SOCIO-ECOLOGICAL AND DEMOGRAPHIC CORRELATES OF THE OPEN BIRTH INTERVAL IN A TRADITIONAL INDIAN SOCIETY

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ABSTRACT: The open birth interval is a major determinant of levels of fertility in high fertility populations. Our study population is a traditional Indian society with individuals still engaged in traditional occupations like agriculture, fishing, cloth washing, hair cutting, cane weaving, and pot-making. The population was non-contracepting and biased toward son preference. Using survival analysis, we identified the following significant predictors of the duration of the open birth interval: mother's education, per capita monthly household income, sub-caste, type of household, sex of the last child born, number of surviving male children, length of the last closed birth interval, number of children ever born, age difference between spouses, surviving status of the last child. Our findings are compatible with an evolutionary analysis of reproductive decision-making.

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Surprisingly little is known about the mechanisms that underlie variation in female fertility in humans. In the study of fertility, two dimensions are important: how frequently women have children and how many women of a given parity birth order proceed to the next parity. A study of closed birth intervals will be adequate only for the analysis of fertility change in the first dimension and is not adequate for second dimension. Srinivasan (1972) demonstrated that the open birth interval could be used in the measurement of fertility in the second dimension.

In the context of a marital fertility-history sample survey of females, the open birth interval (OBI) is the time interval from last birth to the survey date. If a female has had no previous birth, then the starting date of interval is the marriage. The open birth interval is used as an inverse measure of recent fertility (Srinivasan, 1972). In studies where the dependent variable is an ongoing process, such as fertility, and an independent variable is measured at one point in time such as current income level, establishing temporal association between the two variables becomes problematic. What is clearly needed is some measure of recent fertility experience that is as close in time to the date of survey as possible. One such measure is the open birth interval. This is acceptable as a measure of recent fertility on the grounds that a sub-sample of women with a short average interval necessarily has higher recent fertility than a sub-sample of women with a longer average interval. Further, survey research experience with non-sampling error due to factors like recall lapse, illiteracy of the women/respondent, absence of vital records etc.

indicate that particulars regarding the recent births could be obtained with relatively greater accuracy and could be more reliable and dependent upon than any information pertaining to events in the remote past. Distributions of open birth intervals from fertility surveys also can be used to estimate closed birth interval distributions, as Feeney and Ross (1984) demonstrated. Thus OBI distributions are potentially useful measures of fertility.

One potential problem with using the OBI as a measure of recent fertility is that it carries a length bias. In other words, long intervals are more likely to be open at the time of any cross-sectional survey than are short ones. Hence, the sample of open intervals in any such data set is likely to be biased upwards. Rindfuss et al. (1987), however, convincingly demonstrated that bias is not carried over to differentials. Consequently, the use of the OBI as a fertility measure in multivariate analysis does not necessarily bias the structure of relationship affecting fertility. From an evolutionary perspective, the birth interval is also a measure of potential investment in a child. We seek to explore the ecological pattern of fertility to see if the resource-reproduction correlation seen in traditional societies disappears.

In the present analysis, the explanatory variables were divided in to two basic groups: (i) socio-ecological, and (ii) demographic variables. Hazards regression techniques applied to the analysis of Indian demographic data viz., postpartum amenorehoea, breast-feeding, and birth have begun to appear only recently (Nath and Land, 1994; Nath and Goswami, 1997; Nath et al., 1993 a, b; Nath et al., 1994; Nath et al., 1999; Nath et al, 2000; Sahu, 1998; Singh et al., 1993; Singh et al., 1994). Most of these studies were restricted to socio-demographic correlates of the response variables. In the present study, our primary interest is in the ability of socio-ecological variables to explain fertility data in a traditional Indian context.

MATERIALS AND METHODS

DATA

Data for the research presented here come from the retrospective survey, 'A Study on Effects Socio-Economic Factors on Fertility among Scheduled Caste Population in the Rural Areas of Karimganj District, Assam' conducted during 1988-89 (the reference date for survey questions was June 15, 1988) under the auspices of University Grants Commission (UGC), New Delhi.

The survey was confined to only the schedule caste population—the backward and economically deprived class of the Indian population. They are in lowest class of Hindu society—a caste system of social organization found in old India and continuing to the present day. Membership in a caste is hereditary and is fixed for life. A couple was defined as *eligible* for the present study if both the partners were alive on the reference day of the survey and the age of the female spouse was less than 50 years.

The Karimganj district of Southern Assam is a predominantly Bengali speaking area, where a large number of villages are identified as scheduled caste villages. If at least 10 per cent of the village population belongs to the scheduled castes, the village is considered to be a scheduled caste village by the Directorate of Economics and Statistics, Assam. From a list of scheduled castes of the district, a sample of 37 villages was selected by simple random sampling. Then, all scheduled caste households were enumerated. The survey comprises 1,805 scheduled caste households from the selected villages. There were 2052 eligible couples in the sample. The objectives of this survey were to obtain reliable data relating to fertility, to study the socioeconomic and behavioral factors affecting fertility, and to estimate bicultural parameters of human reproduction in traditional societies.

Only those couples who did not practice any method of family planning to space and limit births and for which husband and wife were normal residents of the village were considered. Educational attainment among these groups of people is very low, and most of them are still engaged in traditional occupations like agriculture, fishing, cloth washing, hair cutting, cane weaving, and pot-making. Only a small number of persons were employed in government or nontraditional private sector jobs.

EXPLANATORY VARIABLES AND CORRESPONDING HYPOTHESIS

In the present analysis, the impacts of eleven explanatory variables/covariates on the duration of open birth intervals of mothers are examined. These covariates are *six socio-ecological characteristics*: mother's education, per capita monthly household income, sub-caste, type of household (presence of "grandmother" helper), sex of the last child born, number of surviving male children; and *five demographic characteristics*: length of the last closed birth interval, number of children ever born, age difference between spouses, surviving status of the last child, and mother's current age. The covariates grouped under the demographic characteristic rubric pertain to the survival status of a couple's children and to age and duration variables. By contrast, the covariates grouped under the socio-ecological label comprise variables that, in one way or another, measure the energy expended in producing offspring, and it is the investment of costly energy in reproduction that is the ecological basis for evolutionary success (Krebs and Davies, 1993).

Education is measured as the number of completed years of formal schooling. Females were categorized according to level of education as: (1) those who had no schooling or 1-8 years of schooling, and (2) those with 9 or more years of schooling. The average level of education amongst the married females of this survey population is very low. The cross-national evidence of a strong relationship between education and reproductive behavior is overwhelming (Jejeebhoy, 1995). We may expect to find shorter OBIs for less educated mothers.

Daly and Wilson (1983) found that fertility correlates with income. Vining (1986) argued that there was a negative correlation between wealth and fertility. On the basis of monthly per capita income (PCI), four economic groups were formulated for households: (1) PCI $\leq$ Rs. (rupees) 50.00, (2) Rs.51.00 $\leq$ PCI $\leq$Rs. 75.00, (3) Rs 76.00$\leq$ PCI $\leq$ Rs 100.00, and (3) PCI$\geq$ Rs 101.00. These four income groups represent very low, low, middle and upper income households within this community. Monthly per capita income of the family may be considered as an indicator of both social status and health status of mother and children. It is theorized that, for the study population, the length of the OBI decreases with the increase in the level of PCI.

Individuals within a population may experience different environments; therefore reproductive strategies can vary within subgroups of a population (Low, 1993). There is significant variations in fertility among castes and religion in India (IIPS, 1995; Kost and Amin, 1988; Pandey and Talwar, 1987; Srivastava, 1985). As the survey was restricted to the scheduled caste population, a grouping of subcastes was done for the present analysis, each group having its own distinct social organization and culture. Sub-castes grouping were as follows: (a) Namasudra, who were primarily engaged in cultivation and bamboo basket making, (b) Kaibarta, who traditionally were fisherman, but in addition also cultivated land, and (3) Craftsman, a professional group of people who were barber, washer-man, cobbler, earthen pot-maker, and who rarely had a small plot of land to cultivate. Of course in each of these sub-groups a small percentage of people were employed in non-traditional jobs. Sub-caste groups reflecting different cultural values have distinct variation in OBI distributions.

The influence of older generation women, "grandmothers" on the reproductive success of younger generation women, "daughters", who are either closely related to them or are wives of their sons has been hypothesized to be critical in the evaluation of the human family as a food-sharing unit in which reproductive success or biological fitness is enhanced. So critical is this relationship that it is hypothesized to explain the evolved post-menopausal extension of life span seen in our species and been dubbed the "grandmother hypothesis" viz., through making contributions to the energy needs of younger women producing offspring related to the older women, the later can indirectly increase her own reproductive success at ages past the years of her own reproductive capacity (Hawkes et al., 1998). Grandmothering affects infants in two ways: (a) by feeding nursing mothers and infants, thus accelerating the growth of infants; and (b) by supporting food to weaning, thus allowing infants to be weaned earlier. In the present study, we classified households: (i) with no grandmother or any grandmother-like person who could play the role of a grandmother, (ii) with grandmother or grandmother-like person. We hypothesize that females living with grandmother/grandmother-like helper are likely to experience shorter OBIs and thus greater reproductive success.

The sex of siblings might be expected to influence women's reproductive ability. Recent research (Low, 1991; Mace and Sear, 1997) indicated that the length of birth intervals depends on the sexes of beginning and end of the birth interval. Humans, like most mammals have a polygynous evolutionary history reflected in physical dimorphism – males are larger than females, carried slightly larger in utero, nurse more and more frequently, and over all, are more expensive energetically to produce (Daly and Wilson, 1983; Trivers and Willard, 1973), thus a shorter OBI should be followed by a female child.

In a country like India, parents desire more surviving children (IIPS, 1995) and especially sons as their old-age security as well as for the after-death religious ritual (Mukerjee, 1976). In this rural Hindu society, there is a preference for sons over daughters because of the Hindu belief that only a son can perform some of the religious rites upon death of his parents, and sons also are considered heirs of their fathers' property (Kapadia, 1966; Patwardhan, 1968). Our field experience led us to conclude that having at least 2-3 sons was especially important to females. Thus, the OBI following two or less surviving male children may be expected to be shorter.

Lengths of prior birth intervals are strongly related to the lengths of subsequent intervals (Singh et al, 1993; Nath and Land, 1994). The lengths of the last closed birth intervals (LCBI) were defined as: (i) 24 months or less, and (ii) 25 months or more. We hypothesize that a shorter spacing of LCBI follows a shorter OBI.

The spacing of children follows different time patterns among low- and high- parity women (Chi and Hsin, 1996; Rajaram et al., 1994). Mothers were classified according to their number of children ever born as parity groups: (i) 1-2 parities, (ii) 3-5 parities, and (iii) 6 and more parity. These groupings may indicate families with small, medium, and large family norms respectively. We expect that decreasing duration of OBI will follow lower number of children ever born.

The spousal age difference is also another important factor affecting fertility in developing countries (Sembajwe, 1981; Levin et al., 1997). The difference in age between spouses (present age of husband minus present age of wife) in India generally is high as men usually like to marry younger (higher reproductive value) women. In our sample, we found no husband was younger than his wife was. The age difference between spouses was classified as: (i) five years or less, and (ii) six years or more. We expect that a wife belonging to first category have a shorter OBI.

Infant mortality rates are expected to correlate positively with rates of fertility. Survival of preceding child is significant demographic covariate affecting the length of birth interval (Chandran, 1989; Gubhaju et al., 1991; Naquib et al., 1995; Nur, 1982). These studies reported that infant death resulted in shorter birth intervals. The status of next-to-last births were categorized as: (i) death as an infant (i.e., if child died within first year of the birth), and (ii) surviving the first year of life. It is also expected that a shorter OBI will follow an infant death of a next-to-last birth.

Demographers interested in the effects of biological age on reproduction usually investigate populations that approximate conditions of natural fertility – loosely speaking, fertility in the absence of effective artificial birth control (Henry, 1953; Wilson et al., 1988). In absence of effective method of contraception and induced abortion, there is a near-universal age pattern of marital fertility (Knodel, 1983). This pattern shows a peak in fertility in the early 20s and then declines monotonically, at first gradually and then more rapidly, approaching zero near the age of menopause. Apparent fecundability reflects two things: fecundability per se (the monthly probability of conception, whatever the outcome of the pregnancy) and the risk of early pregnancy loss (death of the conceptions in utero before the pregnancy is detected). In a prospective study based on rural Bangladeshi women, Holman et al. (1998) concluded that the true fecundability varies little between ages 20 and 40. After 40, fecundability is lower because of the disrupted ovarian function associated with pre-menopausal transition.

The OBI by maternal age is highly sensitive to current fertility levels (Srinivasan et al, 1994). We did not include this variable in different multivariate model specifications. However, because it affects the duration of the OBI, hazards regression analysis was performed considering the current age of mother separately only. To investigate the effect of age, mothers were categorized according to their current age as: (i) 20-24 years, (ii) 25-29 years, (iii) 30-34 years, and (iv) 35 - 40 years groups. In the absence of appropriate nutrition and health care, we cannot expect fertility to be constant over 20 to 40 years for this non-contracepting community.

RESPONSE VARIABLE AND ANALYTICAL METHOD

We have restricted our analysis to ever-married women who had at least one live birth and OBI of maximum length of 84 months prior to the reference date of the survey. These OBIs were subjected to survival analysis – by life table techniques and hazards regression analysis. Finally, we investigated the effect of different socio-ecological and demographic variables on the length of OBI after subtracting the length of post-partum amenorohea (PPA). Those females who were pregnant or in the PPA stage or in menopause (as reported by mothers' aged less than 41 years) were not included in the analysis. With these restrictions, the sample yields 877 mothers for the analysis. Life tables of OBIs for groups defined by a single variable were constructed first.

Two summary measures, median OBIs and the proportions of mothers having an OBI by different specified months were calculated by standard life table techniques (Namboodiri and Suchindran, 1987). Univariate proportional hazards analysis was used to measure the effect of each explanatory variable on the duration-specific probabilities of the length of OBI (hazard function) in the absence of controls for the other explanatory variables. Because of the dependence of the length of the OBI on many of the covariates studied, the use of conventional single-decrement life tables, while revealing, is not sufficient for the analysis. To investigate the partial effects of multiple factors on the duration of the OBI, regression analysis was used to determine the effects of each explanatory variable in the context of the others. The use of proportional hazards regression model (Cox, 1972) permits more detailed findings to be extracted from retrospective and longitudinal data. The hazard function or instantaneous risk function at time t is given by:

$$h(t;z) = h(t)\exp(\beta Z)$$

where h(t;z) represents the instantaneous rate of having no birth till time survey point at t given that there is a birth for a married female with a vector of covariates Z, h(t) is an arbitrary non-negative unspecified baseline hazard function not dependent on the covariate; and β is a vector of unknown regression coefficients to be estimated. The hazard function allows estimation of the relative risks of the other groups in relation to specific baseline groups by exponent of the regression coefficient $\exp(\beta)$. Each exponent of the coefficient $\exp(\beta)$ represents the effect of the covariate on the hazards functions for the reference group. When there is no covariate present, the $\exp(\beta)$ term reduces to unity. Values greater than unity indicate that the relative risk of having a shorter OBI is greater for this group compared with the reference group, whereas values less than unity indicate a decrease in the risk.

RESULTS

Univariate life table estimates of median OBIs and the percentages of mothers whose OBIs were less than 12, 24, 36, and 60 months from most recent birth to the reference date of the survey are presented in Table 1. The overall median OBI was slightly less than 2 years and 3 months. There was a distinct variability of the length of OBIs according to the different socio-ecological and demographic characteristics of mothers. The minimum and maximum lengths of OBIs among scheduled caste females were 16.2 and 46.8 months respectively. The average of length of OBIs increases with family income, the length of the last closed birth interval, the birth parity of the mothers, age difference between spouses and mother's current age. The average length of the OBI is comparatively shorter for educated mothers, female index child, mothers having two or less surviving male children (child), Kaibarta sub-castes, mother belonging to "grandmother" family, and mother whose index child dies within twelve months of the birth.

Insert Table 1 About Here

The proportion of mothers whose OBI were within 12, 24, 36 and 60 months from the index child to the survey date reveals the differential length of OBIs among the sub-groups considered. Only 17.3 per cent of the mothers had an OBI of less than one year but 10.6 per cent mothers had an OBI of more than 5 years.

Because some variables are not normally distributed, a non-parametric statistical procedure (the generalized Wilcoxon test) was used to test for significant differences between the survival functions for various groups. All the socio-ecological and demographic explanatory variables in this study were found to produce group differences, which are statistically significantly different; see Table 2.

Insert Table 2 About Here

Results from the estimation of the univariate proportional hazards model for each of the explanatory variables are presented in Table 3. It can be seen from this table that all of the covariates have statistically significant univariate relationships to the OBI dependent variable. Ordered by reductions in chi-square relative to the null model (with only a constant term) accounted for by each explanatory variable from the largest to the smallest, the covariates can be arrayed as follows: current age of mother, surviving status of last child, number of children ever born, age difference between spouses, length of the last closed birth interval, type of household, per capita monthly household income, mother's education, number of surviving male children, sub-caste, and sex of the last child born.

Insert Table 3 About Here

To further analyze the partial effects on OBIs of each of the explanatory variables while controlling other covariates, multivariate hazards regression analysis in four separate model specifications was performed. The results are presented in Tables 4, 5, and 6. Table 4 presents results for all of the socio-ecological covariates under two different specifications (models I & II). It was found that when both PCI and the sub-caste covariate were entered into the same model specification, the effect of sub-caste becomes insignificant (analysis not presented). Accordingly, Model I contains all socio-ecological variables except sub-caste, and Model II includes sub-caste but excludes income. In Model III of Table 5, the effects of all of the demographic covariates are estimated. Model IV in Table 6 is a full model that includes all socio-ecological and demographic variables.

Insert Tables 4 through 6 About Here

Substantively, the risk ratios (i.e., the exponentiated values of the estimated coefficients) indicate that mothers with a 9^{th} grade or higher education are 54 percent (Model IV, Table 6) more likely (net of the effects of the other covariates) to have a shorter OBI than mothers with 8 years of schooling or less. Model IV also shows that the risk ratios increase with a decreasing level of family income, which indicates that lower per capita incomes lead to shorter OBIs. From Model II in Table 4, it is found that Namasudra and Kaibarta mothers are significantly more likely to have shorter OBIs compared to Craftsman mothers. But in the full Model IV of Table 6, these effects become statistically insignificant. This likely is due to the fact that, in this traditional society, occupational patterns depend on caste system that, in turn, may affect the level of income.

Model IV of Table 6 shows that a female living in a family with a grandmother present is 31 percent more likely to have a shorter OBI than a female living in a family with no grandmother present. A mother whose last child is male is 16 per cent less likely to have a shorter OBI compared to a mother whose last child is female. The chances of a shorter OBI for mothers with three or more surviving male children is 25.5 per cent less than that of mothers of two or less surviving male children. Model IV also shows that a shorter last closed birth interval, decreasing parities of the mother, and a smaller spousal age difference increase the chances of a shorter OBI. When the last child born to the mother died as infant, the adjusted risk of a shorter

OBI is very high – 3.384 times higher than for women who had not experienced a death of the last child.

Insert Table 7 About Here

In the multivariate models of Tables 4 though 6, the current age of mother was not included as a regressor, as the length of the OBI is highly sensitive to the current age of mother (recall that this explanatory variable produces the largest univariate effect in Table 3). It was observed that the effects of many other covariates either become insignificant or marginalized in the presence of current age of mother. Estimates of the effect of this explanatory variable analyzed with a univariate proportional hazards model are presented in Table 7. These univariate regressions reveal that the risk of having a shorter OBI is reduced by 49.3 per cent, 70.7 per cent, and 78.6 per cent for corresponding age groups of mothers, 25-29 years, 30-34 years, and 35-40 years, compared to mothers aged (20-24) years.

DISCUSSION

Findings about the mechanisms of variations in marital fertility dynamics are vital to a number of pragmatic and theoretical enterprises, including population planning, infertility treatment and prevention, and evolutionary ecology. Estimates of fecundability among Indian women are low (Singh, 1969) compared to Western standards. A median OBI of nearly 27 months for mothers of this traditional society is an indication of the population's low fecundability. In a recent study for this population, based on logistic regression analysis, Nath and Leonetti (1998) reported low coital frequency. The median monthly income for this survey population also is very low (Rs.75.00). Thus, low coitus activity and poor nutrition may be primary reasons for the low fecundability status of this population.

The investment of costly energy in producing offspring is the ecological basis for reproductive or evolutionary success (Krebs and Davies, 1993). The variation in resources and their allocation to reproduction is basic to understanding differentials in measuring fertility. The lower the cost of each child to the mother, and the shorter the period over which the cost is extracted, the shorter the OBI should be.

In the present analyses, 80 percent of females were reported to have very low education (zero to 4 years of schooling), 5.4 per cent studied beyond 8th grade; and only 10 out of 877 mothers were successful in completing their 10th grade graduation. In brief, there is strong evidence that a modest exposure to education has a different impact on fertility in a context in which average levels of women's education are low. This finding contradicts our hypothesis, and many other reports (Chi and Hsin, 1996; Nair and Nair, 1996; Yadava and Chadney, 1994), where education showed a negative relationship to fertility. However, Hollas and Larsen (1992) found that birth intervals are uncorrelated with the education level of Nigerian women whose education levels were low. They also concluded that urban dwellers with low education followed reproductive strategies similar to rural uneducated women. For Vietnanese birth intervals, Swenson and Thong (1993) observed that educational differentials were apparent only at higher levels of education.

The distribution of wealth has an impact on fertility (Rogers, 1990). He argued that the fact that the rich reproduce more slowly than the poor is not inconsistent with the hypothesis those reproductive strategies have shaped by evolution. It seems that an upper income group family invests more in bearing and rearing their children thus ensuring survivability of their offspring. Higher levels of household incomes are negatively associated with levels of fertility possibly by increasing *inter alia* the cost of having children, and by creating alternative forms of security and pleasure to prospective parents.

Based on hospital records, Srivastava (1985) concluded that high and middle caste Hindus had somewhat higher birth intervals than low caste Hindus. In a life table and multivariate analysis, Nath et al. (1993a) and Singh et al. (1993) reported the substantial variations in the duration of birth intervals among different subcastes, castes and religions. Even today, especially among uneducated lower castes, their occupational patterns are determined by virtue of their birth in a particular caste or sub-caste. For example, in the present study population, the son of a Kaibarta father is supposed to follow fishing and fish selling. Slower transitions to the next birth interval occurred among Craftsman females. This reflects that members of the Craftsman caste invest more in the lives of their offspring.

Several evolutionary biologists (Gaulin, 1980; Hawkes et al., 1989, 1997) have suggested that older females can use their energy to increase the reproductive success of their close relatives. Lower reproduction efforts from younger Hazda mothers of Tanzinia were found to be associated with higher fertility due to the compensating effects of older women' help (Hawkes et al., 1997). Our findings support the hypothesis that the presence of a grandmother or a grandmother-like person in the household increases human fertility. That is, the presence of a grandmother or a grandmother-like woman in the family appears to increase the production of babies faster than otherwise expected because of the grandmother's contribution to childcare and other household tasks.

Research has shown that the length of a birth interval is a measure of parental investment in a child (Low, 1991). Studies in various societies (e.g., Westoff et al., 1961, Wyhak, 1969, Nath and Land, 1994, Mace and Sear, 1997) have found that birth intervals are longer after a male than after a female birth. Median OBIs after boys are longer than after girls in the present study of a traditional Indian society. The difference is a statistically significant 2.5 months. In this society, daughters are considered less desirable than sons. Demographic explanations of variability in inter-birth intervals tend to focus on parental preferences for one sex (Knodel, 1988). If parents are seeking to have a son, they will try to conceive quickly after the birth of a daughter. Accordingly, the birth interval after sons should be longer, regardless of the sex of the next child. Children born before and after a long birth interval are likely to benefit throughout childhood, and possibly beyond, in terms of the resources available to them from their family. The length of the birth interval thus indicates how a particular child may be fairing in the competition for parental, and particularly maternal, resources at a crucial time in its development. Low (1991) found that birth intervals ending with a boy were significantly longer in 19th Century Sweden. The present results are in the same direction.

The mean number of children ever born to women aged 40-49 years for the complete survey of this population was 6.1. One factor contributing to the large average family size in India is the desire of couples, regardless of socio-economic status, to have sons (Goode, 1970). Producing male children is critical under cultural and legal systems where property and other rights are transmitted through men. We found that women with two or fewer surviving male children have OBIs more than eight months shorter than mothers with three or more surviving male children. It seems as soon as a mother has her third surviving son, she is more likely to slow down her reproductive process highly significantly. This finding is consistent with results reported by Nath and Land (1994) and Pong (1994). This result strongly suggests that parents are making active decisions with respect to the length of the OBI, even in a society with little or no access to modern methods of contraception. Variation in the OBI can be interpreted as variation in parental investment. The patterns observed in OBIs in this traditional society could all be understood as an evolved strategy of highest parental investment in those children of highest reproductive potential.

In a multivariate regression analysis of third birth intervals for the same survey population, Nath and Land (1994) found those mothers with shorter proceeding birth intervals had higher relative risks. For Egyptian mothers, Khalifa and Farahat (1993) reported that birth probabilities by length of previous birth interval showed women with long birth intervals having successive long birth intervals. We also found that previous reproductive experience has a significant influence on the length of the OBI. Specifically, we found that the length of the last close birth interval is strongly related to the length of the OBI. Women with shorter OBIs have much higher relative risks.

Birth spacing patterns are parity dependent (Kiani and Nazil, 1988; Rajaram et al., 1994), as is the OBI for this survey population. The median OBI following parity (6+) was two times longer than that of parity two or less. This may be due to a diminished desire to have more children. On the other hand, the significantly higher risk of a shorter OBI for lower parities indicated a strong motivation to have a large number of children accommodating both boys and girls. In this society though the strong desire for sons is traditional, the couple also wants to have at least one daughter. Begetting a daughter in a traditional Bengali society is termed an arrival of "*Lakshmi*" – the Goddess of wealth. Also, marrying off a daughter "*Kanya Dan*" is regarded as an act of virtue.

In a study based on 54 developing countries, Abadian (1996) reported that fertility was strongly related to spousal age difference. Our study also supports this relationship. Young wives may find it difficult to interact frequently with much older husbands. Without contraception, a decrease in the age difference between the spouses may therefore lead to an increase in fertility through free and easy sexual intercourse. Brittain (1992) for a Caribbean population, Khalifa and Farahat (1993) for an Egyptian population, and Ren (1995) for a Chinese population observed that the spacing of births was significantly affected by the infant death of the index child. For the present survey population, we too observe a slower transition to the next birth with an index child surviving more than a year. In a society where having children is related to the old-age security concerns of parents, a higher probability of death for children also is more likely to boost fertility levels to compensate for the risk. The influence of infant death is found to be strongest of all correlates considered in Model IV.

In all human populations, the likelihood of successful reproduction declines with increasing age, most notably with the age of the female partner. This age pattern of fertility is a complex outcome of many factors, both biological and behavioral. Under conditions of natural fertility, age and parity are very highly correlated and it is likely that the apparent trend with parity is in fact driven by age. With increasing ages of females, OBIs become larger and larger. In particular, female fertility declines sharply after 29 years of age for this population. We do not have sufficient data to fully test the Holman et al. (1998) hypothesis that true fecundability varies little between ages 20 and 40.

High fertility continues to be a major factor in the persistence of population growth rate in India. The present study has contributed to an understanding of the probabilistic relationships of a few socio-ecological and demographic correlates to Indian fertility through the use of OBI data. The collection of more quantitative as well as qualitative data on parental investment and the role of grandmothers are necessary to study their ecological impact on longer OBIs and hence Indian fertility.

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Table 1. Life table estimates of median length of open birth intervals and proportions of mothers having open birth interval within specified month by selected characteristics.

Covariates	Median Open birth interval (months)	Percentage of mothers whose open birth interval (months) is less than				
		12	24	36	60	N
Overall	26.9	17.3	44.1	63.8	89.4	877
Socio-ecological characteristics						
Mother's education						
Illiterate or (1-8) grade	27.5	16.8	43.0	62.7	89.0	830
9th grade or above	19.6	25.5	63.8	82.9	95.7	47
Per capita monthly household income						
≤Rs. 50.00	23.5	15.2	40.6	65.4	91.3	197
Rs.51.00-Rs. 75.00	25.3	17.9	47.6	66.3	90.6	279
Rs.76.00-Rs.100.00	27.5	17.2	42.8	58.8	88.9	226
≥ Rs. 101.00	29.1	18.8	44.5	64.5	85.7	175
Sub caste						
Namasudra	27.8	16.8	42.5	63.2	87.8	553
Kaibarta	23.2	20.7	51.8	67.1	92.3	222
Craftsman	29.6	12.7	36.2	59.8	91.1	102
Type of Household						
No Grandmother	28.4	17.4	41.3	60.3	88.2	732
With Grandmother	21.7	16.5	16.5	57.9	80.0	145
Sex of the last child born						
Male	29.6	16.0	44.5	62.3	88.7	441
Female	27.1	18.5	43.7	65.3	90.0	436
Number of surviving male children						
Two or less	25.5	18.6	47.0	65.6	90.0	740
Three or more	33.8	10.2	28.4	54.0	86.1	137

Demographic characteristics						
Length of the last closed birth interval						
24 months or less	21.4	22.4	58.1	75.9	91.7	241
25 months or more	29.6	15.4	38.8	59.2	88.5	636
Number of children ever born						
2 or less	19.6	25.0	64.7	84.7	96.3	275
3-5	31.6	15.1	37.6	56.4	86.6	478
6 or more	38.5	8.8	23.3	45.9	84.6	124
Age difference between spouses						
5 years or less	18.0	32.9	68.1	84.0	97.7	88
6 years or more	28.3	15.5	41.4	61.6	88.4	789
Surviving status of the last child						
12 months or less	16.2	71.5	83.3	91.1	98.0	102
13 months or more	28.9	10.1	38.9	60.2	88.2	775
Mother's current age						
20-24 years	17.0	32.4	71.4	89.9	98.8	259
25-29 years	23.6	18.5	51.0	74.4	93.0	243
30-34 years	39.8	6.4	24.6	42.7	84.6	248
35-40 years	46.8	5.5	13.3	31.5	72.4	127

Table 2. Values of χ^2 based on the Wilcoxon log-rank test for comparison of groups.

Groups	degrees of freedom	χ^2
Socio-ecological characteristics		
Mother's education	1	10.136**
Per capita monthly household income	3	8.011*
Sub-caste	2	6.589*
Type of Household	1	12.874**
Sex of the last child born	1	3.991*
Number of surviving male children	1	12.004**
Demographic characteristics		
Length of the last closed birth interval	1	26.058**
Number of children ever born	2	95.925**
Age difference between spouses	1	37.947**
Surviving status of the last child	1	287.113**
Mother's current age	3	250.607**

* Significant at 5% level

** Significant at 1% level

Table 3. Univariate hazards regression of the selected socio-ecological and demographic covariates on the length of open birth interval.

Model	-2logL with Covariates	χ^2	Model df	p
Null	10180.8	---	---	---
Socio-ecological characteristics				
Mother's education	10173.1	7.8	1	0.0053
Per capita monthly household income	10170.9	9.9	3	0.0283
Sub-caste	10167.8	7.1	2	0.0215
Type of Household	10165.6	15.2	1	0.0001
Sex of the last child born	10175.8	4.1	1	0.0306
Number of surviving male children	10173.4	7.5	1	0.0062
Demographic characteristics				
Length of the last closed birth interval	10164.0	16.8	1	0.0001
Number of children Ever born	10092.7	88.2	2	0.0001
Age difference between spouses	10150.8	30.0	1	0.0001
Surviving status of the last child	10079.8	101.1	1	0.0001
Current age of mother	9949.5	241.4	3	0.0001

Table 4. Hazards regression estimates of the effects of socio-ecological covariates on the length of open birth interval: Model I & II

Covariates	Regression coefficient(β)	Exp (β)	SE	Regression coefficient (β)	Exp (β)	SE
Mother's education						
Illiterate or (1-8) grade		---		---	--- ---	--- ---
9th grade or above	0.452 ***	1.571	0.157	0.402	1.495	0.152
Per capita monthly household income						
≤Rs. 50.00	0.193 ***	1.213	0.108	---	---	--
Rs.51.00-Rs. 75.00	0.166 ***	1.181	0.101	---	---	--
Rs.76.00-Rs.100.00	0.041	1.042	0.103	---	---	--
≥ Rs.101. 00	---	---	---	---	---	--
Sub-caste						
Namasudra	---	---	---	0. 162 *	1.176	0.108
Kaibarta	---	---	---	0. 168 ***	1.183	0.119
Craftsman	---	---	---	---	---	---
Type of Household						
No Grandmother	---	---	---	---	---	--
With Grandmother	0.341 ***	1.406	0.092	0.336 ***	1.399	0.092
Sex of the last child born						
Male	-0. 170 *	0.843	0.069	-0.171 *	0.842	0.069
Female	---	---	---	---	---	--
Number of surviving male children						
Two or less	---	---	---	---	---	---
Three or more	-0.257 ***	0.773	0.097	-0.228 ***	0.796	0.096

*p< 0.05, ** p< 0.01, *** p< 0.001

Table 5. Hazards regression estimates of the effects of demographic covariates on the length of open birth interval: Model III.

Covariates	Regression co-efficient (β)	Exp (β)	SE
Length of the last closed birth interval			
24 months or less	0.186 *	1.204	0.079
25 months or more	---	---	----
Number of children ever born			
2 or less	0.818 ***	2.266	0.112
3-5	0.174 **	1.191	0.101
6 or more	---	---	---
Age difference between spouses			
5 years or less	0.443 ***	1.557	0.115
6 years or more	---	---	---
Surviving status of the last child			
12 months or less	1.201 ***	3.323	0.108

*p< 0.05, ** p< 0.01, *** p< 0.001

Table 6. Hazards regression estimates of the effects of socio-ecological and demographic covariates on the length of open birth interval: Model IV

Covariates	Regression Coefficient(β)	Exp (β)	SE
Socio-ecological characteristics			
Mother's education			
Illiterate or (1-8) grade	---	---	--
9th grade or above	0.433 ***	1.542	0.160
Per capita monthly household income			
Rs.51.00-Rs. 75.00	0.181 ***	1.198	0.104
Rs.76.00-Rs.100.00	0.064	1.066	0.104
≥ Rs.101.00	---	---	--
Sub-caste			
Namasudra	0.047	1.048	0.110
Kaibarta	0.039	1.039	0.124
Craftsman	---	---	---
Type of Household			
No Grandmother	---	---	--
With Grandmother	0.270 **	1.310	0.098
Sex of the last child born			
Male	-0.170 **	0.843	0.070
Female	---	---	---
Number of surviving male children			
Two or less	---	---	---
Three or more	-0.281 **	0.755	0.104

Demographic characteristics			
Length of the last closed birth interval			
24 months or less	0.167 *	1.187	0.081
25 months or more	---	---	---
Number of children ever born			
2 or less	0.083 ***	2.266	0.123
3-5	0.206 ***	1.229	0.104
6 or more	---	---	---
Age difference between spouses			
5 years or less	0.443 ***	1.557	0.117
6 years or more	---	---	---
Surviving status of the last child			
12 months or less	1.219 ***	3.384	0.110
13 months or more	---	---	---

*p< 0.05, ** p< 0.01, *** p< 0.001

Table 7. Hazards regression estimates of the effects of mother's current age on the length of open birth interval.

Covariates	Regression co-efficient (β)	Exp (β)	SE
Mother's current age			
20-24 years	---	---	---
25-29 years	-0.679 ***	0.507	0.092
30-34 years	-1.228 ***	0.293	0.094
35-40 years	-1.554 ***	0.214	0.116

*** $p < 0.001$