type of union. However, notable differences exist; for example, subsequent childbearing occurs much more rapidly for older mothers than for younger mothers if a child dies in infancy. Among the ethnic groups, the Ga-Adangbes and Ewes had, on average, a subsequent child much earlier after the death of an infant compared to other ethnic groups. Other differences were also noted between rural and urban residence and religion. An interesting finding is that among women with secondary or higher levels of education, the median birth interval for women whose child died in the postneonatal period is similar to the median for women whose children survived the postneonatal period.

Effect of infant mortality on parity progression ratios

The effect of child mortality on subsequent fertility is further illustrated by the cohort parity progression ratios calculated for all currently married women aged 35 years and over (Table 2). These ratios suggest that mothers who lose their children in infancy are much more likely to have another child than those whose children survive that period. The parity progression ratios are higher by about two per cent when the first born dies compared to when it survives for progression from first to second births. This difference increases substantially to about 11 per cent for progression from parity four to five.

[Table 2 about here]

By controlling for the number of dead children for higher order parities, it can be seen that the progression to the next higher parity increases with a higher number of dead children (Table 3). For example, women of parity three have a PPR of 0.931 if they have lost two or all three children while the PPR is 0.865 if all the children are alive. This lends some support to the fourth hypothesis that the number of surviving children is negatively associated with subsequent childbearing.

[Table 3 about here]

Table 4 gives the distribution of parity progression ratios by the survival status and the sex of the index child. The percentage difference in the PPRs when the index child survives or when the child dies (the replacement effect) was calculated for both males and females. On the whole, progression to the next parity appears to be faster when female children die compared to when male children die. For example, the replacement effect for women of parity three progressing to the fourth parity is about 8 per cent for females but about 7 per cent for males. However, these results do not take account of other confounding variables.

[Table 4 about here]

Table 5 examines the effect of the sex composition of surviving children on subsequent childbearing. At all parities, women who have more male surviving children proceed more quickly to the next parity than those with an equal number of boys and girls (the reference group). With the exception of the fifth birth, progression is also comparatively quicker for women with more female surviving children compared to those with the same number of boys and girls. Generally, women with only boys or girls progress more slowly than the reference group but those with only male children tend to progress faster after the fifth birth.

[Table 5 about here]

Discrete-time Hazards Multilevel Logistic Regression Analysis

The results from the discrete-time hazards multilevel logistic regression show that the survival status, birth order and sex of the index child, the place of residence, the mother's age at the birth of the child, her level of education, religion, ethnicity, the type of union, and the year of birth are the significant predictors of the risk of having a subsequent birth (see Table 6). The probability of having the next birth is also found to vary significantly with the length of time since the last birth. There is a significant interaction between the survival status and sex of the child and also between the time since last birth and place of residence, birth order, and ethnicity. The number of previous surviving children and their sex composition were not significant in this analysis.

[Table 6 about here]

Table 6 further indicates that after controlling for the explanatory variables, there is a significant variation between clusters but not between women. This variation is significant at the five per cent level of significance indicating unobserved significant variation in the risk of subsequent fertility behaviour between clusters of women. Following Im and Gianola (1988), the child-level variance is estimated to be $A^2/3$ for a standard logistic regression model so that the intra-cluster correlation coefficient for these data is about 0.78 per cent.
Since the between-cluster variance is significant, this means that the exponents of the estimates are interpreted as *average* odds ratios. Similarly the associated average probabilities are calculated by setting the cluster effect to zero. For example, compared to women aged 30 years or more, the average odds of progressing to the next birth for teenage women are about 18 per cent higher while the odds for women aged 20-29 years are about 44 per cent higher. The education estimates indicate that on average, women with secondary education are less likely to progress to the next birth compared to women without formal education. The exponents of the estimates for religion indicate that the average odds ratio of progressing to the next birth for Catholics is about 0.9, indicating a slightly lower likelihood for such women compared to those of other Christian denominations. Muslim women and women professing traditional religions are more likely to progress to another birth than women of other Christian denominations.

To interpret the interaction between the survival status and the sex of the index child, an interaction graph of the estimated average probabilities was constructed (see Figure 2). From the graph, it can be seen that the probability of a woman having a subsequent birth if the index child survives is the same whether the child is a boy or a girl. However, if the index child dies, then the woman is about 32 per cent more likely to have another child if the dead child is a boy compared to a girl. This lends some support to the hypothesis that the death of a male child is associated with a higher chance of having another child compared to the death of a female child.

[Figure 2 about here]

The association between subsequent childbearing and birth order shows that, overall, women with lower parities are more likely to progress to the next birth. Compared to second and third order births, the probability of progressing to the next birth within 72 months is higher by 11 per cent for first births, but 3 and 21 per cent lower for 4-6 and 7 or higher order births, respectively. However, for first, second, and third birth orders, over 40 per cent of women have their next birth between 36 and 48 months after the birth of the index child (see Figure 3). In the case of fourth and higher order births, progression to the next birth is more rapid, with nearly 40 percent of the women having another birth after an interval of between 24 and 36 months.

[Figure 3 about here]

The results also suggest that women living in urban areas are about 25 per cent less likely to progress to the next birth compared to those living in rural areas. However, women in the rural areas are more likely to progress to the next birth after 36 months while women in urban areas tend to have the next birth much earlier. Ethnic differentials are also observed but only the Ga-Adangbe, Ewe, and the Mole-Dagbani groups differ significantly from the Akans and the Guans who are the reference group. Overall, progression to the next birth is most common between 24 and 48 months for all groups; however, the probability of Ga-Adangbes and Ewes progressing to the next birth is lower by about 8 per cent compared to the reference group. Beyond 48 months, there are no real differences between the Ga-Adangbes and Ewes and the rest of the ethnic groups. For the Mole Dagbanis, the probability of progressing is about 6 per cent lower compared to the Akans and Guans but this difference in the risk of subsequent childbearing is more apparent before 36 months (see Figure 4).

[Figure 4 about here]

Discussion

The positive relationship between childhood mortality and fertility rates in sub-Saharan African countries has been documented in the literature (Olsen 1980; Cohen and Montgomery, 1998). At the individual woman level, child loss, particularly in infancy, has been shown to be related to subsequent childbearing (Ben-Porath 1976; Olsen 1980; Frankenberg 1998; Defo 1998). Our results confirm these findings that the death of an infant increases the probability of subsequent childbearing. The main causal link between infant death and subsequent childbearing is thought to be the cessation of breastfeeding, which in turn leads to the early resumption of ovulation. Grummer-Strawn *et al*. (1998) explain that the absence of breastfeeding alone accounts for about 64 per cent of the excess risk of a subsequent birth after an infant death. In their study, they found that, on average, child survival increased the birth interval by 60 per cent, postpartum amenorrhoea by 178 per cent and postpartum abstinence by 47 per cent across the 46 surveys studied.

In Ghana, where breastfeeding is almost universal during the first year of life, the duration of breastfeeding is naturally shorter if a child dies in infancy. The period of postpartum amenorrhoea is also shortened by about 67 per cent if the child dies and thus, subsequent conception would be expected to occur earlier in the absence of contraception. There is evidence of voluntary replacement behaviour in Ghana; the average duration of postpartum abstinence is about 9 months when the child survives infancy, but only 5 if the child dies. Similarly, the use of contraception is about 57 per cent less when the child dies. Rahman (1998) found similar replacement behaviour among women in rural Bangladesh.

The findings from this study also show that the earlier an infant dies, the more quickly subsequent childbearing is resumed. The median birth intervals if a child died during the neonatal period was about 24 months while that associated with a child death during the postneonatal period was about 28 months. Frankenberg (1998) and Defo (1998) found similar results using data from Indonesia and Cameroon, respectively.

It has been argued that son preference in Africa is not as strong as in Asian countries. Goody *et al.* (1981), using data from Ghana, concluded that the apparent son preference in the data was an artefact of the data due to higher male mortality. However, their study used bivariate contingency analysis without controlling for confounders. Indeed, the bivariate results from our study suggested a faster pace of childbearing when a female child died but this was reversed in the multivariate analysis. Our results from the discrete-time hazards multilevel model suggest that if a male child dies, progression to the next birth is about 32 per cent higher than if a female dies. This provides some evidence of son preference. Sons are preferred because of their perceived utility in extending the lineage and providing social and economic support. Another reason why there is son preference is that in many societies males inherit property and not females.

Although there was no strong link between the number of surviving children and subsequent childbearing in this study, there is evidence that family size is a strong predictor of subsequent childbearing. Ghanaian women with lower parities are more likely to progress to the next birth compared to women of higher parities. However, the timing of the next birth indicates that women with three or fewer children progress much more slowly (typically after three to four years) while women of higher parities progress within two to three years. This is consistent with expectation since the average birth interval of women with many children is short compared to women of the same age but with fewer children.

There are also large educational differences in the probability of progressing from one birth to the next birth. Primary, secondary and higher levels of education are negatively associated with subsequent fertility. A plausible explanation is the link between education and occupation. Women who are in wage employment (a disproportionately high number of which have some education) may find that such work is incompatible with frequent childbearing. Women with some education are also more likely to be using contraception; about 29 per cent of women with education were using contraception compared to only 8 per cent of those with no education in the 1993 demographic and health survey.

The ethnic differences in subsequent fertility behaviour may be explained by the differences in breastfeeding and contraceptive behaviour. The pattern demonstrated by the Mole-Dagbanis is consistent with communities who practice prolonged breastfeeding and postpartum sexual abstinence, but who do not use contraception. On average, this ethnic group breastfeeds for a period of about 29 months (compared to an average of about 20 months). Such prolonged breastfeeding may lengthen the amenorrhoiec period. The Mole-Dagbanis also practice longer postpartum sexual abstinence. Consequently, they are more likely to resume childbearing later than women from other tribes. Since the fertility-inhibiting effect of breastfeeding wanes with time, it is not surprising to see that the probability of having a subsequent birth increases after 36 months. In the case of the Ga-Adangbes and Ewes, their comparatively low probability of progressing to the next birth may be attributed to their higher level of contraceptive use (28 per cent) compared to other ethnic groups (about 20 per cent).

The pattern demonstrated by the relationship between childhood mortality and subsequent childbearing between rural and urban women is again consistent with contraceptive behaviour; the proportion of urban women using contraception is double that of rural women. About one-quarter of the urban women had the next birth after an interval of between 24 and 35 months which might indicate deliberate spacing behaviour to attain ideal intervals of about two to three years. The religious differentials may reflect differences in beliefs about the length of the postpartum sexual taboo and use of contraception (Defo 1998). Muslims, for example, are required to observe 40 days of postpartum sexual abstinence (i.e. the taboo only remains in force for as long as the bleeding lasts). In the absence of contraception, such women are likely to fall pregnant again quickly.

The lack of significance of the family-level variance in the discrete-time hazards model may perhaps reflect that the chance of subsequent childbearing is largely explained by the variables included in the model. Variables such as the survival status and sex of the index child, the birth order, maternal age, the level of education, ethnicity, and religion may explain much of the differences in fertility behaviour between women. The cluster or community-level parameter is small but significant at the 5 per cent level, suggesting that there is heterogeneity in fertility behaviour between communities. This is not surprising, since in low contracepting countries, the main mechanisms for controlling fertility such as abstinence and breastfeeding operate at the community level. Women in a community, especially in rural areas, tend to be of the same ethnic group and they are likely to have similar beliefs and practices for spacing births. Contraceptive use also tends to be clustered, with those communities which have better access to family planning services exhibiting higher levels of use (Steele, Curtis and Choe 1999; Tuoane, Diamond and Madise1999).

Summary and Conclusion

The analyses of median birth intervals, parity progression ratios and multilevel discrete time hazards regression estimates have shown that a link exists between the death of a child and subsequent childbearing in Ghana. Without controlling for confounders, birth intervals are shortened by 14 months, on average, if a child dies in infancy compared to the case where the child survives. The speed with which a birth interval is closed is also dependent on the timing of death of the infant. If a child dies at the neonatal stage, the length of the interval is shortened by 15 months compared to a reduction of 11 months when the death occurs at the postneonatal stage. These results are supported by findings from research done by Defo (1998), Grummer-Strawn *et al.* (1998), Knodel (1978), and Vallin and Lery (1978). The parity progression ratios also show that, at all parity levels, the rate of progression is higher if an infant dies than if it survives.

Similarly, when relevant predictors are controlled for, the probability of progressing to the next birth is raised by a substantial amount if a child dies relative to when the child survives. This is particularly true for male children. Fertility behaviour appears to be correlated for women within a community and this may be attributed to factors such as the duration of postpartum abstinence, breastfeeding, and contraception, which were not included in the model. In all, the current fertility decline in Ghana is occurring in an environment where the practice of child replacement appears to be taking place, as suggested by the progression to the next birth of those who lose their children in infancy. Therefore, a sustained decline in childhood mortality is very likely to have prospects for further reductions in fertility.

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Table 1 Median succeeding birth intervals in months for singleton births occurring in the last 10 years to currently married women who progressed within 72 months. Ghana, 1993.

Background Characteristics	Index child survives the 1st year of life	Index child dies during the 1st year of life and before the conception date of next child at			Reduction in median birth interval associated with the death of the index child at		
		0 mth	1-11 mths	0-11 mths	0 mth	1-11 mths	0-11 mths
Overall	39	24	28	25	15	11	14
Parity							
1-2	38	26	28	27	12	10	11
2-3	37	24	32	26	13	5	11
3-4	39	26	27	27	13	12	12
4-5	40	24	31	25	16	9	15
5-6	39	21	32	23	19	8	17
Sex of child							
Male	39	23	27	24	16	12	15
Female	40	25	29	27	15	11	13
Mother's age at birth of child							
< 20	39	25	28	27	14	11	12
20-29	38	24	28	25	14	10	13
30+	46	24	28	25	22	18	21
Mother's education							
None	38	24	30	27	14	8	11
Primary	40	23	24	24	17	16	16
Secondary & above	58	45	58	45	13	0	13
Mother's ethnicity							
Akan/Guan	39	24	31	25	15	8	14
Ga-Adangbe/Ewe	43	24	24	24	19	19	19
Mole Dagbani	39	25	29	27	14	10	12
Other	37	25	28	27	12	9	10
Usual Place of residence							
Rural	38	24	29	26	14	9	12
Urban	48	25	25	25	23	23	23
Religion							
Catholic	41	28	29	29	13	12	12
Other Christian	40	23	24	24	17	16	16
Muslim	38	23	28	25	15	10	13
Traditional/none	38	25	31	28	13	7	10
Marital history							
In 1st union	39	24	28	25	15	11	14
In 2nd or higher union	40	24	27	26	16	13	14
Type of union							
Monogamous	39	24	28	25	15	11	14
Polygamous	40	24	28	26	16	12	14

Table 2 Cohort parity progression ratios for currently married women aged 35 years and above by the survival status of index child. Ghana, 1993.

Parity	All children	Survival status of index child		
		Alive	Dead	% Difference
1	0.978	0.978	1.000	2.20
2	0.948	0.948	0.996	5.06
3	0.873	0.873	0.960	9.97
4	0.843	0.842	0.933	10.81
5	0.791	0.791	0.856	8.22
6	0.721	0.724	0.821	13.40

Note: n =1007 births, excludes premarital births.

Table 3 Cohort parity progression ratios for currently married women aged 35 years and above by number of dead children. Ghana, 1993.

Parity	Parity progression ratios	% Difference
First to Second		
No infant death	0.978	---
Child dies in infancy	1.000	2.2
Second to third child		
No infant death	0.941	--
One or more infant deaths[a]	0.990	5.2
Third to fourth child		
No infant death	0.865	---
One infant death	0.883	2.1
Two or more infant deaths	0.931	7.1
Fourth to fifth child		
No infant death	0.832	---
One infant death	0.841	1.1
Two or more infant deaths	0.929	11.7

Note: n=1007 births, excludes premarital births.
[a] There were too few cases to separate the number of dead children into more than one group.

Table 4 Cohort parity progression ratios for currently married women aged 35 years and above by survival status of index child standardized by sex of child. Ghana, 1993.

Parity	Male			Female		
	Alive	Dead	Replacement Effect (% Difference)	Alive	Dead	Replacement Effect (% Difference)
1	0.991	0.995	0.40	0.987	0.994	0.71
2	0.957	0.991	3.55	0.962	0.991	3.01
3	0.896	0.958	6.92	0.888	0.957	7.77
4	0.847	0.931	9.92	0.855	0.927	8.42
5	0.798	0.865	8.40	0.796	0.883	10.93
6	0.724	0.797	10.08	0.722	0.806	11.63

Note: n=1007 births, excludes premarital births.

Table 5 Parity progression ratios for currently married women aged 35 years and above by sex composition of surviving children. Ghana, 1993.

	All children	Sex Composition of Surviving Children					% Difference			
		Both sexes			Single sex		(2)-(1)	(3)-(1)	(4)-(1)	(5)-(1)
		Equal male & female (1)	More male (2)	More female (3)	Males Only (4)	Females Only (5)				
1	0.978	-	-	-	0.985	0.977	-	-	-	-
2	0.948	0.963	-	-	0.950	0.951	-	-	-1.35	-1.25
3	0.873	0.919	0.937	0.929	0.882	0.873	1.96	1.09	-4.03	-5.01
4	0.843	0.853	0.872	0.898	0.847	0.848	2.23	5.28	-0.70	-0.59
5	0.791	0.805	0.826	0.802	0.822	0.776	2.61	-0.37	2.11	-3.60
6	0.721	0.728	0.758	0.733	0.734	0.711	4.12	0.69	0.82	-2.34

Note: n=1007 women, excludes premarital births.

Table 6 Parameter estimates for the multilevel discrete-time hazards model for the odds of progressing to another birth. Ghana, 1993.

Parameter	Estimate	Standard error
Constant	-1.396	0.115
Survival status of index child in infancy		
Survives (Ref.)	0.000	---
Dies	1.787***	0.152
Birth order of child		
First	-0.104	0.118
2-3 (Ref.)	0.000	---
4-6	0.080	0.104
7+	-0.232*	0.141
Sex of Child		
Male	0.000	---
Female	0.029	0.044
Usual place of residence		
Rural (Ref.)	0.000	---
Urban	-0.362***	0.110
Mother's age at birth of child		
<20	0.164*	0.097
20-29	0.368***	0.064
30+ (Ref.)	0.000	---
Mother's level of education		
None (Ref.)	0.000	---
Primary	-0.123**	0.055
Secondary & above	-0.583***	0.119
Mother's ethnic background		
Akan/Guan (Ref.)	0.000	---
Ga-Adangbe/Ewe	-0.277**	0.121
Mole-Dagbani	-0.372***	0.123
Other	-0.157	0.141
Religion		
Catholic	-0.110*	0.066
Other Christian (Ref.)	0.000	---
Muslim	0.167**	0.081
Traditional/None	0.108*	0.066
Year of birth of child		
1983-1988	0.000	---
1989-1993	-1.430***	0.046
Time since birth of index child		
9-23 months (Ref.)	0.000	---
24-35 months	0.881***	0.115
36-47 months	1.043***	0.126
48-59 months	0.190	0.148
60-72 months	-0.776***	0.234

*** =P<0.01 **=P<0.05 *=P<0.10

Note: n = 5066 singleton births occurring in the last 10 years to currently married women.

Table 6 continued

Parameter	Estimate	Standard error
Interaction Effects		
Survival status*sex of index child	-0.588***	0.202
Area of residence and time		
Urban*time 24-35 mths	-0.106	0.138
Urban*time 36-47 mths	-0.329**	0.151
Urban*time 48-59 mths	0.152	0.171
Urban*time 60-72 mths	0.204	0.232
Birth order and time		
Birth order 1*time 24-35 mths	0.243	0.151
Birth order 1*time 36-47 mths	0.227	0.165
Birth order 1*time 48-59 mths	0.476**	0.190
Birth order 1*time 60-72 mths	0.808***	0.265
Birth order 4-6*time 24-35 mths	-0.005	0.135
Birth order 4-6*time 36-47 mths	-0.298**	0.149
Birth order 4-6*time 48-59 mths	-0.169	0.175
Birth order 4-6*time 60-72 mths	-0.106	0.263
Birth order 7+*time 24-35 mths	0.041	0.186
Birth order 7+*time 36-47 mths	-0.385*	0.210
Birth order 7+*time 48-59 mths	0.000	0.000
Birth order 7+*time 60-72 mths	-0.791*	0.468
Ethnicity and Time		
Ga-Adangbe/Ewe*time 24-35 mths	0.196	0.155
Ga-Adangbe/Ewe*time 36-47 mths	-0.133	0.174
Ga-Adangbe/Ewe*time 48-59 mths	0.341*	0.196
Ga-Adangbe/Ewe*time 60-72 mths	0.603**	0.260
Mole-Dagbani*time 24-35 mths	0.129	0.148
Mole/Dagbani*time 36-47 mths	0.440***	0.159
Mole/Dagbani*time 48-59 mths	0.273	0.201
Mole/Dagbani*time 60-72 mths	0.468*	0.279
Other*time 24-35 mths	0.190	0.178
Other*time 36-47 mths	0.234	0.199
Other*time 48-59 mths	0.475**	0.238
Other*time 60-72 mths	-0.536	0.469
Random effects		
Cluster (Φ^2)	0.026**	0.013

*** =P<0.01 **=P<0.05 *=P<0.10

Note: n = 5066 singleton births occurring in the last 10 years to currently married women

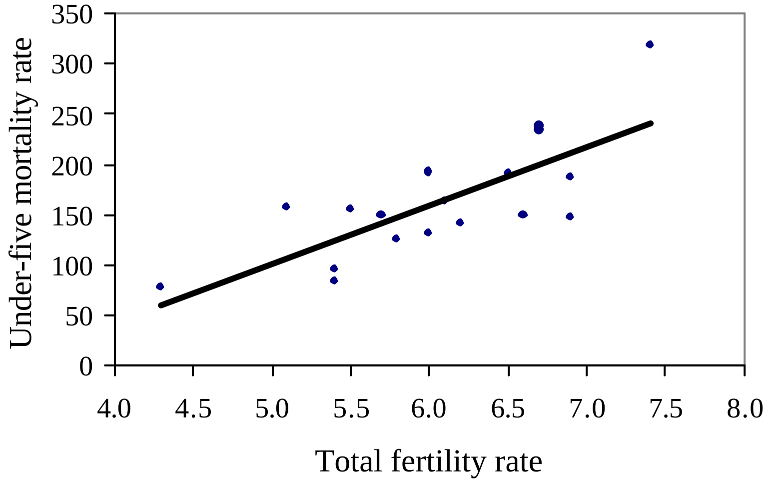

Figure 1 A scatter plot of under-five mortality and total fertility rates for selected countries in sub-Saharan Africa

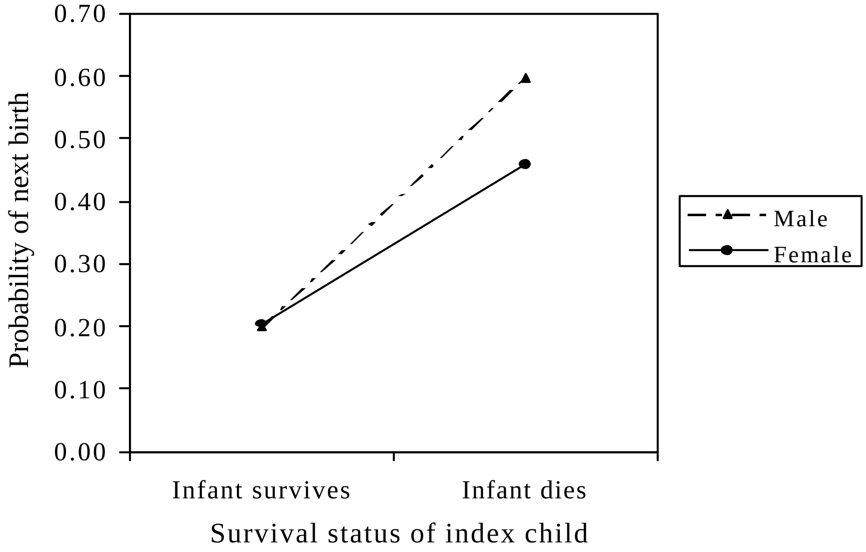

Figure 2 Interaction graph showing the relation between survival status and sex

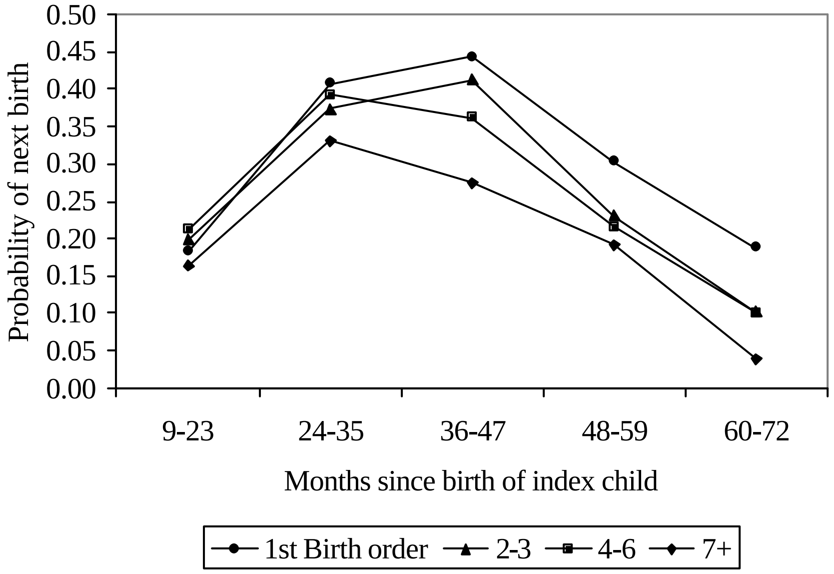

Figure 3 Probability of having a subsequent birth by birth order of the index child

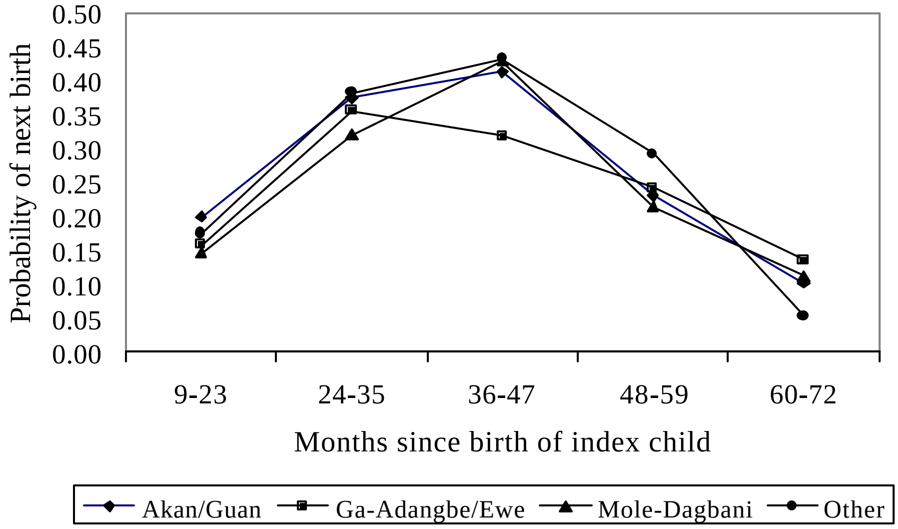

Figure 4 Probability of having a subsequent birth by ethnic group, Ghana 1993

Appendix

Data for Figures

Figure 1 Under-five mortality and total fertility rates for selected countries in sub-Saharan Africa (DHS surveys, 1990-1995)

Country	*Year*	*TFR*	*Under-five mortality*
Namibia	1992	5.4	83
Kenya	1993	5.4	96
Ghana	1993	5.5	155
Cameroon	1991	5.8	126
Senegal	1992/1993	6.0	131
Rwanda	1992	6.6	150
Madagascar	1992	6.1	163
Burkina Faso	1993	6.9	187
Zambia	1992	6.5	191
Nigeria	1990	6.0	192
Malawi	1992	6.7	234
Niger	1992	7.4	318
Tanzania	1991	6.2	141
Central African Republic	1994	5.1	157
Zimbabwe	1994	4.3	77
Cote D'Ivoire	1994	5.7	150
Uganda	1995	6.9	147
Mali	1995	6.7	238

Figure 2 Probability of having the next birth by survival status of index child. Ghana, 1993

Survival status of index child	Sex of child	
	Male	Female
Infant survives	0.1985	0.2032
Infant dies	0.5965	0.4581

Figure 3 Probability of having the next birth by birth order of index child.

Ghana, 1993

Birth order of child	Months since birth of index child				
	9-23	24-35	36-47	48-59	60-72

1	0.1825	0.4073	0.4430	0.3029	0.1873
2-3	0.1985	0.3741	0.4127	0.2304	0.1023
4-6	0.2114	0.3918	0.3610	0.2150	0.0999
7+	0.1641	0.3305	0.2750	0.1919	0.0394

Figure 4 Probability of having the next birth by ethnic group, Ghana 1993

Ethnic group	Months since birth of index child				
	9-23	24-35	36-47	48-59	60-72
Akan/Guan	0.1985	0.3741	0.4127	0.2304	0.1023
Ga-Adangbe/Ewe	0.1581	0.3553	0.3180	0.2421	0.1364
Mole-Dagbani	0.1458	0.3190	0.4291	0.2134	0.1114
Other	0.1747	0.3819	0.4316	0.2917	0.0540