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CHILD MORTALITY LEVELS AND SURVIVAL PATTERNS FROM SOUTHERN SUDAN

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Summary. Data from a 1985 survey in two major population centres in Southern Sudan, Juba and Wau, were analysed in order to assess childhood mortality levels and the effect of UNICEF's health care programme. There are continuing high levels of childhood mortality. Logistic regression analysis shows significant positive associations between child survival and immunization, oral rehydration therapy and maternal education.

Introduction

One interest of the United Nations Children's Fund (UNICEF) is the delivery of child health technology and education at the village level, encouraging growth monitoring, oral rehydration therapy, breast-feeding, immunization, female education, family planning, and feeding supplements. Its largest African programme today is in the Sudan.

While the field effectiveness of the programme in diverse cultures (UNICEF, 1986) is proven, its long term effects are not so clear and principally there is concern about (1) the hesitancy to accept the more modern components of the strategy (e.g. immunization and oral rehydration therapy) and (2) the emphasis on technological, rather than social change (Mosley, 1984). The former is exemplified by World Health Organization (1981) findings of low tetanus toxoid usage among expectant mothers in the Third World, due to fear of injection, lack of information, and traditional or familial objections. The latter is represented by continuing high morbidity and mortality in Bangladesh for children treated in oral rehydration centres, after their return to household environments with high risk of reinfection (Roy, Chowdhury & Rahaman, 1983).

In Southern Sudan evaluation of these programmes is severely hampered by lack of data on infant and childhood mortality. In this region, with a population of approximately five million and an area of 650,000 km^2, communication and transportation systems are poor. The protracted periods of civil war adversely affected Sudan's national censuses, curtailing areal enumeration in the first in 1955–56 (Demeny, 1968), and causing the 1979 World Fertility Survey (1982) and World Health Organization survey (Callum, 1983), to restrict their investigations to

Northern Sudanese populations. Yet such data as there are show an apparently severe mortality difference between Northern and Southern Sudan. The 1973 National Census indicated a 12-year difference in life-expectancy between the two regions, with levels of childhood mortality approximately 66% higher in the south (Sudan Department of Statistics, 1979), while residence in one of the then three Southern provinces raised child mortality rates relative to Khartoum, the Northern capital of the Sudan, by 48–71% (Farah & Preston, 1982) after controlling for paternal education, employment status, housing structure, and marriage type.

To delineate childhood mortality levels and to assess the effect of its strategy, UNICEF-Sudan sponsored in 1985 a survey of mothers with children in the major urban centres of Juba and Wau (Fig. 1). Juba is the main administrative centre of the region, while Wau is the most important urban area for the Dinka, Southern Sudan's largest tribal group. To both population centres parts of the UNICEF programme have been introduced over the past 15–20 years. At present, community health centres and hospitals participate in child immunization programmes in both towns and both have been the focus of immunization programmes. Anti-diarrhoeal oral rehydration (ORT) packets are currently available from UNICEF offices, health clinics and from private dispensaries and medical practitioners in both towns.

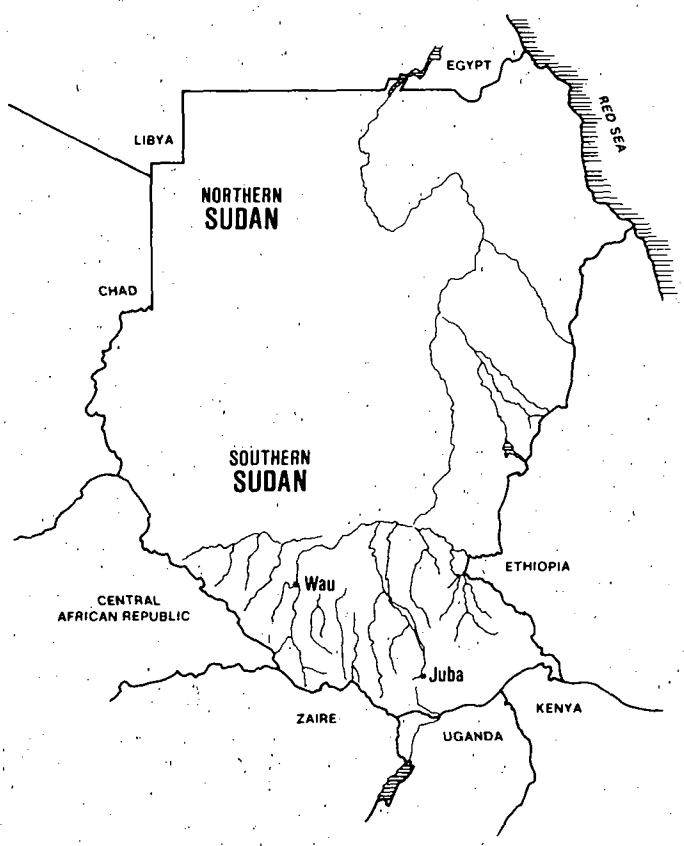

Fig. 1. Map of study sites in Sudan.

Materials and methods

Sampling followed a random stratified scheme, with the local administrative unit, the quarter council, forming the primary sampling unit. The increase in population of both towns by refugees from the civil war made estimates of numbers in these divisions impossible. However, concentration on quarter councils allowed a representative socioeconomic profile of each town, as each contains a range of housing from simple mud huts to elaborate concrete homes. Therefore sampling proceeded, with the object of completing interviews for 250 households per quarter council in the larger population of Juba and 200 in Wau.

A final sample of 5120 mothers (Juba 3061 and Wau 2059) who had borne a total of 21,509 offspring (respectively 11,352 and 10,157) was collected from the towns (Table 1). Mortality levels were indirectly estimated by Brass & Coale's (1968) method as subsequently refined (United Nations, 1983). The Brass logit life table system was used to give model life table values in the form

$$\lambda(l^*(x)) = \alpha + \beta\lambda(l(x))$$

where $(l^*(x))$ and $l(x)$ are different life table survival values, alpha and beta constants and $\lambda l(x)$ is the logit transformation of age-specific survival such that

$$\lambda(l(x)) = 0{\cdot}5 \ln(1{\cdot}0 - l(x))/(l(x)).$$

Estimates of alpha and beta values followed United Nations (1983) methods of fitting group means for observed logit values to a model life table, in this case Brass & Coale's (1968) original African standard. From this a smoothed life table was produced by the formula

$$l^*(x) = (1{\cdot}0 + \exp(2\alpha + 2\beta\lambda s(x)))^{-1}$$

where λs is the age-specific logit from the standard.

Logistic regression analysis was used to delineate determinants of child survival, although some important independent variables were omitted, e.g. growth

Table 1. Fertility and mortality data, Juba and Wau

Maternal age	No. of mothers	No. of children	Parity (mean)	Dead children	
				No.	Proportion
15–19	519	872	1·6802	121	0·1388
20–24	1092	2,610	2·3901	506	0·1939
25–29	1319	4,703	3·5656	941	0·2001
30–34	802	3,953	4·9289	1018	0·2575
35–39	790	4,772	6·0405	1275	0·2672
40–44	311	2,348	7·5498	654	0·2785
45–49	245	1,977	8·0694	607	0·3070
50+	42	274	6·5238	90	0·3285
Total	5120	21,509		5212	

Table 2. Summary data for independent and dependent variables

Independent variables	Dependent variable: no. of children		
	Total	Died	Survived
Maternal education			
1 = Illiterate	6345	1530	4815
2 = Literate	5793	1056	4737
Oral rehydration therapy			
1 = Not used	7995	1774	6221
2 = Used	4143	811	3332
Child immunization			
1 = Children not immunized	6236	1466	4770
2 = Children immunized	5902	1120	4782
Income			
1 = Low	5250	1177	4073
2 = High	6888	1409	5479

monitoring, family planning and feeding supplements, on account of insufficient data, and breast-feeding which is almost universal.

But the independent variables included maternal responses to survey questions on treatment of childhood diarrhoeal disease and immunization, treated as simple dichotomies. Maternal education, repeatedly shown (Caldwell, 1979; Caldwell & McDonald, 1981) to be an important determinant of child survival, was dichotomized into literate and illiterate mothers, since very few mothers in the sample had even a primary school education. Family income was used to denote socioeconomic status, again dichotomized, with respect to median income. Together the selected variables represent a mixture of socioeconomic status, cultural and biological, preventative and curative, factors (Table 2).

The sample used in the analysis was restricted to offspring born to women aged 15–34 at the time of the survey. This represented 12,138 births, and 2586 deaths before age 5.

Logistic regression assessed the effects of these independent variables upon the dependent variable by maximum likelihood coefficients, representing the additive effect of a unit increment of an independent variable on the dependent variable. Following the method of El Tom *et al.* (1985), these coefficients were multiplied by their antilogs to determine the multiplicative effect of an independent variable upon the dependent variable. Thus a coefficient of 1·0 represents no effect, those above 1·0 a positive effect, and those less than 1·0 a negative effect.

Results

Levels of child mortality

The child mortality measures (Table 3) denote continued high infant and child mortality levels for Southern Sudan. Linear interpolation of survival values from the

Table 3. Mortality data and life table by logit analysis

Maternal age	Child's age	Proportion died	Probability of dying* (qx)	Survival* (lx)
15–19	1	0·1388	0·1423	0·8577
20–24	2	0·1939	0·1911	0·8089
25–29	3	0·2001	0·2149	0·7851
30–34	5	0·2575	0·2388	0·7612
35–39	10	0·2672	0·2745	0·7255
40–44	15	0·2785	0·2881	0·7119
45–49	20	0·3070	0·3106	0·6894

* Logit smoothed values.
qx = probability of dying from birth to age x.
$lx = (1{\cdot}0 + \exp(2\alpha + 2\beta\lambda_s(x)))$.

logit-based family of model life tables derived by Carrier & Hobcraft (1971) for developing countries yielded a life expectancy at birth of 40·6 years, and at age 5 of 41·2 years. Comparing the observed l*(x) values with model life table figures (Fig. 2) shows poorer survival than in the 1979 World Fertility Survey (1981) of Northern Sudan, based on 3115 women from different provinces. The latter are irregular and hard to interpret, but employing linear interpolation with the Carrier & Hobcraft

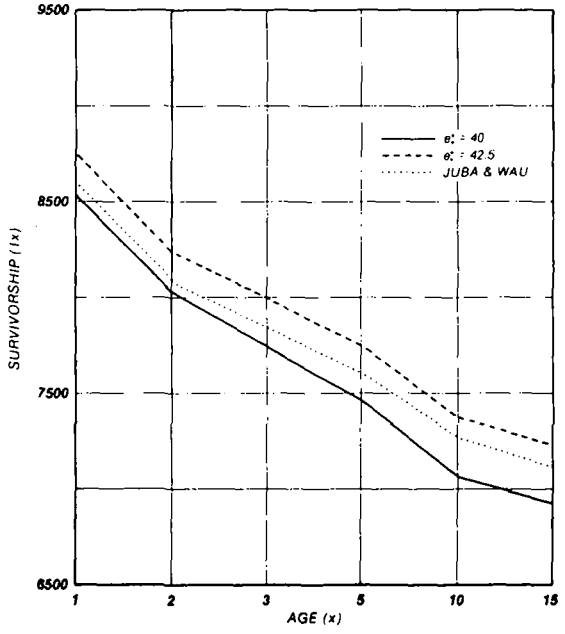

Fig. 2. Plot of observed survival values (lx) compared with Carrier & Hobcraft (1971) model life tables for average life expectation at birth of 40·0 and 42·5 years.

Table 4. Logistic regression results

Variable	Maximum likelihood coefficient	SE	χ^2	P	Coefficient × antilog
Maternal education	+0·3086	0·0469	43·20	<0·0001	1·362
Oral rehydration therapy	+0·1068	0·0482	4·92	0·0265	1·112
Child immunization	+0·1772	0·0467	14·42	<0·0001	1·194
Income	+0·0380	0·0456	0·70	0·4042	1·039
	Intercept = 0·4006				
	Model log-likelihood χ^2 = 14·32*				

* Non-significant, $P = 0·2158$.

(1971) models the q_5 value of 0·1450 corresponds to an estimated average life expectancy of 51·2 years, a full 10 years more than in the present Southern sample.

Child survival determinants

Table 4 shows the results of the logistic regression of child survival on the four independent variables, maternal education, oral rehydration therapy, immunization, and family income. For three of the variables the coefficients are significantly positive, indicating increased survival for offspring born to literate mothers, mothers using oral rehydration therapy, and mothers who give their children at least some degree of protection from infectious diseases via immunization. In contrast, the low coefficient for income is not significant, possibly because the several pathways to child health that better income potentially provides, are already subsumed in the other independent variables. Maternal education, which also endows potential multiple causal pathways to child health, is most highly associated with child survival. Offspring born to literate mothers are 1·36 times as likely to survive as those born to non-educated mothers.

Discussion

This analysis of Southern Sudanese childhood mortality in two major population centres by indirect estimation techniques shows continuation of the severe mortality difference previously noted (cf. Farah & Preston, 1982) for the Northern Sudanese level. The mortality levels are little changed from those reported for the 1973 National Sudan Census. At that time the Southern region consisted of three provinces, Upper Nile, Bahr al Ghazal and Equatoria, with respective average life expectancies at birth of 35·7, 34·2 and 39·9 years.

More optimistically, the logistic regression analysis indicated that three components of the UNICEF programme are significantly associated with child survival. The importance of maternal education agrees with past studies (e.g. Caldwell & McDonald, 1981) noting this variable as the single most important determinant of child mortality. What remain unclear are the exact pathways that lead from this

variable to reduced child mortality. These may be as diverse as the simple tasks of having children wash their hands before eating, and female autonomy in the more culturally elaborate processes, exemplified by the overriding of cultural taboos associated with traditional childhood feeding or medical practices. The absence of association of child survival with income may be due to a narrow income range, or to the fact that its effects are already measured in the other variables. But combined with the highly significant values for the three components of the UNICEF programme, this argues for the effectiveness of inexpensive modern medical technologies compared to attainment of higher income per head.

Whether these findings will mark the beginning of a long term decline in child mortality precipitated by the UNICEF initiative remains unclear for both practical and theoretical reasons. As regards the former only 32% of the sample utilized oral rehydration therapy, while less than half the respondents (47%) had at least started immunization programmes for their children. Certainly these figures would be much lower in rural areas, where the great majority of Southern Sudanese live. In such areas hesitancy to use modern medical treatment would undoubtedly be more manifest, and the technological and logistic problems of therapy delivery and maintenance are very real. On a theoretical level the crucial concern is whether the association of the variables with increased child survival represents incipient erosion only of the 'soft rock' of child mortality, reflecting the control or eradication of communicable diseases by modern medical technology (United Nations, 1963). The remaining 'hard rock' of child mortality, e.g. deriving from entrenched cultural values, crowded housing conditions, unclean drinking water and poor sanitation, may be more difficult to attack.

One possible bridge between all these facets of child health technologies and resultant child mortality in developing countries is maternal education, affecting both the cure and prevention of child ill-health. The findings of this study, that maternal education is at present the most important determinant of child survival, concur with previous studies which have noted its critical relevance for other developing countries with scarce resources.

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