Review Article

Relationship of Infant-Child Mortality to Fertility: Some Theoretical and Empirical Considerations Relevant to Pakistan

IQBAL ALAM*

Of considerable interest to social scientists, particularly the demographers, is the process of family limitation—a critical link in the demographic transition from high to low fertility. The available literature identifies numerous macro socio-economic and cultural variables found to be correlated with fertility behaviour [9]. However, little is known regarding the key motivational factors which, by impinging upon individual couples, result in a reduction of family size. The advocates of family planning programmes claim that family limitation can be achieved by providing couples with information about contraception along with effective means of birth control. The critics of current family planning programmes while recognising the importance of accessibility of effective contraception in family limitation, however, strongly feel that the reduction in fertility of the developing countries may not be achieved without substantial social, economic and cultural changes in those countries. These changes, among other things, are postulated to result in a substantial decline in levels of mortality—a generally accepted antecedent condition for substantial decline in fertility.

Freedman [6], in a recent paper, has contributed to our conceptualization of factors affecting fertility behaviour by means of macro analytical model. In his model he presents a taxonomy of independent variables, specifies relevant intervening variables, and indicates their combined influence on fertility (Fig. 1).

The arrows in Figure 1 represent the direction of causation but in no way is it explicitly claimed by Freedman that the classes are exhaustive. One may, however, point out the fact that, typically, fertility is treated as a dependent variable and the social processes as independent variables. It is assumed here that at the level of the individual family lower fertility also influences both

*The author is Research Demographer at the Pakistan Institute of Development Economics (PIDE), Islamabad. He acknowledges helpful suggestions and comments of J. Gilbert Hardee, Nasra M. Shah and M. Afzal on an earlier draft. The author alone, however, takes full responsibility for any errors or omissions.

Review Article

Relationship of Infant-Child Mortality to Fertility: Some Theoretical and Empirical Considerations Relevant to Pakistan

IQBAL ALAM*

Of considerable interest to social scientists, particularly the demographers, is the process of family limitation—a critical link in the demographic transition from high to low fertility. The available literature identifies numerous macro socio-economic and cultural variables found to be correlated with fertility behaviour [9]. However, little is known regarding the key motivational factors which, by impinging upon individual couples, result in a reduction of family size. The advocates of family planning programmes claim that family limitation can be achieved by providing couples with information about contraception along with effective means of birth control. The critics of current family planning programmes while recognising the importance of accessibility of effective contraception in family limitation, however, strongly feel that the reduction in fertility of the developing countries may not be achieved without substantial social, economic and cultural changes in those countries. These changes, among other things, are postulated to result in a substantial decline in levels of mortality—a generally accepted antecedent condition for substantial decline in fertility.

Freedman [6], in a recent paper, has contributed to our conceptualization of factors affecting fertility behaviour by means of macro analytical model. In his model he presents a taxonomy of independent variables, specifies relevant intervening variables, and indicates their combined influence on fertility (Fig. 1).

The arrows in Figure 1 represent the direction of causation but in no way is it explicitly claimed by Freedman that the classes are exhaustive. One may, however, point out the fact that, typically, fertility is treated as a dependent variable and the social processes as independent variables. It is assumed here that at the level of the individual family lower fertility also influences both

*The author is Research Demographer at the Pakistan Institute of Development Economics (PIDE), Islamabad. He acknowledges helpful suggestions and comments of J. Gilbert Hardee, Nasra M. Shah and M. Afzal on an earlier draft. The author alone, however, takes full responsibility for any errors or omissions.

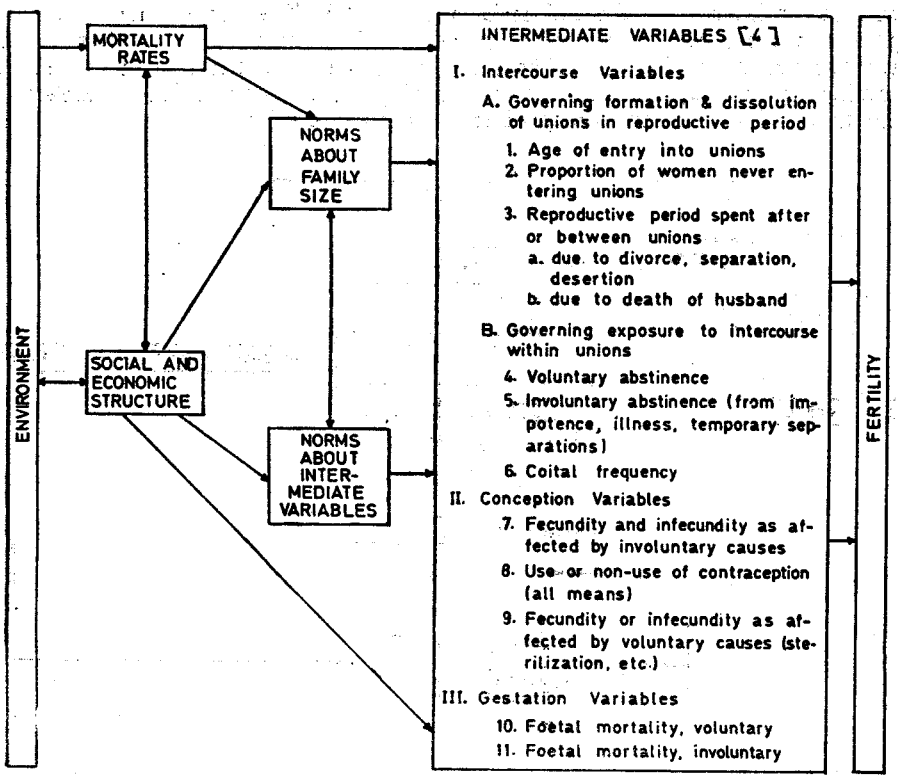

FIG. 1

Determinants of Fertility

economic and social well-being. However, a discussion of this relationship is beyond the scope of this paper.

In this paper an attempt has been made to translate a part of Freedman's taxonomy into a micro-level conceptual model to examine the relationship of infant-child mortality and fertility. The causal arrows in Fig. 2 are not claimed to be unidirectional; nor is the model considered exhaustive. The main argument in favour of such a taxonomy lies not in its exhaustiveness but in the fact that even a rudimentary micro model will help in improving research designs. Such models could lead to more specific researches resulting in a better understanding of the dynamic relationship of infant-child mortality with fertility, and also in a more effective allocation of limited public funds (resources) that governments are spending for overcoming the problem of rapid population growth.

Only recently have attempts been made to establish a causal relationship between fertility and mortality. Historically, the proponents of the theory of Demographic Transition generally assumed that the rapid growth of population

was due primarily to the industrial revolution.[1] The current macro studies point to the existence of a positive correlation between the decline of mortality and the decline of fertility. These studies, however, suffer from many shortcomings, particularly the lack of accounting for the compositional aspect of the area under study and the problem of autocorrelation.

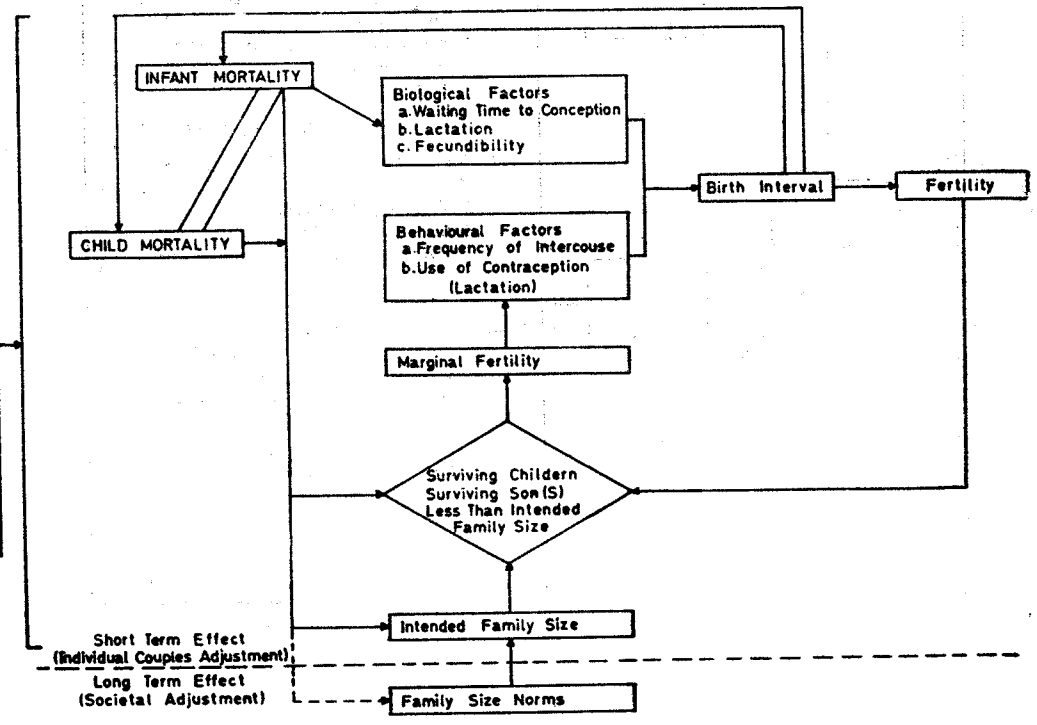

FIG. 2

Relationship of Infant /Child Mortality to Fertility

It was not until 1964 that a study, focussed on both fertility and mortality at the individual family level was conducted. Hassan [8], using data collected in 1963 from a stratified sample of 2,695 women in Cairo (Egypt), concluded that differentials in fertility and contraceptive use within the Egyptian society were not related to socio-economic and cultural characteristics but were due, mainly, to the differential use of modern medicine and sanitary practices resulting in differential infant and child mortality.[2] Consequently, he predicted that as

[1]The theory of demographic transition recognizes the association between the decline of mortality and its lag effect on fertility [2, 3, 12 and 17]. The decline of fertility, however, was explained as a consequence of economic development, industrialization and urbanization [17], not as an effect of delcine in mortality.

[2]The main argument was that the couples with high socio-economic status have much better access to modern medicine and sanitary conditions and thus experience very low levels of infant-child mortality.

these differences in the use of modern medicine disappear, fertility will become positively related to socio-economic variables. His conclusions are very questionable, chiefly because he did not allow for achieved parity as a control variable. If a woman with more births has a higher probability of infant-child loss, then one would always expect a positive relationship between infant-child loss and fertility both at the macro (i.e. societal) level and at the micro level. Furthermore, Hassan's analysis does not adequately account for the likely interrelated and combined effect of socio-economic/cultural factors and modern medical practice on both infant-child mortality and fertility, e.g., increased education is likely to have a simultaneous affect on the utilization of modern medicine, reduction in the probability of infant-child loss and fertility. Thus we must question Hassan's conclusion that differentials in socio-economic and cultural characteristics have little effect on fertility except in the absence of differences in the use of modern medicine.

Knodel [12], using the late 19th century data from rural Bavaria, found that infants born after short intervals were subject to considerably higher mortality risks than infants born after longer intervals, provided the previous child survived. He found inconclusive evidence regarding relationship between infant mortality and the limitation of family size. He further observed that the relationship between infant mortality and birth intervals, independent of lactation, was negligible suggesting that the discontinuance of breast feeding following an infant-child loss results in a loss of protection from the risk of further pregnancy.[3]

Adlakha [1], using data on 803 married women in the city of Ankara (Turkey) and a census of women in four villages near Ankara, found that a "high infant mortality rate produces shortened intervals between births" and that "this can't be explained entirely be lactation differences and may be partly due to parental motivation to replace the dead child," a finding contrary to Knodel's. Adlakha concluded that "women with the experience of infant mortality are characterized by less use of contraception, higher current fertility and higher expected fertility." He utilized a very crude control for the effect of parity on infant mortality by using only deaths occurring among the first four births. The observed average birth intervals for the women in his sample who experienced a loss of child and those who did not experience such a loss were 25 and 34 months, respectively.

Harrington [7], using three sets of data collected in Upper Volta, Niger and Ghana, showed that the proportion of women having a subsequent pregnancy was greater at each parity if the previous child died before age one than if the child survived.

Rutstein [15] undertook a detailed study of the relationship between infant-child mortality and fertility in Taiwan using sample survey data collected

[3]An inter-live birth interval is the sum of the following sub-intervals:

1. Post-partum amenorrhea, an after-birth anovulatory period of variable length, depending on lactation, which may include one or two anovulatory menstrual cycles even in the absence of lactation.
2. Waiting time for conception, a period when ovulation is resumed and most cycles are ovulatory.
3. Pregnancy wastage, including both early and late fetal losses.
4. Gestation, a period of non-risk extending from conception to the termination of pregnancy.

in 1967 and 1969. This is one of the most elaborate and extensive studies undertaken to date to analyse the relationship between fertility and mortality. He discusses in substantial detail the previous studies and has attempted to overcome some of the problems encountered in the analysis of data by Hassan, Adlakha and others. A detailed discussion of his methodology and findings is presented below.

Using Multiple Classification Analysis (MCA), Rutstein concluded that "couples with a child death or fear of child mortality tend to have more births than other couples." He further observed that sex of the child was not an important factor in replacement motivation, that the child mortality experience had a slight effect on the average birth interval, and that the experience of child mortality delayed the initial use of contraception. Using a very crude index of fear of child mortality (MCFI)[4] he found that the fear of child mortality resulted in a slightly increased probability of having an additional birth at each parity level (the largest increase being for couples with fewer births), and that the fear of child mortality had little effect on the timing of first contraceptive use.

Although Rutstein's index of fear of mortality is based on three questions, only one question deals directly with the fear of mortality; the others deal with the perception of family size norms, change in mortality and the possible implications thereof. Besides, his treatment of the fear index involves the dubious assumption that the index is constant over the total child-bearing period. As a measure of fertility differential, he used "parity progression probabilities"—the proportion of couples having at least (n+1) births out of the couples having (n) births. One shortcoming of using these probabilities is that they do not take into account the effect of age. If we agree that the probability of moving from (n)th to (n+1)th birth is dependent, in part, on the age of the mother at the time of the (n)th birth, and if the probability of losing a child is positively correlated with the age of the mother, then there is every possibility that a weak gross relationship might disappear if mother's age is used as a control variable. Furthermore, the use of average closed birth intervals[5], without excluding the last birth interval and not allowing for parity and age, may also give biased findings. It has been observed that the inclusion of the last birth interval tends to increase the average inter-live birth interval[6] and also that the average birth interval also tends to increase with age and parity.

Though no systematic study of infant-child mortality has been undertaken in Pakistan, Khan [11], using data from the National Impact Survey

---

[4]The index was constructed using three questions—one closed and two open-ended, asked of the husband during the 1969 survey. The closed question was "Generally speaking, in the past, children often died and therefore it was a great advantage to have at least 3 or 4 sons. Do you think this is equally true today?" A response could be "equally true", "less true" or "uncertain." The husband scored one if he answered "equally true" and zero if he answered "less true." The uncertain responses were excluded from the analysis. The two open-ended questions were (i) "Most people feel that a couple with five or more children has a large family. In your view, what are the main disadvantages of having such a large family?" and (ii) "are there any important disadvantages to having only two children? What are they?" The husband received one point on each question if he answered child mortality "*spontaneously*." Of the couples, 66.3% scored zero (no fear) 26.2% scored one, 2.0% scored two and none scored three.

[5]The intervals between marriage and first birth, as well as all subsequent inter-live birth interval is called closed birth interval.

[6]The inclusion of last birth intervals has a truncation effect. For details, see [16].

1968-69, has examined the relationship. Basing his analysis on 2905 currently married women, Khan concludes that women reporting no infant-child loss, on the average, have 2.5 births against 4.5 for those who had lost an infant-child, compared to 6.9 for those who had two infant-child losses and 7.9 for women with three infant-child losses. The same trend persists even after adjustment is made for age of the mother. When controlled for fecundity by excluding those women who have attained an age of 25 years or more without a live birth and a similar proportion of women under 25 years of age, the magnitude of relationship is reduced but the relationship nevertheless persists (Table 1). One should not jump to any firm conclusion from this part of Khan's analysis as the probability of women with high parity experiencing a loss is higher than of women having had few births.

One way of overcoming some of the problems is to undertake a perspective analysis. Khan [11] has done so by observing women experiencing a child loss and those with no experience of loss in a specified time, i.e. from marriage to 1960 and following them over the period 1962-68. The analysis shows that fertility rates for those who had experienced no loss were generally lower than for those who had experienced a loss (Table 2). The same trend was observed when adjustment was made for age. From a further extension of this analysis to those women who experienced a loss during 1960-63 and observing their fertility for the period 1965-68, Khan observes that the loss of a child had a positive influence on subsequent fertility. Using as a measure of fertility the number of living children and living sons instead of the number of children born alive, Khan concludes that among women with a small number of living children or living sons there is a strong positive relationship between infant-child mortality and subsequent fertility while among the group of women who have many surviving children the relationship is relatively weak.

Carrying his analysis further by using the life table technique to calculate the probability of moving from (n−1)th birth to (n)th birth (an index similar to parity progression ratio), Khan found substantial differences in the time taken to move to next parity in the two groups of women, with and without infant-child loss. A higher probability of moving to the next birth in a shorter duration was found to be true in the cases of women who had experienced a loss.

While attempting to separate the biological and behavioural components resulting in differential fertility, Khan reported a positive influence of infant-child death on fertility, independent of biological influence. The data limitations did not permit anything but a very crude analysis.

In sum, many studies have demonstrated a positive relationship between infant-child mortality and subsequent fertility at the individual level. However, the relative strength of the relationship varies: for countries with a high level of mortality (e.g., Pakistan, Egypt, Turkey, Ghana, Upper Volta and Niger) the relationship is strong; while for Taiwan, a country with relatively low mortality, the relationship is weak. One explanation of these differentials may lie in the fact that in the demographic transition a point is reached where any further decline in mortality does not have any significant impact on fertility. Also in countries that have reached low levels of mortality, differential mortality among families tends to disappear. Furthermore, it is our contention that the introduction and acceptance of modern contraceptive technology definitely changes the dynamics of fertility behaviour. It provides couples with easier means to

Table 1

Average Number of Children Ever Born through 1968 *for* 2731 *Currently Married and Fecund*[a] *Women, by their Age at Interview and Number of Child Deaths through* 1968[b]

Age at Interview	Number of Children Who Died				All Women
	0	1	2	3+	
Below 25	1.26 (669)	2.38 (128)	3.63 (30)	4.36 (14)	1.57 (841)
25—29	3.18 (331)	3.94 (151)	4.85 (48)	6.00 (35)	3.70 (575)
30—34	4.42 (176)	5.23 (128)	5.96 (78)	6.84 (56)	5.24 (438)
35—39	5.00 (146)	5.50 (115)	7.21 (75)	8.35 (105)	6.30 (441)
40+	5.26 (93)	6.06 (109)	7.05 (96)	8.85 (138)	6.99 (436)
All ages	2.75 (1415)	4.52 (641)	6.19 (327)	7.91 (348)	4.23 (2731)
Age-adjusted number[c]	3.41	4.26	5.38	6.46	

Source: Khan [11]

[a]Excludes from 25 years and above age groups those who had never born any child through 1968, and from below 25 years age group the expected number by applying the said proportion.

[b]Number of cases are shown in parentheses.

[c]Age adjustment done by using the total numbers in "All Women".

Table 2

Age Specific Rate for Fecund Women[a], 1962-68, *by Number of Child Death through* 1960,[b] *and Previous Fertility Level*

Age at Interview		Parity (Beginning 1962) 1—2 No Death	1—2 1 Death	1—2 1+ Deaths	2—3 No Death	2—3 1 Death	2—3 1+ Deaths	5+ No Death	5+ 1 Death	5+ 1+ Deaths	All Parities No Death	All Parities 1 Death	All Parities 1+ Deaths
25	Rate	333.3	346.9	346.9	—	—	—	—	—	—	333.33	346.9	346.9
	(N)	(45)	(7)	(7)							(45)	(7)	(7)
	% Diff.[c]		4.1	4.1								4.1	4.1
25—29	Rate	310.3	310.3	303.6	285.7	285.7	292.2	—	[d]	[d]	306.8	300.9	293.2
	(N)	(180)	(29)	(32)	(30)	(17)	(22)				(210)	(47)	(57)
	% Diff.		0	—2.2		0	2.2					—1.9	—4.4
30—34	Rate	283.4	220.2	220.2	261.6	302.0	280.3	243.7	265.3	266.7	268.2	268.1	263.0
	(N)	(61)	(24)	(24)	(77)	(35)	(53)	(17)	(14)	(30)	(155)	(73)	(107)
	% Diff.		—22.3	—22.3		15.4	7.1		8.9	9.4		0	—1.9
35—39	Rate	166.7	79.4	79.4	182.7	227.5	210.7	229.2	244.9	223.5	206.6	201.8	204.0
	(N)	(42)	(18)	(18)	(49)	(27)	(40)	(48)	(35)	(101)	(139)	(80)	(159)
	%Deff.		—52.4	—52.4		4.0	—3.7		6.8	—2.5		—2.3	—1.3
40+	Rate	57.1	35.7	31.7	76.2	102.9	84.9	106.4	119.8	114.1	88.5	108.3	106.7
	(N)	(15)	(8)	(9)	(30)	(25)	37)	(47)	(62)	(199)	(92)	(95)	(245)
	% Diff.		—37.5	—44.5		35.0	11.4		12.6	7.2		22.4	20.6
All age	Rate	279.9	214.3	212.7	224.3	232.1	216.2	179.8	178.6	161.7	246.3	207.2	184.1
	(N)	(343)	(86)	(90)	(186)	(104)	(152)	(112)	(112)	(333)	(641)	(302)	(575)
	% Diff.		—23.4	—23.9		3.5	—3.6		—0.7	—10.1		—15.9	—25.3
Total Fertility		1.151	.993	.982	.842	.918	.868	.579	.630	.604	1.203	1.226	1.214
Age-Adjusted Rate[e]		200.1	159.8	157.2	193.8	212.1	199.7	138.2	150.4	185.7	214.6	218.1	215.4
% Diff.			—20.1	—21.4		9.4	3.0		8.8	34.4		1.6	0.4

Source: Khan [11]

[a]Cases which had no child birth before 1962 were excluded.

[b]Cases which had any child death after 1960 were excluded.

[c]% difference from rate for no child death group.

[d]Number of cases five or less. The numbers and rates were, however, considered for calculation of total and adjusted rates and total fertility.

[e]Adjustment done by using total number in "All Parities."

control fertility and thus encourages a shift toward higher level of rationality. Thus, in such societies, the conventional methods used in the analysis of the relationship of infant-child mortality and fertility may not be applicable. The couples may change their inter-live birth intervals without altering their achieved fertility levels. We may not observe any difference in achieved fertility of women who have or have not experienced a child loss, not because they do not intend to compensate for the loss, but because they are planning to make up the loss at a later time. One way to overcome this problem is either to wait until the two groups of women complete their reproductive life and then look at the differentials or to undertake a retrospective and prospective study. The intention of this criticism is not to minimize the usefulness of the types of studies discussed earlier, but only to caution the reader regarding some of the pitfalls of such studies.

The above discussion of a number of micro level studies points to the following:

(*a*) Death of an infant/child may motivate parents to replace the loss.
(*b*) The replacement effect may result in over-compensation in an effort to guard against future loss.
(*c*) The *perception* of parent(s) regarding the infant-child loss may have some effect on the desired number of children the parents may like to have.
(*d*) Infant-child loss results in discontinuation of breast feeding and thus in the loss of protection against future pregnancy in cases where effective contraception is not used.

All these findings lead one to conclude that infant-child mortality is a variable to be reckoned with in attempting to bring about a change in fertility levels and that efforts to reduce the fertility levels without concurrent vigorous efforts to improve health conditions may not achieve the desired goals. These findings, though derived in some cases from poorly designed studies, do point toward a positive relationship between fertility and infant-child mortality; however, within a broader context of fertility determinants there is a need to incorporate a wider range of micro and macro elements. Hence, the explanation of fertility involves different levels of analysis. The taxonomy presented in Figure 2 is one way of conceptualizing the links between macro and micro analysis. Once this link is more clearly understood, it will be possible to incorporate this link in the overall social organizational determinants such as norms about family size etc. The present status of the research might be termed as being at the level of empirical generalization about the relationship between mortality and fertility without adequately looking at the overall dynamic relationship between micro and macro levels. The suggested simple model is expected to provide other researchers with additional insights into such a structure.

Fertility (the dependent variable), whose variation generally is being explained, is the focus of nearly all of the recent family planning oriented research. All the factors which influence fertility—the biological, social, psychological, economic and cultural—do so through a limited set of intervening variables. In the suggested taxonomy the "intervening variables" are being used to classify the sequence of relationships. This is done with the objective of calling attention to the fact that any change in fertility levels in response to infant-

child loss can be brought about through various combinations of 'intervening variables.' Finally, the role of environmental, socio-economic and cultural factors cannot be denied. In consequence, what is suggested is a sort of combination of micro and macro variables for studying the relationship between fertility and infant-child mortality.

The main emphasis of this paper has been on presenting a comprehensive review of the available literature along with a suggested model for future research. The model is a very tentative one and in no way is it claimed to be exhaustive. The purpose is to illustrate in a succinct model the dynamic relationship between different behavioural, biological and cultural variables.

The positive relationship of infant-child mortality and fertility suggests that the implication of mortality decline should be taken into account for a planned demographic transition in Pakistan and other developing countries [5]. But before taking any further steps, it is imperative that more careful consideration be given to the dynamics of the relationship relevant to each society. Particularly the cost-effectiveness of the investment in mortality reduction and likely effect on fertility reduction needs to be studied very carefully. Furthermore, many governments are thinking of providing some incentives, along with the family planning services, to achieve the desired reduction in fertility [14]. Some such incentives are planned to provide parents with guarantees of security in older age in case of child loss if they agree to have small families. Finally, more substantive research both at the macro and micro levels on the relationship between infant-child mortality and fertility should provide important and more reliable information for use by family planning personnel and others involved in motivating families to have fewer children. As mortality levels decline an important component of education-communication programmes could be that of interpreting for couples the changing probabilities that their children, especially after reaching ages one to three, will survive to adulthood.

References

1. Adlakha, Arjun Lal. "A Study of Infant Mortality in Turkey." Unpublished Ph. D. dissertation, Department of Sociology, University of Michigan, Ann Arbor (Michigan, USA). 1970.

2. Blacker, C.P. "Stages in Population Growth." *Eugenics Review*. Vol. 39. 1947.

3. Davis, Kingsley. *Human Society*. New York: MacMillan. 1949.

4. Davis, Kingsley and Judith Blake Davis. "Social Structure and Fertility: An Analysis Framework." *Economic Development and Cultural Change*. Vol. 4. 1956.

5. Eger, Gudrun. "On the Relationship between Socio-Economic Factors and Population Growth-Family Planning Programmes or Social Change." Paper presented at Population Tribune meeting, August 18-30, 1974 at Bucharest (Romania).

6. Freedman, R. "Application of the Behavioural Sciences to Family Planning Programmes." *Studies in Family Planning*. No. 23. October 1967.

7. Harrington, J.A. "A Comparative Study of Infant and Childhood Survivorship in West Africa." Unpublished Ph. D. dissertation, Graduate School, Cornell University, Ithaca (New York, USA). 1971.

8. Hassan, Shafick S. "Influence of Child Mortality on Population Growth." Unpublished Ph. D dissertation, Graduate School, Cornell University, Ithaca (New York, USA). 1964.

9. Hawthorn, Geoffery. *The Sociology of Fertility*. London: Collier-MacMillan Ltd. 1970.

10. Heer, David M. and Hsin-ying Wu. "The Effect of Infant and Child Mortality and Preference for Sons upon Fertility and Family Planning Behaviour and Attitudes in Taiwan." Los Angeles (Calif., USA): University of Southern California. 1973. (Mimeographed)

11. Khan, A.F.M. Atiqur Rehman. "Relationship between Child Mortality and Subsequent Fertility Behaviour—Pakistan Experience." Unpublished Dr. P.H. dissertation, School of Hygiene and Public Health, The Johns Hopkins University, Baltimore (Maryland, USA). 1973.

12. Knodel, J. "Infant Mortality and Fertility in Three Bavarian Villages: An Analysis of Family Histories from the 19th Century." *Population Studies*. Vol. 22. 1968.

13. Notestein, Frank W. "The Economics of Population and Food Supply." In *Proceedings of the Eighth International Conference of Agricultural Economists*. London: Oxford University Press. 1953.

14. Ridker, Roland and Robert Muscat. "Incentives for Family Welfare and Fertility Reduction: An Illustration for Malaysia." *Studies in Family Planning*. Vol. 4, No. 1. 1973.

15. Rutstein, S. O. "The Influence of Child Mortality on Fertility in Taiwan." Unpublished Ph. D. dissertation, University of Michigan, Ann Arbor (Michigan USA). 1971.

16. Sheps, M.C. "Truncation Effect in Birth Interval Data." *Journal of the American Statistical Association*. Vol. 65. 1970.

17. Thompson, Warren S. *Population and Peace in the Pacific*. Chicago (Ill., USA): University of Chicago Press. 1946.