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ASSESSING AND INTERPRETING BIRTH SPACING GOALS IN COSTA RICA

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Summary. A procedure for assessing birth spacing goals, an important component of fertility preferences, is proposed and applied to 1993 Costa Rican data. Based on a reverse or backward survival analysis, preferred birth intervals are estimated to range between 3·5 and 4·5 years (1·5 years for the interval union to first birth). These intervals are 2 or 3 years shorter than crude estimates from data on open or last closed intervals, which are upwardly biased by selection and left censoring effects. To achieve these spacing preferences, a cohort must spend about two-thirds of the time using contraception (one-third in the interval union to first birth). An inverse association between desired family size and desired birth interval is evident only in parity-specific analyses.

Introduction

The motivational forces that drive the fertility transition in developing countries may include both the desire to stop childbearing after couples reach their preferred family size and the desire to lengthen birth intervals, either as a goal by itself or as a means to achieve small family sizes. A comparative study of the Demographic and Health Surveys (DHS) shows that in sub-Saharan Africa more than half of contraceptive use is for spacing purposes; in the rest of the developing world spacing motivations account for about one-fourth of contraceptive prevalence (Westoff & Ochoa, 1991). However, little is known about these spacing motivations in different cultural settings or at different stages of fertility transition, or about the contribution of spacing goals to the fertility transition, their covariates, and their interaction with goals about family size. Spacing preferences often are ignored in studies of the fertility transition (e.g. Pritchett, 1994). A first step in understanding this aspect of reproductive motivations is to measure people's goals on birth spacing. This article illustrates some of the problems of measuring the desired length of birth intervals (DBI) with data from a DHS-type survey conducted in Costa Rica in 1992–93.

Data and methods

The data are from the Costa Rican Reproductive Health Survey (ESR) conducted in 1992–93 by the Social Security Office with assistance from the US Centers for Disease

Control and Prevention (CDC). The ESR is a nationally representative, DHS-type survey of about 3600 women aged 15–49 years (Caja Costarricense de Seguro Social, 1994).

The Costa Rican ESR, as most DHS-type surveys, collected information about spacing preferences for open and closed birth intervals, which in combination with the actual length of these intervals can lead to an estimate of the desired birth interval (DBI). For the open birth interval, women who want to have more children were asked: 'How long would you like to wait from now before the birth of another child?' Non-responses were followed with the probe: 'How old would you like your youngest child to be?' For the last closed birth interval (in many surveys the information is available for all birth intervals ending in the 5-year period before the survey), women were asked: 'Before you became pregnant, did you want to have a(nother) child at that time, did you want to wait longer, or did you want no more children?' 'Wait longer' responses were followed by the question: 'How much longer would you like to have waited?' For those women who were pregnant at the interview, the questions about the open birth interval refer to the period following the pregnancy and questions about the closed interval refer to the wantedness and timing of the current pregnancy.

Three estimates of the DBI can be calculated directly with this information: (1) open birth interval, (2) closed birth interval, and (3) cohort estimate. Two major problems afflict these estimates: (1) selection bias and (2) left censoring. A fourth procedure, reverse or backward life table, is developed in this article to improve the validity of DBI estimates.

Estimate based on the open birth interval

Following Westoff (1991) a first estimate of the DBI adds to the length of the open birth interval (the time elapsed since the last birth, or the date of marriage for first intervals) the reported intentions about how long the respondent wants to wait for the next birth. Intentions of the type 'as soon as possible' are taken as zero waiting time and the DBI is in this estimate assumed equal to the open birth interval. Women who want no more children are excluded.

Estimate based on the closed birth interval

A second estimate analogously uses the information on closed birth intervals. In the case of a mistimed birth (when the respondent would have preferred to wait to become pregnant) the DBI is assessed by adding the desired additional waiting period to the actual length of the interval. For wanted and timely births, the DBI is taken as the length of the closed interval. Women who did not want more children are excluded.

An important shortcoming in these procedures that probably biases the two DBI estimates in an upward direction is a selection effect. Shorter DBIs tend to be under-represented in a sample of open birth intervals, since women wanting a birth soon tend to move more quickly to higher order intervals. In other words, women with very long intervals (open or closed) at the time of the survey are selected members of their interval cohort who continue to be in that interval because they wanted a long DBI. Most members of that interval cohort with short DBI have already left the interval.

Cohort estimate

The cure for this selection bias is a cohort or longitudinal approach. Under an ideal design, one should interview a cohort of women who are getting married or having a baby and ask them about their goals for the interval they are about to start. In a DHS-type survey, this prospective design may be simulated by selecting subgroups of women who started an interval in a predetermined period (the information on preferences for this group is, however, retrospective, which means the possibility of recall and rationalisation biases).

This study operationalised a retrospective cohort analysis by selecting only women who started a union or had a birth in the 60-month period before the survey and who wanted more children, i.e. those who started a wanted birth interval in the last 60 months. For women who started more than one wanted interval in this period, only the earliest one was considered. The earliest interval can be a closed or an open interval so this procedure blends the information from the two types of intervals.

However, the proposed cohort estimate, as well as the two previous estimates, is afflicted by a 'left censoring' bias. Few women become pregnant in the first month they intend it. A waiting time for conceiving is inherent in the reproductive process (Leridon, 1977). Average waiting times of 5–6 months are common for populations with normal fecundability; i.e. a monthly probability of conceiving of the order of 0·20. Women who state that they would like to have a birth 'as soon as possible' are thus suggesting a DBI shorter than the time elapsed since the last birth and have probably been trying to conceive for several months. Similarly, women reporting that a previous birth was wanted and was not mistimed are suggesting a DBI shorter than the length of the corresponding closed interval. These women are 'left censored', in analogy to the 'right censoring' that occurs in survival analyses when an individual stops being observed. Figure 1 (top panel) illustrates what is known in conventional survival analysis as a 'death' (X) and a censored observation (O). Although in a censored individual the complete survival time, the time until death, is unknown, this individual still provides important information since a survival time longer than the observation time is implied. For retrospective data (e.g. birth and marriage histories), the most common cause of censoring is the date of the interview.

The middle panel in Fig. 1 illustrates the situations analysed in the present study. For closed intervals and mistimed births (case A), the survival time is known and equals the sum of the closed interval plus the time the respondent would have liked to wait. For open intervals in which the respondent still wants to wait (case C) the survival time is also known. However, left censoring occurs in closed or open intervals in which respondents reported that they wanted to become pregnant right away (cases B and D). The DBI—the survival time—is shorter than the observed interval but its exact length is unknown.

Reverse life table

The procedure to account for the left censoring effect, a reverse or backward life table for the observations taken as in the cohort estimate, is based on the principle that if one counts the survival time backwards, starting from an upper DBI bound ω (say,

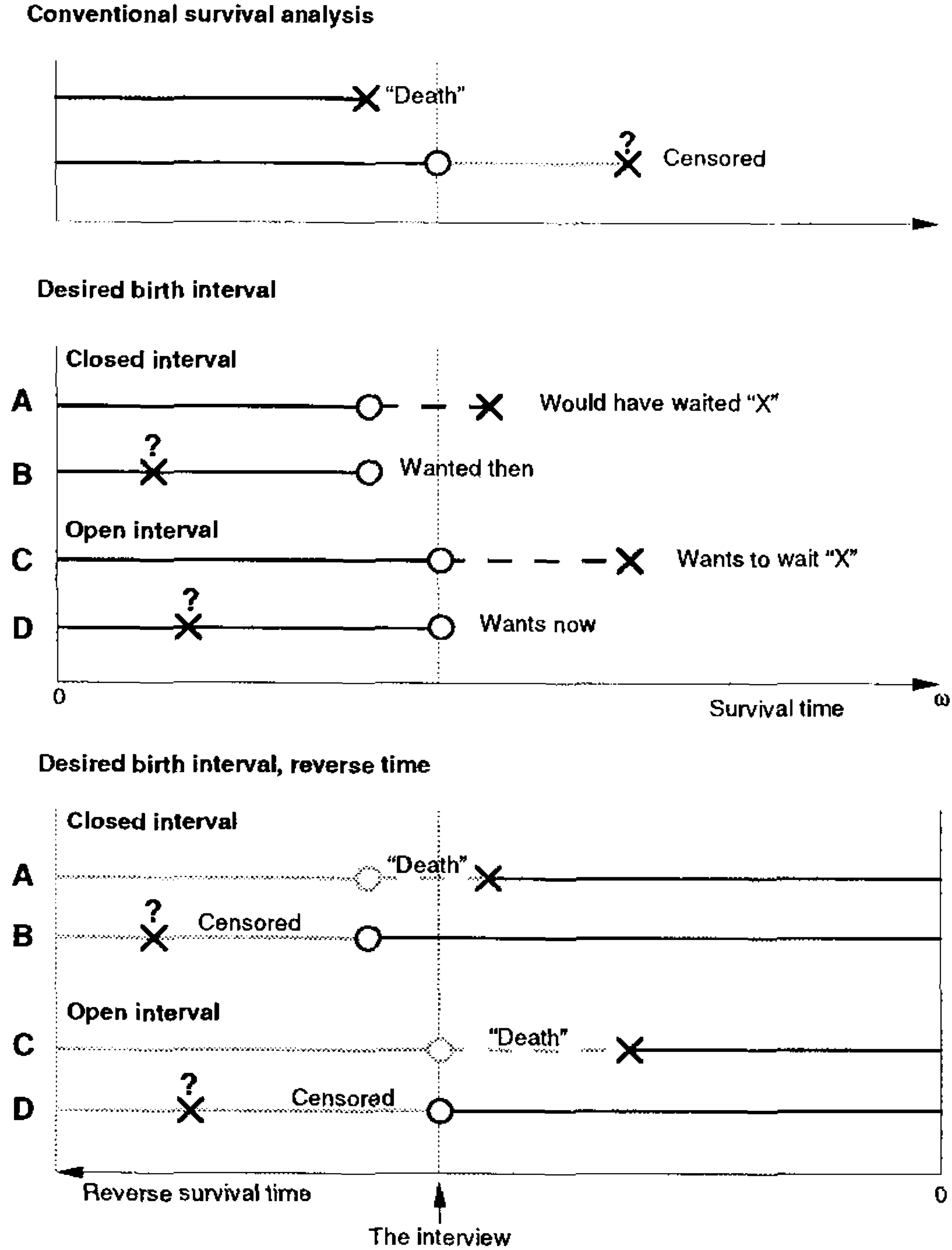

Fig. 1. Survival analysis with censored observations.

144 months), left censoring becomes right censoring and thus standard survival methods apply. Thus in Fig. 1 (lower panel), cases A and C continue to be deaths and cases B and C become conventional censored observations. The cumulative failure

Table 1. Reverse life table to estimate the DBI for the 5 years prior to the survey, all birth orders

Reverse DBI life table						DBI life table *			
Time $t=\omega-x$	Observations	'Deaths'	Censored	Survival R_t	Failure $1-R_t$	Time (x months)	Survival S_x	Hazard $_6h_x000$	Expectancy (years)
0	805	3	4	1·0000	0·0000	0	1·0000	0·0	2·9
6	798	4	0	0·9963	0·0037	6	1·0000	102·9	2·4
12	794	2	1	0·9913	0·0087	12	0·5281	5·0	3·8
18	791	2	0	0·9888	0·0112	18	0·5124	9·3	3·5
24	789	5	0	0·9863	0·0137	24	0·4847	12·8	3·1
30	784	3	1	0·9800	0·0200	30	0·4488	18·0	2·9
36	780	5	1	0·9763	0·0237	36	0·4027	14·8	2·7
42	774	18	2	0·9700	0·0300	42	0·3684	22·4	2·4
48	754	9	5	0·9474	0·0526	48	0·3221	25·2	2·2
54	740	14	2	0·9361	0·0639	54	0·2769	30·1	2·0
60	724	23	3	0·9183	0·0817	60	0·2311	34·4	1·9
66	698	25	5	0·8891	0·1109	66	0·1879	45·3	1·7
72	668	35	5	0·8571	0·1429	72	0·1429	42·0	1·7
78	628	33	15	0·8121	0·1879	78	0·1109	50·5	1·6
84	580	34	18	0·7689	0·2311	84	0·0817	40·8	1·6
90	528	32	33	0·7231	0·2769	90	0·0639	32·3	1·5
96	463	30	46	0·6779	0·3221	96	0·0526	91·2	1·3
102	387	20	39	0·6316	0·3684	102	0·0300	39·1	1·6
108	328	23	60	0·5973	0·4027	108	0·0237	28·2	1·5
114	245	14	60	0·5512	0·4488	114	0·0200	62·3	1·2
120	171	7	81	0·5153	0·4847	120	0·0137	33·5	1·1
126	83	2	42	0·4876	0·5124	126	0·0112	41·9	0·8
132	39	39	0	0·4719	0·5281	132	0·0087	134·4	0·5
138				0·0000	1·0000	138	0·0037	333·3	0·3
144					1·0000	144	0·0000		

function in the reverse life table, which is estimated using conventional methods, happens to be the survival function of the straight table. The reverse and straight tables are thus linked by:

$$S_x = 1 - R_t; \qquad t = \omega - x$$

where x is the DBI, i.e. the straight survival time,
t is the reverse survival time,
ω is an arbitrary upper bound for x.
S_x is the survival function at time x,
R_t is the reverse survival function at reverse time t.

In addition, the implicit relationship between the hazard rate h and the reverse hazard r is given by:

$$h_x = \frac{R_t}{1 - R_t} r_t; \qquad t = \omega - x$$

Table 1 illustrates the procedure for computing a reverse life table with Costa Rican data (all birth order intervals altogether) and for shifting from the reverse to the straight DBI life table. Having the survival function in the straight DBI life table, the remaining functions of the table, including the expected length of the DBI, are easily computed using conventional formulae (Trussell, Hankison & Tilton, 1992).

Some studies on survival analysis apply the term left censored observations to those with unknown starting date; this arises when individuals are observed from an arbitrary date (e.g. 5 years before the survey) and no information is available about the date of the event that opens the interval (previous birth, marriage). In the present study the term left censoring is used in a different way: for 'deaths' that occurred before the observation time, but where the exact date is not known.

An article by Allison (1985) on survival analysis of backward recurrence times does not apply to the problem studied here. Allison's and other studies deal with the problem of retrospectively analysing open intervals by treating time as if it ran backwards from the date of the survey, i.e. in all individuals the observation has been interrupted at the time of the survey, which means that all observations are censored—a complicated situation.

The major limitation of the reverse life table procedure proposed here comes from the implicit assumption that censored observations do not differ from uncensored observations regarding the remaining reverse survival time. This assumption probably does not hold since censored observations had a short remaining reverse survival time, which equals the waiting time for conceiving. Estimates of DBI based on reverse life tables might thus be minimalist estimates of the spacing goals of censored observations.

All the present estimates impose on the data a minimum DBI of 11 months (9 months of pregnancy plus a minimum 2 months of waiting time for conception or postpartum infecundity). Negative DBIs (prenuptial births) or DBIs shorter than 11 months are thus taken as 11 months. All analyses are for women in a union, aged 15–49 years, fecund, non-sterilised and wanting more children.

Table 2. Estimates of the average DBI by several procedures

Birth interval	Open interval	Closed interval	Cohort	Reverse life table
All	5·7	4·9	3·9	2·9
	(758)	(1462)	(805)	(805)
0–1	3·8	2·9	2·3	1·5
	(121)	(362)	(315)	(315)
1–2	5·1	5·5	4·7	3·5
	(279)	(461)	(176)	(176)
2–3	6·7	5·8	5·1	4·3
	(196)	(322)	(169)	(169)
3–4	6·9	5·8	5·5	4·5
	(105)	(148)	(78)	(78)
4+	6·8	5·4	4·8	3·9
	(57)	(169)	(67)	(67)

N in parentheses.

Results

Table 2 shows the mean DBIs estimated by the four procedures. The estimates based on crude data on both the open and last closed interval result in fairly long DBIs. After the first birth, the preferred intervals range from 5 to 7 years according to this crude approach. For the interval from union to the first birth the range is 3–4 years. The DHS estimates for 26 developing countries based on the open interval resulted in median DBIs ranging from 3 to 5 years for all birth intervals (Westoff, 1991). In Latin America, the minimum median DBI was in Guatemala and the Dominican Republic (3·3 years) and the maximum in Ecuador and Perú (4·7 years). The comparable estimate for Costa Rica is a median of 5·1 years (open interval), which is among the longest in Latin America.

As expected, controlling for the selection effect reduces the estimated mean DBI (cohort column in Table 2). This reduction is substantial—almost 2 years—especially in comparison to the open interval estimate. According to the cohort estimates, Costa Rican women prefer to wait 2·3 years on average to have a first birth. After the first birth, the mean DBI is of the order of 5 years.

A further reduction occurs after correcting for the left censoring effect. The reverse live table procedure yields DBI estimates about 1 year shorter than the cohort procedure (Table 2). The mean DBIs estimated by the reverse life table are about 4 years for intervals after the first birth and only 1·5 years for the interval between the union and the first birth.

Figure 2 shows the survival curves (S_x) estimated by the reverse life table procedure. For the interval from first to second birth, 68% of women want an interval 18 months or longer and 29% want an interval 60 months or longer. Since the number of observations drops substantially for short durations, the survival curves are less reliable at short durations. For example, only 83 observations remain at 18 months (126

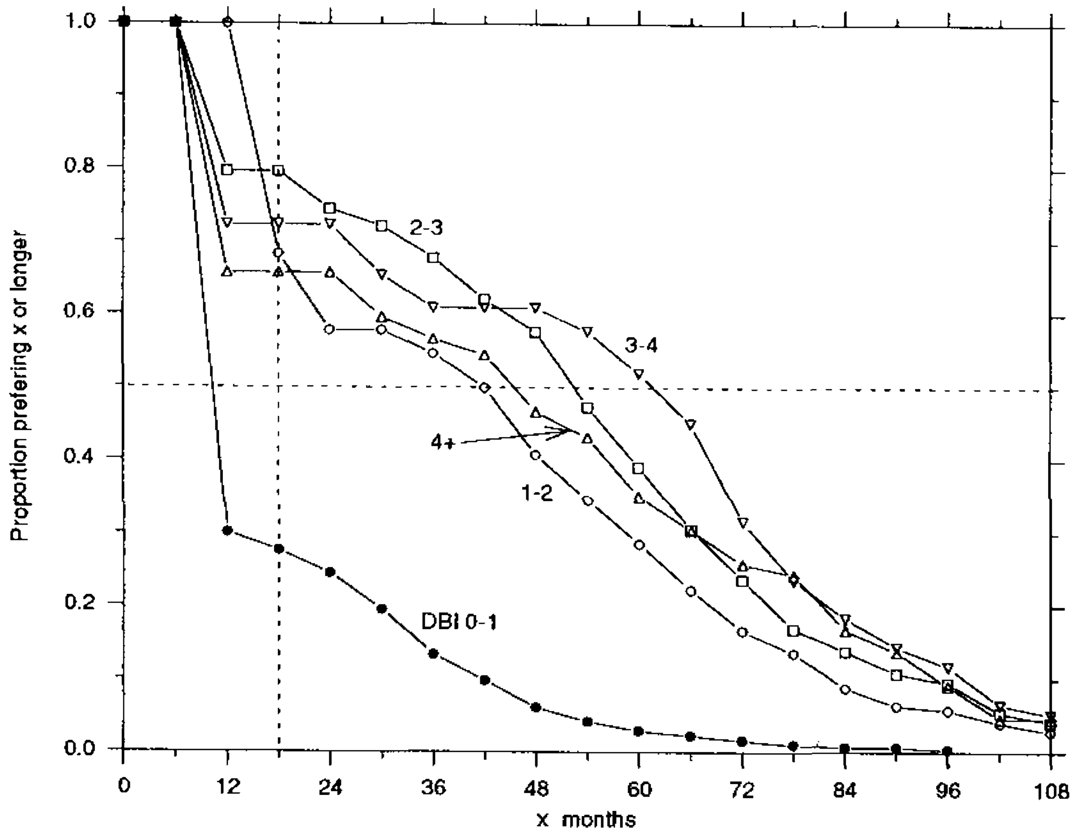

Fig. 2. Desired birth interval curves by birth interval.

months in reverse time) in the table that pools all the intervals, from which, 42 are further left censored in the previous 6 months (see Table 1).

A potentially important use of these estimates is in the analysis of the demand and unmet need for family planning. Depending on the customs of breast-feeding and postpartum abstinence in a particular population, one can define an interval threshold beyond which women who want to postpone a birth will need to use contraception. A threshold of 18 months seems reasonable for Costa Rica, where the mean duration of breast-feeding is less than 6 months and postpartum abstinence is not practised. This threshold includes 9 months of pregnancy plus 9 months of postpartum infecundity and waiting time to conception. Figure 2 shows the 18-month threshold for the estimated survival curves. The cumulative survival function evaluated at this threshold indicates the proportion of women eventually demanding family planning for spacing purposes (among those who want more children). The area under the curve after the threshold indicates the amount of time these women will need to use contraception. The last two columns in Table 3 show this time as an average per woman eventually in need of spacing contraception and as a percentage of the desired birth interval, respectively.

The proportion of women eventually in need of family planning for spacing purposes (conditional on wanting more children) is only 28% in the first birth interval, but ranges from 66% to 80% in other intervals. These women will have to use contraception for about 2

Table 3. Need of family planning for birth spacing derived from DBI estimates

Birth interval	N	Mean DBI (years)	% will need	Mean years of need	% of DBI time
All	805	2·9	51	3·5	61
0–1	315	1·5	28	1·9	35
1–2	176	3·5	68	3·3	64
2–3	169	4·3	80	3·7	69
3–4	78	4·5	72	4·5	72
4+	67	3·9	66	4·1	68

Table 4. Mean DBI by desired family size

		Desired family size		
Interval	Total	<3 children	3 children	4+ children
All	2·9	2·5	3·2	3·1
	(805)	(303)	(228)	(274)
0–1	1·5	1·6	1·5	1·0
	(315)	(180)	(85)	(50)
1–2	3·6	4·0	2·8	3·0
	(176)	(93)	(42)	(41)
2–3	4·3		5·2	3·2
	(169)		(88)	(67)
3–4	4·5			4·3
	(78)			(62)
4+–5+	3·9			3·9
	(67)			(54)

N in parentheses.

years in the first interval and for about 4 years on average in other intervals. The proportion of time that these cohorts should spend using contraceptives to fulfil their spacing goals is one-third of the first DBI and about two-thirds of the other intervals (Table 3).

These estimates are for women who want to have more children at each parity. These estimates could be combined with data on desired parity progression ratios to generate estimates of the demand for family planning in a hypothetical cohort. These estimates would measure the intrinsic demand for family planning independently of compositional perturbances.

Measuring the preferred length of birth intervals is the first step to understand the role of birth spacing in the fertility transition, as well as the factors associated to spacing preferences. A critical issue is whether desired family sizes (DFS) are associated with DBIs (Table 4).

In the estimates for all intervals combined, there is no association between DBI and DFS. Even those who want small families (less than three children) apparently also want shorter intervals (2·5 years versus more than 3 years for DFS of three or more children). This is, however, a spurious association. In actuality, the parity specific estimates suggest an inverse association between DFS and DBI: the smaller the preferred family size the longer the preferred length of birth intervals. The fact that the first DBI (union to first birth) is substantially shorter than the others, combined with a propensity to find more women in this interval for smaller DFS, results in the illusion that there is a direct (or no) association between DFS and DBI. If parity-specific analyses are not performed, it is likely that an analogous situation will occur in comparisons of populations at different stages of the fertility transition: shorter DBIs and smaller proportions wanting to postpone births may be observed in populations with lower fertility as a consequence of increased proportions of women with no children or in low parities.

Discussion

Using DHS-type data from Costa Rica, this paper shows that estimates of the preferred length of birth intervals based on crude data for both the open and the last closed interval can be misleading. Selection and left censoring effects bias these estimates in an upward direction. An interval cohort approach is suggested to eliminate the selection bias. For dealing in addition with left censored observations a reverse life table procedure is proposed. The mean desired birth intervals estimated by this procedure are 1·5 years for the interval union to first birth and from 3·5 to 4·5 years for the other birth intervals. These figures may underestimate the true DBI if censored observations tend to have a shorter remaining reverse time than non-censored observations. This point, however, cannot be addressed with the data available. Surveys should ask the length of time the woman has been trying to conceive when she reports that she wants a baby now or that she did not want to wait longer to become pregnant.

The most recent DHS surveys ask a direct question about the ideal or the best birth interval. An analysis of these data in sixteen developing countries concludes that 'Virtually all responses to this question were two, three or four years. . . . There is little variation across countries . . .' (Bankole & Westoff, 1995). This lack of variation limits the uses of this information. Additional limitations are that the question is not parity-specific and it is framed in terms of ideal rather than real life conditions. It thus probably measures the societal norm rather than the real preferences or intentions of the individuals. As with the direct questions on desired family size, biases probably arise from rationalisation, and from non-numerical, unreliable, and conditioned responses (Knodel & Prachuabmoh, 1973; Bongaarts, 1990). Asking a direct question probably is of little help for improving DBI estimates.

Cohort based estimates of the demand for family planning can be derived from DBI estimates. Assuming that contraception is required to extend birth intervals beyond 18 months, a cohort should spend about two-thirds of the DBI using contraception (one-third for the interval union to first birth). These figures are mostly of analytical interest since they are free of the confounding effect of the distribution by the length of the open birth interval. For immediate interventions, the straightforward figures of demand derived from the proportion that want to postpone pregnancy at the time of the survey are probably more useful.

The Costa Rican data show an inverse association between desired family size and DBI. This association may be missed if one does not look at parity-specific intervals. Also, a changing parity composition along the fertility transition may create the illusion that DBIs are becoming shorter, even though parity-specific DBIs are actually becoming longer.

Given that a short birth interval increases the risks of growth retardation, disease, and death of children, assessing the preferences of birth spacing is important for studying the relationship between family planning and child health, as well as for guiding policies that aim to increase birth interval lengths. What would be the potential impact of a campaign to dissuade couples from having very short birth intervals? Is the occurrence of very short birth intervals a matter of preferences or of unmet needs? What is the expected impact of family planning services on child mortality through extended birth intervals? Knowledge about birth spacing goals is needed for answering these questions.

Determining DBIs is also important for understanding the fertility transition. Even though most explanations of the causes of fertility transition ignore the contribution of birth spacing and the corresponding motivational factors, survey data repeatedly show that a substantial proportion of contraceptive use– usually between one-fourth and one-half– is for birth spacing purposes. Moreover, the fertility impact of this contraceptive use is amplified by its occurring mostly among young women, in the prime reproductive ages.

References

ALLISON, P. D. (1985) Survival analysis of backward recurrence times. *J. Am. statist. Ass.* **80**, 315–322.

BANKOLE, A. & WESTOFF, C. (1995) *Childbearing Attitudes and Intentions.* Demographic and Health Surveys Comparative Studies 17. Macro International, Calverton, Maryland.

BONGAARTS, J. (1990) The measurement of wanted fertility. *Popul. Dev. Rev.* **16**, 487–506.

CAJA COSTARRICENSE DE SEGURO SOCIAL (1994) *Fecundidad y Formación de la Familia. Encuesta Nacional de Salud Reproductiva 1993.* Caja Costarricense de Seguro Social, San José, Costa Rica.

KNODEL, J. & PRACHUABMOH, V. (1973) Desired family size in Thailand: are the responses meaningful? *Demography*, **10**, 619–637.

LERIDON, H. (1977) *Human Fertility, the Basic Components.* University of Chicago Press, Chicago.

PRITCHETT, L. (1994) Desired fertility and the impact of population policies. *Popul. Dev. Rev.* **20**, 1–56.

TRUSSELL, J., HANKINSON, R. & TILTON, J. (1992) *Demographic Applications of Event History Analysis.* Clarendon Press, Oxford.

WESTOFF, C. (1991) *Reproductive Preferences.* Demographic and Health Surveys Comparative Studies 3. Institute for Resource Development/Macro International, Columbia, Maryland.

WESTOFF, C. & OCHOA, L. (1991) *Unmet Need and the Demand for Family Planning.* Demographic and Health Surveys Comparative Studies 5. Institute for Resource Development/Macro International, Columbia, Maryland.