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Infant Mortality and the Level of Fertility in India : A Review

THE relationship between the fertility and infant mortality may be viewed in socio-psychological context in which decline in infant mortality is regarded as one of the factors responsible for creating a climate favourable to the development of family limitation. It is argued that survival of children would be an incentive for the practice of family planning in order to avoid heavier economic burden with the increased number of children. On the contrary, the prevailing high infant mortality fosters a feeling of insecurity of life at early age in which more births are favoured to make up the loss.

This important relationship between infant mortality and fertility has received very little attention uptil now in this country. It was not even recognised before it became apparent that high infant mortality served as a great deterrent to the promotion of small family norm.

Level of Infant Mortality Rate

Before 1921, the Indian demographic situation was marked by high birth and death rates. Infant mortality was evidently very high. It attracted the attention of some public health research workers and administrators even before the beginning of the present century. For example, Satur and Bhatia [77], mention that the first information on infant mortality rate appeared in the Annual Report of the Sanitary Commissioner of India in 1864, which showed that annual infant mortality rate in some provinces of British India was as high

as 400 per 1000 live births in some years of the last two decades of the nineteenth century.

Since 1920, reports of the Public Health Commissioner of the Government of India are perhaps the only historical source of information about the infant mortality rates in India. In considering these data, it is necessary to keep in mind the fact that vital statistics in India are grossly deficient due to under-registration. There existed also a great deal of confusion about the compilation of infant mortality rate particularly regarding still births which were included as infant deaths in some States and considered both as births and deaths in some other States.

For a time series, a preliminary idea of the trend can be obtained by combining the figures computed by Kingsley Da vis from 1911 onwards, those quoted by Chandrasekhar for the period 1946-1950 [14] and those of the Sample Registration System for the period 1968-71 as shown in Table 1.

TABLE 1-INFANT MORTALITY RATES FOR REGISTRATION AREA IN INDIA

Period	*Infant mortality rate*
1911-1915	204 (5 year average)
1916-1920	219 (5 year average)
1921-1925	174 (5 year average)
1926-1930	178 (5 year average)
1931-1935	174 (5 year average)
1936-1940	161 (5 year average)
1941-1945	161 (5 year average)
1946-1950	134 (5 year average)
1951-1961	146 (Acturial report)
1963	146 (Rural India)
1968	137 (Rural India)
1969	140 (Rural India)
1970	133 (Rural India)
1971	131 (Rural India)

It would appear that there has been a decline in infant mortality rate in recent times. This impression is strengthened and the generality of decline among States is confirmed by the rates computed from the data of the different rounds of the National Sample Survey given in Appendix Table 1. It is notable that these rates based on the NSS contain a measure of under-cstimation due to recall lapse.

There have been also attempts by scholars to estimate infant mortality rates by local investigations or from different medical and non-medical sources. The more scope and objectives of these ad-hoc studies are restricted and their procedures have been varied. Local conditions including famines and epidemics, might also have influenced the estimates of such studies. Even so, we may give in Table 2 these rates from the different investigations and individual studies since 1942.

Trend of Infant Mortality Rate

The Public Health Commissioner's Report for 1930 has discussed at some length the trend of infant mortality rate in the 11 Provinces and in India as a whole from 1892 to 1930. After commenting on the unsatisfactory data on registration of births during the first half of the period, the Report has noted continuous improvement in mortality rates from 1918 onwards. This improvement was partly attributed to better registration.

Basak's study [5] on infant mortatity in India from 1926-1935 based on the Annual Reports of the Public Health Commissioner also concluded that registration of births of earlier years was not comparable with the practice of later years. He suggested that there was no indication of any appreciable decrease in infant mortality rates during the decade 1926-35.

The infant mortality rates from 1935 to 1944 varied between 164.0 and 169.3 per mille of live births. About the health conditions of the latter year, Col. Bozman (Additional Public Health Commissioner) drew attention to the prevailing very high rates of infant mortality and made a strong plea for improving health conditions.

Over the next two years, the recorded infant mortality rate fell to about 132.6. No explanation was put forth how this phenomenal reduction in infant morta-

TABLE 2—INFANT MORTALITY RATES FROM AD-HOC SURVEYS AND STUDIES

State	*Area*	*Yearof survey*	*Population*	*In/ant mortality rate*
Andhra Pradesh	Vetapalem	1958	61948	88.7
Assam	Rangiya	1957	54977	101
Bihar	Ekangarsarai	1956	85691	57.8
Madhya Pradesh	Dabra	1955-56	83411	135
Manipur	Thoubal	1957	79474	48
Orissa	Talcher	1958	63537	139
Uttar Pradesh	Captainganj	1956-57	67059	63.8
West Bengal	Singur	1944	63000	137
	Singur Resurvey (old area)	1957	73413	98.1
	Saktigarh	1955	85928	82
	Singur (New Area)	1957	45349	91.5
	Singur (Balrampur, Bora and Begumpur Unions of Hooghly Distt.)	1957	N.A.	98.6
	Gopalnagar and Daluigacha village of Gopalnagar Union	1956	N.A.	92.0
	-do-	1957	N.A.	146.5
	-do-	1958	N.A.	145.5
	-do-	1959	N.A.	141.9
	-do-	1960	N.A.	121.7
	-do-	1961	N.A.	116.9

	Infant mortality rate limits	
	Lower	*Upper*
(i) Ghosh and Chandrasekhar (1942) in Calcutta study of 2589 infants	146.1	175.5
(ii) Idem (1944) in a rural area near Calcutta, 448 infants	•—	80.5
(iii) Orkney (1946) in suburbs of Delhi	_	220.1

lity rate had occurred. Another study by Swaroop [90], noted a substantial decline in the infant mortality rate between 1920 and 1946.

Reviewing the trends over the same period, Kingsley Davis [22] observes, "If we take the years 1916, 1917 and 1920 as our base, we find that the average general mortality decreased 27.6 per cent by 1936-40, whereas infant mortality declined only 19.6 per cent. But despite its failure to drop quite as fast as general mortality, infant mortality has nevertheless been reduced substantially according to official returns."[1]

The improvement in mortality conditions, which was initiated in the 1920's, appears to have been carried forward with greater speed since Independence. With the introduction of planning and increased investment on medical and public health, the gap between the declining mortality and stationary fertility widened considerably. The death rate has fallen and there was also a fall in infant mortality but the relation between these declines in the two rates has not been systematically investigated at the national level. Some local studies provide some clues. For example, Wyon and Gordon in their Khanna study observe, "A detailed examination of death rates of Punjab children less than five years old confirms the relatively greater decline in death rates after the five year of life. According to this evidence, the death rates during the first year declined by 20 per cent between approximately 1898 and 1958 in contrast to a decline of 55 per cent for the subsequent four years of life."[2]

Several studies have also attempted to decompose further the infant mortality rate to indicate generally that the improvement has been more in the post neo-natal rates than in the neo-natal rates. Ruzicka and Kanitkar [72] in their study of infant mortality in Greater Bombay for 1966-68, observed a very significant improvement of mortality rates during late part of infancy (6-11 months), whereas neo-natal rate (0-27 days) only fluctuated around approximately 45 deaths per 1000 live births throughout the review period.

Data collected by the Singur Health Centre of the All-India Institute of Hygiene and Public Health, Calcutta [79] in 1953 from some rural areas of West Bengal also show that during 1947-1952 the decrease in deaths in neo-natal period had been less than that in the post neo-natal period. A subsequent Singur study [68] collected demographic data for the period 1956-61 from about

1. *Op. cit.*, p. 35.
2. *Op. cit.*, p. 179.

1052 couples. According to these data, the infant mortality rate had decreased from 146.5 in 1957 to 116.9 in 1961. But neo-natal mortality rates had remained stable at the level of 70-78. However, the proportion of the infant in total deaths had remained almost constant during the period. The decline in infant mortality rate was not fully accompanied by a decline in neo-natal mortality rate.

In contrast, Chandrasekhar [14] has tried to show that from 1920 to 1965, the relative proportions of infant mortality under one month, 1-6 months and 6-12 months had remained practically steady suggesting thereby that the decline in mortality is shared by all periods of infant life. His analysis, however, takes into account only the registration data, overlooking the possibility of relatively greater incidence of undercount of neo-natal deaths.

The more recent data of Sample Registration System indicate the neonatal mortality rates to be respectively 74 and 75 per 1000 live births for 1968 and 1969 respectively. These data show that about 55 per cent of infant deaths occur in the first month (neo-natal mortality). Further, these data show that risk of dying is greatest during the first week of life, as shown in Table 3.

TABLE 3—INFANT MORTALITY BY AGE : SAMPLE REGISTRATION SYSTEM, 1968 AND 69 (RURAL)

Year	*Infant mortality rates*				
	Below 7 days	*7-25 days*	*29 days — 6 months*	*6 months but below 1 year*	*Total*
1968	43.3	30.7	39.0	23.8	136.8
1969	42.7	32.1	42.7	22.4	139.9

Causes of Infant Mortality

The gross inadequacies of data severely restricts the analysis of mortality by cause of death. However, attempts have been made from time to time to identify the causes of death by administrators in the health departments as well as by individual scholars, expert groups and committees. We will refer to a few of these experiences for an appreciation of the general situation.

Public Health Commissioner in 1934 attributed the high infant mortality rates to several general factors like poor nutrition of mother, over-crowding, high birth rate, high maternal mortality rate, premature births, prevalence of

respiratory and communicable diseases *like* malaria, syphilis etc. He also found that both birth rate and infant death rate were high in the poorer classes. The report of the Special Committee [10] for review of Maternity and Child Health Welfare Work in India observed that during 1932-36 prematurity, malnutrition, high maternal mortality were the causes for high mortality in neo-natal period, whereas the respiratory diseases were the leading causes in post neo-natal period. Dasgupta's analysis [20] of infant deaths in Bombay threw up the same conclusions for 1946-48.

Rao [71] analysed by age and cause infant deaths registered in the city of Madras during 1964. His observations did not deviate from those of the above Special Committee. He found that the infantile debility, malnutrition and premature births accounted for the largest number of deaths during neo-natal period and the respiratory diseases in the post neo-natal. Likewise, Chandrasekhar [14] pronounced immaturity, congenital malformation and respiratory diseases as the major causes of infant deaths in India. He contends that "the basic causes of excess of infant mortality in India are poor nutritional status of infants and their over exposure to the large doses of pathogenic and micro-organism and the community's excessive fertility."

Further, confirmation of prematurity as the common cause of infant deaths in all parts of the country is provided, for example, by the data published from 1958 onwards by the Registrar General of India, on the basis of medical certificates for selected areas known to have reliable statistics; by a recent study on infant mortality trends in a rural health centre of Pondicherry, by Srinivasa, Danabalan and Anand [89] and by the enquiry into post neo-natal deaths by the Rural Health Research Centre, Narangwal [65].

Data on cause of death are also collected under the Model Registration Scheme of the Registrar General of India. Only those primary health centre villages are covered by the scheme which have medical officers and para-medical personnel for investigation. The causes thrown up by these data are birth injuries, prematurity, infection of the new born, diseases peculiar to infancy, broncho-pneumonia and pneumonia.

Chronological view of these studies points to the fact that the pattern of mortality by cause has not significantly changed since the beginning of the century. While there has been a considerable reduction in infant deaths in the post neo-natal period due to the control of exogenous factors like the communi-

cable diseases associated with hazardous environment, the deaths in the neo-natal period, which account for the largest share of infant deaths and are caused by endogenous factors, are still rampant. Further prospect of decline in infant mortality therefore lies in controlling these factors of which mother's health is the most important [87].

Fertility and Infant Mortality

In India, children and specially sons, are valued for reasons of economic security and support, especially in old age and the women's status depends on her becoming a mother of a son or sons. Satisfaction in family life lies in having children around. This cultural context, in the face of high infant mortality, impels couples to go for more births than they want. An appreciable reduction of infant mortality is not unlikely to infuse confidence in the survival of the children already born and to encourage the practice of family planning.

This hypothesis remains yet to be tested in this country. There are, however, several indirect references on this topic. Chandrasekhar [14] for example, quotes a correlation attempted by Kleinman of the infant mortality with the birth rates for Indian states in 1951-61. The correlation is positive but small (0.34) with the higher infant mortality rate.

Mrs. Dandekar's study of demographic change during the three five year plan periods in rural areas of the Satara district [16] showed a parallel fall both in birth rate and infant mortality rate between 1954 and 1965. Anker's [2], analysis of the data of a sample of 470 couples in Gujarat for December, 1970-April 1971, indicated that child mortality is one of the most important predictors of the average of actual family size and also actual number of sons.

More recently, the increasing interest in the interaction of infant mortality and fertility has led to the launching of several studies bearing directly on this topic. One of the more important of these studies in this field was launched by the Rural Health Research Centre, Narangwal in 1971. Among other things, this programme seeks to test the hypothesis that decline in infant and child mortality will lead to increased contraceptive practice, because increased expectation of child survival will result in a decrease in the number of births desired by the parents.

The experimental design constructed to test this and other hypotheses comprises four cells of three to four villages each with about 500 population, but differing in the programme strategy. In the first cell, the strategy is confined to family planning alone; in the second, family planning combined with general health services for women 15 to 49 years of age; in the third, with child health service for children under 0 to 3 years; and in the fourth, with general health services for women between 15 to 49 years of age and health services for children less than three years. The study is in progress. Its annual report for 1972-73 indicates that in the villages where child care is provided, there has been a definite indication of the fall in infant and child mortality rates. It would take some time, however, to see if this has any effect on the practice of family planning.

Another field investigation has been carried out in Tamil Nadu by the Gandhigram Institute of Rural Health and Family Planning in collaboration with W.H.O. with a view to studying (i) the relationship between birth order, family size and spacing on family health, especially health of the mother and children, and *(ii)* the influence of the level of infant and childhood mortality on the level of fertility. The data collected are being processed. A preliminary analysis has shown that loss of children of the first three orders has a significant direct relationship with fertility measured in terms of gravidity and mean parity. More than two thirds of the child loss herein considered is of infants. When mean family size is considered, child loss has a significantly depressing effect.

Infant Mortality in Relation to the Age of Mother and Parity

Health and physiological aspects of the relationship between fertility and infant mortality have aroused greater interest among the public health workers in this country. This relationship has been studied by considering the impact of reproductive behaviour and health of mothers on the health and survival of infants and vice-versa. The variables considered, singly or jointly, in these studies are : age of the mother, parity, interval between two successive pregnancies, breast-feeding, period of amenorrhoea, premature births, birth weight of infant and reproductive wastage.

Examining variation of infant mortality by age of mother, the Khanna Study [95] suggested that the rate was higher for both the young and relatively older mothers as compared to those in middle of reproductive span. Ruzicka and

Kanitkar [72] advanced a similar conclusion on the basis of their data for Greater Bombay for 1960-65. They also noted that the highest infant and neo-natal mortality rates were found in the first order and the lowest in fifth and sixth orders of pregnancies. Their study indicates that while neo-natal mortality was not related to parity, post neo-natal mortality rates were somewhat higher than average for the first four pregnancy orders and perinatal death rate was the highest for the first, moderate for the next three and high again for the fifth and subsequent birth orders. Observation of some 900 cases of perinatal deaths during a period of four years at the Government hospital in Hyderabad by Mehdi and Naidu [52] showed that perinatal mortality rate maintained a low level for second to fourth parity and then rose steadily over successive higher parities. They also show that perinatal mortality was highest for mothers in 30-34 age-group and the second highest for mothers in 15-19 age-group. These findings are corroborated by a study of Das and Bhargava [18].

Maternal Health and Nutrition

Maternal health is a factor of considerable importance in infant mortality. In the developing countries like India with high maternal mortality rates, the relationship between mother's health and child survival cannot be ignored. Not only her health but her attitude, care and concern for the child also play an important role in the survival of children. This is particularly important as children and infants are mostly brought up on breast feeding. It is at the same time true that repeated pregnancies involving continuous breast feeding tell upon mother's health resulting, in turn, in some reproductive wastage.

In a study conducted in a Delhi hospital, Tripathy [92] showed that the birth weight of the child was strongly correlated with the weight of the mother and that the nutritional status of the mother contributed to the incidence of premature births. Gopalan [38] observes that over 30 per cent of women were found to be suffering from severe anaemia. He contends that such malnutrition in pregnancy is responsible for low birth weights and poor nutritional status of the infants.

Jain [43] takes into account breast feeding practice in defining the inter-relationship between mortality and fertility, in his review of studies carried out in India and abroad. He supports the conclusion that breast feeding prolongs post-partum amenorrhoea period so that if the child survives and is kept on the breast feeding, next conception may be delayed.

Infant Mortality in Relation to Spacing of Births

The influence that the death of an infant has on the interval between successive live births has been analysed in the Singur Study [68] on the basis of inter-pregnancy intervals of the mothers experiencing infant deaths and of those who had no such experience. The results of this analysis show correspondence between short intervals between the successive pregnancies and greater risk of the child dying within one year; alternatively, the resumption of mensturation earlier on account of the stopping of breast feeding following an infant death might result in an earlier conception. Thus pregnancy interval and infant death may be mutually interrelated. The finding agrees with observation of Sen and Mathen [81] that the inter-pregnancy interval was the smallest where obstetrics and neo-natal mortality were the highest. Their general finding was that next pregnancy was accorded earlier when the child died before completing one year than when he survived for one year.

Birth Weight in Relation to Fertility

Birth weight is an important factor in the survival of infants [67]. Gandotra and Das [33] made an analysis of the data pertaining to 6272 single live births during the period 1968-70 in a Baroda hospital, which indicated that for babies with low birth weight there was a higher risk of death in first year of life. The risk of baby's death within a week bf birth was greater than the average for mothers of less than 25 years or more than 35 years old. It was, however, suggested that maternal age by itself was not significantly associated with mortality within the first week of birth.

Examination of 3831 cases of consecutive single live births in Goa Medical College in 1961-65 byRamaiah and Narasimhan [67] showed that infants born to the youngest mothers possess lowest birth weight. We may also refer here to Tripathy's study [92] which suggests a relationship between spacing and weight of the baby. He observed that the prematurity rate was at the minimum for intervals ranging from 2.5 to 3.5 years.

Several other studies of Indian data broadly suggest that (/) the risk of death is the highest for the first order births, it is much lower for the second order but thereafter tends to increase progressively; *(ii)* the shorter the interval between births, the greater is the risk and (in) the risk was positively related to

the size of family, which often varied inversely with the social and economic status of the family.

We may finally refer to the following conclusions of Gulick's [40] attempt to relate parity specific data on birth rates and infant deaths obtained from 11 villages in Punjab to the 1961 Census data and to estimate age specific death rates by applying appropriate life table probabilities :

(i) About 23 per cent of the babies born in India were the result of sixth seventh and even higher pregnancies which accounted for over nine points of the estimated birth rate of 41.3 per thousand population;

(ii) Infants form less than 4 per cent of the population, but account for about 28 per cent of all deaths in a community in a year. Higher mortality is associated with order of birth. The risk of death afflicts the first born child and then the fourth and higher orders of birth much more sharply than second and third;

(iii) Childhood malnutrition is related to the order of birth. Children of the fourth or a higher parity are at a distinct disadvantage as compared with those of the first three parties;

(iv) The birth rate is directly related to the number of couples practising contraception for the purpose of limiting family size. As noted earlier, the group of women responsible for the sixth and higher parities in any given year account for about 23 per cent of all live births;

(v) Contraception for the purpose of preventing pregnancy after the fifth live birth, involving about 25 per cent of all fertile couples, would reduce the incidence of infant deaths by about 28 per cent; and

(vi) The predominant causes of infant deaths in India are diarrhoea, pneumonia and measles. These common diseases often result in death because of low resistance of the infant child, which is associated with low birth weight.

About 20 per cent of all infant deaths could be prevented by increasing the birth weight of the unborn child through supplemental diet for mothers in the last three months of pregnancy and other types of ante-natal and post-natal care. About 28 per cent of infant deaths could be prevented through contarception of 25 per cent of the fertile mothers. Together, these: two measures may help in securing a substantial reduction in infant mortality.

Areas for Further Research

Considerable work has been done in this country on the health aspect of fertility and reproduction. Realisation that this knowledge can be used for promoting the acceptance of the small family norm, is beginning to gain ground. The existing lack of knowledge about the influence of declining infant mortality on the pattern of family formation handicaps this approach. The complex interaction of cultural mores, human motivations and values in the processes of conception, birth and infant mortality should be adequately understood. The excess of infant mortality in India, as compared to technologically more developed countries, needs to be viewed as a product of cultural .and material factors of the Indian environment (Yankauer [96]). Conception here is seldom a result of planning. It is governed by physical, emotional, economical and social circumstances.

If due cognizance is taken of mother's health spacing of births, and nutrition etc., there would result a decline in infant mortality. Family planning experts, demographers and public health workers have started advocating this approach. They plead that improved maternal and child health services will reduce maternal and infant deaths which will, in turn, lead to greater acceptance of small family norm.

The effect of reduction of infant and child mortality on the level of fertility is still controversial. Results of several studies conducted in other countries are not consistent. Some studies show a very little effect of infant and child mortality on the level of fertility, while some others suggest very significant positive relation. This controversy highlights the importance of purposeful research into the relationship between reproduction and the family formation and mortality, perinatal mortality and maternal mortality in the Indian cultural context.

Such studies should be undertaken in rural areas and urban areas and in different religious and cultural groups. Quantitative relationships and their threshhold values should be identified in respect of factors influencing fertility through maternal and child health such as nutrition, control of perinatal diseases, management of pregnancy, child care etc.

The proposed integration of health and family planning services through multi-purpose workers raises hopes for better acceptance of family planning

as a way of life. Maternal and child welfare services along with nutrition and immunization programme have the potential of contributing to the decreasing trend of infant mortality rates.

References

1. Agrawal, R. D. and Jaiswal, S. S. S., 1972, Recent trend in infant mortality in India, *Sample Registration Bulletin,* Office of the Registrar General, India, Ministry of Home Affairs, New Delhi, 6(3 and 4), 27-34.
2. Anker, R. B., 1973, *Socio-Economic Determinants of Reproductive Behaviour in Households of Rural Gujarat.* A dissertation submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy (Economics) in the University of Michigan.
3. Bajpai, P. C., 1966, Observations in peri-natal mortality, *Indian Pediatrics, 3,* 83-98.
4. Balfour, M. I., 1930, Early infant mortality in India with special reference to premature birth, *Indian Medical Gazette, 65,* 630-636.
5. Basak, K. C., 1938, Infant mortality in British India, *Indian Journal of Pediatrics, 5,* 145-162.
6. Basavarajappa, K. G., 1953, Effect of declines in mortality on the birth rate and related measures, *Population Studies,* 2(16), 237-256.
7. Bhan, I., 1956, The environmental and social factors associated with infant mortality in Srinagar (J and K), *Master's Thesis in Social Work,* University of Delhi.
8. Bhatnagar, N. K., 1975, *Implications of Family Planning for Maternal and Child Health in India,* Department of Family Planning, Government of India, New Delhi, (unpublished).
9. Biswas, N., 1968, The trend of fertility and vital losses of pregnancy in an urban community, *Journal of the Indian Medical Association,* 51, 10-16.
10. Central Advisory Board of Health, 1938, *Report on Maternity and Child Health Welfare Work in India by Special Committee,* Government of India Press, Simla.
11. Chakraborty, B., 1961, A sixteen-year trend in the regional mortality in India, 1947-63, Series I: Calcutta City, *Indian Journal of Public Health, Calcutta,* **11,** 51-57.
12. ___, 1968, A sixteen-year trend in the regional mortality in India, 1947-63, Series II: Bombay City, *Indian Medical Gazette,* 8, 19-30.
13. Chakraborty, P. N., 1962, Trend of infant mortality in Chetla area, *Indian Journal of Public Health, 6,* 175-178.
14. Chandrasekhar, S., 1972, *Infant Mortality, Population Growth and Family Planning in India,* The University of North Carolina Press, Chapel Hill, North Carolina-27514.
15. ___, 1965, Infant mortality in Madras City, *Population Review, 9,* 100-103.
16. Dandekar, K., 1974, *Rural Satara Project-Demographic Change during Three Five Year Plan Period,* Demographic Research Centre, Poona.
17. ___ and Bhate, Vaijayanti, 1972, Infant death rates in Poona City : An evaluation. *Studies on Mortality in India,* The Gandhigram Institute of Rural Health and Family Planning, Gandhigram, Madurai, Tamil Nadu, Monograph Series No. 5, 31-43.

18. Dass, A. andBhargava, V. L., 1961, Statistical review of stilt-births, *The Journal of Obstetrics and Gynaecology of India,* 12, 172-177.
19. Das, Kedarnath and Mahalanobis, P. C., 1934, A preliminary note on the rates of maternal deaths and still-births in Calcutta, *Sankhya,* The Indian Journal of Statistics, Calcutta, 1, 215-230.
20. Das Gupta, B. C., 1951, *Enquiry into the Bearing of Premature and Immature Births on Infant Mortality in Bombay, 1946-48,* Indian Council of Medical Research, New Delhi.
21. Davis, Kingsley, 1954, *Fertility Control and the Demographic Transition in India,* The Milbank Memorial Fund, New York.
22. .___, 1951, *The Population of India and Pakistan,* Princeton University Press, Princeton, New Jersey.
23. DattaBanik, N. D., *et al.,* 1969, A longitudinal study of morbidity and mortality pattern of children under the age of five years in an urban community, *The Indian Journal of Medical Research,* 57, 948-957.
24. .____, 1970, A longitudinal study of physical growth of children from birth upto 5 years of age in Delhi, *The Indian Journal of Medical Research,* 58, 135-142.
25. ___, 1973, Growth pattern of Indian school children in relation to nutrition and adolescence, *Indian Journal of Pediatrics,* 40, 173-179.
26. ___1972, Some observations on low birth weight babies during first year, *Indian Pediatrics,* 9, 95-98.
27. ___, 1970, A semi-longitudinal study on physical growth of primary school children in Delhi, *Indian Journal of Pediatrics,* 37, 453-459.
28. ___, 1969, The influence of maternal factors on birth weight of the new born, *Indian Journal of Pediatrics,* 36, 278-283.
29. De, A. K. and Som, R. K. 1963, *Fertility and Mortality in Rural India,* National Sample Survey No. 76, 14th Round : July, 1958-June 1959, Manager of Publications, Delhi.
30. Dey, S. R. and Das, R. K., 1974, Grand Multipara (A clinical study), *The Journal of Obstetrics and Gynaecology of India,* 24, 146-152.
31. Easterlin, Richard, 1969, Towards a socio-economic theory of fertility, *Fertility and Family Planning : A World View,* Ed. S. J. Behraman. *et al.,* Ann Arbor, University of Michigan Press, 127.
32. Friediander, Stanley and Silver, Morris, 1967, A quantitative study of the determinants of fertility behaviour, *Demography,* 4, 30-70.
33. Gandotra, M. M. and Das, N., 1974, *Factors Influencing Semanatal Mortality—An Analysis by a Binary Variable Multiple Regression Method,* Demographic Research Centre, Faculty of Science, Baroda, Gujarat.
34. Ghosh, S., 1961, A study of childhood mortality, *The Indian Journal of Child Health,* 10, 277-233.
35. Ghosh, Leila and Chandrasekhar, C., 1942, *Enquiry into Vital Loss upto the One Year of Life as Recorded by Seven Maternity and Child Welfare Centres in Calcutta,* All India Institute of Hygiene and Public Health, Calcutta.
36. Ghosh, S., 1974, Child Care—A national priority, in : *Population in India's Development : 1947-2000,* ed. by Bose, Ashish *et a!.,* Indian Association for the Study of Population, Delhi, 109-120.

37. Gandhigram Institute of Rural Health and Family Planning, Gandhigram, Madurai, Tamil Nadu, 1975, Summary of the salient features of the study on health and human reproduction : Personal Communication.
38. Gopalan, C., 1974, Some aspects of nutrition in India, in : *Population in India's Development, 1947-2000,* ed. by Bose, Ashish, *et al.,* Indian Association for the Study of Population, Delhi, 101-108.
39. Gulati, P. V., 1967, Mortality rate and causes of deaths among children below five years—A field study in a semi-urban area of Delhi, *Indian Journal of Pediatrics,* 34, 273-279.
40. Gulicfc, F. A., 1971, Parity, contraception and infant mortality : A note on some parallel relationship, *All India Seminar on Demography and Statistics,* Demographic Research Centre, Banaras Hindu University, Varanasi, Uttar Pradesh.
41. Gupta. S. and Krishnamoorthy, 1970, Morbidity and mortality in children, *Indian Pediatrics, 1,* 563-570.
42. ___, Srivastava, G. and Berry, A. M., 1969, Mortality in low birth weight babies, *Pediatrics Clinics of India,* 4, 331-337.
43. Jain, S. P., 1974, *A Status Study on Population Research in India*—II, *Demography,* Family Planning Foundation, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
44. Jain, V. C., 1968, Some social components of infant mortality in India, *Indian Journal of Pediatrics,* 3, 109-112.
45. Jha, S. S., 1961, Still births in the city of Bombay, *British Journal of Social and Preventive Medicine,* 15, 389-391.
46. Jhirad, J., 1956, Report on an investigation into the causes of maternal mortality in the city of Bombay, *Health Bulletin, No.* 29, Manager of Publications, Delhi.
47. Kaul, K. K., 1973, Child Health and Family Planning, *Indian Pediatrics,* 10, 59-60.
48. Lal, A., 1963, Infant mortality (Sources and coverage of data for research workers in child health), *Indian Medical Journal,* 57, 119-123.
49. ___, 1964, Nuptiality as an index of human fertility, *Indian Medical Journal,* 59, 255-56.
50. Manchanda, S. S. and Sachdev, K. K., 1962, Morbidity and mortality in children in North India (Punjab), *Indian Journal of Pediatrics,* 29, 333-350.
51. Martin, J. F., 1972, Immunization programmes and maternal and child health services, *Indian Journal of Preventive and Social Medicine,* 3, 255-259.
52. Mehdi, Z. and Naidu, P. M., 1961, Perinatal mortality : A statistical survey from Hyderabad, *The Journal of Obstetrics and Gynaecology of India,* 12, 165-171.
53. Meerdink, J. and Ramachandran, K., 1962, Infant mortality according to social status in Greater Bombay, *Journal of the Indian Medical Association,* 39, 477-482.
54. Menon, M. K. K., 1963, Perinatal mortality in India, *Journal of the International Federation of Gynaecology and Obstrerics,* 1, 30-37.
55. Mitra, K. N., Bhattacharya, B., Dey, K., Dawn, C. S., Obadiah, M. and Gayen, A.K., 1951, A study of recent trend in infantile mortality rates in Calcutta by longitudinal survey, *Sankhya,* The Indian Journal of Statistics, Calcutta, 11, 167-182.
56. Mitra, K. N. and Gayen, A. K., 1954, On the advantages of longitudinal survey for the determination of infantile mortality rates in India, *Bulletin of the International Statistical Institute,* 33, 105-112.

57. Mitra, S., 1934, Infant mortality and its relation to normal and abnormal conditions of pregnancy and labour, *Indian Journal of Pediatrics,* 2, 16-25.
58. Mudaliar, A. L., 1928, *The Causes of Ante-Natal, Natal and Neo-Natal Mortality of Infants with Special Reference to South India,* University of Madras, Madras.
59. Nag, M., 1962, *Factors Affecting Human Fertility in Non-Industrial Societies : A Cross Cultural Study,* Yale University Publications in Anthropology, New Haven, No. 66, pp. 227.
60. Nag, A. C,, 1952, Studies on age at marriage and fertility, *The 'Modern Review,* 91, 475-478.
61. Palakoran, A., 1954, Human fertility and child mortality, *Diploma Thesis in Social Service Administration,* Madras School of Social Work.
62. Pandit, S., 1948, *Summary of the Findings of Investigation into the Causes of Maternal Mortality in India,* Indian Research Fund Association, Special Report No. 17, New Delhi.
63. Park, J. E. and Chandra, H. A., 1964, A study on the bearing of infants in Gwalior City, Madhya Pradesh, *Indian Journal of Pediatrics,* 31, 217-222.
64. Poti, S. Janardan and Biswas. S., 1963, A study of child health during the first year of life, *Sankhya,* The Indian Journal of Statistics, Calcutta, 25, 85-120.
65. *Rural Health Services and Family Planning Utilisation : Annual Report of Population Research : 1972-73.* Rural Health Research Centre, Narangwal, Punjab, India.
66. Ramaiah, T. J., 1967, Evidence of prematurity and perinatal mortality: A statistical study, *Indian Journal of Public Health,* 11, 185-192.
67. ___and Narasimham, V. L., 1967, Birth weight as a measure of prematurity and its relationship with certain maternal factors, *Indian Journal of Medical Research,* 55, 513-524.
68. Rao, M. N. and Mathen, K. K., 1970, *Rural Field Study of Population Control, Singur: 1957-69,* All India Institute of Hygiene and Public Health, Calcutta.
69. Rao, K. B., 1968, Problem of perinatal mortality in India, *Pediatrics Clinics of India,* 1,50-51.
70. Rao, P. S. S. and Inbaraj, S. G., 1973, Some aspects of pregnancy terminations in a South Indian Population, *The Indian Journal of Medical Research,* 61, 1247-1255.
71. ___, Sundar, 1972, Analysis of factors affecting infant and early childhood mortality in India, *Studies of Mortality in India,* Gandhigram Institute of Rural Health and Family Planning, Gandhigram, Tamilnadu, Monograph Series No. 5, 205-221.
72. Ruzicka, L. T. and Kanitkar, T., 1972, Infant mortality in an urban setting : The case of Greater Bombay, *Studies on Mortality in India,* Gandhigram Institute of Rural Health and Family Planning, Gandhigram, Tamil Nadu, Monograph Series No. 5, 186-204.
73. Saksena, D. N., 1974, Some demographic aspects of Tharu families, *Demographic Research Centre,* Department of Economics, Lucknow University, Lucknow, Uttar Pradesh, Series C : Occasional Paper No. 7.
74. ——— and Rastogi, S. R., 1974, Fertility, child mortality and family planning in rural areas of Uttar Pradesh, *Workshop in Demographic Surveys,* East-West Population Institute, Honolulu, Hawai.
75. Sarma, A. S. R., 1975, Infant mortality and fertility in India during 1951-71 : Unpub-

lished, *Directorate General of Health Services,* Central Bureau of Health Intelligence, New Delhi.

76. Sarma, R. S. S., 1972, Effect of declining mortality on fertility, *Studies on Mortality in India,* Gandhigram Institute of Rural Health and Family Planning, Gandhigram, Tamil Nadu, Monograph Series No. 5, 309-320.
77. Satur, D. N. and Bhatia, S., 1957, A review of work done on infant mortality, *Indian Council of Medical Research,* New Delhi.
78. Sehgal, B. S. and Singh, R., 1967, Breast feeding, amenorrhoea and rates of conception in women, *The Journal of Family Welfare,* 14, 44-49.
79. Sen, M., 1953, Infant deaths in the Sigpur Health Centre area, West Bengal: 1947-52, *Indian Journal of Pediatrics,* 20, 67-74.
80. ___and Mathen, K. K., 1962, Family planning and health of mothers and children, *Alumni Association Bulletin,* All India Institute of Hygiene and Public Health, Calcutta, **11,** 9-13.
81. ___and___ , 1954, Enquiry into the vital losses of pregnancy and infancy in a rural population, *The Indian Journal of Medical Research, 42,* 267-278.
82. Shah, P. M., Udani, P. M. and (Mrs.) Shah, K. P., 1969, Analysis of the vital statistics from the rural community, Palghar-1 : Foetal wastage and maternal mortality, *Indian Pediatrics, 6,* 595-607.
83. Sharma, M. L., 1933, Infant mortality in India—Its causes and prevention, *The Indian Medical Journal,* 27, 717-725.
84. Sheth, S. C., 1961, Perinatal morbidity and mortality, *Indian Journal of Child Health,* 10, 325-328.
85. Shadnagar Standard Fertility Survey : Final Report, 1972, *Council for Social Development,* New Delhi.
86. Singh, S. N., Pandey, G. D. and Tripathi, A. P., 1974, Neonatal and post-neonatal mortality rates in Varanasi (Rural), *Demographic Research Centre,* Banaras Hindu University, Varanasi, Uttar Pradesh.
87. Singha, P. and Arora, R. R., Maternal health and infant morbidity in the surveillance area (to be published), *Journal of Communicable Diseases,* Delhi.
88. Sinha, S. M., 1955, Maternity statistics from Gauhati, *Man in India (Ranchi), 35,* 101-109.
89. Srimvasa, D. K., Danabalan, M. and Anand, D., 1974, Infant mortality trends in a rural health centre of Pondicherry, *Indian Medical Association, 62,* 39-43.
90. Swaroop, S., 1949, Probable effect of decrease in infantile mortality of future population, *Census of India,* Paper No. 3.
91. ___ , 1941, A note on the probable effect of decrease in infantile mortality on the future population of India, *Census of India,* 1(1) (Tables).
92. Tripathy, D. D., 1968, Foetal, maternal and socio-economic factors in relation to prematurity, *Thesis For M.D. (Pediatrics),* University of Delhi.
93. Vaidyanathan, K. E., 1972, Testing deficiencies in death registration statistics and estimation of mortality in India : 1965-66, *Studies on Mortality in India,* Gandhigram Institute of Rural Health and Family Planning, Gandhigram, Tamil Nadu, Monograph Series No. *S,* 1-30.

94. Visaria, P. M., 1969, Mortality and fertility in India : 1951-61, *The Milbank Memorial Fund Quarterly,* 47, 91-116.
95. Wyon, John, B. and Gordon, John, E., 1971, *Population Problems in the Rural Punjab : The Khanna Study,* Harvard University Press, Cambridge, Massachusetts.
96. Yankauer, Alfred, 1959, An approach to the cultural base of infant mortality in India, *Population Review,* 3, 39-51,

APPENDIX

TABLE 1—INFANT MORTALITY RATES FROM DIFFERENT NATIONAL SAMPLE SURVEY ROUNDS IN VARIOUS STATES OF INDIA

States	*14th Round (7/58-6/59)*	*15th Round* (7/59-6/60)	*17th Round (9J61-7I62)*		*18th Round (2/63-1I64)*		*19th Round (7/64-6/65)*	
	Rural	*Rural*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*
Andhra Pradesh	111.38	81	86.97	81.22	106.02	87.65	107.26	66.40
Assam	96.85	92	75.87	65.44	85.22	43.47	81.67	58.25
Bihar	161.08	99	99.02	78.89	96.17	105.45	119.02	91.61
Gujarat	133.66	84	78.23	59.90	78.27	71.49	83.06	56.46
Haryana	—	—	—	—	—	—	243.38	83.33
J& K	94.84	86	109.81	38.54	74.95	47.63	66.67	39.69
Kerala	88.86	60	70.27	63.29	70.74	50.09	55.26	46.07
Madhya Pradesh	163.05	94	152.03	106.16	139.11	115.11	117.50	72.41
Maharashtra	134.59	83	92.13	61.63	111.48	69.76	77.53	63.28
Karnataka	102.98	96	90.26	74.20	115.06	80.83	117.56	87.33
Orissa	153.88	102	118.77	119.54	101.64	99.98	90.35	63.24
Punjab*	122.72	87	115.67	59.02	107.70	72.57	85.83	82.12
Rajasthan	113.76	67	129.76	100.90	140.37	133.30	120.79	111.11
Tamil Nadu	118.50	89	96.03	94.35	101.72	82.30	86.03	77.55
Uttar Pradesh	220.94	142	173.72	131.12	209.86	136.77	160.49	128.11
West Bengal	83.02	64	77.23	45.02	82.15	51.94	81.03	65.26
All India	145.86	97	118.87	82.72	127.90	89.96	114.50	79.93

*Including Delhi, Haryana and Himachal Pradesh.