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Sustained Effects of the 1974–5 Famine on Infant and Child Mortality in a Rural Area of Bangladesh*

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INTRODUCTION

It has long been known that mortality rates in populations affected by famine are relatively high; however, little is known about the sustained effects of famine on cohort mortality.[1] While it has been suggested that excess mortality generally continues for several years after the end of a famine, it has also been noted that under certain conditions the death rate during the post-famine period can fall significantly below the pre-famine level.[2] Empirical evidence on the sustained impact of famine on mortality has been limited because of the difficulties associated with compiling accurate cohort-based mortality data for both the famine and post-famine periods.[3]

An important exception in this regard is the analysis by Stein *et al.*[4] of children born or conceived during the Dutch Hunger Winter of 1944–5. Using vital registration records the authors compared age-specific mortality rates for different cohorts. While there was some evidence for a sustained effect of famine on mortality, this was, for the

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[1] L. C. Chen, and A. K. M. Chowdhury, 'The dynamics of contemporary famine', *International Population Conference Mexico*, Vol. 1, pp. 409–425, Liège (1977). G. T. Curlin, L. C. Chen and B. Hussain, 'Demographic crisis: the impact of the Bangladesh civil war 1971 on births and deaths in a rural area of Bangladesh', *Population Studies*, **30**, 1 (1976), pp. 87–105. A. Razzaque, 'Effects of 1974–75 famine on demographic variables in rural Bangladesh', M. A. thesis. Department of Demography, The Australian National University, Canberra (1985). B. Ashton, K. Hill, A. Piazza and R. Zeitz, 'Famine in China, 1958–61', *Population and Development Review*, **10**, 4 (1984), pp. 613–645. J. C. Caldwell, 'The Sahelian Drought and its Demographic Implications', Paper, No. 8. Overseas Liaison Committee, American Council on Education (1975). R. P. Greenough, *Prosperity and Misery in Modern Bengal: The Famine of 1943–44*. New York (1982). A. K. Sen, 'Famine mortality: a study of the Bengal famine of 1943', in E. J. Hobsbawm, W. Kula, Ashok Mitra, K. N. Raj and Ignancy Sachs (eds), *Peasants in History: Essays in Honour of Daniel Thorner* (Calcutta, 1980), pp. 194–220. V. G. Valaoras, 'Some effects of famine on the population of Greece', *The Milbank Memorial Fund Quarterly*, **24**, 3 (1946), pp. 215–234. S. C. Watkins and J. Menken, 'Famines in historical perspective', *Population and Development Review*, **11**, 4 (1987), pp. 647–675.

[2] J. Bongaarts and M. Cain, 'Demographic responses to famine', Working Papers, No. 77. Center for Policy Studies, The Population Council (1981).

[3] G. J. Hugo, 'The demographic impact of famine: a review' in B. Currey and G. Hugo (eds), *Famine as a Geographical Phenomenon* (Dordrecht: 1984), pp. 7–31.

[4] Z. Stein, M. Susser, G. Saenger and F. Marolla, *Famine and Human Development: The Dutch Hunger Winter of 1944–45*, New York (1975).

most part, limited to infants whose late gestational period coincided with the famine.[5] Other potential effects of the famine on children seem to have been mitigated because the Dutch established a rationing policy that favoured youngsters. In addition, the famine lasted only seven months and was followed by a rapid return to an adequate supply of food.

There are other reasons to question the generality of conclusions drawn from the Dutch Hunger Winter. For example, using occupation (manual/non-manual) as a measure of social class it was concluded that there was no evidence in the Dutch population for an 'unequal impact of pre-natal famine exposure on mortality' by social class.[6] Empirical evidence relating to the effects of famine on period mortality in rural Bangladesh has suggested that increases in mortality during famine periods are highest among the relatively poor.[7] If the effect of famine on period mortality had varied with socio-economic status, the sustained effects on cohort mortality are also likely to be sensitive to these factors.

Finally, because of limitations in the data available to Stein *et al*[8] it was not possible to evaluate the interaction of famine with social factors other than occupation. While such factors as age of mother and sex of child are known to be associated with mortality, little is known about how these patterns change under famine conditions. In addition, the number of conceptions that result in live births drops during a famine and does so differentially in different social groups.[9] The observed changes in mortality during and after the famine period could, in part, be determined by this changing composition of births by social group. By incorporating appropriate covariates into the analysis it is possible to control for these compositional effects.

In this paper we examine the sustained effects of the Bangladesh famine of 1974–5, using micro-level data. This tragic famine was caused by severe monsoon flooding in 1974 which destroyed more than two-thirds of the annual rice crop. Because of inadequacies in the food distribution system, the shortfall in rice production led to escalation of rice prices, increased unemployment, and the erosion of the purchasing power of the poor.[10] Mortality was 62 per cent higher during the famine period (1974–5) and 31 per cent higher during the post-famine (1975–6) period than during the non-famine (1978–9) period.[11]

POPULATION AND METHODS

Study area and population

The International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR, B) has maintained a Demographic Surveillance System (DSS) in Matlab, a rural area of

[5] Excess mortality at ages 1 and 2 was observed for cohorts born during the early part of the famine: however, since this pattern was also observed in control areas not subject to severe food shortages, it is not possible to attribute these effects directly to famine. Stein *et al.* suggested that the observed patterns were the result of a 'mysterious epidemic' that swept through the Netherlands during the post-war period (p. 163). In addition, early pre-natal exposure to the famine was associated with higher perinatal mortality.

[6] Stein *et al.*, *op. cit.* in footnote 4.

[7] See, for example: A. Razzaque, 'Socio-demographic differentials in mortality during the 1974–75 famine in a rural area of Bangladesh', *Journal of Biosocial Science*, **21** (1989), pp. 13–22. P. C. Mahalanobis, R. Mukherjea and A. Ghosh, 'A sample survey of after-effects of the Bengal famine of 1943', *Sankhya*, **7**, 4 (1946), pp. 337–400. C. W. McCord, S. A. Chowdhury, A. H. Khan and A. Ashraf, 'Death rate, land and the price of rice 1977–78'. *Report of the Christian Commission for Development in Bangladesh*', No. 9. (1980). K. Mukherji, 'Agriculture, famine and rehabilitation in South Asia', *Visva Bharati, Santiniketan* (1965).

[8] *Stein et al., op. cit.* in footnote 4.

[9] A. Razzaque, 'Effect of famine on fertility in a rural area of Bangladesh', *Journal of Biosocial Science*, **20** (1988), pp. 287–294. Stein *et al., op cit.* in footnote 4.

[10] A. Razzaque, *op. cit.* in footnote 1.

[11] A. Razzaque, *loc. cit.* in footnote 7.

Bangladesh, since 1966. The DSS includes regular cross-sectional censuses and continuous registration of births, deaths, migrations and marriages.

The Matlab field research area forms a part of the low-lying deltaic plain of Bangladesh situated about 70 km southeast of Dhaka and criss-crossed by numerous rivers and canals. During the monsoon a large portion of the area is inundated and country boats comprise the only means of transport. Population density exceeds 2,000 per square mile. About 85 per cent of the inhabitants are Muslims and the rest are Hindus. The average household size is nearly six persons. Households of patrilineally related families are grouped in clusters called *baris*, and share a common courtyard. Farming is the principal occupation of the study population, fishing being the second most common. There are three rice harvests annually: *aman*, accounting for over half of the annual yield, harvested in November–December; *boro* harvested in March–April, and *aus*, in June–July. Most of the housing units are built of sticks and mud with thatched or tin roofs. Sanitation in the villages is poor. Sewage is usually drained to nearby surface water, sometimes to the same source that is used for washing.

Data collection

The DSS data are collected in an ongoing system which has been designed to ensure accurate registration of vital events.[12] Although surveillance work was disturbed during the flood of 1974 (August–October), measures were taken later to record any missed events, and very few errors were found.

Of the 149 villages in the DSS, 66 on the riverside were selected for this analysis, on the assumption that these villages were more severely affected by the flood than others. Data on births, deaths and out-migrations from these villages for 1974–82 were obtained from the DSS vital registration files. Survival status and age at death or migration (where applicable) were ascertained by linking birth, death, and migration records for each individual.

In order to examine the interaction of famine with other factors thought likely to influence mortality, age of mother, sex of child, and household economic status were also incorporated into the analysis. Age of the mother and sex of the child were available from the birth registration record. The measure of household economic status (based on ownership of radio, watch, hurricane lamp, quilt, and whether remittances were received from a family member) was extracted from the Census of 1974 and linked to the birth record.

Method of analysis

Since individuals *born* during a famine may be affected differently from those *conceived* during the famine, three separate cohorts were examined: famine-born (born during the famine period), famine-conceived (conceived during the famine period, but born subsequently), and non-famine (conceived and born during the post-famine period). The dates used to define the different cohorts are somewhat arbitrary. An examination of rice prices, suggests that famine was confined to the period from July 1974 to June 1975, with the most severe period in October 1974.[13] Additional complications are caused by the

[12] CRL (Cholera Research Laboratory), 'Demographic surveillance system, Matlab, Methods and Procedures', *Cholera Research Laboratory*, **1** (1978). Scientific Report No. 9.

[13] R. L. Langsten and S. A. Chowdhury, '*The Demographic Effects of Famine in Contemporary Bangladesh*'. Carolina Population Center, University of North Carolina (1984).

marked seasonality of births and deaths in rural Bangladesh;[14] in order to assure comparability of the different cohorts, it was necessary to consider groups born during the same period of the year. Therefore, those born between July 1974 and March 1975 are classified as famine-born, those born between July 1975 and March 1976 as famine-conceived and those born between July 1976 and March 1977 as non-famine.

Neonatal mortality is thought to be affected primarily by endogenous factors (conditions present during the development of the fetus or at birth), while post-neonatal mortality is influenced more by exogenous or environmental factors. It has also been observed that babies breastfed during the post-neonatal period are less sensitive to their environment.[15] During the weaning period and shortly after, children are more likely to be adversely affected by malnutrition and are more susceptible to infectious diseases.[16] Since the association between social factors, famine, and mortality is likely to vary with age, separate analyses were carried out for four different age groups: 0–29 days, 1–11 months, 12–23 months (age 1), and 24–59 months (age 2–4).

Socio-economic status was determined as follows. From the variable articles owned (coded as 1 if owned, otherwise 0) a new variable (articles) was defined as their sum.[17] Mothers' ages were grouped into three categories: < 20, 20–34, and 35+. The cohort variable was divided into three categories, as defined earlier. Thus all variables were categorical with the exception of 'articles', which was treated as continuous in some parts of the analysis, and as categorical (none, some) in others.

The analysis was carried out in two stages. First, the crude effect of each factor was evaluated in a bivariate analysis. Secondly, the net effects of these factors, controlling for all other variables, were estimated, using the SAS multivariate logistic regression program. Initially, all the variables and their first-order interactions with cohort were included in the model. The procedure for selecting the final model involved the elimination of the interaction term with the lowest statistical significance and re-estimation of the model. This process continued until only significant interaction terms remained.

RESULTS

The mortality and migration status of the three cohorts at the end of the five year follow-up period is shown in Table 1. Of the famine-born cohort, 23 per cent died before their fifth birthday, in the famine-conceived cohort the figure was 17 per cent, and in the non-famine cohort 15 per cent. Mortality was significantly higher amongst the famine-born than the non-famine born. A similar pattern was observed for each sex, children born to mothers of different ages, and of different socio-economic status. Migration rates did not differ significantly between the cohorts.

The age-specific mortality rates for the three cohorts as a whole and by articles owned, sex, and mothers' age are presented in Table 2. Mortality among the famine-born was

[14] There is pronounced seasonality in both births and deaths in Matlab. See, for example: S. Becker, 'Seasonality of deaths in Matlab, Bangladesh', *International Journal of Epidemiology*, **10**, 3 (1981), pp. 271–80. S. Becker, 'Seasonality of fertility in Matlab, Bangladesh', *Journal of Biosocial Science*, **13**, 1 (1981), pp. 97–105.

[15] M. Rahman, B. Wojtyniak, M. M. Rahaman and K. M. S. Aziz, 'Impact of environmental sanitation and crowding on infant mortality in rural Bangladesh', *The Lancet* (1985), pp. 28–32.

[16] K. H. Brown, R. E. Black, S. Becker and A. Haque, 'Pattern of physical growth in a longitudinal study of young children in rural Bangladesh', *The American Journal of Clinical Nutrition*, **36** (1982), pp. 294–302.

[17] Questions about four types of articles: quilts, hurricane lamps, radios, watches, as well as about remittances were asked. Thus, a household with one quilt, one hurricane lamp, one radio, one watch and remittances would be coded as 5; a household with 4 watches and 3 quilts but no remittances, hurricane lamps, or radios would be coded as 2.

Table 1. *Percentage dead or out-migrated by birthday 5, by socio-demographic characteristics for the three cohorts*†

Factors	Famine-born			Famine-conceived			Non-famine		
	Number of births	(a) Death	(b) Out-migration	Number of births	(c) Death	(d) Out-migration	Number of births	(e) Death	(f) Out-migration
All	2,476	23.2**	8.2	1,621	17.1	7.2	3,167	15.4	7.3
Articles owned									
None	722	29.5**	9.1	428	17.5	6.8	937	16.6	6.9
Some	1,754	20.7*	7.8	1,193	17.1	7.4	2,230	14.9	7.5
Sex									
Male	1,259	21.8**	7.8	859	15.7	7.1	1,597	13.9	7.6
Female	1,217	24.7**	8.6	762	18.6	7.3	1,570	16.9	7.1
Mothers' age									
< 20	538	27.9**	9.1	365	20.0	10.7	607	15.8	11.7
20–34	1,661	21.1**	8.3	1,084	15.8	6.3	2,195	14.5	6.6
35+	277	27.0*	5.8	172	18.6	5.2	365	20.3	4.1

* $P < 0.05$; ** $P < 0.01$ [value in column (a) or (c) compared with value in column (e), (b) or (d) compared with (f)].
† Famine-born = born between July 1974 and March 1975, Famine-conceived = born between July 1975 and March 1976 and Non-famine = born between July 1977 and March 1978.

Table 2. *Age-specific death rate (per 1,000) by socio-demographic characteristics for the three cohorts*†

Factors	0–29 days			1–11 months			12–23 months			24–59 months		
	(a) Famine born	(b) Famine conceived	(c) Non famine	(a) Famine born	(b) Famine conceived	(c) Non famine	(a) Famine born	(b) Famine conceived	(c) Non famine	(a) Famine born	(b) Famine conceived	(c) Non famine
All	67.5	76.5*	57.2	103.3**	47.8	37.9	46.3**	18.7	26.2	15.8	14.5	15.9
Articles owned												
None	69.3	86.4*	54.5	154.4**	31.0	36.6	63.2*	19.2	36.3	21.5	16.7	19.0
Some	66.7	72.9	58.4	82.6**	53.8	38.5	40.2**	18.6	21.9	13.9	13.7	14.7
Sex												
Male	73.1	73.3	67.0	86.7**	45.7	33.2	43.4**	18.9	18.6	14.4	10.6	10.4
Female	61.7	80.1**	47.2	120.0**	50.4	42.7	49.4	18.6	33.9	17.5	19.0	21.7
Mothers' age												
< 20	91.1	104.1	70.9	137.8**	49.7	41.5	50.1**	30.4	11.6	13.9	12.5	16.9
20–34	53.0	64.6*	47.9	92.3**	48.7	35.8	45.8**	17.0	29.6	16.0	13.9	15.1
35+	109.1	93.0	90.4	104.0**	38.8	45.4	42.7	6.8	28.8	18.8	21.5	19.4

* $P < 0.05$; ** $P < 0.01$ [compared (a) or (b) with (c)].
† see Table 1

Table 3. *Linear logistic regression models for infant (neonatal and post-neonatal) and child (12–23 and 24–59 months) mortality*†

Variable	Reference category	Neonatal		Post-neonatal		12–23 months		24–59 months	
		B	Odds ratio (95% CI)	B	Odds ratio (95% CI)	B	Odds ratio (95% CI)	B	Odds ratio (95% CI)
Constant	—	−2.412	—	−3.124	—	−3.294	—	−2.155	—
Cohorts									
Famine-born	Non-famine	0.161	1.17 (0.94–1.46)	1.551***	4.71 (3.44–6.46)	0.504***	1.65 (1.17–2.33)	−0.215	0.80 (0.55–1.17)
Famine-conceived	Non-famine	0.287**	1.33 (1.05–1.69)	0.236	1.26 (0.93–1.72)	−0.596*	0.55 (0.32–0.94)	−0.025	0.97 (0.70–1.35)
Other covariates									
Sex	Female	0.181*	1.20 (1.00–1.44)	−0.265**	0.76 (0.63–0.94)	−0.295*	0.74 (0.55–0.99)	−0.707***	0.49 (0.36–0.67)
Articles owned (continuous)	N.A	−0.026	0.97 (0.90–1.05)	0.032	1.03 (0.92–1.16)	−0.160**	0.85 (0.75–0.96)	−0.272***	0.76 (0.68–0.85)
Mothers' age									
< 20	35+	−0.120	0.88 (0.66–1.19)	0.218	1.24 (0.86–1.79)	−0.763	0.46 (0.18–1.20)	−0.202	0.81 (0.52–1.27)
20–34	35+	−0.644***	0.52 (0.40–0.68)	−0.095	0.90 (0.65–1.26)	0.133	1.14 (0.70–1.86)	−0.279	0.75 (0.52–1.09)
Interactions									
Famine-born × Sex	—	—	—	—	—	—	—	0.558*	1.74 (1.01–3.01)
Articles owned	—	—	—	−0.372***	0.69 (0.58–0.81)	—	—	—	—
Mothers' age < 20	—	—	—	—	—	0.989*	2.69 (1.00–7.20)	—	—
Famine-conceived × Mothers' age < 20	—	—	—	—	—	1.605***	4.98 (1.54–16.12)	—	—
Comparison of initial and final models									
Final model									
Lik. stat. (d.f.)		3,463.41 (7249)		2,960.93 (6954)		1,633.08 (6070)		2,046.69 (5620)	
Initial model‡									
Lik. stat. (d.f.)		3,457.17 (7241)		2,955.35 (6587)		1,627.58 (6064)		2,044.23 (5613)	
Difference (d.f.)		6.24 (8)		5.58 (7)		5.50 (6)		2.46 (7)	

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.
† dependent variable equals 1 if child died during period, 0 otherwise.
‡ see Table 4.

significantly higher than in the non-famine cohort, in the post-neonatal period for the group as a whole, for the poorest and the better off, both sexes, and every age group of mother. During the second year of life (12–23 months), a similar pattern was found with two exceptions. There was no significant difference between the mortality of infants born to women aged 35 and over, possibly because of small sample sizes. More interestingly, mortality was not significantly higher for female babies. In the non-famine cohort, the death rate for girls exceeded that for boys by 82 per cent. The mortality rate was much higher for famine-born boys than girls, so that the sex differential was small. Between two and four years of age, the mortality of the famine-born was similar to that of the group that had not experienced the famine.

When the famine-conceived cohort is compared with the non-famine cohort, neonatal mortality is significantly higher for the population as a whole, the poorest groups, girls, and infants of mothers aged 20–34. No significant differences in mortality for the famine-conceived cohort are observed during the second year of life, or among children aged between two and four years.

The final results of the multivariate analysis appear in Table 3, in which the logistic regression coefficients and odds ratios for the final models for each of the four age goups are shown.[18]

Neonates. Odds of dying were 33 per cent higher for the famine-conceived neonates than for those from the non-famine cohort. Although the odds were also higher for the famine-born, the difference was not significant. Odds were significantly higher (20 per cent) for boys than for girls, and 48 per cent lower for neonates whose mothers were aged 20–34 than for those whose mothers were 35 or older. Interestingly, there were no significant interaction terms between the famine-cohort variables and the others.

Post-neonates. Mortality odds for the famine-born were 4.71 times those for the non-famine cohort. Further, the poorest suffered most; the observed negative interaction between articles owned and famine-born implies that the effect of the famine decreased linearly with rising socio-economic status.[19] The mortality advantage of girls had disappeared by the post-neonatal period; instead of mortality odds being higher for boys they were now 24 per cent lower than for girls. There were no significant interactions between cohort and sex of the child or mother's age.

Second year of life. Mortality was higher in the famine-born cohort (odds 65 per cent higher) during the second year of life than in the non-famine cohort, while odds for the famine-conceived were 45 per cent lower. These results apply to children whose mothers were at least 20 years old. Children with younger mothers were particularly likely to suffer from the famine, as indicated by the significant positive interaction between teenage mothers and the famine-cohort variables. Again, mortality odds were lower for boys (26 per cent) and the better off (15 per cent). No significant interactions between cohort and sex or socio-economic status were observed.[20]

[18] In Table 3 we present likelihood statistics which may be used to compare the initial (including all main effects and interaction terms) and final models (including all main effects and significant interaction terms). A joint test of the hypothesis that the excluded interaction terms are zero is not rejected for any age group. Coefficient estimates in Table 3 refer to the final model; estimates from the initial model are presented in Table 4).

[19] In fact the figure of 4.71 refers only to births in households which did not possess any of the articles. Because of a negative interaction term the relative odds for households with some articles will be less than 4.71. In particular, for a household with N articles the relative odds will be $\exp(1.551-0.372N)$. Thus, for a household with four articles the mortality odds in the famine-born will only be 1.065 times those in the non-famine cohort.

[20] The absence of a cohort–sex interaction is surprising in view of the strong relationship observed in the bivariate analysis (Table 2). It seems that after controlling for the cohort–mothers' age interaction any differential effects of the famine by sex are no longer significant. Attempts to explain this result in terms of the sex ratio at birth by mothers' age proved unsuccessful (not shown).

Table 4. *Linear logistic regression model for infant (neonatal and post-neonatal) and child (12–23 and 24–59 months) mortality*

Variable	Reference category	Neonatal	Post-neonatal	12–23 months	24–59 months
Constant	—	−2.512	−2.888	−3.001	−2.232
Cohorts					
Famine-born	Non-famine	0.383	1.310***	0.163	−0.083
Famine-conceived	Non-famine	0.333	−0.443	−1.964	0.121
Other covariates					
Sex	Female	0.359**	−0.259	−0.653***	−0.758***
Articles owned (continuous)	N.A.	0.015	−0.032	−0.225**	−0.222***
Mothers' age					
< 20	35+	−0.253	−0.065	−0.838	−0.053
20–34	35+	−0.685***	−0.229	0.039	−0.259
Interactions					
Famine-born ×					
Sex	—	−0.154	−0.054	0.543	0.615**
Articles owned	—	−0.084	−0.311***	0.054	−0.148
Mothers' age					
< 20	—	0.104	0.433	1.046	−0.188
20–34	—	−0.083	0.119	0.061	0.063
Famine-conceived ×					
Sex	—	−0.471	0.156	0.653	0.165
Articles owned	—	−0.047	0.161	0.211	−0.015
Mothers' age					
< 20	—	0.389	0.290	2.377***	−0.418
20–34	—	0.292	0.436	0.893	−0.174
Lik. stat.	—	3,457.17	2,955.35	1,627.58	2,044.23
d.f.	—	7241	6587	6064	5613

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

Children. Differences in the effect of the famine on mortality emerged in the multivariate analysis although none was found in the bivariate analyses. In particular, boys' mortality odds were 51 per cent lower than those of girls in the non-famine and the famine-conceived cohorts, but only 14 per cent lower in the famine-born cohort.

DISCUSSION

Neonatal mortality was significantly higher among infants conceived during the famine. Their mothers probably suffered from severe malnutrition, disease, lack of ante-natal care, and anxiety during gestation. As a result, it is likely that the proportion of these babies with low birth weights was higher, and so, therefore, was neonatal mortality. This observation is consistent with the findings of Stein *et al.*[21] that babies born to women who were pregnant during periods of famine were likely to be relatively light and subject to relatively high mortality. Those born during the famine seem to have been better insulated against the effects of their environment before birth; neonatal mortality for the famine-born did not differ significantly from that in the non-famine cohort.

In contrast to the results obtained for the first month of life, post-neonatal death rates were significantly higher among the famine-born but not among the famine-conceived. Babies born during the famine probably suffered from inadequate nutrition and lack of

[21] Stein *et al*, *op. cit.* in footnote 4.

medical care during their post-neonatal period. This interpretation is supported by the fact that there was no excess mortality among children born to mothers from the wealthiest households (e.g. those possessing four or five items) during the famine period.

Breastfeeding is likely to have played an important role here. In this population, breastfeeding is likely to be the primary, if not the only, source of nutrition during the first year of life.[22] As Antonov[23] has recorded, severe malnutrition of the mother affects her milk supply, and young infants become highly vulnerable. Not only will children born during a famine receive less nourishment from breastfeeding, they may even be partially weaned (and thus receive poor-quality water and inadequate food) at an earlier age. These results seem to contrast with those from the Netherlands,[24] and China[25] in which infants born before or during the early stages of famine seemed to be insulated from its effects as a result of social policy.

High mortality among the famine-born continued into the second year of life. Since the famine ended before these children's first birthday it is no longer possible to attribute this excess mortality directly to the famine. Instead, there is the suggestion that this continuing excess mortality was a result of debilitation during the famine period, which increased the risk of later mortality. A similar pattern of excess mortality was observed during the years following the Bengal famine of 1943–5.[26]

The low mortality observed among the famine-born between the ages of 24 and 59 months, and the famine-conceived at ages 12–23 months may be a result of selection. The basic idea is, that if in a population individuals vary in frailty and are subject to excess mortality during one period, average frailty during subsequent periods, will be lower than in a similar population not subject to excess mortality.[27]

In all cohorts, neonatal mortality was higher for boys than for girls. During the post-neonatal and childhood period, girls' mortality was higher, indicating greater parental concern for boys by the provision of better food and health care. The gap increased through early childhood so that, between the ages of 24 and 59 months, the risk of dying for boys was only half that for girls. The relatively small difference between the mortality of the sexes at ages 24–59 months in the famine-born cohort is surprising. Again, selection may be at work: excess mortality of girls coupled with relatively high post-neonatal and early childhood mortality for the famine-born may lead to especially sturdy survivors of girls aged 24–59 months (or, conversely, in which boys are, on average, more frail) so that any advantages given to boys during early childhood do not much improve their survival chances relative to those of girls.

Socio-economic status was not significantly related to neonatal mortality. Nor was it related to post-neonatal mortality in the non-famine or famine-conceived cohorts; however, in the famine-born cohort mortality of children of different socio-economic status was significantly different. Indeed, children in the higher socio-economic groups seemed largely unaffected by the famine. Evidently, household resources can play an important role in determining the ability of infants to survive during famine periods, even though their importance in determining the ability of a child to survive during normal years is small. This result is consistent with other research from the Indian sub-

[22] S. L. Huffman, A. K. M. A. Chowdbury, J. Chakraborty and N. Simpson, 'Breastfeeding patterns in rural Bangladesh', *American Journal of Clinical Nutrition*, **33** (1980), pp. 144–53.

[23] A. N. Antonov, 'Children born during the siege of Leningrad in 1942', *Journal of Paediatrics*, **30**, 3 (1947), pp. 250–259.

[24] Stein *et al.*, *op. cit.* in footnote 4.

[25] Ashton *et al.*, *loc. cit.* in footnote 1.

[26] Sen, *loc. cit.* in footnote 1.

[27] J. W. Vaupel, K. G. Manton, and E. Stallard, 'The impact of heterogeneity in individual frailty on the dynamics of mortality', *Demography*, **16** (1979), pp. 439–54.

continent.[28] It is interesting to note that this difference does not continue into the second year of life or later, and that it is confined to the famine-born cohort.

Mothers' age was incorporated into the analysis as an important biological correlate of mortality. While neonatal mortality was relatively low among children born to women aged 20–34, mothers' age was not significantly related to survival of older children. An interesting interaction was observed between famine and mothers' age: mortality of infants during their second year of life born to or conceived by young mothers (< 20) during the famine was unusually high. Biological or social immaturity may play a role here, but it is obvious why this effect should only be significant during the second year of life. It is possible that these mothers were least able to supply weaning foods, but we cannot tell this from our data.

CONCLUSIONS

We have examined the continuing effect on infant and child mortality of the 1974–5 famine in a rural area of Bangladesh by comparing the mortality rates of three cohorts of children who were born during and after the famine. Using the non-famine born cohort as the reference group, our findings indicate that mortality was higher in the famine-born cohort up to the second year of life, while in the famine-conceived cohort it was higher only in the first year. Thereafter, mortality in these two cohorts was lower and the difference eventually disappeared after the 24th month. Further, post-neonatal mortality among the poor in the famine-born cohort was higher than among the better-off. Mortality of children of very young mothers (< 20) born or conceived during the famine was unusually high in their second year.

Our primary object was to gain insight into the continuing effects of famine on mortality in rural Bangladesh, and to identify the groups most affected by the famine. However, it has become clear that our data can also provide a more general insight into the development of mortality. In particular, the results suggest that heterogeneity in individual frailty can play an important role in determining the age-pattern of mortality in a chronically undernourished population.

[28] Mahalanobis *et al.*, *loc. cit.* in footnote 7. Mukherji, *loc. cit.* in footnote 7. McCord *et al.*, *loc. cit.* in footnote 7. Razzaque, *loc. cit.* in footnote 7.