The Effects of Birthspacing and Breastfeeding on Childhood Mortality in the Philippines[1]

Josefina V. Cabigon

Abstract. *This article demonstrates the marked low mortality risks associated with wide birthspacing and breastfeeding independent of the levels of bio-demographic, socioeconomic and health-related factors. Effects of preceding and succeeding birth intervals are strongest at ages 3-11 months. Those of the former are less strong but nevertheless appreciable at the other childhood ages. Benefits from breastfeeding are greatest at ages 0-2 months and gradually diminished with age. Breastfeeding is not the main mechanism through which birthspacing affected Philippine child mortality. These findings are interpreted according to their relevance for mortality research, theory and policy.*

Keywords: Index children; infant and child mortality; breastfeeding; birthspacing; mortality research; 1983 NDS; Philippines.

1. Introduction

Addressing the complicated mechanisms through which birthspacing and breastfeeding affect the mortality of a child, usually termed the index child, has been the focus of several studies (e.g. DaVanzo et al. 1983; Hobcraft et al. 1983; Cleland and Sathar 1984; Palloni and Tienda 1986; Palloni 1989). These mechanisms include competition between siblings for care and resources; maternal depletion syndrome, resulting in premature and underweight babies; and premature cessation of breastfeeding. The greater the number of children a woman bears, the greater is the competition between siblings for food and maternal care; the more likely she is to become physically deprived, especially where birth intervals are short; the more likely is premature weaning; and the greater the mortality for her children. These conditions are further complicated in societies where socioeconomic, cultural, and other health-related factors are also associated with brief birthspacing and lessened or non-breastfeeding and where replacing a lost child is the norm.

These studies demonstrate the complexity of specifying these mechanisms. However, they also show that estimating and controlling for some of these mechanisms can be handled through well-defined hypotheses tested appropriately by well-specified models.

Palloni and Tienda (1986: 31-39) and Palloni (1989: 164-170) present strategies for studying these complexities. The first is to control for the confounding effects of variables that covary with birthspacing, such as age of the mother at the birth of the child, birth order, and mother's or household's characteristics. For example, higher maternal age at childbirth is associated both with higher mortality at young ages and longer birth intervals, owing to increased infecundity. The second strategy is to control for the spurious effects caused by the high correlation of mortality among siblings and the tendency to replace a lost child. The death of the child early in a birth interval may result in the reduction of the interval due either to eagerness to replace this child or to shortened postpartum amenorrhea; these are not unadulterated effects of birthspacing and they exaggerate the effects of birthspacing. The third strategy is to deal with the consequent simultaneity bias of the effects of the following birth interval caused by the possibility that quicker conception is the result, rather than the cause, of the death of the index (earlier) child, especially when the replacement behaviour is one of the main mechanisms operating; this bias causes an overstatement of the effects of the following birth interval.

The fourth strategy is to examine the role of breastfeeding as a mediating mechanism between birthspacing and infant and child mortality. Censoring problems produced by the curtailment of breastfeeding due to death of the index child exaggerate the bias of the effects of breastfeeding. However, this bias can be reduced by considering the mortality risk of the index child in a given age segment in months, x, x+n, of whether or not he was breastfed for at least x months, where x was defined later under the section on data and methods of analysis.

The fifth strategy is to recognize that the effects of these mechanisms change when the index child is older (see also Da Vanzo et al. 1983). The effects of short interbirth intervals (operating through prematurity and low birthweight) and of breastfeeding, are greatest during the first months of life. The effects of birthspacing (both the preceding and following birth intervals) operating through sibling competition for resources and care are important during the first five years of life depending on the socioeconomic and cultural conditions of the index child.

This article aims to examine the effects of birthspacing and breastfeeding on infant and child mortality in the Philippines. By adopting the above five strategies, it illustrates the survival advantage of widely spaced or breastfed babies. It also considers whether breastfeeding is solely or mainly the mechanism through which birthspacing affects the mortality risks of Filipino children.

2. Data and Methods of Analysis

I used the 1983 National Demographic Survey (NDS) conducted by a consortium of research centers composed of the University of the Philippines Population Institute, University of San Carlos Office of Population Studies and Xavier University Mindanao Centre for Population Studies. The 1983 NDS collected information from a nationally representative sample of 13000 households. The sampling design featured a two-stage sampling scheme where the primary sampling unit (*barangay*)[2] was drawn with replacement and with probability proportional to the number of households per *barangay*. The ultimate sampling unit was the household, drawn systematically with a random start.

The analysis was based on two sets of data. The first refers to index children born between 5 and 16 completed years before the survey (i.e. 1 January 1968 to 31 December 1977); restricting the analysis to this set minimizes temporal variations and allows the analysis to cover the first five years of life, free of the problems of censoring or curtailment of exposure to the risk of dying by the interview date at ages three to five years of the youngest possible index children under study. With this set, breastfeeding information was not available. The second set relates to births between one and six completed years preceding the survey (i.e. 1 January 1978 to 31 December 1981), each with detailed information on breastfeeding. With this set, the censoring problem is evident with exposure to the risk of dying at ages 24-59 months but not at younger ages. For example, the exposure of the youngest possible infants born two years before the survey date to the risk of dying during their first and second years of life is not censored at interview date because they have already passed such ages at survey date. However, their exposure to mortality risk during their third to fifth years is censored at the time of the survey. They have not yet reached ages three to five years and may therefore either die or survive at ages three to five years. To avoid this censoring problem in examining the effects of birthspacing and breastfeeding with this second set, child mortality was studied only up to the 23rd month.

Variables, except breastfeeding, that relate to these births in both sets emanated from the pregnancy history[3]. Breastfeeding came from the history on factors other than contraception collected for each birth five years before the survey. Socioeconomic and health-related background variables were drawn from the files on the household and the ever-married.

The statistical tool used was the log-linear rate model fitted by using the package GLIM 3.77 (Payne 1985). Basically, a log-linear rate model considers the ratio of the total number of deaths of children with a particular set of characteristics to the total amount of exposure of children with those characteristics at a given childhood age in question. This model is based on the assumption that there is homogeneity within children with similar characteristics and that the number of deaths occurring to a group of index children exposed at the same risk level follows a Poison distribution (Hobcraft et al. 1984: 209-210). Given a vector of levels 1, 2 and 3 of a categorical independent variable, GLIM automatically sets level 1 to zero and measures the effects of levels 2 and 3 as deviations from this. For example, preceding birth interval (P) has three categories: less than 18 months as level or code 1, 18-30 and 31 and over months as levels or codes 2 and 3, respectively. The category less than 18 months (P1) is set to zero or is the omitted or reference category; the estimated parameters refer to the other categories, 18-30 months (P2) and 31 and over months (P3) and are measured as deviations from the reference category.

Mortality as the dependent variable was looked at in specific age segments in months, x, $x+n$,----0, 1-2, 3-5, 6-11, 12-23, and 24-59. This is in accord with the need to investigate the changing structures of mortality determinants when the index child is older. This disaggregation permits the identification of the particular ages in childhood at which the independent variables of interest and controls have a greater or weaker effect on infant and child mortality. Table 1 presents the number of cases analysed for each age segment for the two sets of data, the definition of the independent variables of interest and bio-demographic controls and the most important socioeconomic and health-related controls discussed below.

Table 1

DEFINITION OF INDEPENDENT VARIABLES OF INTEREST AND BIO-DEMOGRAPHIC CONTROLS, BEST SOCIOECONOMIC AND HEALTH-RELATED COVARIATES OF CHILD MORTALITY AND NUMBER OF CASES ANALYSED FOR EACH AGE SEGMENT IN QUESTION, 1983 NDS

A. Definition of independent variables of interest

1. Preceding birth interval ; PI=less than 18 months, reference category; P2=18-30 months; P3=31 or over months + first births.
2. Pace of following conception: PFCIx=conception occurring before the index child reached the lower bound of specified age segment (x), reference category; PFC2x=no conception occurring before the index child reached the lower bound of a specified age segment (x) + last born index children
3. Breastfeeding: B1x=index child not breastfed up to the lower bound of a specified age segment (x), reference category; B2x=index child breastfed for at least x months.

B. Definition of bio-demographic controls

1. Previous sibling mortality: PSI=previous sibling died before reaching age one year and before the conception date of the index child, reference category; PS2=previous sibling alive before the conception date of the index child.
2. Birth order: B01=first births, reference category; B02=second and third births; B03=fourth or higher births.
3. Maternal age at childbirth: MI=less than 20 years, reference category; M2=20-34 years; M3=35 or over years.

C. Best socioeconomic and health-related covariates (defined in text) and number of cases

	Birth between			
Age segments	5 and 15 years before the survey		1 and 6 years before the survey	
in months (x)	Best covariates	Number of cases	Best covariates	Number of cases
0	Mother's education	18570	Mother's education	9121
1-2	Mother's education+ housing quality	18154	Average household income	8935
3-5	Mother's education+ family composition	18002	Mother's education	8872
6-11	Mother's education+ toilet facility	17856	Mother's education	8872
12-23	Mother's education+ income+toilet facility	17626	Mother's education+ toilet facility	8703
24-59	Mother's education + toilet facility	17372	--	--

The independent variables of interest were:

(1) Length of the preceding birth interval (in months: less than 18, 18-30, and 31 or over, coded respectively as 1 to 3, PI-P3). First births were assigned the longest category interval to ensure that they were not characterised by short preceding intervals and the accompanying stresses;

(2) Pace of following conception (PFC) defined as a dichotomous variable coded 1 if a following conception occurred before the index child reached the lower bound of a specified age segment; otherwise code 2, last born index children also coded 2. Since the analysis was based on birth history, the conception date was imputed by subtracting nine months from the birth date; this variable helps to suppress simultaneity biases affecting the relation between following-birth interval and relative mortality risks of the index child, but it is only relevant for age segments three months or more, owing to the rarity of conceptions before the first month after a birth; and

(3) Breastfeeding (B) defined as a dichotomous variable coded 2 if the index child breastfed for at least x months; otherwise code 1; this operational definition reduces the problems created by censoring or truncation of breastfeeding because of the death of the index child, but not the problems related to the exaggerated effects of breastfeeding.

The bio-demographic controls were:

(1) Previous sibling mortality defined as a dichotomous variable coded 1 if the previous sibling died before the conception date of the index child and if death occurred before the previous sibling reached age one year. otherwise code 2. This control reduces the exaggeration of the negative effects of interbirth interval on mortality due to past mortality experience. It is evident from the 1983 NDS that about eight percent of 10114 mothers experienced a loss of two or more children due to death and this small proportion accounted for about 55 percent of the total 3641 child deaths from the whole pregnancy history;

(2) Birth order (first, second and third and fourth and higher, coded 1 to 3 in that order). This control reduces the distortion of the longest category of preceding birth interval due to first births and serves as a control for influences on mortality that are due to birth order; and

(3) Maternal age at birth of index child (in years: less than 20, 20-34, and 35 and over, coded respectively as 1 to 3); this variable serves as a control for effects on mortality due to very early or late age of mother at birth of the index child.

The primary focus was on the effects of birthspacing and breastfeeding controlling for the confounding influences of bio-demographic, socioeconomic and health-related variables. Given that these socioeconomic and health-related factors were numerous, it was necessary to determine which of them satisfy the best-fitting equation or the most parsimonious model that describes the socioeconomic, health-related and child mortality relationship for each dependent variable under consideration. These models were chosen on the basis of simplicity (a model with the minimum number of predictors) and parsimony (a model with the minimum number of parameters) following the forward approach in modelling.

The socioeconomic variables explored included (a) presence of electricity in the household (with and without); (b) average household income (less than P1000 and P1000 and over); and (c) education of mother (primary and below, elementary, high school, and college or over)[4]. The health-related variables examined were (a) source of drinking water supply (*unsafe*: lake or river, stream, spring, rainwater, open well, pump shallow well; and *safe*: artesian deep well, pipe water); (b) presence of toilet (none, outside the house, inside the house); (c) housing quality (*inadequate*: walls made of scrap materials, *nipa*, other thatch, *sawali*, bamboo, rough-hewn timber and/or poorly-fitted planks and floors of earth or bamboo and wood; and *adequate*: walls made of painted and/or well-fitted wood or hollow blocks, cement or other expensive materials and floors of expensive wood, linoleum or tiles); and (d) family composition (extended and nuclear).

Out of these socioeconomic and health-related variables based on births between 5 and 16 years before the survey, maternal education persisted as the 'best' socioeconomic indicator for all age segments in question. Average household income became highly significant only at age segment 12-23 months; when maternal education only was controlled and when maternal education and toilet facility were controlled, the changes in deviance at one degree of freedom were 14.1 and 7.4, respectively. Housing quality was the 'best' health-related factor at age segment 1-2 months, addition of any of the other health-related variables did not improve the fit of the models; it was family composition at age segment 3-5 months and toilet facility at ages six months or over.

With births between one and six years before the survey, mother's education again persisted as the 'best' socioeconomic indicator in all age segments. except age segment 1-2 months in which average monthly income emerged as the 'best' predictor. Toilet facility again stood out as the 'best' representative health-related indicator beyond the first year of life.

Given that stratified sampling with probability proportional to size was used in selecting the sample, weights were assigned to each record in the survey to reflect the sampling proportions. I used the weights for estimating parameters and the unweighted data for testing and selecting the best models and for estimating standard errors of the parameter estimates. Use of weights will yield unbiased parameter estimates, but estimates of the standard errors and all other statistical tests will be more biased with weighted data than with unweighted data (Lee et al. 1986; Clogg and Eliason 1987).

3. Results

Table 2 presents the estimated log-linear rate coefficients of preceding birth interval (P2 and P3), pace of following conception (PFC2x) for both data sets and breastfeeding (B2x) for the data set in which it was available. A lower mortality at any age segment in question (highly significant at most segments) was associated with longer preceding birth intervals, no conception occurring shortly after the birth of index children and breastfeeding.

With births between 5 and 16 years before the survey, preceding birth interval remained highly significant at any given age segment even with the introduction of pace of following conception (compare Models-1 and 2). With more recent births, the highly significant effect of preceding birth interval observed with the bigger set (Model-1) at ages 1-2 and 12-23 months was not maintained. One possible reason is that there were fewer deaths at these age segments with the smaller set, causing less stable estimates than with the bigger set. The observed apparent inconsistency in revealing the influence of preceding birth interval between the two sets may be a statistical artifact. Credence should then be given more to the measured effect based on the bigger set at the age segments in question. As expected, the introduction of breastfeeding into the model (Model-3) and of breastfeeding and pace of following conception (Model-4) reduced but did not eliminate the negative effects of preceding birth interval. Its highly significant impact persisted for both categories (P2 or 18-30 months and P3 or 31 or more months) on mortality at ages 3-5 months and only for the longest preceding birth interval (P3) on mortality at ages 6-11 months; it then weakened, but still was significant, at ages 12-23 months. The net influence of preceding birth interval was stronger at ages 3-11 months than at the other age segments.

Table 2
EFFECTS OF BIRTHSPACING AND BREASTEEDING ON CHILD MORTALITY: 1983 NDS

Data set/Model/ Variable[a]	Age segments in months (x) 0	1-2	3-5	6-11	12-23	24-59
1. Births between 5 and 16 years before the survey						
Model 1						
P2	-0.70 ***	-0.88 ***	-0.69 ***	-0.47 ***	-0.94 ***	-0.57 ***
	(0.13)	(0.19)	(0.20)	(0.16)	(0.16)	(0.15)
P3	-0.80 ***	-1.52 ***	-1.11 ***	-0.95 ***	-0.93 ***	-0.68 ***
	(0.16)	(0.26)	(0.27)	(0.20)	(0.18)	(0.18)
Model 2						
P2	--	--	-0.67 ***	-0.40 **	-0.93 ***	-0.57 ***
			(0.21)	(0.16)	(0.16)	(0.15)
P3	--	--	-1.09 ***	-0.89 ***	-0.92 ***	-0.66 ***
			(0.27)	(0.20)	(0.18)	(0.18)
PFC2x	--	--	-0.53	-0.88 ***	-0.21	-0.23
			(0.30)	(0.15)	(0.13)	(0.13)
2. Births between 1 and 6 years before the survey						
Model 1						
P2	-0.78 ***	-0.63 *	-1.05 ***	-0.613 ***	-0.54 *	--
	(0.19)	(0.32)	(0.33)	(0.24)	(0.24)	
P3	-0.66 ***	-0.49	-1.02 ***	-1.25 ***	-0.64 *	--
	(0.21)	(0.34)	(0.33)	(0.31)	(0.27)	--
Model 2						
P2	--	--	-1.03 ***	-0.58 **	-0.50 *	--
			(0.33)	(0.24)	(0.24)	--
P3	--	--	-1.01 ***	-1.20 ***	-0.59 *	--
			(0.33)	(0.31)	(0.28)	--
PFC2x	--	--	-1.11 ***	-0.96 ***	-0.40	--
	--	--	(0.40)	(0.24)	(0.20)	--
Model 3						
P2	-0.52 ***	-0.46	-0.92 ***	-0.49 *	-0.48 *	--
P3	-0.49 *	-0.35	-0.91 ***	-1.14 ***	-0.58 *	--
	(0.21)	(0.34)	(0.33)	(0.31)	(0.30)	--
B2x	-2.47 ***	-1.68 ***	-1.13 ***	-1.05 ***	-0.50 **	--
	(0.16)	(0.26)	(0.26)	(0.20)	(0.20)	--
Model 4						
P2	--	--	-0.91 ***	-0.46	-0.46	--
			(0.33)	(0.24)	(0.24)	--
P3	--	--	-0.91 ***	-1.11 ***	-0.56 *	--
			(0.33)	(0.31)	(0.28)	--
PFC2x	--	--	-0.83 *	-0.68 ***	-0.30	--
			(0.41)	(0.25)	(0.21)	--
B2x	--	--	-1.07 ***	-0.90 ***	-0.43 *	--
			(0.26)	(0.21)	(0.20)	--

Note: a = All models include birth order, maternal age at childbirth, previous sibling mortality and the socioeconomic and health-related best predictors emerging from the modelling as shown in Table 1 for each age segment. The variables are also defined in Table 1. Model 1 adds preceding birth interval to the controls; model 2 adds preceding birth interval and pace of following conception to the controls; model 3 adds preceding birth interval and breasfeeding to the controls; model 4 includes all independent variables of interest and controls.

* significant at $p < 0.05$; ** significant at $p < 0.02$; *** significant at $p < 0.01$. Figures in parentheses are standard errors.

The effects of pace of following conception were also in the expected direction but they were highly significant only at age segment 6-11 months among births between 5 and 16 years before the survey, and at age segments 3-5 and 6-11 months among births between 1 and 6 years before the survey (Model-2). The mediating role of breastfeeding was also evident as seen in the diminished magnitude of the effects of pace of following conception (contrast Models-2 and 4). However, as with preceding birth interval, the significant effects of pace of following conception remained.

As expected, the effects of breastfeeding were strongest at the first month of life and decreased with age of the index child. It greatly weakened the effects of preceding birth interval at the first months of life (0-2 months) as evident when Models-1 and 3 were contrasted, contrary to its minimal mediating effect on the significance of both preceding birth interval and pace of following conception at ages 3-23 months of life of the index child, as noted earlier. Its exaggerated effects on mortality at the first two months of life of the index child may be due to an artefactual relation between breastfeeding and mortality, resulting from the failure to control for pre-existing health status of the index child. An index child born after a very short interval is likely to have very low weight at birth and to die shortly after birth, which in turn truncates breastfeeding (Palloni 1989: 184). The failure of breastfeeding to eliminate the effects of both measures of birthspacing at older ages of the index child may suggest that there are other mechanisms operating through which birthspacing affects child mortality; or that there are systematic errors in the reporting of breastfeeding durations.

However, as the breastfeeding information refers to births five years before the survey, the reporting of breastfeeding duration may not have been seriously inaccurate; recent events are likely to be remembered more accurately than events in the more distant past. This supposition is supported by the absence of any gross inaccuracies in the reporting of breastfeeding durations, with only 24 percent of children reported to have been breastfed for 12 months and the remaining 76 percent distributed over the other durations (Table 3). If there were gross errors of misreporting, especially the tendency to round to 12 months, most of the births would have been concentrated on this duration and there would have been no reported breastfeeding at most of the other durations, especially those ending in odd digits. Hence, there is reason to believe that there are other mechanisms operating, other than breastfeeding, through which birthspacing affected child mortality in the Philippines.

Table 3
PERCENTAGE DISTRIBUTION OF BREASTFEEDING DURATION IN MONTHS, 1983 NDS

Months	Per cent
0	2.2
1	3.5
2	3.8
3	4.4
4	3.5
5	3.1
6	4.8
7	3.7
8	4.9
9	4.9
10	3.8
11	1.7
12	24.2
13	2.4
14	4.5
15	4.0
16	1.8
17	1.4
18	5.7
19	1.1
20	1.4
21	0.5
22	0.5
23	0.3
24	4.7
25	0.3
26	0.3
27+	2.6
Total	100.0
N of cases	7381

To examine whether these persistent effects of birthspacing and breastfeeding were due to their significant interactions with mother's education, the 'best' socioeconomic control, and with each other, these interaction terms were introduced into the complete models for both sets of observations. With births between 5 and 16 years before the survey, these models were Model-1 for age segments 0 and 1-2 months and Model-2 for all the older age segments. With births between 1 and 6 years preceding the survey, they were Model-3 for age segments 0 and 1-2 months and Model-4 for all the older age segments. Interestingly, significant interactions occurred only between the highest maternal education (college or higher, E4) and preceding birth interval for neonatal mortality with the bigger data set and between pace of following conception and breastfeeding for mortality at ages 6-11 months with the smaller data set; these significant interactions were the only ones presented in Table 4, upper panel. The positive sign of the significant interaction between mother's education and preceding birth interval indicates that among index children of mothers with college or higher education, the role of preceding birth interval is irrelevant as shown with the insignificance of the coefficients for the highest education category. The negative sign of the significant interaction between pace of following conception and breastfeeding further confirmed the expected negative effects of these variables on mortality at ages 6-11 months. These findings indicate that there is no strong evidence from which to argue that the main effects of birthspacing and breastfeeding were either enhanced or weakened by their interactions with mother's education and with each other.

The estimated effects of birthspacing (both preceding and following birth intervals) and breastfeeding may be appreciated more if they are converted into relative risks by simply exponentiating the parameter estimates of these complete models. Any value less or more than unity means, respectively, lower or higher relative risk of dying at the age segment in question of the group under consideration than in the baseline or reference group. The exponential of the constant term is the fitted rate for the reference group. Multiplying this rate by the relative risks of the considered categories yields probabilities of dying or fitted rates for such groups (Hobcraft et al. 1984). These relative risks are shown in the lower panel of Table 4.

Table 4
SIGNIFICANT INTERACTIONS AND RELATIVE RISKS, COMPLETE MODELS
1983 NDS

A. Significant interactions

1. Model 1, age segment 0, births between 5 and 16 years before the survey

Interaction	Coefficient	Standard error
E4.P2	1.35*	0.60
E4.P3	1.27*	0.59

	E1	E2	E3	E4
P1	0.00	-0.59 ***	-0.39	1.71 **
		(0.19)	(0.23)	(0.51)
P2	-0.749 ***	-1.31 ***	-1.34 *	-1.10
	(0.20)	(0.49)	(0.58)	(1.01)
P3	-1.05 ***	-1.16 *	-1.36	1.49
	(0.22)	(0.49)	(0.57)	(1.01)

2. Model 4, age segment 6-11, birth between 1 and 6 years before the survey

Interaction	Coefficient	Standard error
B2x.PFC2x	-1.51***	0.47

B. Relative Risks or Exponentiated Parameter Estimates

Data set/Model/	Age segment in months					
Variable	0	1-2	3-5	6-11	12-23	24-59
1. Births between 5 and 16 years before the survey						
Model 1 for age segments 0 and 1-2; otherwise Model 2						
P1	1.000	1.000	1.000	1.000	1.000	1.000
P2	0.497	0.415	0.512	0.670	0.395	0.566
P3	0.449	0.219	0.336	0.411	0.399	0.517
PFC1x	--	--	1.000	1.000	1.000	1.000
PFC1x	--	--	0.589	0.415	0.811	0.795
Constant	0.496	0.220	0.421	0.090	0.024	0.010
2. Births between 1 and 6 years before the survey						
Model 3 for age segments 0 and 1-2; otherwise Model 4						
P1	1.000	1.000	1.000	1.000	1.000	--
P2	0.594	0.631	0.402	0.631	0.631	--
P3	0.613	0.705	0.402	0.330	0.571	--
PFC1x	--	--	1.000	1.000	1.00	--
PFC2x	--	--	0.436	0.502	0.741	--
B1x	1.000	1.000	1.000	1.000	1.000	--
B2x	0.085	0.186	0.343	0.407	0.650	--
Constant	0.097	0.191	0.535	0.297	0.021	--

Notes: E1= Primary education or below; E2=elementary; E3=high school; E4=college of over. The other variables are defined in Table 1. Models are defined in Table 2.

* significant at p < 0.05; ** significant at p< 0.02; *** significant at p< 0.01. Figures in parentheses are standard errors.

Considering the model based on data set without breastfeeding information, index children preceded by birth intervals of 18 months or over were 50-55, 58-78, 49-66, 33-59, 60 and 43-48 percent less likely to die at ages 0, 1-2, 3-5, 6-11, 12-23 and 24-59 months, respectively, than those preceded by intervals of less than 18 months. If there was no conception shortly after the birth of the index child, the mortality risk at ages 6-11 months (taking only the significant coefficient) was reduced by 58 percent. Contrasting two extreme groups illustrates these marked effects on mortality of wide spacing, preceding and following birth intervals. For example, the mortality rate at ages 6-11 months for the baseline group, index children with previous intervals of less than 18 months and whose births were rapidly followed by another conception, was 90 per thousand births, which is 6 times the rate (0.090*0.415*0.411) for index children preceded by intervals of 31 months or over and whose births were not soon followed by another conception.

With the complete model based on data set with breastfeeding information (smaller sample size), long preceding birth intervals decreased the mortality risk at any age segment by 30-60 percent; non-occurrence of conception shortly after birth reduced mortality at ages 3-11 months by 50-56 percent. Breastfeeding lowered mortality at ages 0, 1-2, 3-5, 6-11 and 12-23 months by 91, 81, 66, 61 and 35 percent, in that order.

Again, contrasting two extreme groups, the model based on the smaller data set suggested that the neonatal mortality rate for the baseline group, index children preceded by birth intervals of less than 18 months and not breastfed was 97 per thousand births, which is about 19 times the rate (0.097*0.085*0.613) for index children preceded by intervals of 31 months or more and breastfed. Similarly, the mortality rate at ages 6-11 months of 297 per thousand births for the baseline group, index children preceded by intervals of less than 18 months, whose birth was followed shortly by a conception, and who were not breastfed was 15.6 times the rate (0.297*0.395*0.502*0.330) for index children preceded by intervals of 31 months or more, whose birth was not followed rapidly by another conception, and who were breastfed. Beyond the first year of life, the gap between such extreme disadvantaged and advantaged groups was decreased to 3.5 and 2.5 times (21 vs. 6 and 10 vs. 4 per thousand births, respectively), clearly indicating that the effects of birthspacing and breastfeeding were strongest at the first months of life and declined thereafter. However, the magnitude of 2.5 to 3.5 times difference still suggests the considerable effects of these variables on mortality, even at older ages of childhood.

4. Discussion

The present log-linear rate analysis of the 1983 NDS has established the marked importance of long interbirth intervals and breastfeeding in preventing Philippine infant and child mortality. The mortality risk faced by non-breastfed index children with previous short birth intervals was 19 and 7 times that encountered by breastfed index children with long preceding birth intervals at ages 0 and 1-2 months, respectively. Mortality rates for non-breastfed index children preceded by birth intervals of less than 18 months and followed by another conception shorly after their births were, at ages 3-11 months 16 times, and beyond infancy 2-3 times, the mortality rates for breastfed and widely spaced index children. These findings obviously point to the importance of birthspacing and breastfeeding in the delivery of maternal and child health and family planning services to the Philippine populace.

The present analysis identified the impact of birthspacing and breastfeeding independent of the confounding influences of factors, which are bio-demographic (previous sibling mortality, birth order and maternal age at childbirth), socioeconomic (mother's education and average household income) and health-related (toilet facility, housing quality and family composition). This analytical strategy is one of the many approaches whereby to understand properly the determinants of child mortality. The Cebu Longitudinal Health and Nutrition Study in the Philippines (Cebu Study Team forthcoming), expressly built around the Mosley and Chen (1984) framework, presents another methodology for assessing the effects of 'underlying' social factors and 'proximate' behavioural and biomedical factors on infant morbidity, growth and mortality.

The magnitude of the effects of birthspacing and breastfeeding differed by age of the index child. All other things being equal, the largest reduction (50-67 percent) of mortality resulting from long preceding and succeeding birth intervals occurred at ages 3-11 months; the reduction of mortality at the other ages due to long preceding birth interval was smaller but still considerable (about 40 percent). Breastfeeding reduced mortality risks the most (80-90 percent) at the first two months of life and at a declining but nevertheless significant level at the older ages. As the present analysis adopted the strategies of Palloni and Tienda (1986) and Palloni (1989) in analysing Latin American data, the similarity of the findings is to be expected. However, it is worthwhile citing the studies of DaVanzo et al. (1983) using Malaysian data, and Popkin et al. (forthcoming) using data from the Cebu Longitudinal Health and Nutrition Study, which show that breastfeeding effects are stronger during the first six months than the last six months of infancy. This changing structure of mortality determinants as the index child is older needs to be considered both in health planning and mortality research.

The significant effect of preceding birth interval is also consistent with findings of other studies (e.g. Hobcraft et al. 1983; Cleland and Sathar 1984; Casterline forthcoming). Its persistent impact with controls, which include previous sibling mortality, does not seem to support the argument that replacing a dead child prevails in the Philippines. In fact, de Guzman (1984a; 1984b) finds no importance of child replacement in fertility, although his separate analysis of feelings about mortality implies some insurance effects on fertility, these are not clear enough to warrant definitive conclusions. What then are the mechanisms through which preceding birth interval affects Philippine child mortality? It is difficult to identify the exact mechanisms owing to lack of medical information, but an inference can be made. The two possible mechanisms are maternal depletion syndrome and competition between siblings for care and resources as mentioned earlier. Previous sibling mortality was significant only during the first half of infancy but minimally reduced the magnitude of the effects of preceding birth interval when it was introduced into the models. This indicates that the presence of an older sibling to compete with the index child for food and care is not the main mechanism. Adair's analysis of relevant data from the Cebu Longitudinal Health and Nutrition Study (1989) reveals that low birthweight is a better predictor of poor postnatal growth than is small-for-gestational age. Low birthweight was one of the most important proximate covariates of infant mortality (DaVanzo et al. 1983; Cramer 1987). This maternal depletion syndrome causing low birthweight or prematurity, through which short preceding birth intervals tend to heighten mortality risks, appears to be the more likely mechanism than competition between siblings. It should be considered in the provision of pre- and postnatal care and in encouraging the practice of family planning.

The very high mortality of index children whose birth is followed shortly by another conception, supports the findings of Hobcraft et al. (1983: 597) using World Fertility Survey data. They found that the Philippines is one of the 16 of 23 countries where the birth of another child within 18 months raises the mortality risk of the index child in the second year of life. The lessened but persistent significance of the effect of following birth interval after the introduction of breastfeeding clearly illustrates the influence of following birth interval operating through direct competition with a later birth or poorer care and breastfeeding. This finding implies that equal attention should be given to breastfeeding and family planning (adequate birthspacing or family limitation) in determining the best mix of strategies for preventing child deaths.

Notes

1. The research on which this article was based was undertaken while I was a postdoctoral fellow of the Rockefeller Foundation at the Division of Demography and Sociology of the Research School of Social Sciences, The Australian National University. I am grateful to Dr. Alan Gray, my academic adviser under the fellowship, for his comments which helped to improve the final version of this article and to Ms. Wendy Cosford and Mr. Robert Hyslop for patiently editing it.

2. The *barangay* is the smallest political unit in the Philippines. "Village" is its nearest synonym in English.

3. An evaluation of the 1983 NDS pregnancy history (Cabigon, 1990) revealed that the problems common in many surveys--systematic event misplacement toward the survey, and omission of events, especially by earlier cohorts and in earlier periods—were not noticeable in most cohorts of women in the survey. As in previous national surveys undertaken in the Philippines, the errors observed might not have caused serious distortions in the maternity history.

4. The reasons for considering a four-level categorisation of maternal education are presented elsewhere (Cabigon 1990). The same categorisation is maintained here for consistency.

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Josefina V. Cabigon, PhD. Population Institute University of the Philippines Quezon City, Philippine. Fax no.: (632) 9205402; E-mail: POPINST@NICOLE.UPD.EDU.PH