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SIBLING MORTALITY CORRELATION IN KENYA

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Summary. This paper examines whether infant and child mortality risks among successive siblings are closely correlated, and if so, whether the survival status of the preceding child is an important factor affecting infant and child mortality in Kenya. The data were drawn from the 1988/89 Kenya Demographic and Health Survey. Logistic regression was used as the major method of data analysis. The results show that both infant and child mortality rates are significantly higher among subsequent children whose preceding siblings had died in infancy than for those whose preceding sibling had survived through infancy. The effect of the survival status of the preceding child on infant mortality was statistically strong, even after a large number of control variables were taken into account. However, its effect on child mortality appears to be spurious since it was rendered statistically insignificant when just a few control variables were introduced into the analysis. The results provide empirical evidence that infant and child mortality risks among successive siblings are closely correlated in Kenyan families, and that the effect of the survival status of the preceding child is important in determining infant mortality but not child mortality.

Introduction

This paper seeks to examine whether or not there is intra-family mortality correlation between two successive siblings in Kenyan families. Studies conducted in Nepal (Gubhaju, 1984; Pant, 1995), Bangladesh (Majumder, 1989; Gubhaju, 1984; Zenger, 1993), Indonesia (Hull & Gubhaju, 1986), India (Das Gupta, 1990), Uganda (Ebong, 1993), Zimbabwe (Jhamba, 1995), Guatemala (Guo, 1993) and Brazil (Curtis, Diamond & MacDonald, 1993) indicate a tendency for infant and child deaths to cluster in certain families. Most of these studies indicate that the mortality risk of the subsequent child is significantly higher when the preceding child has died, and that the survival status of the preceding child is an important factor determining infant and child mortality. For instance, in Nepal the risk of infant and child mortality was found to be substantially higher for children whose immediately preceding sibling was dead than for children whose immediately preceding sibling was alive (Gubhaju, 1984). A similar result was obtained by Pant (1995). A study of 10,358 singletons in Uganda found a significantly higher infant mortality risk among subsequent children whose preceding siblings had died in infancy; their odds of dying were 63% higher than those of subsequent children whose immediately preceding siblings were alive (Ebong, 1993).

The influence of the survival status of the preceding child on the mortality risk of the index child has been explained in terms of the existence or lack of sibling competition for maternal attention and household resources (Hobcraft, 1987; Koenig *et al.*, 1990). The increased risk of mortality of an index child preceded by a sibling who died could be due to shared common biological, social and even behavioural problems affecting the mothers of such children (Winikoff, 1983; Eberstein & Parker, 1984; Hobcraft, 1987; Cramer, 1987; Das Gupta, 1990; Aaby, 1990; Guo, 1993; Sastry, 1997). For example, Das Gupta (1990) argued that death clustering may be explained mainly by abilities and personality characteristics of the mothers, independently of education, occupation, income and wealth. In a more recent study, Das Gupta (1997) found significant evidence of death clustering only in the lowest socioeconomic and educational groups in rural Punjab. Her study also indicated that short birth intervals and high parities were not the cause of clustering of child deaths. Ronsmans (1995) adds that, in the case of Senegal, the different ecological settings in which children of different families grow up is another possible explanation for death clustering.

In the recent past there have been attempts to establish empirically the existence of death clustering in Kenya. In their illustrative study using mother-based measures, Zaba & David (1996) found that there was evidence of death clustering in Kenya. They found a close link between high parity and increased mortality risk, but their study did not focus on whether intra-family variation in mortality was related to the experience of close siblings. Similarly, in their comparative study of Bolivia, Kenya, Peru and Tanzania, Curtis & Steele (1996) found that in Kenya, as in the other three countries, there was a close family association in neonatal mortality risks. The strength of this association was similar in the four countries. In their view, these results suggest a biological explanation for the association.

This paper examines sibling mortality correlation in Kenya because little is known about the effect of the survival status of the previous child on the mortality risk of the subsequent child or children in this country. Previous studies on child survival in Kenya have not focused explicitly on this issue. However, a close examination of the meaning of some of the names that Kenyan parents give their children seems to suggest that infant and child mortality risks among siblings tend to be closely correlated, and that the survival status of the preceding child seems to be an important determinant of infant and child mortality. For example, among the Iteso people, the name *Etyang* is given to a newborn child whose preceding sibling(s) have died in infancy. Similarly, among the Luhya and the Luo the names *Makhokha* and *Wenwa*, respectively, are given to such newborn children. These names are an admonition to death to stay away. Social class seems not to be an important differentiating factor because children bearing such names can be found in any household in these communities.

As indicated earlier, studies done elsewhere suggest that death clustering is an important factor in early childhood mortality and its reduction in developing countries (Gubhaju, 1984; Pant, 1995, Majumder, 1989; Hull & Gubhaju, 1986; Das Gupta, 1990; Ebong, 1993). For instance, the study by Das Gupta (1990) in rural Punjab, India, showed that clustering of deaths in the same families accounted for a very high proportion of the child deaths reported by the respondents. The results obtained showed that 67% of the 2935 women sampled experienced no child deaths, and 12·6% of the women experienced multiple child loss and accounted for 62·2% of all the 1580 child deaths that occurred among sampled women.

It is therefore worthwhile to investigate whether in the Kenyan context there is a close correlation between the mortality risk of two successive children born to the same mother and whether the death or survival status of the previous child is a determinant of infant and child morality. This paper aims to establish whether infant and child deaths among successive siblings are closely correlated, and if so, to establish whether the survival status of the preceding child is an important factor in infant and child mortality in Kenya. In this study, it is assumed that mortality risks among successive siblings tend to be closely correlated in Kenya and that the survival status of the preceding child or sibling is important in determining both infant and child mortality.

Source of data

The data for this study were drawn from the 1988/89 Kenya Demographic and Health Survey (KDHS). The 1988/89 KDHS was conducted between December 1988 and May 1989 to collect data on fertility, family planning, and maternal and child health. It was carried out by the National Council for Population and Development (NCPD) in collaboration with the Institute of Resource Development (IRD), Westinghouse (USA). as part of the worldwide DHS programme. The survey covered a national representative sample of 7150 women aged 15–49 years and a sub-sample of 1116 husbands of these women. The sampling methodology used and the sampling and weighting procedures are presented and discussed in the first report of the survey (NCPD, 1989).

The survey provides a retrospective maternity history of the sampled women. Data were obtained on date of birth, sex, survival status, and current age or age at death of each live birth. These maternity histories constitute the database for this study. A sub-set of data, where children were taken as the unit of analysis, was created by extracting data from the mother's birth history and joining them with her personal characteristics.

Detailed assessment of the quality of the data reported by Ikamari (1996) and Brass (1993) indicates modest mis-statement of age among mothers, and a few omissions of births and deaths among some older women aged 35–49 years, despite the numerous checks and series of questions asked during the 1988/89 KDHS to obtain an accurate maternity history of each respondent. The tendency of older women to fail to report all their children, alive and dead, is often attributed to their inability to recall accurately the number of children who were born or died in the distant past. In Kenya, as well as in other developing countries, cultural factors may also contribute to the omission of certain births and deaths, particularly by older mothers. It is not uncommon for some old people in Kenya to avoid counting their children because counting children is often associated with bad luck, and is believed to cause children to die. Generally, people are reluctant to talk about the children who have died because no one wants to remember the sad event.

Ikamari's assessment of the data indicates modest age heaping of both living and dead children at ages 0, 12, 24 and 36 months. Age heaping at ages 0, 24 or 36 months has no adverse effects on the analysis because age 0 months falls within the age bracket for infant mortality and 24 and 36 months are in the age range for child mortality. However, age heaping at age 12 months may pose a problem if it is substantial, because it can affect the estimates of both infant and child mortality as age 12 months is the cut-off point for infant and child mortality. Heaping at ages 12, 24 and 36 months could be the result of some children dying, either before or after the exact age. If a substantial number of children had died before age 12 months and were reported as having died at age 12 months, then infant mortality rate derived from such information would be underestimated. Consequently, child mortality rate would be overestimated. However, the primary focus of this study is not the estimation of the overall levels of infant and child mortality, but differential mortality.

It should be pointed out that during the 1988/89 KDHS no information was collected on still-births and abortions. These omissions do not pose any problem to the results reported here as still-births and abortions are not typically used in the analysis of infant and child mortality, as such analysis is usually based on live births. Similarly, the 1988/89 KDHS did not seek information regarding the cause of death of the children reported dead. Nor was any information regarding birth weight and medical history of the dead children sought. Hence no analysis of causes of infant and child death is presented here.

Analytical approach and method of analysis

This study adopted a two-stage analytical approach. In the first stage infant and child mortality were calculated on the basis of the survival status of the preceding child at exactly age one. The analysis of both infant and child mortality was restricted to examining the effect of the survival status of the preceding sibling at age one on the mortality risk of the immediately succeeding or following (younger) sibling. In order to reduce the possible biases that some of the data problems previously discussed can cause, the analysis of infant mortality was based on a cohort of singleton births that occurred between 1970 and 1987, because these were the births that had at least 1 year of exposure to the risk of dying at the time of the 1988/89 survey. The analysis of child mortality was restricted to the children born between 1970 and 1983 and who survived infancy, because these were the children who had experienced at least 5 years of exposure to the risk of dying at the time of the survey.

In the demographic literature the reporting of births and deaths that occurred in the distant past is often considered less accurate than that of more recent births and deaths. This has been explained in terms of the inability of older mothers to recall and to report accurately all the births and deaths that may have occurred in the distant past. Due to memory lapse, older mothers are likely to report incorrectly the age at death of some of their dead children. Births that occurred before January 1970 were therefore excluded from the analysis in order to minimize problems of omission of dead children and mis-statement of age. In addition, the reference period should be as near as possible to the survey time because some of the characteristics, particularly household characteristics which were used in this study to construct a household economic status index, reported by the mother were those that were obtaining at the time of the survey. They might not be relevant to some of the children that were born in the distant past. These birth cohorts were chosen in order to have sufficiently large numbers of observations to obtain robust results. Furthermore, the analysis of infant mortality was restricted to 0–11 months, while that of child mortality was restricted to 12–59 months.

In the second stage of the analysis, the effects of the survival status of the preceding child on both infant and child mortality were assessed by fitting logistic models. In all the models fitted, live births that had no information on some of the control variables were excluded. Model fitting was carried out using the General Linear Interactive Model (GLIM), a computer software developed by the Royal Statistical Society, London. Both gross and net effects of the survival status of the preceding sibling on infant and child mortality were assessed.

Results

Infant and child mortality rates according to the survival status of the preceding sibling

Analyses were based on the children who had at least one preceding sibling, unless indicated otherwise. The results presented in Table 1 show that infant and child mortality rates were substantially greater when the immediately preceding siblings had died in infancy than when they had survived infancy. Infant mortality among children whose immediately preceding sibling had died in infancy was 294% higher than among children whose immediately preceding sibling survived infancy, and child mortality was only 74% higher.

If all the preceding singleton siblings had survived through infancy, a total of 772 infant deaths would have occurred instead of the 920 deaths implicit in the figures presented in Table 1. The overall infant mortality rate would have been 47 instead of the observed rate of the 56 deaths per 1000 live births. Therefore, the excess of 9 infant deaths per 1000 live births is attributable to the fact that the preceding sibling had died in infancy. Similarly, if all the children who survived through infancy to age one had all their immediately preceding singleton siblings alive at the exact age one, child mortality rate would have been 35 per 1000 exposed children instead of 36·5 deaths per 1000 exposed children.

The association between the survival status of the preceding sibling and the mortality risk of the subsequent index child shown in Table 1 may be exaggerated if the length of the preceding birth interval, maternal age and birth order of the child are not taken into account. With regard to the possible confounding effect of the preceding birth interval, the argument is that an early child death of the older child tends to shorten the interval between the two births by abrupt curtailment of breast-feeding, leading to an early resumption of ovulation. In addition, because the couple may want to replace the dead child, there may be an early resumption of sexual intercourse. In such a situation, it is very unlikely that the couple would want to use contraception, so the mother is likely to conceive on resumption of sexual intercourse, all other factors being equal. As a result of this situation her resources may be depleted due to closely spaced births, and this may result in the phenomenon termed ‘maternal depletion syndrome’. This may give rise to pre-term and under-weight births, which are subject

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Table 1. Infant and child mortality rates according to the survival status of the preceding child: Kenya, 1988/89 KDHS

Survival status	Infant mortality[a]	Child mortality[b]
Alive	47 (15,416)	35 (10,597)
Dead	185 (1009)	63 (620)
Total	56 (16,425)	36·5 (11,217)

[a]Per 1000 live births that occurred between 1970 and 1987. [b]Per 1000 children that survived to age one among those that were born between 1970 and 1983. Both were weighted cases.
Source: Primary analysis of the 1988/89 KDHS data.

to higher risk of mortality. Irrespective of the survival status of the preceding child, children with short preceding birth intervals have been found to suffer elevated risks of infant and child mortality (Cleland & Sathar, 1984; Palloni & Tiende, 1986; Boerma & Bicego, 1992), so the length of the preceding birth interval must be taken into account.

Consequently, the infant and child mortality rates shown in Table 1 were re-calculated on the basis of both length of the preceding birth interval and the survival status of the preceding child. The results are shown in Table 2. They indicate that infant and child mortality rates were much higher at each birth interval among the children whose immediately preceding siblings were dead than those for children whose preceding siblings were still alive. For example, the infant mortality rate for children whose preceding siblings were alive and with preceding birth intervals of less than 24 months was 67 per 1000, compared with 202 per 1000 for children whose preceding siblings had died in infancy.

The results also show that, among the two groups of children, infant and child mortality declined with increasing preceding birth interval. However, the pattern is much less clear with respect to child mortality among children whose preceding sibling died in infancy. The child mortality rate for children with a preceding birth interval of 24–35 months was greater than for children with a preceding birth interval of less than 24 months, and no deaths occurred among the 101 children with a preceding birth interval of at least 36 months. However, it is evident that the number of child deaths declined with the increase in the preceding birth interval for those mothers whose preceding child was alive at age one.

Survival status of the preceding sibling and demographic factors

The effects of the survival status of the preceding child on both infant and child mortality were assessed. In addition, its effects were adjusted for the length of the preceding birth interval, maternal age at birth of the index child and birth order. Like the preceding birth interval, maternal age and birth order are closely associated with infant and child mortality. Children born to younger mothers (<20 years) and older mothers (>34 years), and first-born children and those of higher birth order, are also

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Table 2. Infant and child mortality rates according to the preceding birth interval and survival status of the preceding child: Kenya, 1988/89 KDHS

Birth interval (in months)	Infant mortality[a]		Child mortality[b]	
Preceding child was alive at age one				
<24	67	(5226)	47	(3722)
24–35	42	(6025)	34	(4098)
36+	31	(4165)	19	(2777)
Total	47	(15,415)	35	(10,597)
Preceding child had died in infancy				
<24	202	(563)	59	(337)
24–35	190	(295)	104	(182)
36+	113	(151)	—	(101)
Total	185	(1009)	63	(620)

[a]Per 1000 live births that occurred between 1970 and 1987 irrespective of the marital status of the mother. [b]Per 1000 children that survived to age one among those that were born between 1970 and 1983 irrespective of the mother's marital status. Both were weighted cases. The numbers in the parentheses are exposed live births for infant mortality and exposed children for child mortality. (—) no deaths occurred among the children in the category.
Source: Primary analysis of the 1988/89 KDHS data.

known to be subject to higher risks of infant and child mortality (Hobcraft, MacDonald & Rustein, 1985; Da Vanzo, 1984; Rutstein, 1984; De Sweemer, 1984; Cleland & Sathar, 1984; Palloni & Tiende, 1986; Gubhaju, 1984, p.134; Ikamari, 1996).

The higher risk of dying among children born to older mothers may be a result of a decline in the efficacy of the reproductive system with age and economic pressure on the family, while the excess risk at young maternal ages is partly due to physical immaturity and lack of childcare skills and access to health care services (Da Vanzo *et al.*, 1983; Pebley & Stupp, 1987). Pebley & Stupp (1987) are of the opinion that, irrespective of the age of the mother, first-born children may be at a greater risk of mortality because their mothers' reproductive systems are in the process of adapting to pregnancy, or because their mothers are less likely to receive adequate prenatal care and to know how to care for themselves during pregnancy. These variables need to be controlled for, and are therefore included in the models whose main results are shown in Table 3.

The results shown in Table 3 confirm that the survival status of the immediately preceding child was significantly related to both infant and child mortality ('Gross effect' column). Children whose immediately preceding siblings had died in infancy were at a significantly greater risk of dying in infancy and between ages 1 and 5 years than those children whose preceding siblings had survived infancy. In gross terms, a

Table 3. Odds ratios and likelihood chi-square values indicating the effect of the survival status of the preceding child on infant and child mortality, adjusted for birth order, preceding birth interval and maternal age at birth: Kenya, 1988/89 KDHS

	Gross effect	Adjusted for BO	Adjusted for PBI	Adjusted for MAB	Adjusted for BO, PBI and MAB
Infant mortality					
LRχ^2	223·60	216·90	188·60	219·70	179·70
df	1	1	1	1	1
p	<0·001	<0·001	<0·001	<0·001	<0·001
Survival status of the preceding child					
Alive	1·00	1·00	1·00	1·00	1·00
Dead	4·53***	4·43***	4·00***	4·47***	3·88***
Child mortality					
LRχ^2	4·58	4·88	2·78	3·79	2·44
df	1	1	1	1	1
p	<0·05	<0·05	>0·05	>0·05	>0·10
Survival status of the preceding child					
Alive	1·00	1·00	1·00	1·00	1·00
Dead	1·54*	1·57*	1·40*	1·49*	1·37

The LRχ^2 values shown here are those associated with the survival status of the sibling only and not with the variables in the model. Based on live births that had a preceding sibling irrespective of whether they had a subsequent birth interval. BO: birth order. MAB: maternal age at birth. PBI: preceding birth interval. *$p<0·05$; **$p<0·01$; ***$p<0·001$.
Source: Primary analysis of the 1988/89 KDHS data.

child whose preceding sibling had died in infancy was 4·53 times more likely to die in infancy, and if such a child survived infancy, it was 1·54 times more likely to die between ages 1 and 5 years than a child whose preceding sibling survived infancy. These results indicate that a mother who loses her child in infancy is more likely to lose her next child in its infancy or between ages 1 and 5 years.

Table 3 shows that the effect of the survival status of the preceding sibling on infant mortality was slightly reduced when birth order, maternal age and the preceding birth interval were each and severally taken into account. This suggests that its effect on infant mortality is largely independent of the child's birth order, maternal age at birth and the length of the preceding birth interval. However, its effect on child mortality was rendered statistically insignificant at the 5% level when maternal age at birth and the preceding birth interval were each taken into account. These results suggest that its effect on child mortality is not statistically strong, and therefore not an important determinant of child mortality among the children of the second and higher birth orders included in this study.

Survival status of the preceding sibling and socioeconomic factors

Controls were made for the effects of maternal education, household economic status, father's education and region of residence. An index of household economic

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status (HSES) was constructed to serve as proxy for household wealth and disposable income since no data were collected in the survey on household income. This index was constructed as suggested by Bicego & Boerma (1991, p.182), using data on possession of a radio and television, the type of main materials used in floor construction of the dwelling house and the possession of a motorized means of transport. These socioeconomic factors were taken into consideration because they have been found to be closely associated with infant and child morality in Kenya (Anker & Knowles, 1980; Mosley, 1989; Ikamari, 1996). In addition, recent studies have indicated that these socioeconomic determinants of infant and child mortality are also closely associated with death clustering in families. For instance, the study by Guo (1993) indicates that in Guatemalan families the household's economic status and mother's education could explain death clustering. In rural Punjab, death clustering was found only among families in the lowest socioeconomic and educational categories (Das Gupta, 1997). In Senegal, death clustering could be explained partially by differences in ecological settings in which different children live (Ronsmans, 1995).

Household economic status determines the family's access to safe drinking water, good sanitation, adequate nutrition and health care. Here, this variable was used to capture a family's access to these human welfare services. Both parental education variables, particularly maternal education, were used to reflect household health-related behaviour and the parents' ability to manipulate the environment to the survival advantage of their children (Cleland & van Ginneken, 1988; Das Gupta, 1997). In addition, the region of residence variable was used to represent aspects of socioeconomic development and ecological, sociocultural and ethnic configurations not captured by the other variables included in this study. For example, with the exception of Nairobi, each province in Kenya is dominated by one ethnic grouping: in Nyanza the Luo are the majority, Kalenjin are the majority in the Rift Valley province, the Luhya are the majority in the Western province, the Coast province is dominated by the Mijikenda, the Central province is mainly inhabited by the Kikuyu and the Eastern province by the Kamba. The Coast, Nyanza and Western provinces are lowlands characterized by a humid climate. The Central and Rift Valley provinces are mainly highland areas. As a consequence, the Coast, Nyanza and Western provinces are more prone to malaria than the other provinces (Ominde, 1988).

Hence the effect of the survival status of the preceding child was re-analysed to take into account maternal education, household economic status, father's education and region of residence. The analysis was restricted to infant mortality only since the effect of survival status of the preceding child on child mortality appears insignificant. The results are shown in Table 4. They indicate that the effect of the survival status of the preceding child remained more or less the same when maternal education and household economic status were each taken into account. This suggests that the survival status of the preceding child influenced infant mortality independently of parental education and household economic status. However, its effect was modestly attenuated when the variable denoting region of residence was taken into account, suggesting that some of the influences embedded in the region of residence variable account for a small part of the effect of the survival status of the preceding child on infant mortality in Kenya. These results suggest that the effect of the survival status of the preceding child on infant mortality is largely independent of the socioeconomic

Table 4. Odds ratios and likelihood chi-square values indicating the effect of survival status of the preceding child on infant mortality, adjusted for socioeconomic factors: Kenya, 1988/89 KDHS

Explanatory variable	Gross effect	Adjusted for MEDU	Adjusted for HSES	Adjusted for REG	Adjusted for SOCF
$LR\chi^2$	223·80	210·50	208·00	179·80	164·00
df	1	1	1	1	1
p	$<0·001$	$<0·001$	$<0·001$	$<0·001$	$<0·001$
Survival status of the preceding child					
Alive	1·00	1·00	1·00	1·00	1·00
Dead	4·53***	4·33***	4·30***	3·87***	3·65***

The $LR\chi^2$ values shown here are those associated with survival status of the preceding child only and not with all the variables in model. ***$p<0·001$. MEDU: maternal education. HSES: household economic status. REG: region of current residence. SOCF: socioeconomic factors, i.e. maternal education, household economic status, region of residence and father's educational level.
Source: Primary analysis of the 1988/89 KDHS data.

Table 5. Odds ratios and likelihood chi-square values indicating the effect of survival status of the preceding child on infant mortality, adjusted for both socioeconomic and maternal factors: Kenya, 1988/89 KDHS

Explanatory variable	Gross effect	Adjusted for SOCF and MATF
$LR\chi^2$	223·80	127·03
df	1	1
p	$<0·001$	$<0·001$
Survival status of the preceding child		
Alive	1·00	1·00
Dead	4·53***	3·15***

The $LR\chi^2$ values shown here are those associated with survival status of the preceding child only and not with all the variables in model. ***$p<0·001$. SOCF: socioeconomic factors, i.e. maternal education, household economic status, father's educational level and region of residence. MATF: maternal factors, namely maternal age at birth of the child and the length of the preceding birth interval.
Source: Primary analysis of the 1988/89 KDHS data.

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factors included in this analysis, and that is itself an important determinant of infant mortality.

The last column of Table 5 shows the results obtained after both socioeconomic and demographic factors were simultaneously taken into account. It is evident from these results that the effect of survival status was modestly reduced. For example, the relative odds of dying in infancy among children whose preceding sibling had died in infancy were reduced to 3·15 from 4·53. This indicates that the effect of the survival status of the preceding child on infant mortality is largely independent of all the demographic and socioeconomic factors included in this study.

Conclusion

Overall, these results show that infant and child mortality risks among successive siblings in Kenya are closely correlated. It was found that the risk of infant and child mortality was greater when the preceding sibling was dead than when it was alive. The risk was greater during infancy than between ages 1 and 5 years. When the possible effects of the preceding birth interval, birth order and maternal age at birth were each and severally taken into account, the effect of the survival status on infant mortality was slightly diminished, whereas its effect on child mortality was no longer significant at the 5% level, though the odds of dying among children whose preceding sibling had died in infancy were still 37% higher than those for children whose preceding sibling had survived infancy.

These results indicate that the survival status of the preceding child affects child survival during infancy, largely independently of the length of the preceding birth interval, maternal age and birth order. A shorter preceding birth interval, young maternal age and higher birth order only worsen its effect. Furthermore, the results show that its effect on infant mortality remain strong and highly significant, even after a large number of other variables, including socioeconomic factors, are taken into account. However, its effect on child mortality is rendered insignificant in multivariate analysis.

In the literature sibling competition for household resources and disease transmission among closely spaced young siblings are often offered as the main links between the survival status of the preceding child and mortality risk of the subsequent child. Had this been the case here, the mortality risks should have been higher when the preceding child was alive than when it was dead, because the death of the preceding sibling should remove or at least reduce the competition among young siblings for household resources and parental attention. However, controlling for the effects of maternal education, father's education, household economic status, region of residence, birth order of the child and maternal age at birth did not substantially reduce the effect of the survival status of the preceding child. Thus, in this case, sibling competition and disease transmission cannot be the major causes of the observed sibling mortality correlation.

Differences in ecological settings in which children of different Kenyan families grow up is not a major explanation for the observed significant correlation in mortality risks among siblings. If it were, then there would have been substantial attenuation in the mortality risks when the variable denoting region of residence was included in the analysis. Since there was but a modest attenuation, it can only be a minor explanation.

The results strongly suggest that the excess risk of mortality among the children preceded by a sibling who died in infancy could be due to the shared physiological problems affecting the mother, and to a larger extent the shared biological and social environment (Winikoff, 1983; De Sweemer, 1984; Boerma & Bicego, 1992; Guo, 1993; Ronsmans, 1995). These could include problems such as poor nutritional reserves among the mothers of such children resulting in low-birth-weight babies and impaired lactation, genetically linked diseases such as sickle cell anaemia, HIV/AIDS infection, poor parenting and social as well as economic deprivation. Further insight into the possible mechanisms could have been made in this study but for the absence of data on cause of death, birth weight and medical history for the dead children included in the study and lack of data on nutritional status, medical history and social conditions of their mothers at the time they were pregnant or gave birth to these children.

The results obtained in this study are consistent with those obtained in sub-Saharan Africa (Ebong, 1993; Jhamba; 1995) and in Asia (Gubhaju, 1984; Hull & Gubhaju, 1986; Pant, 1995; Majumder, 1989; Das Gupta, 1990). They show that infant and child morality risks among successive siblings are closely related: a mother who loses her child in infancy is more likely to lose her next child in its infancy. They also show that the survival status of the preceding sibling is important in determining infant mortality in Kenya. These results imply that mothers whose children die in infancy should be targeted for health or medical assistance. They should be encouraged to use modern antenatal services, to have institutionalized child delivery and to use postnatal health care services.

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References

Aaby, P. (1990) Crowding and severity of measles infection. In: *What We Know About Health Transition: The Cultural, Social and Behavioural Determinants of Health*. Health Transition Series 2, Vol. 1, pp. 441–461. Edited by J. Caldwell *et al.* Health Transition Centre, The Australian National University, Canberra.

Anker, R. & Knowles, J. C. (1980) An empirical analysis of mortality differentials in Kenya at the macro and micro levels. *Econ. Develop. cult. Change* **29**(1), 165–185.

Bicego, G. & Boerma, J. T. (1991) Maternal education and child survival: a comparative analysis of DHS data. In: *DHS, Proceedings of Demographic and Health Surveys World Conference, August 5–7*, pp. 177–204. Washington, DC.

Boerma, J. T. & Bicego, G. (1992) Preceding birth interval and child survival: searching for pathways of influence. *Stud Fam. Plann.* **23**(4), 243–267.

Brass, W. (1993) Child mortality improvement and the initiation of fertility falls in Kenya. In: *International Population Conference, Montreal*, pp. 73–79. IUSSP, Liege.

Cleland, J. & Sathar, Z. A. (1984) The effect of birth spacing on childhood mortality in Pakistan. *Popul. Stud.* **38**(1), 401–418.

Cleland, J. & van Ginneken, J. K. (1988) Maternal education and child survival: a search for pathways of influence. *Soc. Sci. Med.* **27**(2), 82–117.

Cramer, J. C. (1987) Social factors and infant mortality: identifying high-risk groups and proximate causes. *Demography* **24**(3), 299–322.

Curtis, S. L., Diamond, I. & MacDonald, J. W. (1993) Birth interval and family effects on post-neonatal mortality in Brazil. *Demography* **30**(1), 33–43.

Curtis, S. L. & Steele, F. (1996) Variations in familial neonatal mortality risks in four countries. *J. biosoc. Sci.* **28**, 141–159.

Da Vanzo, J., Burtz, W. P. & Habicht, J. P. (1983) How biological and behavioural influences on mortality in Malaysia vary during the first year of life. *Popul. Stud.* **37**(13), 381–402.

Da Vanzo, J. (1984) A household survey of child mortality determinants in Malaysia. *Popul. Dev. Rev.* (supplement) **10**, 307–324.

Das Gupta, M. (1990) Death clustering, mother's education and determinants of child mortality in rural Punjab, India. In: *What We Know About Health Transition: The Cultural, Social and Behavioural Determinants of Health.* Health Transition Series 2, Vol. 1, pp. 441–461. Edited by J. Caldwell *et al.* Health Transition Centre, The Australian National University, Canberra.

Das Gupta, M. (1997) Socio-economic status and clustering of child mortality in rural Punjab. *Popul. Status* **51**, 191–202.

De Sweemer, C. (1984) The influence of child spacing on child survival. *Popul. Stud.* **38**(1): 47–72.

Eberstein, I. W. & Parker, J. R. (1984) Racial differences in infant mortality by cause of death: the impact of birth weight and maternal age. *Demography* **21**(3), 309–321.

Ebong, G. (1993) *Family Formation Patterns and Child Survival in Uganda*. Master of Arts Project Paper, National Centre for Development Studies, The Australian National University, Canberra.

Gubhaju, B. (1984) *Demographic and Social Correlates of Infant and Child Mortality in Nepal.* Unpublished PhD Thesis. The Australian National University, Canberra.

Guo, G. (1993) Use of sibling data to estimate family mortality effects in Guatemala. *Demography* **30**(1) 1–31

Hobcraft, J. (1987) *Does Family Planning Save Children?* Technical background paper prepared for the International Conference on Better Health For Children and Mothers Through Family Planning, Nairobi. Population Council, New York.

Hobcraft, J. N., MacDonald, J. W. & Rutstein, S. O. (1983) Child spacing effects on infant and early childhood mortality. *Popul. Index* **49**(4), 585–618.

Hull, T. H. & Gubhaju, B. (1986) Multivariate analysis of infant and child mortality in Java and Bali. *J. biosoc. Sci.* **18**(1), 109–118.

Ikamari, L. (1996) *Factors Affecting Child Survival in Kenya*. Unpublished PhD Thesis. The Research School of the Social Sciences, The Australian National University, Canberra.

Jhamba, T. (1995) *Infant and Child Mortality in Zimbabwe: An Analysis of Levels, Trends, Differentials and Determinants*. Unpublished PhD Thesis. The Research School of the Social Sciences, The Australian National University, Canberra.

Koenig, M. A., Phillip, J. F., Campbell, O. M. & D'Souza, S. (1990) Birth intervals and childhood mortality in rural Bangladesh. *Demography* **27**(2), 251–265.

Majumder, A. K. (1989) *Determinants of Infant and Child Mortality in Bangladesh*. Unpublished PhD Thesis. The Australian National University, Canberra.

Mosley, H. W. (1989) Will primary health care reduce infant and child mortality? In: *Selected Readings in the Cultural, Social and Behavioural Determinants of Health*. Health Transition Series 1, pp. 261–294. Edited by J. Caldwell & G. Santow. The Health Transition Centre, The Australian National University, Canberra.

National Council for Population and Development (NCPD) (1989) *Kenya Demographic and Health Survey First Report*. Government Printer, Nairobi.

OMINDE, S. H. (1988) Demography and vector-born diseases in Kenya. In: *Kenya's Population Growth and Development to the Year 2000*, pp. 108–119. Edited by S. H. Ominde. Heinemann, Nairobi.

PALLONI, A. & TIENDE, M. (1986) The effects of breastfeeding and pace of child bearing on mortality at early ages. *Demography* **23**(1), 31–52.

PANT, P. D. (1995) *Infant and Child Mortality in Nepal: Socio-economic, Demographic and Cultural Factors*. Unpublished PhD Thesis. The Research School of the Social Sciences, The Australian National University, Canberra.

PEBLEY, A. R. & STUPP, P. W. (1987) Reproductive patterns and child mortality in Guatemala. *Demography* **24**(1), 43–60.

RONSMANS, C. (1995) Patterns of clustering of child mortality in rural areas of Senegal. *Popul. Stud.* **49**, 443–461.

RUTSTEIN, S. O. (1984) *Infant and Child Mortality: Levels, Trends and Demographic Differentials*. World Fertility Survey Comparative Studies Report 43 (Revised Edition). World Fertility Survey, London.

SASTRY, N. (1997) Family-level clustering of childhood mortality in North-East Brazil. *Popul. Stud.* **51**, 245–261.

WINIKOFF, B. (1983) The effect of birth spacing on child and maternal health. *Stud. Fam. Plann.* **14**(10), 231–245.

ZABA, B. & DAVID, P. H. (1996) Fertility and distribution of child mortality risks among women: an illustrative analysis. *Popul. Stud.* **50**, 263–278.

ZENGER, E. (1993) Sibling neonatal mortality risks and birth spacing in Bangladesh. *Demography* **30**(3), 477–488.