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Birth Spacing and Child Survival in Rural Senegal

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était doctorante à l'époque

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Background. Studies examining the associations between short birth spacing and child mortality have often concentrated on the strength of the associations whilst the public health importance of short spacing in specific communities has received less attention. This study re-examines the association between short birth intervals and child mortality in rural Senegal and discusses the potential direct effects of efforts to delay births on child mortality in this community.

Methods. The study uses longitudinal data in a cohort of 4852 children born between 1983 and 1989. The associations between birth spacing and child mortality are examined using logistic and Cox proportional hazards regression models.

Results. The probability of dying before age five is 224 per 1000 livebirths. The median interval between births is 33 months and only 12% of the birth intervals are less than 24 months in length. The odds of dying in the neonatal and post-neonatal period is 2.27 and 2.12 times higher respectively for children born after preceding birth intervals of one year or less compared to children born after longer intervals. Children born within two years of a subsequent birth are at 4.09 times higher risk of dying in the second year of life than children whose mother gave birth more than 2 years after the index birth.

Conclusions. In this community where prolonged breastfeeding causes women to space their births at long intervals, short birth intervals are a consequence rather than a cause of child mortality and the potential direct effects of birth spacing efforts on child mortality are limited. To reduce the high levels of child mortality, efforts will have to be made to ensure effective preventive and curative health services, and to maintain the traditional pattern of breastfeeding.

Keywords: birth intervals, birth spacing, child mortality, family planning, developing countries, Senegal

The associations between short intervals between births and impaired child survival are well established.[1–4] It is generally accepted that if closely spaced births were delayed, particularly in countries where mortality and fertility are still high, child mortality levels would fall.[5] Increasing the interval between births to improve the health of women and children has thus become one of the primary rationales for family planning programmes.[5,6]

Despite the existence of a large body of evidence on the association between birth spacing and child survival, many questions remain regarding the strength and nature of the association, and the magnitude of mortality reductions that can be expected from family planning programmes are still the subject of debate.[7–9] Most studies have been based on retrospective surveys, and recall biases may have led to an overestimation of the strength of the association between short birth intervals and mortality.[10] In addition, the potential confounding effect of unmeasured variables, particularly prematurity,[11] but also socio-economic characteristics of the households, may call into question the existence of a causal association. Finally, empirical evidence on the causal pathways that explain the associations is poor.[3,12,13]

This study re-examines the association between short birth intervals and mortality in childhood using longitudinal data from rural Senegal. The objectives of the study are (1) to describe the distribution of birth intervals; (2) to explore the extent to which a child death shortens the length of time between subsequent births; and (3) to examine the association between a short preceding birth interval and neonatal and post-neonatal mortality and between a short subsequent birth interval and mortality after age one. The findings are discussed in the context of the potential effects of child spacing efforts on child mortality.

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METHODS

Population

The study population lives in Niakhar, a rural area located about 150 km east of Dakar, the capital of

Senegal. The population consists largely of a single ethnic group, the Sereer, who are subsistence farmers growing millet and peanuts. The farming activities are almost entirely concentrated in the rainy season from July to October. The population is mostly Muslim and the level of education is poor.

The study area has about 25 000 inhabitants and has been under demographic surveillance since March 1983.[14] From 1983 to 1987, yearly censuses were conducted to obtain information on births, deaths and migration among all residents of the study area, and from January 1987 onwards, demographic data were collected by weekly visits to all households.[15,16]

Prolonged breastfeeding is widespread and there was no deliberate control of family size during the period studied. The average age at weaning was 23 months.[14] From 1983 onwards, two physicians visited the area regularly and provided medical care and advice. From January 1987, a physician was living permanently in Niakhar. Vaccine coverage was low in 1984, but reached almost 100% in 1989.[15]

Sample Selection and Analysis

The analysis consists of four parts. For each part, separate samples were selected from the 4852 single births which occurred between March 1983 and December 1989, to mothers who were resident in 22 villages of the study area in 1983.

First, to estimate the levels of child mortality, the entire sample of 4852 children was used. Mortality levels were estimated using standard life tables.[17]

Second, to calculate the average length of birth intervals, the non-parametric Kaplan Meier survival probability of a next birth among women giving birth during the study period was used. This analysis was then repeated by the age at death of the index child. Index children were categorized by month of death until the age of 24 months, after which they were categorized as surviving after 24 months. Children censored before reaching the age of 24 months were excluded. Survival curves were compared using the log rank test.

Third, to examine the effect of a short preceding birth interval on mortality, children with at least one preceding birth in the follow-up period were chosen. The sample consisted of 2465 livebirths for neonatal mortality, and of 2346 children surviving after 27 days for post-neonatal mortality.

Fourth, to examine the effect of a short subsequent birth interval on mortality after age one, the 2509 children with at least one subsequent birth in the follow-up period were chosen. Since a child death can only have been *causally* associated with the length of the subsequent interval if it occurs *after* the mother became pregnant again, children who died before the estimated date of conception of the subsequent birth were excluded. The date of conception was estimated by subtracting 280 days from the date of birth. Among those children whose mother had a subsequent birth, 2161 survived after the first year of life and 1963 after the second year of life. Of those, 103 children aged 12–23 months and 18 aged 24–35 months died before the estimated date of the subsequent conception, and were excluded from the analysis of the effect of subsequent birth intervals.

Mortality was expressed per 1000 livebirths for neonatal mortality and per 1000 child-years at risk for all other age groups. In addition to the duration of birth intervals, the following variables were studied. For all age groups, mortality was analysed by birth order and sex of the child, by maternal age and literacy (whether the mother could read or write), and by season. The seasonal risks were expressed as binary variables, referring to the month of birth for the neonatal period and to the month of exposure for other age groups. For neonatal mortality, the high risk season was defined from June through October, reflecting the months of seasonal weight losses in women in this area.[15] For mortality in the other age groups, the high risk season was taken to extend from August through November, which includes the rainy season.[18] For neonatal mortality and post-neonatal mortality, the fate of the immediately preceding sibling was included as a possible confounder of the birth interval–mortality association. The death of the immediately preceding sibling usually shortens the duration to the next birth and can be a powerful independent predictor of the survival of the index child.[3,12] Thus failure to control for survival of the preceding child may bias estimates of the effect of interval length. The fate of the immediately preceding sibling was defined as whether or not the immediately preceding sibling survived the neonatal period for neonatal mortality and whether or not the immediately preceding sibling survived infancy (including the neonatal period) for post-neonatal mortality.

Multivariate analyses were done using logistic regression analysis for neonatal mortality and Cox proportional hazards regression for post-neonatal mortality and mortality between 12 and 23 months and between 24 and 35 months. Separate models were fitted to the different age groups because of differing sample selections (see above). In the Cox proportional hazards model, season of exposure was coded as a time-varying covariate, so that a child's observation time was divided in periods of high and low seasonal risk according to the months of observation. Backwards stepwise procedures were used to select the final model, progressively

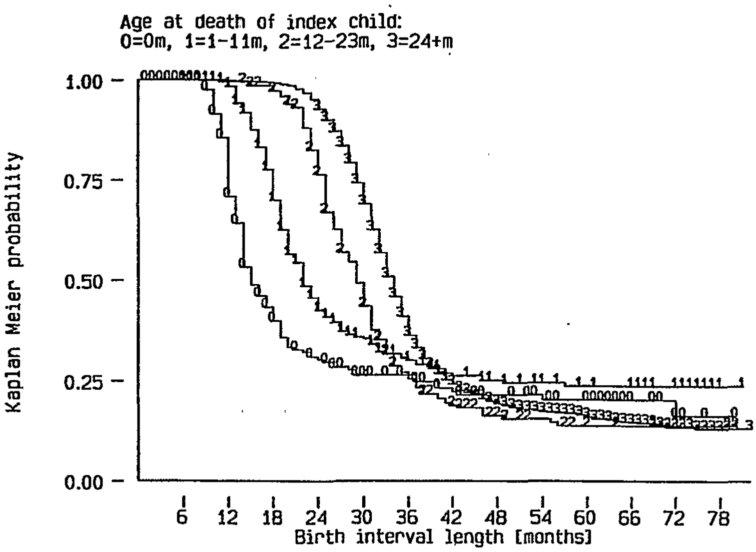

FIGURE 1 *Distribution of birth interval length by age at death of the index child*

eliminating the least significant variables and retaining those in which the regression coefficients yielded a P-value of ≤ 0.10.

RESULTS

Levels of Mortality

The probability of dying in the first year of life is 103.5 per 1000 livebirths and for children surviving after one year of age, the probability of dying before age five is 134.3 per 1000. The probability of a newborn child dying before its fifth birthday is 223.8 per 1000.

Distribution of the Length of Birth Intervals

The median length of birth intervals is 33 months and only 4.6 % and 11.9 % of the women have another birth within 18 and 24 months respectively after a previous birth. The Kaplan Meier probabilities of a next birth by age at death of the index child are shown in Figure 1. As expected, there is a clear shift to longer durations with increasing ages at death ($\chi^2(3)$ = 145.25, $P = 0.0000$). After a neonatal death, 50% of the women have a next birth within 15 months, and the median time to the next birth increases to 22, 29 and 33 months after an infant death, a death between 12 and 23 months and survival after 24 months respectively. In fact, when a child survives infancy, the proportion of women having a next birth within 12, 18 or 24 months is very low (0.2, 0.8 and 8.4% respectively).

The above association between a child death and the interval to the next birth could be partly because the child is weaned off the breast and thus placed at greater risk of infection and undernutrition when its mother becomes pregnant again. It may also be related to the effect of a child death on the return of ovulation.[13,19] One way to separate these two mechanisms is to calculate the proportion of children who died *before* the estimated date of conception of the next child, since only the latter can influence the timing to the next birth. The majority (413/501) of the children who died before 2 years of age and were followed by another birth, died *before* the estimated date of conception of the next child, hence their death will have resulted in the next pregnancy rather than having been caused by it. Although the large majority of neonatal (96%) and post-neonatal deaths (94%) occurred before the estimated date of the next conception, a large proportion (41%) of deaths between one and two years occurred after that date. It seems therefore that there is a possibility that deaths between one and two years are caused by a subsequent pregnancy occurring too early.

Effects of the Length of the Preceding Birth Interval

The differentials in neonatal and post-neonatal mortality rates by length of the preceding birth interval are shown in Table 1. Neonatal mortality increases after very short or very long intervals between births. For children surviving the neonatal period, post-neonatal mortality is only increased if they were born within one year of a previous birth.

The trends for other variables are much as anticipated. Neonatal mortality is higher in children whose

TABLE 1 *Crude differentials in neonatal and post-neonatal mortality by selected variables*

Variable	Neonatal mortality[a] (number of deaths) [number of observations]	Post-neonatal mortality[a] (number of deaths) [number of observations]
Duration of preceding birth interval (months)		
≤12	79.54* (7)[88]	105.34 (7)[81]
13–24	38.08 (19)[499]	53.97 (21)[477]
25–36	35.02 (52)[1485]	50.06 (56)[1420]
37–48	42.94 (14)[326]	54.29 (13)[310]
≥49	119.40** (8)[67]	55.37 (2)[58]
Immediately preceding child[b]		
survived	38.94 (90)[2311]	52.33 (83)[2202]
died	64.94 (10)[154]	60.84 (16)[144]
Season of birth/exposure[b]		
low risk	33.53 (45)[1342]	34.88 (41)
high risk	48.98 (55)[1123]	84.84** (58)
Birth order		
2–5	39.19 (52)[1327]	48.58 (49)[1261]
6–9	32.77 (31)[946]	59.29 (42)[912]
≥10	88.54** (17)[192]	60.15 (8)[173]
Maternal age		
15–19	40.00 (2)[50]	97.56 (4)[2081]
20–29	35.66 (44)[1234]	55.33 (50)[1176]
30–39	34.99 (33)[943]	43.63 (31)[906]
≥40	88.23** (21)[238]	86.42* (14)[216]
Sex		
boy	45.60 (56)[1228]	55.07 (50)[1159]
girl	35.57 (44)[1237]	52.02 (49)[1187]
Maternal literacy		
yes	32.26 (2)[64]	42.09 (2)[60]
no	40.70 (98)[2401]	53.82 (97)[2286]
Year of birth		
1984–1985	21.74 (4)[184]	49.70 (8)[180]
1986–1887	44.50 (49)[1101]	61.48 (57)[1041]
1988–1989	39.83 (47)[1180]	44.53 (34)[1125]
All	40.57 (100)[2465]	53.52 (99)[2346]

[a] Neonatal mortality is expressed in deaths per 1000 livebirths, post-neonatal mortality in deaths per 1000 child-years at risk.
[b] See text.
* $P < 0.05$, ** $P < 0.01$ when compared to category of lowest risk.

mother was 40 years or older when she gave birth, and in children born at birth order 10 or more. Similar patterns are observed for post-neonatal mortality, although the associations only reach significance at the 5% level for seasonal exposure and old maternal age.

The multivariate analysis does not modify the findings, except for birth order which does not retain statistical significance (Table 2). Children born within one year after their older sibling was born are twice as likely to die in the neonatal and post-neonatal period than children born after longer intervals. The most striking feature of this analysis is the strong seasonality of post-neonatal mortality: in the rainy season, children are at 2.58 times higher risk of dying than in the dry season.

TABLE 2 *Multivariate analysis of neonatal and post-neonatal mortality*

Variable	Neonatal mortality Odds ratio (95% CI)	Post-neonatal mortality Hazard ratio (95% CI)
Duration of preceding birth interval (months)		
≤12	2.27 (1.01–5.10)*	2.12 (0.98–4.54)
13–48	1.00	1.00[a]
≥49	3.05 (1.39–6.68)**	–
Season of birth/exposure		
low risk	1.00	1.00
high risk	1.44 (0.96–2.16)	2.58 (1.73–3.85)**
Maternal age		
15–19	1.12 (0.27–4.72)	1.94 (0.71–5.29)
20–39	1.00	1.00
≥40	2.52 (1.51–4.20)**	1.79 (1.01–3.16)*

[a] Reference is ≥13 months.
* $P < 0.05$, ** $P < 0.01$.

Effects of the Length of the Subsequent Birth Interval

The duration of the subsequent birth interval clearly affects mortality in the second year of life and to a lesser extent, but not significantly so, in the third year of life (Tables 3 and 4). If the child's mother delivers another child within 2 years of the birth of the index child, the risk of mortality is four times higher in the second year of life than if the next birth takes place more than 2 years after the index child's birth. In addition, the rainy season raises the risk twofold in the second year of life and almost threefold in the third year of life. Trends in mortality over time were impressive: mortality in both age groups almost halved over the study period. Birth order, age of the mother, sex of the child or literacy, on the other hand, do not seem to affect childhood mortality to a large extent.

DISCUSSION

The findings of this study add evidence to the widely observed association between the length of birth intervals and child survival. In this population, a short preceding interval increases the risk of neonatal and to a lesser extent post-neonatal mortality, and a short subsequent interval increases the risk of mortality in childhood.

There are, however, two observations in this study which differ from what has been found in other studies, and which have implications for the potential effect of spacing programmes on mortality. Firstly, preceding birth intervals of 1–2 years did not affect neonatal or post-neonatal mortality. The latter finding merits attention, since it is generally believed that children throughout the developing world are much more likely to die if they were born less than 2 years after their mother's previous birth.[2,4] Secondly, short succeeding birth intervals, in contrast, have major adverse consequences for child survival, and the size of the effect is larger than those found by other authors.[2,4,20]

The lack of an association between preceding intervals of between one and two years and neonatal and post-neonatal mortality may in part be due to the small sample in this risk group and in part to the fact that short birth intervals almost invariably follow an infant death. If there is no surviving young child to compete for the mother's resources at the time of birth of the next child, the adverse effect of short spacing may be reduced. However, similar trends have been found in an earlier study in the same population using a much larger sample and incorporating a control for the survival status of the immediately preceding child.[21] In addition, many studies have found a stronger association between a short preceding birth interval and neonatal or post-neonatal mortality when the preceding sibling died than when it survived.[3,20,22] In fact, there is also evidence from Bangladesh that only very short preceding birth intervals affect neonatal and post-neonatal mortality.[3,11]

The association between preceding intervals of one year or less and neonatal and post-neonatal mortality raises concerns about the confounding effect of prematurity. Very short birth intervals are likely to include a large proportion of infants born after a short gestation, which affects child survival, and removing the confounding effect of prematurity may reduce the estimates

TABLE 3 *Crude differentials in mortality between 12 and 23 months and between 24 and 35 months by selected variables*

Variable	Mortality between 12 and 23 months[a] (number of deaths) [number of observations]	Mortality between 24 and 35 months[a] (number of deaths) [number of observations]
Duration of subsequent birth interval (months)[b]		
≤24	180.59** (40)[243]	54.32 (9)[197]
25–30	46.70 (30)[655]	39.09 (22)[619]
31–36	–	40.09 (29)[751]
37–42	–	8.09** (2)[240]
Season of exposure[c]		
low risk	64.38 (85)	25.98 (31)
high risk	120.27** (90)	74.97** (49)
Birth order		
1	71.61 (15)[220]	48.09 (9)[202]
2–5	85.79 (102)[1244]	38.61 (41)[1131]
6–9	82.95 (49)[624]	49.53 (26)[566]
≥10	135.56 (9)[73]	70.68 (4)[64]
Maternal age		
15–19	81.61 (15)[194]	55.00 (9)[177]
20–39	83.45 (149)[1870]	40.29 (64)[1700]
≥40	124.19 (11)[97]	89.43 (7)[86]
Sex		
boy	90.54 (98)[1140]	42.28 (41)[1032]
girl	97.13 (77)[1021]	45.30 (39)[931]
Maternal literacy		
yes	89.41 (5)[59]	0.00 (0)[53]
no	85.02 (170)[2102]	44.91 (80)[1910]
Year of birth		
1983–1984	115.31** (103)[951]	57.21** (46)[844]
1985–1886	61.17 (59)[1001]	32.15 (29)[927]
1987–1988	65.57 (13)[209]	39.95 (5)[192]
All	85.14 (175)[2161]	43.70 (80)[1963]

[a] Mortality is expressed as deaths per 1000 child-years at risk.
[b] Excluding children who died before the estimated date of conception of the next birth (excluding 103 children for mortality age 12–23 months and 18 children for mortality age 24–35 months). Rates are not shown for cells in which the subsequent birth could not affect mortality in the age group of interest.
[c] See text.
* $P < 0.05$, ** $P < 0.01$ when compared to category of lowest risk.

of relative risks by as much as 50%.[11] Information on the length of gestation was not available in this study, but the weakness of the observed associations and the likely confounding by premature births raises doubts about the presence of a causal association between short preceding intervals and neonatal and post-neonatal mortality in this population.

Short subsequent intervals, on the other hand, pose major health risks to a child. The fourfold increase in the risk of death in the second year of life for children whose mother gave birth less than 2 years after their birth is also a reminder of the well-known substantial benefits that breastfeeding confers to a child. Previous research in this population has already shown the link between weaning and high mortality, particularly when children were weaned at 12–17 months because their mother became pregnant again.[21] Although it cannot be concluded with certainty that the abrupt cessation of

TABLE 4 *Multivariate analysis of mortality between 12 and 23 months and between 24 and 35 months*

Variable	Mortality between 12 and 23 months Hazard ratio (95% CI)	Mortality between 24 and 35 months Hazard ratio (95% CI)
Duration of subsequent birth interval (months)		
≤24	4.09 (2.54–6.58)**	1.38 (0.65–2.96)
25–30	1.00	0.99 (0.56–1.72)
31–36	–	1.00
37–42	–	0.20 (0.05–0.84)*
Season of exposure		
low risk	1.00	1.00
high risk	1.99 (1.24–3.18)**	2.80 (1.69–4.66)**
Maternal age		
15–19	–	1.22 (0.55–2.72)
20–39	–	1.00
≥40	–	2.86 (1.22–6.69)*
Year of birth		
1983–1984	1.00	1.00
1985–1986	0.56 (0.34–0.92)**	0.60 (0.35–1.01)
1987–1988	0.34 (0.15–0.77)**	0.57 (0.22–1.49)

* $P < 0.05$, ** $P < 0.01$.

breastfeeding has caused the death in children whose mothers became pregnant too quickly, the fact that the children died after the following child was conceived and that the effects are most pronounced in the second year of life when the child is particularly sensitive to abrupt weaning is consistent with this hypothesis.

The analysis of the direction of causality with birth interval data is hampered by the close interrelations between child mortality and fertility.[13,19] A short subsequent birth interval can be the cause as well as the consequence of a child death. In societies such as rural Senegal in which extended breastfeeding and postpartum abstinence are common[14,24] the death of an infant may shorten the time to the next birth through the early return of ovulation after abrupt cessation of breastfeeding. Conversely, a new pregnancy may cause premature removal of the child from the breast and increase its risk of death. The relative importance of these two mechanisms was assessed by comparing the proportion of children who died before their mother became pregnant again to the proportion of children who died while their mother was pregnant. Since the pregnancy status of the mother at the time of the death of the child was not known, it was estimated by subtracting a gestational duration of 280 days from the date of the next birth. Some pregnancies may have lasted less than 280 days, hence the proportion of children who died while their mother was pregnant—and whose death may have been caused by the new pregnancy—may have been overestimated.

The potential direct effects of birth spacing efforts on child mortality are limited in this population. Lactational amenorrhea causes women to space their births at long intervals, and the majority of the women who have a rapid succession of pregnancies do so because their children die early, not vice versa. The potential benefits in the second year of life, on the other hand, may be more important, but the public health impact is likely to be small because so few children fall in the high risk intervals. Among those who survived after the first year of life, only 8% were followed by a next birth within 2 years after their birth. The proportion of children truly exposed to the higher risk is probably even smaller, since more than half of the deaths in the second year of life may actually have facilitated the next pregnancy, rather than having been caused by it.

An average of one-third of birth intervals in developing countries are estimated to be shorter than 2 years, so the extremely long pattern of birth spacing in this population may be unusual and may disappear as the society develops and contraceptives become available.[23] The long spacing patterns in this population are largely due to the effects of prolonged breastfeeding on ovulation and to a lesser extent to the practice of postpartum abstinence.[24] Although it is commonly believed that traditional birth spacing practices may be abandoned as a society develops, there is very little empirical evidence to support this hypothesis.[25] In this population, as is the case in Senegal as a whole, there is no indication that the duration of breastfeeding has been declining over time.[14,26]

When the direct effects of child spacing on child survival are viewed in the context of other factors associated with child survival, such as seasonal variations in mortality, their relative importance diminishes even more. The high child mortality rates in the rainy season in West Africa have been documented many decades ago, and are probably associated with a higher incidence of infectious diseases such as malaria, acute respiratory and diarrhoeal diseases, compounded by the nutritional stresses while awaiting the upcoming harvest.[18] The fact that the large reductions in infant and child mortality in this population have not brought about perceptible reductions in seasonally high mortality rates indicates that much remains to be done. The focus on preventable diseases such as measles and pertussis through immunization programmes may have had a more pronounced effect on child mortality in the dry than in the rainy season. Prevention of infectious diseases associated with the rainy season, on the other hand, may be difficult and the reduction of mortality from these diseases may require the provision of effective and accessible curative services.[27,28]

Family planning programmes can of course do much more than increase the intervals between births.[9] Although difficult to measure, the most important public health consequences of reduced fertility rates are probably improved economic well-being and reduced obstetric mortality and morbidity. However, family planning services are sometimes presented as a more or less exclusive answer to situations that in fact can only change if other conditions are fulfilled. The low levels of education in this population, and the high prevailing levels of child mortality—one out of four newborn children does not survive to its fifth birthday—indicate the need for an increased effort to educate women and men, to provide an adequate health infrastructure, and to guarantee effective preventive and curative health services.

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