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INFANT AND CHILD MORTALITY IN RURAL MALI

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INFANT AND CHILD MORTALITY IN RURAL MALI

INTRODUCTION

From the work of Preston (1976), we have come to accept as axiomatic that there are distinctive age patterns of mortality in national populations, and that these patterns are the outcome of particular combinations of age-and sex-specific causes of death. By extension, we expect sub-groups within the national populations to display characteristic age patterns (and levels) of mortality for the same basic reason. The analysis of linked census and death registration records for Great Britain has begun to indicate the importance of these sub-national differentials, even within a reasonably homogenous population with generally low mortality (Fox & Goldblatt, 1982). Nevertheless, our knowledge of age patterns of death both in non-Western and in high mortality countries remains inadequate: only twenty-two empirical life tables for non-Western countries were deemed sufficiently reliable to be included in the new UN model life tables for developing countries (UN, 1982). Some new work using both indirect and direct estimation techniques is just beginning to produce results for a variety of high mortality countries (see Blacker, Hill and Moser, 1983); Moser (1983) and Timaeus (1983) for details). The lacunae of knowledge about African mortality, let alone causes of death, is especially striking; only Tunisia of all the African countries was able to contribute a life table to the new UN model system. More specifically, the description and explanation of what appear to be marked contrasts in the mortality patterns of children in high mortality situations remain at an early stage. Even Preston's work on causes of death by age does not cover the ages of childhood in which, for most developing countries, the majority of deaths are concentrated.

For several decades, research by people from various disciplines has indicated some of the peculiarities of age patterns of mortality in tropical Africa, and quite marked variations in early childhood mortality within particular groups in small areas. It was Brass's study of mortality in French-speaking territories in the 1960's which led to the development of the African standard mortality schedule (see chapter 3 and 7 in Brass et al., 1968), incorporating some of the characteristic features of the mortality patterns established there. Subsequently, Cantrelle (1974) has made out a strong case for the existence of a standard pattern of tropical mortality but lacked the comparative data to test his hypothesis seriously, although Waltisperger was later able to produce corrected model life tables for seven populations in tropical Africa (Waltisperger, 1977, chapter 4). Page (1974) looked at some systematic variations in infant and early childhood (ages one to four) mortality in Africa based on the application of indirect techniques of estimation, and Jellife (1968)

suggested that the high levels of mortality for one to four year olds in the tropics could be related to infant nutrition. Whilst ideas abound, rigorous tests of selected hypotheses are at a premium. As Brass wryly remarked in an early paper on child mortality differentials in Africa by the marriage experience of mothers: "Where the data are extensive, their accuracy is often suspect, and where they are accurate the size of the population is usually small". (Brass, 1959).

For Africa in recent years, some of the most reliable sources of information on infant and child mortality have emerged from two long-established studies, one in Senegal (Siné-Saloum), the other in the Gambia (Keneba). These data indicate (by western standards) a highly atypical age pattern of child mortality with approximately equal numbers of deaths to infants (under one year) and to children aged 1-4 years (McGregor et al., 1979; Cantrelle, 1969 and 1974; Garenne, 1981). Since the figures came from a multi-round survey (Siné-Saloum) or from a continuous registration system (Keneba), the dating of both births and deaths is sufficiently accurate for us to accept as realistic the observed age patterns of child mortality. Nonetheless, we must remain sceptical of some features of both sets of data, namely the small numbers in the Keneba study (1138 live births and 715 child deaths in the 1951-1975 period) and the possibility of omission of some early infant deaths in Siné-Saloum because of the twelve month interval between successive rounds (Cantrelle, 1969).

Although theoretically a large-scale multi-round survey with brief gaps between visits is the ideal system for collecting reliable data on child deaths where vital registration is inadequate, there are many practical reasons (including the high cost and long gestation period of such studies) which prevent the establishment of these schemes, especially in remote rural areas or amongst nomadic or semi-nomadic populations. Recently, the life table analysis of maternity history data from single round surveys has emerged as a tool which allows us to exploit more efficiently the wealth of information in these histories both for the examination of fertility (Rodriguez and Hobcraft, 1980) and the analysis of child mortality (Rutstein, 1983). Without doubt, the accuracy of reporting of birth dates and of children's ages at death is lower than in a study population followed for a prolonged period, but to some extent the use of summary measures such as the cumulative proportions surviving to any age (x), $\ell(x)$, circumvents some of the most severe problems associated

with misdating of vital events.

Here, we present some new data on child mortality amongst three distinct ethnic groups (Bambara, Fulani and Kel Tamasheq) resident in two distinct zones of rural Mali (the Niger river flood zone or "inner delta," and the surrounding semi-arid and savanna areas). The data were gathered during a programme of single - round demographic surveys and both direct and indirect estimates of child mortality are presented. The bulk of the analysis is based on life table analysis of the maternity history data. We begin by inspecting the data, checking for flaws and inconsistencies and follow this with an account of the observed age patterns of child mortality by ethnic group and zone. Some within-group differences by social class are highlighted as a pointer to possible reasons for the striking differences observed. Finally, some additional material based on field observations is introduced to attempt to explain the major discrepancies between the anticipated findings and the data themselves.

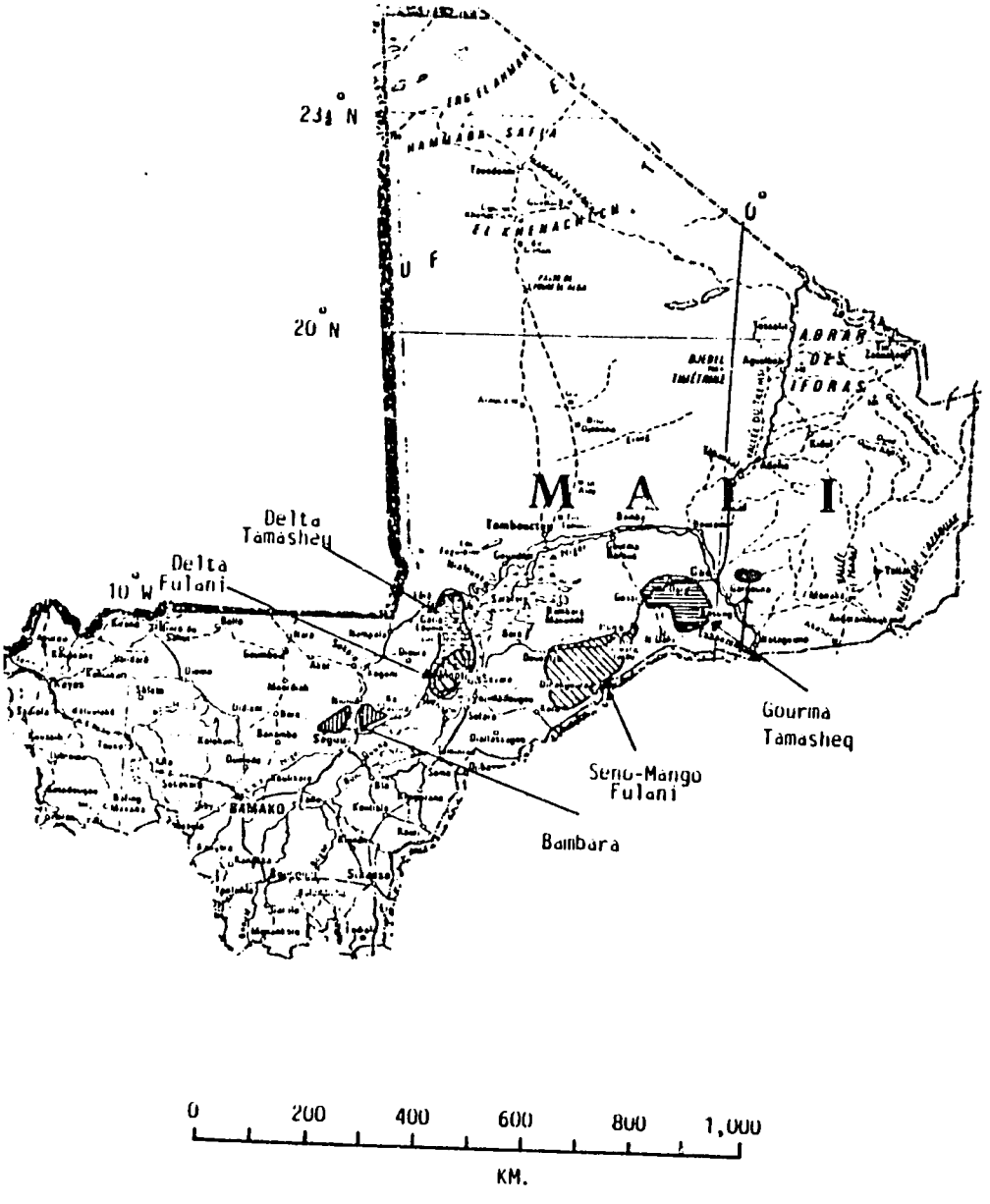
I. DATA AND METHODS

The populations examined

The results discussed here stem from a series of surveys conducted by a team of demographers from the London School of Hygiene and Tropical Medicine working in conjunction with the International Livestock Centre for Africa and the Malian Direction de la Statistique et de l'Informatique. Since the demographic surveys formed part of a large programme of socio-economic research on selected herding populations of the Sahel, the groups to be surveyed were pre-determined for us. No claims are made that the groups studied are representative of other pastoral or agro-pastoral communities in the Sahel. Nonetheless, our data do span a range of groups with contrasting ways of life shown in Figure 1. They include:

- sedentary Bambara millet farmers,
- the agro-pastoral Fulani of the delta,
- the semi-nomadic Séno-Mango Fulani,
- fully nomadic Kel Tamasheq who are dependent on their animals for their subsistence.

Figure 1: Map of Mali showing the areas included in the 1981-2 demographic surveys



The Bambara villages enumerated in March-May 1981, lie to the north of Ségou in the arrondissements of Doura and Monnimpé, on either side of the Canal du Sahel which carries water northwards from the river Niger to commercial irrigation schemes run by the Office du Niger and Opération Riz. Since our aim was to obtain data on the rural population dependent on rain-fed millet cultivation for their subsistence, we chose villages away from these schemes and beyond daily commuting distance of Ségou, Niono and other sizeable towns.

The Fulani population interviewed in the first quarter of 1982 was located in two different areas, one in the main flood zone or "inner delta" of the Niger, the other in the drier, more typically Sahelian zone known as the Séno-Mango ("great dune" in Fulfuldé). In the latter zone, long-term average rainfall totals about 400mm per annum. After the arrival of the flood water from Guinea and the first rains in July, the Niger delta becomes impassable in a wheeled vehicle until December or January. Even at the end of the dry season, there is water in the rivers Niger, Bani and Diaka, as well as standing water in pools or marshes, which are used by humans and animals for all their water needs. This availability of surface water in virtually all seasons is the feature which markedly distinguishes the Niger delta from the rest of the Sahelian zone. A variety of ethnic groups, Bambara farmers, Fulani pastoralists and agro-pastoralists, Bozo fishermen and Tamasheq pastoralists, to name only a few, separately exploit different facets of the delta. Irrigated rice is the staple cereal of most of the delta population although millet becomes more common towards its drier margins. The delta Fulani sample was located in the cercle of Tenenkou, some in villages fronting on the river Diaka, others nearer the delta's western margin.

To the east of Mopti lies the semi-arid, sandy zone where the second part of the Fulani sample was interviewed. Here, water is at a premium in all seasons but especially during the long,hot, dry season extending from early March to late June (Tiédou in Fulfuldé). Drinking water for people and for animals has to be raised from deep wells, some 100m in depth. With inadequate and irregular rainfall, only rain-fed millet and sorghum are produced.

Like the Fulani, the Tamasheq sample was split between the delta and the semi-arid zone further east. The Kel Tamasheq interviewed in mid 1981, who spend the dry season in the delta usually leave with their animals when the Niger and the Diaka flood in July, but in years of poor rainfall, some may chose to stay within or close to the delta and its shallow ponds and marshes around which some pasture can usually be found. Thus, they probably avoid some of the health risks faced by permanent residents of the delta such as the Fulani, risks which appear to mount during the hot, rainy season when mosquitoes and other disease vectors are widespread. By contrast, the Kel Tamasheq of the second zone, the Gourma, which is physically very similar to the Séno-Mango but further east (nearer to Gao), rely on wells (some of them shallow pits) for dry season water supply and pools during the rains. They are also more remote from markets for the sale of animals and the purchase of cereals than the Kel Tamasheq of the delta, a factor which may affect their diet, as well as their income and their access to health care of any kind.

One final point about the characteristics of the Fulani and the Kel Tamasheq is worth stressing. Both populations are markedly stratified into castes or endogamous social status groups. Whilst there is a complex hierachy of Fulani social classes and castes (see, Dupire, 1970 for details), the principal distinction drawn in this paper is between the Fulani nobles, here called Fulbé, whose culture and value system is strongly pastoral and their erstwhile agricultural dependents, called Rimaïbé in Mali, who are principally cultivators of rice and millet. (All ethnic groups are beginning to diversify their economic activities more than in the past). For the Kel Tamasheq, we have drawn a simple two-fold division between the free Tamasheq (called Illelan in Tamasheq) which includes several social classes (.e.g. Imoshar, Imghad, Ineselman), and their ex-slaves, (Iklan) now legally free, who are known as Bella. The blacksmiths (Inhaden) are here included with the Bella. For the Gourma, an additional distinction was drawn between the nobles (Imoshar, Ineselmen and Imghad) and groups of poorer, free Tamasheq of mixed origin here referred to as"low status Illelan". A summary of the numbers surveyed in each group by class and zone is shown in Table 1.

Organization of the surveys

. The surveyswere all conducted during two periods of fieldwork in the

TABLE 1 SUMMARY OF THE POPULATION BY ETHNIC GROUP, ZONE AND CLASS

	ETHNIC GROUP				
	BAMBARA	DELTA TAMASHEQ	DELTA FULANI	SENO FULANI	GOURMA TAMASHEQ
	I. Household Interview				
MALES	4,975	3,030	3,267	2,912	3,032
FEMALES	5,184	3,098	3,180	2,772	3,491
TOTAL	10,159	6,128	6,447	5,684	6,523
of which:	DOURA	NOBLES	FULBE	FULBE	NOBLES
	6,900	3,251	2,693	4,151	1,507
	MONNIMPE	IKLAN & INHADEN	RIMAIBE	RIMAIBE	LOW STATUS ILLELAN
	3,259	2,877	3,754	1,533	2,141
					IKLAN
					2,875
	I. Women's Interview				
WOMEN	1,815	1,289	1,325	951	1,505
BIRTHS	7,805	3,463	4,851	3,512	4,270

NB: The age of the women interviewed separately was 15-49 years except for the Fulani and the Gourma Tamasheq where the upper age limit was 54 years.

first half of 1981 and 1982. This time of year was chosen because the delta is accessible by vehicle, and the dry season is the time when farmers have some spare time in which to answer questions. Since households, families, camps and villages change considerably in composition depending on the season, our data inevitably reflect the dry season configuration of residential groups. Our basis for enumeration was de facto, although we did collect data on all usual residents absent the night before interview.

The residential unit used for enumeration varied widely since we wanted to work with terms easily recognized by the respondents. For the Bambara, we used the Gwa, a corporate lineage group, with a recognized head (Gwa Tigi), all cultivating and cooking together. The Bambara are polygynous and each wife has a separate hut. Amongst the Fulani, we used the Gallé, a term indicating a compound also with a recognized head, Diom Gallé. For the Tamasheq, since families and households are in a continuous state of flux, we settled for the tent as the basic unit of enumeration.

For each household head, a male interviewer from our team filled in the basic demographic data for each member of the household (age, sex, marital status, relationship to household head etc). The retrospective questions on children ever born and surviving were asked for all women 15-49. The upper limit was raised to 54 years for the Fulani and the Gourma Tamasheq because of age heaping. Questions on orphanhood were put to all respondents and the ever-married were questioned about the survival or otherwise of their first spouse. The women identified as age 15-49 or 54 on the household form were then interviewed separately by a female interviewer and a full birth history was collected. This is the source of the data used for the direct calculation of child mortality, whereas the data from the household interviews are used for the indirect calculation of child and adult mortality.

A major problem throughout was the estimation of dates of birth, marriage and of death. Very few respondents were acquainted with either the western or the Islamic calendar of months and years, but almost everyone could recall the season in which the event look place. Using this information in conjunction with a local event calendar, worked out in advance for each ethnic group and zone, we were able to derive an acceptable date for each event expressed in terms of the season of occurrence and number of completed years prior to the survey. The dates of births occurring in the

twenty-four months preceding the survey were noted in months in the field, and where not known directly, were calculated using a table to convert from season or part of season of occurrence and the date of the interview. Ages at death were expressed in months up to age two and in complete years thereafter. All these dates and ages were checked and re-coded in the field and by computer, using the reference table of months and seasons shown in Figure 2.

Quality of the Data

With no fully registered infant and child death rates in Mali to use as a reference, most of our checks on the quality of the data have to be based on tests of internal consistency and on the existence of logical patterns in the results. Some reasonably accurate child mortality data for two small populations in nearby Senegal and the Gambia must serve as our only source of broadly comparable and reliable figures.

Misreporting of both the birth dates and the ages at death of the children in the maternity histories is the fundamental difficulty affecting the direct calculation of child mortality rates. A graph of the birth dates in months for the pre-survey period (Figure 3) shows that there are substantial departures from the flat distribution expected. Locating birthdays on either side of the boundary between under and over age one, that is born less or more than twelve months ago, is always difficult, and mothers in all five groups clearly had difficulty with the decision. The early peak at ten months for the Bambara in Figure 3 is probably an artifact of our system of calculating ages from season and year of birth; the Bambara seasons are fewer in number and hence on average longer than for all other groups (see Figure 2 for details). This does not explain the second peak of births for the Bambara at thirty six months; the likeliest explanation is some tendency to report normative birth intervals of around two years. Although the number of births per month does fluctuate for all five groups, part of this is directly attributable to the small numbers involved. Births average only 30 per month for the Bambara and as few as ten to fifteen per month for the Séno Fulani. As far as our child mortality estimates are concerned, the main effect of this heaping of birth dates will be to introduce errors into the monthly mortality measures centred on age one year.

Figure 2: Names of seasons and their average location in months for the five populations surveyed.

CLIMATE	SPRING	RAINY				HARVEST		COLD			HOT & DRY		
CALENDAR MONTH	J	J	A	S	O	N	D	J	F	M	A	M
BAMBARA		SAMITA			KAULA		FONINE			TILEMA		
DELTA TAMASHEQ		TWC	AKASSA		GHARAT	GJ	TADJIRIST		AFOSCOU		EWAYLEN	
DELTA FULANI	K	N'DOUNGOU			DIAMDE	DABOUNDE				T	TIEDOU	
SENO FULANI	K	N'DOUNGOU			DIAMDE	DABOUNDE				T	TIEDOU	
GOURMA TAMASHEQ	A	AKASSA			GHARAT		TADJIRIST			AF	EWAYLEN	

Abbreviations

A = Amoukoussou

AF = Afoscou

GJ = Gharat Djiris

K = Korsol

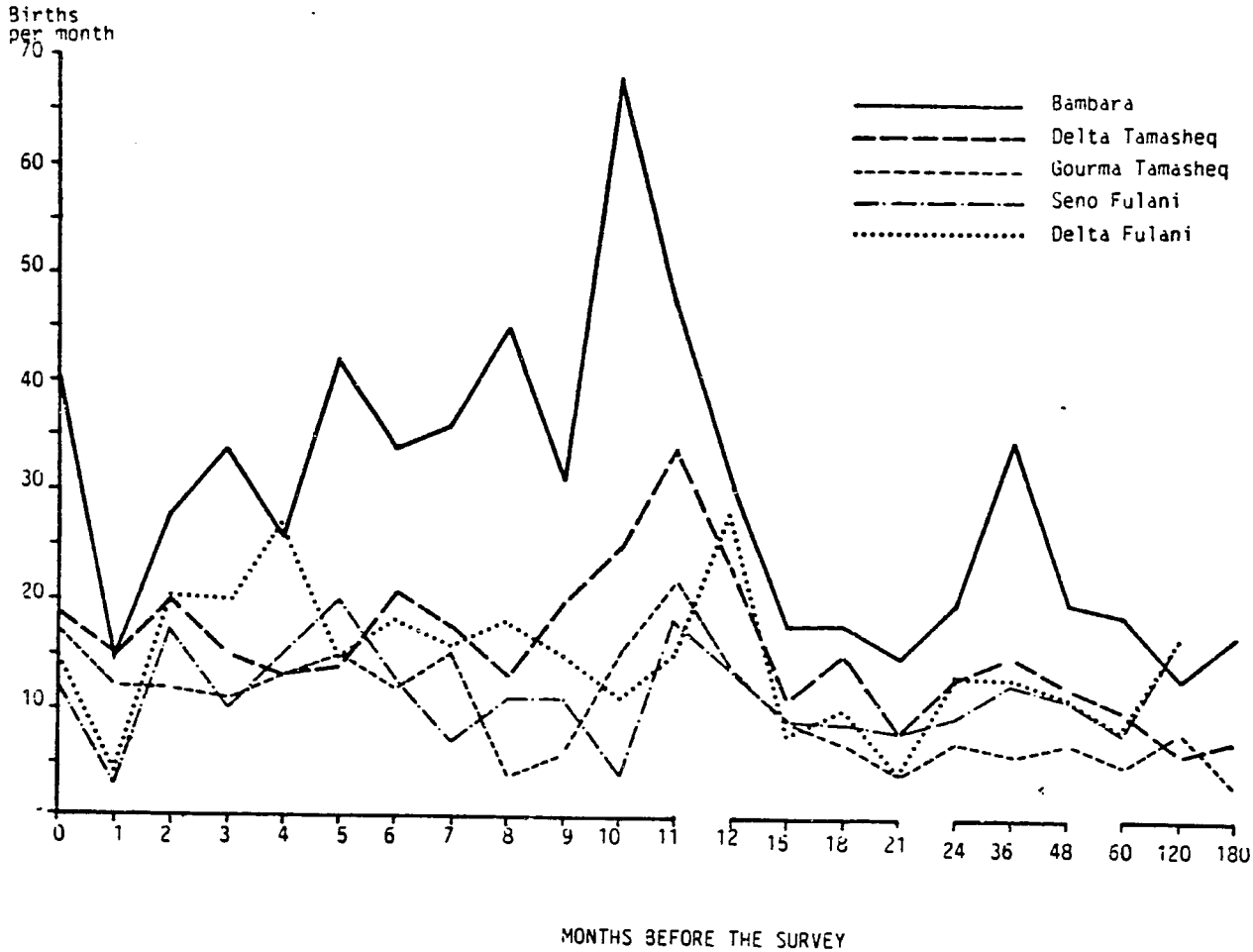
T = Tiolté

TWC = Tich-wa-chawa

Notes

(a) A better transliteration of the pronounciation of the Fulani season N'Diamde in the Delta is Yawndé.

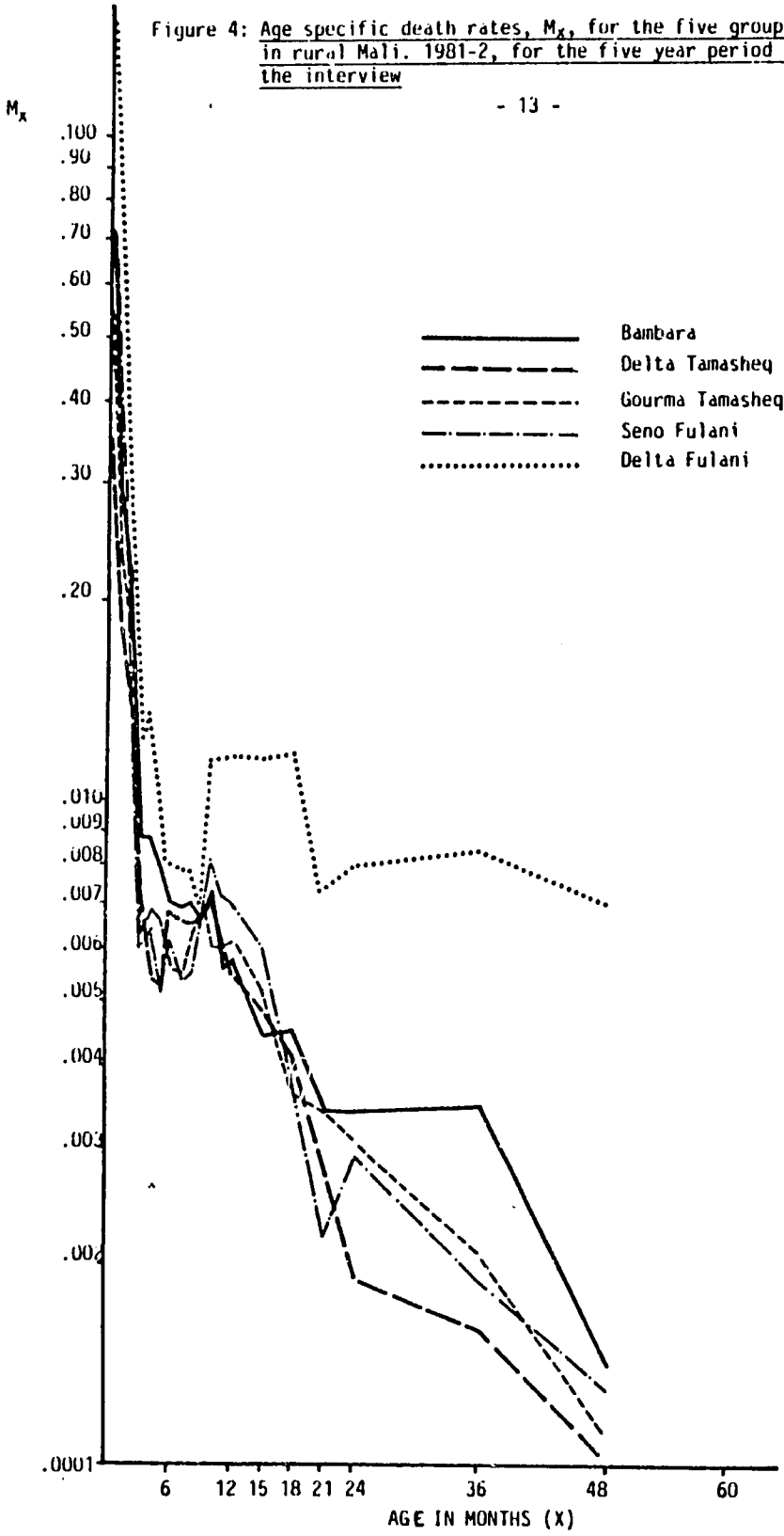
(b) The Fulani have a short season called Djuka which occurs in the middle of the wet season in August.


Births per month
70
60
50
40
30
20
10
Bambara
Delta Tamasheq
Gourma Tamasheq
Seno Fulani
Delta Fulani
0
1
2
3
4
5
6
7
8
9
10
11
12
15
18
21
24
36
48
60
120
180
MONTHS BEFORE THE SURVEY

Errors due to misreporting of age at death are much harder to distinguish from true concentrations of deaths at certain ages because we know less about the real pattern to be expected. Calculation of the age-specific death rates for single months upto twelve months, for quarters upto twenty four months, and for whole years thereafter, reveals a great deal of irregularity, especially for the Delta Fulani. Selected columns from the uncorrected life tables for all five groups, both sexes combined, are presented in Appendix A. The sharp peaks and troughs in the monthly age-specific death rates suggest that the pattern is largely attributable to pronounced heaping of reported ages at death, rather than being a true feature of the data. This impression is confirmed by inspection of the distribution of the reported ages at death for sets of five-year time periods prior to the survey. The heaping around the twelfth and the twenty-fourth months becomes more pronounced in the periods further from the survey date; this tendency is most marked amongst the two Fulani samples, especially the delta Fulani.

In an attempt to deal with these errors in the reporting of children's age at death, for the purposes of the analysis of the age pattern of childhood mortality, we chose to concentrate on the life tables for the most recent period, i.e. 0-4 years before each survey. In addition, to take care of some of the heaping of favoured months, we smoothed the raw life table age-specific death rates using a five-point moving average. The resulting corrected age-specific death rates for all five groups are shown in Figure 4. Despite the smoothing, two distinctive age patterns of mortality emerge; one represented by the Delta Fulani, and the other by the four other groups. The distinctive feature of the age pattern of child mortality displayed by the Delta Fulani is the relatively heavy mortality in the second and third years of life - a pattern akin to that reported by Cantrelle, McGregor, Garenne and Pison from Sene-Gambia. Despite the errors in the reporting of the exact age of death, the differences between the Delta Fulani age pattern and the pattern for all the other four groups are quite marked, and cannot be dismissed as due entirely to reporting error. We can accept, for example, that some children who died in their ninth or fourteenth month of life had their ages at death reported as eleven or twelve months, but it seems most unlikely, given the consistency of the data in other respects (see below), that the ages at death of either very young babies or of four-year olds or over, were misreported to such an extent as to give the bulge between the tenth and the thirty-sixth month shown in Figure 4.

Figure 4: Age specific death rates, M_x, for the five groups surveyed in rural Mali. 1981-2, for the five year period preceding the interview



To bring out the similarities and differences between the partial life tables from rural Mali and those from Sene-Gambia, the average of the age-specific death rates for Sene-Gambia and for the two sets of life tables for the populations studied in rural Mali, Delta Fulani versus the remaining four, are shown in Figure 5. This graph plainly illustrates the much lower later child mortality (after the first birthday) amongst the samples from rural Mali for 1981-2 relative to Sene-Gambia in the 1950s and 1960s and early 1970s for all except the Delta Fulani group. Another notable feature of the graph is the absence from the four-group average life table for rural Mali (B in Figure 5), of the pronounced trough at about three months and the peak at about one year, seen in the Sene-Gambia results (labelled A in Figure 5). The sharpness of the reversal in the age-specific death rates in the Sene-Gambia figures is disconcerting, since it suggests that there may be substantial age errors in these data despite the undoubted quality and thoroughness of the field work. The existence of these peaks and troughs in the data for the Delta Fulani, which we know to be more affected by heaping of ages at death than the other Mali samples, is further cause for suspicion of such sharp fluctuations in the probability of dying over periods as short as a month or two. Only if there were a single major age-specific cause of death of young children could we anticipate such pronounced changes in death rates, and in both the Sene-Gambia and in Mali, young children die from a number of causes, not simply one.

A possibly more revealing way of examining the raw age-specific death rates is to compare the figures with those from another similar population. The choice is very narrow but we have taken the average of the quarterly ℓ_x values from the life tables for Ngayokheme (Senegal) and Keneba (the Gambia) presented by Garenne (1981), and used this as a standard for comparison with our data. A plot of the logits of the ℓ_x values for our five populations against the logits from this standard is shown in Figure 6.
A summary of the fits, shown in Table 2, brings out several features:

a. The generally good fit of the logits of the Mali populations' life tables to the logits of the Sene-Gambian standard (correlation co-efficients 0.98 or over). Data errors become plain in the graph with some populations (Bambara, Delta Fulani and Gourma Tamasheq) particularly affected by avoidance of ages at deaths of six months, others show very pronounced heaping of deaths at twelve months (Delta and Séno Fulani); and a third set(Bambara and the two Fulani groups) particularly eschew ages at death close to twenty-one months in favour of dates close to exactly two years.

Figure 5: Comparison of the age specific death rates from Sene-Gambia with those for rural Mali (Delta Fulani; all other groups combined)

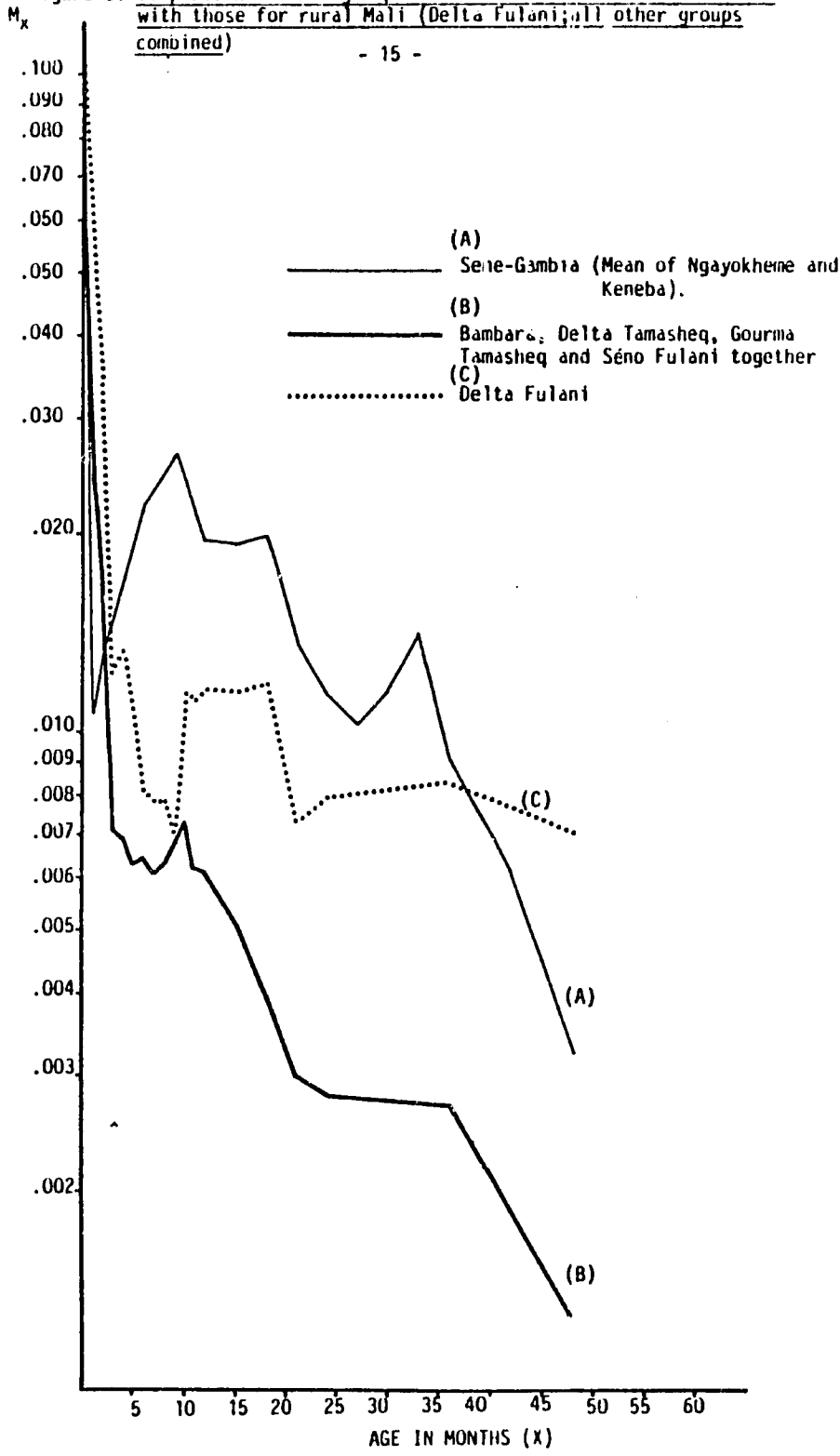


Figure 6: Logits of the $\ell(x)$ values from the life tables for rural Mali in the five year prior before the survey, $Y(x)$, plotted against the logits of the Sene-Gambian life table, $Y_s(x)$

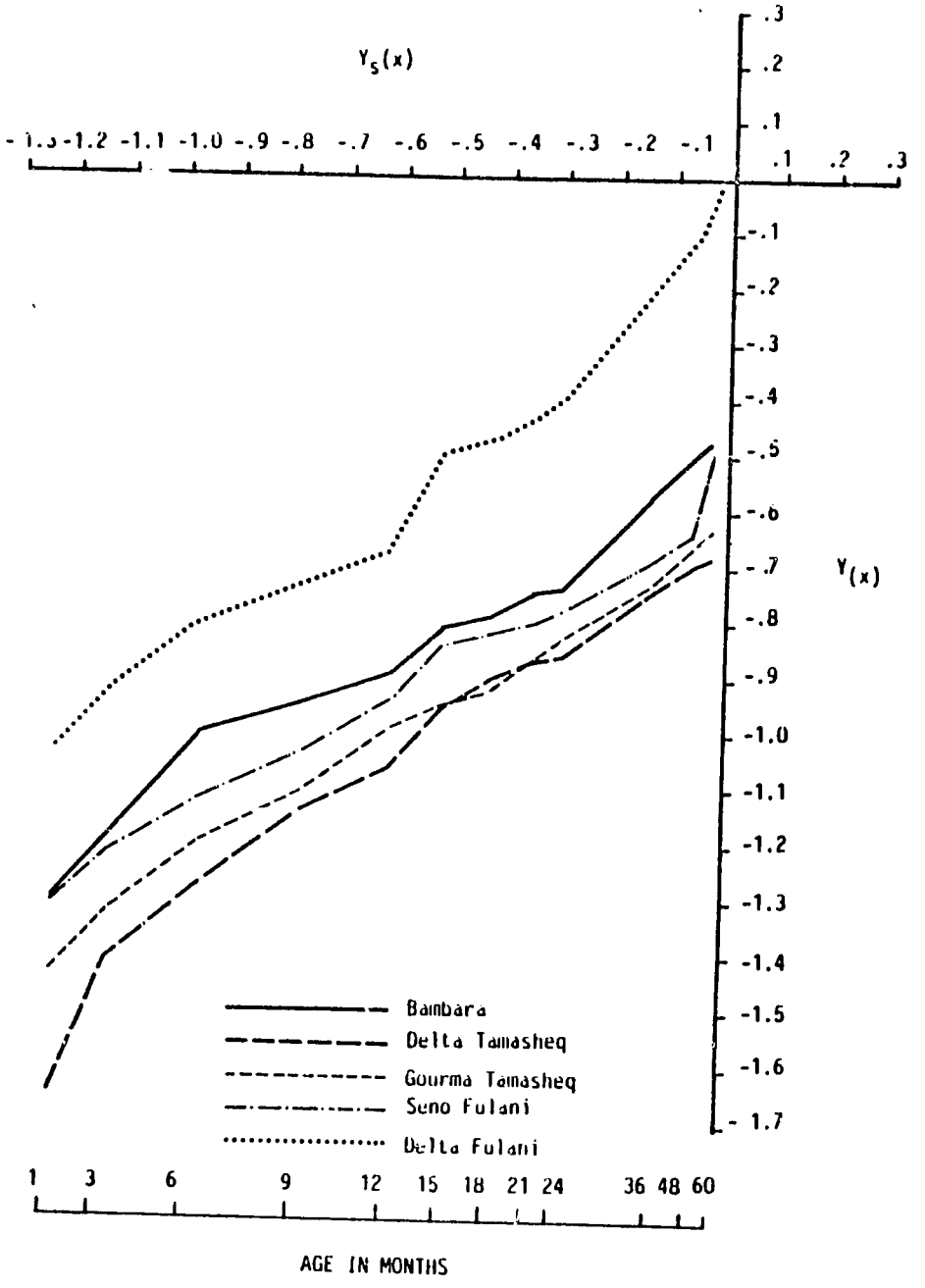


TABLE 2: CONSTANTS FROM THE REGRESSION OF THE LOGITS OF THE $\ell(x)$ VALUES, $Y(x)$, FOR THE FIVE MALIAN POPULATIONS ON THE LOGITS OF THE STANDARD, $Ys(x)$, FROM SENE-GAMBIA

EQUATION : $Y_x = \alpha + \beta . Ys_x$

POPULATION	α (1)	β (2)	CORRELATION COEFFICIENT R (3)
BAMBARA	- .494	.616	.988
DELTA TAMASHEQ	- .638	.669	.997
DELTA FULANI	- .099	.780	.978
SENO FULANI	- .572	.582	.983
GOURMA TAMASHEQ	- .639	.597	.997

Note: The range of x in the regressions was from 3 to 60 in months, in steps of 3 months upto the 24th month and in 12 month steps thereafter. All the correlation coefficients are significant at or below the 1 per cent level ($p < 0.01$; D.F. = 9)

b. The lower overall level of the infant and child mortality in rural Mali in comparison with the Sene-Gambian data. However, the Mali estimates are for a more recent period: (see the sizeable negative values of alpha for all but the Delta Fulani in Table 2).

c. The marked contrasts in the age pattern of all the Malian life tables with the Sene-Gambian reference populati n. For all five groups, the beta values from the regressions are less than 0.78, indicating a different relationship between early and late child mortality than in the Sene-Gambian life tables. All the partial life tables for Mali are characterized by lower later child mortality than in Sene-Gambia. The delta Fulani age pattern and level of child mortality is more like the Sene-Gambian model than the others. The pattern for the Bambara, whom we would expect to be most similar in other ways to the farming populalations represented in the model, is most dissimilar (see Figure 5 and the beta values presented in Table 2). Interestingly, the Mali age patterns of child mortality appear to fall midway between the extreme pattern reported for the Gambia and Senegal and the data for Upper Volta and Ghana (Retel-Laurentin & Benoit, 1976; Gaisie, 1975). The latter are themselves similar to Princeton (South) models.

So far, we have only examined the data for their overall consistency ithout considering the possibility of some omission of both births and hild deaths. A basic comparison we can make is between the totals of hildren ever born and surviving from the household interview with the quivalent figure aggregated from the birth histories. Although the two ources are not totally independent, the close agreement between both sets f figures is reassuring (Table 3). As anticipated from the close imilarity of the two sets of data, the direct and indirect estimates of hild mortality are extremely close; the major inconsistency, as is often he case, is the unrepresentative values for infant mortality obtained by he indirect method from reports on children by women age 15-19 at survey compare the ${}_1q_0$ values in table 4).

A much stronger test of completeness of reporting of births and child eaths is to examine life table measures of child mortality by the age roup of the respondents and the time period of the rates. We would expect ore dead children to be omitted by older women, and by all women for periods

TABLE 3 : COMPARISON OF REPORTS ON CHILDREN EVER BORN AND PROPORTIONS OF THESE CHILDREN ALIVE FROM THE HOUSEHOLD(HH) AND THE INDIVIDUAL(I) INTERVIEWS, BY AGE OF WOMEN AND ETHNIC GROUP

ETHNIC GROUP

I. TOTAL CHILDREN EVER BORN

AGE OF WOMEN	BAMBARA		DELTA TAMASHEQ		DELTA FULANI		SENO FULANI		GOURMA TAMASHEQ	
	HH (1)	I (2)	HH (3)	I (4)	HH (5)	I (6)	HH (7)	I (8)	HH (9)	I (10)
15-19	0.31	0.30	0.25	0.22	0.32	0.27	0.28	0.33	0.32	0.36
20-24	1.90	1.86	1.28	1.32	1.69	1.72	1.50	1.34	1.47	1.47
25-29	3.35	3.58	2.47	2.55	3.08	2.99	3.00	2.88	2.66	2.69
30-34	5.31	5.39	3.97	3.85	4.29	4.40	4.42	4.32	3.58	3.46
35-39	6.21	6.32	4.63	4.81	5.43	5.40	5.44	5.43	4.05	4.06
40-44	7.06	7.44	5.22	4.88	5.75	5.86	5.67	5.81	4.79	4.88
45-49	7.56	7.78	5.20	4.57	6.42	6.62	7.14	6.84	5.28	5.17
No. of women	2288	1782	1428	1265	1615	1325	1214	951	1682	1441

II. PER CENT ALIVE OF CHILDREN EVER BORN

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
15-19	83.0	87.4	76.8	81.1	57.8	62.7	74.3	69.6	79.6	86.9
20-24	70.2	71.9	78.4	81.9	59.0	60.3	75.2	78.1	78.2	77.2
25-29	65.6	67.8	74.5	76.6	51.2	54.3	74.4	74.6	67.8	73.0
30-34	62.3	62.1	66.8	70.6	50.4	50.8	66.5	71.1	60.8	61.5
35-39	59.8	62.1	66.4	68.1	50.6	48.3	59.4	62.5	62.3	62.0
40-44	59.0	59.4	60.7	60.0	47.9	47.1	63.1	62.5	56.5	55.8
45-49	56.6	55.9	61.2	61.1	51.7	49.4	61.5	59.7	58.3	59.2
No. of women	2288	1782	1428	1265	1615	1325	1214	951	1682	1441

TABLE 4 : DIRECT AND INDIRECT ESTIMATES OF CHILD MORTALITY COMPARED, BY ETHNIC GROUP

(Rates per 1000)

ETHNIC GROUP	$_1q_0$ (1)	$_2q_0$ (2)	$_3q_0$ (3)	$_5q_0$ (4)	$_{10}q_0$ (5)	$_{15}q_0$ (6)	R for cols 2 - 6 (7)
BAMBARA							
Direct	204	257	321	376	408	422	.992
Indirect	183	301	333	369	402	403	(p=< .01)
DELTA TAMASHEQ							
Direct	125	195	238	287	336	353	.974
Indirect	221	217	253	335	346	397	(p=< .01)
DELTA FULANI							
Direct	222	325	422	499	536	568	r = .977
Indirect	200	416	476	497	526	520	(p=< .01)
SENO FULANI							
Direct	151	215	269	323	371	421	r = .878
Indirect	247	253	256	340	421	375	(p=< .01)
GOURMA TAMASHEQ							
Direct	154	220	268	325	396	430	r = .922
Indirect	185	215	316	392	385	437	(p=< .05)

Notes:

1. The direct measures were calculated from the maternity histories using life table techniques.

2. For the indirect measures, the South version of the Princeton life tables were used throughout. Note that the indirect estimates of $_1q_0$ and $_2q_0$ are often seriously misleading because of selection effects and other errors. The estimate of $_1q_0$ is calculated from reports on proportions dead of children ever born to 15-19 year old women, and $_2q_0$ from reports by 20-24 year old women - women who have just begun their child-bearing and whose experience is therefore not generally representative.

further back in time. These errors would show up in the form of a false trend in child mortality, with higher mortality amongst the children of younger mothers and for the most recent pre-survey period.

Inspection of the data on survival to the eighteenth and to the sixtieth month by mothers' age (Table 5) indicates no clear ascending trend in survivorship with age. The same conclusion can be drawn from the data on survivorship to the same ages by time period (Table 6).

An additional way of stretching the data in the search for systematic errors and omissions is to examine the child mortality rates by birth orde From experience elsewhere, we anticipate that the survival of second and third children will be higher than for first births, and that the survival chances for children of orders four and above will decline steadily with increasing orders, although some reliable data from studies in Latin Ameri indicate that there may not be a single universal pattern due to complications introduced by age and length of birth intervals (see Somoza, 1980 for a Colombian illustration). The data showing the probability of surviving to the sixth or to the eighteenth month by parity groups for the five Mali populations are shown in Table 7.

Before drawing any conclusions from these data, several points are worth noting. First, the fertility of the different groups varies conside (see Table 3) and for the lower fertility groups like the Kel Tamasheq, the proportion of women with higher parities is much smaller than amongst, say, the Bambara. One of the reasons for these differences in fertility is due to differences in marriage customs. Many older Tamasheq women whose marriages are terminated by death or divorce tend not to re-marry, and since almost all children are born within marriage, we find proportionatel fewer older Tamasheq women bearing children than amongst the Fulani or the Bambara. This alone may affect the data on child mortality by parity since there is an interaction between age and parity. A second point also concerns the Kel Tamasheq, especially the nobles, who encourage some girls to marry very young, at times before puberty. Such child marriages are often dissolved and because of a certain shame attached to divorce, especi if initiated by the women, the marriage and any dead offspring are not discussed publicly. Obviously, it will be more difficult to conceal any living children stemming from such unions. The result of this feature will be to produce higher under-reporting of dead first born amongst the Kel Tamasheq than amongst other groups.

TABLE 5: CUMULATIVE PROPORTIONS OF CHILDREN SURVIVING TO SELECTED AGES BY MOTHERS' CURRENT AGE AND ETHNIC GROUP

AGE OF MOTHERS	ETHNIC GROUP: BAMBARA	DELTA TWAREG	DELTA FULANI	SENO FULANI	GOURMA TAMASHEQ
I. Proportion Surviving to Eighteenth Month, $\ell_{1.5}$					
20 - 24	.753	.867	.710	.785	.818
25 - 29	.780	.843	.694	.831	.802
30 - 34	.759	.833	.674	.833	.776
35 - 39	.755	.828	.701	.777	.822
40 - 44	.743	.800	.700	.809	.810
45 - 49	.738	.798	.732	.808	.824
ALL	.754	.827	.698	.798	.808
No. of Births	5045	2457	2912	2454	2878
II. Proportion Surviving to Sixtieth Month, ℓ_5					
20 - 24	.657	.766	.494	.748	.707
25 - 29	.637	.744	.487	.718	.704
30 - 34	.606	.710	.485	.715	.623
35 - 39	.633	.704	.484	.655	.667
40 - 44	.635	.684	.510	.666	.664
45 - 49	.606	.707	.551	.687	.705
ALL	.624	.713	.501	.677	.674
No. of Births	3386	1658	1765	1761	1958

TABLE 6 : CUMULATIVE PROPORTIONS OF CHILDREN SURVIVING TO SELECTED AGES BY TIME PERIOD AND ETHNIC GROUP

TIME PERIOD BEFORE SURVEY (YEARS)	ETHNIC GROUP: BAMBARA	DELTA TAMASHEQ	DELTA FULANI	SENO FULANI	GOURMA TAMASHEQ
I. Proportions Surviving to Eighteenth Month, $\ell_{1.5}$					
0 - 4	.817	.861	.720	.837	.863
5 - 9	.735	.837	.655	.781	.776
10 - 14	.722	.792	.690	.805	.772
15 +	.727	.807	.720	.780	.811
ALL	.754	.827	.697	.798	.808
No. of Births	5045	2457	2912	2454	2878
II. Proportions Surviving to Sixtieth Month, ℓ_5					
0 - 4	.718	.802	.509	.727	.780
5 - 9	.606	.718	.459	.673	.649
10 - 14	.590	.651	.471	.646	.579
15 +	.600	.701	.543	.663	.597
ALL	.624	.713	.501	.677	.674
No. of births	3386	1658	1765	1761	1958

TABLE 7 : CUMULATIVE PROPORTIONS OF CHILDREN SURVIVING TO SELECTED AGES BY BIRTH ORDER AND ETHNIC GROUP

BIRTH ORDER	BAMBARA	DELTA TAMASHEQ	DELTA FULANI	SENO FULANI	GOURMA TAMASHEQ
	ETHNIC GROUP				
	I. Proportions Surviving to Sixth Month, $\ell_{0.5}$				
1	.775	.926	.774	.853	.878
2 - 3	.846	.929	.825	.903	.890
4 - 6	.875	.918	.842	.915	.906
7 +	.832	.907	.824	.868	.922
ALL	.839	.923	.819	.891	.894
No. of Births	6033	2942	3648	2865	3434
	II. Proportions Surviving to Eighteenth Month, $\ell_{1.5}$				
1	.691	.829	.678	.770	.795
2 - 3	.770	.830	.711	.830	.798
4 - 6	.785	.825	.706	.797	.826
7 +	.737	.820	.678	.769	.836
ALL	.754	.827	.698	.798	.808
No. of Births	5045	2457	2887	2428	2878

Turning now to Table 7, we find everywhere that amongst the first born, the probability of dying is higher than for parity groups two to three. We believe that the factors discussed above explain why in both Tamasheq sample the differences in the proportions surviving to the sixth and the eighteenth month for the first born are not as pronounced as amongst the other groups. The ℓ_x values for parities two to three and parities four to six are not very rent for all five groups, although any clear trend is disguised by some irregularities in the data. In general, the pattern is similar to that described by Cantrelle for Senegal, where for first and high order births (seven and over), child mortality was similar and for intermediate parities (two to six), the rates are a little lower but similar to each other (Cantrelle and Leridon, 1971). Overall, with the major exception of the Kel Tamasheq, the data in Table 7 correspond to this coarse pattern.

One common error in almost any series describing early childhood mortality is the under-reporting of neo-natal child deaths. In Mali, children are not given names until they are eight days old and as a result, some early child deaths are probably omitted during interview. The reported neo-natal mortality rates vary widely between the five groups and for some, especially the Delta Fulani, the reported rates are high (111 per thousand); as high as the values of 119 per thousand for Keneba and higher than for Ngayokheme some years ago, (Garenne, 1981, Table 1.1 and 1.6).

Our fit of the logits of the Mali life tables to the data from Sene-Gambia provides a neat check on the completeness of the reporting of neo-natal deaths. Essentially, we assume that the proportionality of the logits of the three-monthly ℓ_x values extends to the first month of life and we use the regression constants shown in Table 2 , excluding the first month, to obtain new estimates of the neo-natal death rates. The estimated completeness of the reporting of neo-natal deaths by ethnic group (for births in the last five years) is shown in Table 8, together with revised estimates of neo-natal mortality. These numbers are not to be interpreted too exactly but in general, the coverage of these early child deaths appears to have been reasonably good, especially amongst the two Fulani groups.

From the foregoing analysis of the quality of the birth history data, we conclude that although the data are far from perfect, they can be relied on to give an acceptably accurate indication of the level, overall age pattern and principal differentials of child mortality in the populations

TABLE 8 : COMPLETENESS OF REPORTING OF NEO-NATAL DEATHS AND CORRECTED NEO-NATAL DEATHS RATES ESTIMATED BY REGRESSION (USING BIRTHS IN THE PRECEDING FIVE YEARS ONLY)

ETHNIC GROUP	ESTIMATED COMPLETENESS OF REPORTING OF NEO-NATAL DEATHS %	OBSERVED NEO-NATAL DEATH RATE $100._{1/12}M_o$	ESTIMATED NEO-NATAL DEATH RATE $100._{1/12}M_o$
BAMBARA	90.3	68	76
DELTA TAMASHEQ	69.9	36	51
DELTA FULANI	105.0	111	106
SENO FULANI	95.6	68	71
GOURMA TAMASHEQ	89.2	54	60

surveyed. The most serious error identified is the tendency for respond to misreport ages at death for deaths occurring between the ninth and th fifteenth month . With this established, we can select mortality measur which span this critical age boundary in order to avoid the worst of the data errors.

II. ANTICIPATED FINDINGS

Before considering in detail the results from the life tables calcu directly from the birth histories, it seems worthwhile to set out in adv our expectations about childhood mortality differentials based on our pr conceptions of the situation and on impressions obtained during the fiel work. Comparison of our predictions about child mortality differentials will be useful in identifying surprising results worth further investig Our expectations were based on several conflicting notions:

- that farmers and agro-pastoralists were probably better off than true pastoralists;
- that the populations resident outside the delta were likely to b healthier than those living inside because the risks of infecti were less than in the delta. On the other hand, we believed th the existence of two cultivation systems in the delta, one depe on the Niger flood, the other on rainfall, would guarantee a gr measure of food security and outweigh the environmental hazards the delta.
- that the higher social class groups within Fulani and Tamasheq society would be able to command more in the way of resources a to be able to care better for their children as a result. In t case of the Bambara, we predicted that the populations of the l remote villages of Monnimpé arrondissement would be better off the villages of Doura arrondissement.

Based on these assumptions and on information received from a var of sources before the results from the demographic surveys became avail we can produce a list of the five groups surveyed ranked according to t anticipated level of child mortality (upto age 5). The predicted rank are:

1. Delta Fulani
2. Bambara
3. Séno-Mango Fulani
4. Delta Tamasheq
5. Gourma Tamasheq

(1 = lowest child mortality; 5 = worst child mortality). Obviously, this is a list drawn up on the basis of a number of subjective judgements about the relative importance of a number of factors thought to affect child survival. It is reasonable to explain some of the thinking which lies behind the final rankings.

Firstly, the Delta Fulani were predicted to have the lowest levels of child mortality because of what seemed to us their obvious prosperity. In effect, this is equivalent to saying that food supplies seemed to be everywhere more than adequate for bare subsistence, and that a substantial surplus was available for sale or exchange in most years. In part, the reason for this is the reduced dependence of the delta on rainfall amounts falling within Mali. Most of the rice crop produced in the delta is flood rice grown when the rivers Niger, Bani and Diaka flood the rice fields in July. This water comes mostly from the uplands of Guinea (Fouta Djalon) where rainfall is heavier and less variable than in Mali. In addition, the delta is an area of good pasture where enough fodder and water for animals can usually be found throughout the dry season. Herd sizes are larger than elsewhere and during most of the year, apart from the period between sowing the cereals and the harvest, the animals are not very far from the main village. Thus, young children not only have adequate supplies of rice and millet to eat, they also have plenty of milk in most seasons. The additional availability of fish from the rivers with vegetables and spices for sauces makes the delta seem a very hospitable zone in which to raise young children. The main disadvantage of the delta is its humidity and the wide scope it offers for the rapid transmission of infections. The delta is densely settled (up to 40 persons per km^2) and the Fulani population lives in large villages, often in very crowded compounds. Water supplies from ponds and rivers are quite polluted at the end of the dry season. However, we felt that the area's relative prosperity and the basic health and other services provided in the small towns of the zone would more than compensate for the environmental risks described above.

Within the Fulani groups of both the delta and the Séno-Mango, we expected the erstwhile "masters" or nobles, Fulbé, to have lower child mortality levels than the formerly dependent Rimaibé.

The Bambara were placed second since they appeared to have a well-organized productive system based on agriculture supplemented by some exchange of millet and water for milk from Fulani herders. In addition, most of the villages in the two arrondissements surveyed are within a day's walk of towns with markets and some minimal health and other services, although the arrondissement of Monnimpé is much better placed than Doura in this respect. The main source of drinking water for the Bambara is wells, often quite deep (30m). Families remain intact for most of the time although in the dry season, there is some out-migration by young men in search of work elsewhere. Mothers and children stay together and babies go with their mothers to the fields during the cultivation season. The drawbacks of Bambara life from the point of view of small children seemed to centre around the lack of milk or suitable weaning foods. The millet porridge staple served in various consistencies seemed to us a poor source of energy for small children. We considered that some other disadvantages for Bambara children were the need for all able people, mothers with young children included, to work in the fields during the rainy season; and the crowded living conditions in the villages.

Ranked third by us are the Séno Fulani who appeared to live a more uncertain existence than the Delta Fulani or the Bambara. The Séno is an area of low rainfall (less than 400mm of average over the long term) with a high degree of inter-annual variability. Growing millet and raising cattle are both activities affected by varying rainfall amounts. In dry years, both the millet harvest and milk production are adversely affected. The stress of the dry season, when the heavy work of drawing and carrying water coincides with diminishing supplies of milk and millet, seemed to us an important factor which would bear on child welfare and survival. Further, the Séno Fulani are not in the fortunate position of their counterparts in the delta of having easy access to urban markets. The Séno is a large, poorly developed area with only rudimentary services widely scattered in a few small towns. In their favour, the Séno Fulani live in a area where some of the vectors of disease are absent, and at the same time the small size and dispersed distribution of their camps probably inhibit the rapid spread of infectious diseases.

Both the Tamasheq populations were ranked below all the others largely because of our notion that pastoralists would always be worse off in all respects than settled farming populations. The Tamasheq from the delta were thought to be richer than the Gourma Tamasheq since the former had access to the better pastures of the delta and to the delta's urban services and markets. Here we should mention that a high proportion of the delta's animals have been inoculated, with marked effects on calf mortality and the health of the herds there. Conversely, the Delta Tamasheq share some of the risks of living in the delta experienced by the Delta Fulani. However, as the Tamasheq generally leave the delta during the rainy season, they may miss some of the infections, especially malaria, which prevail there during this season.

Finally, we ranked the Gourma Tamasheq lowest because they could not benefit from any of the advantages available to the Delta Tamasheq. In their favour, the Gourma Tamasheq did live in the semi-arid zone thought to be generally healthier than the delta but we felt that any advantage of this would be masked by their lack of water and the enormous seasonal load imposed by the need to search for pasture and to draw water from wells at great depths. Their remoteness reduces their ability to exchange animal products for grain and increases the price of the grain available to them, as well as isolating them from any of the available health services.

III. RESULTS

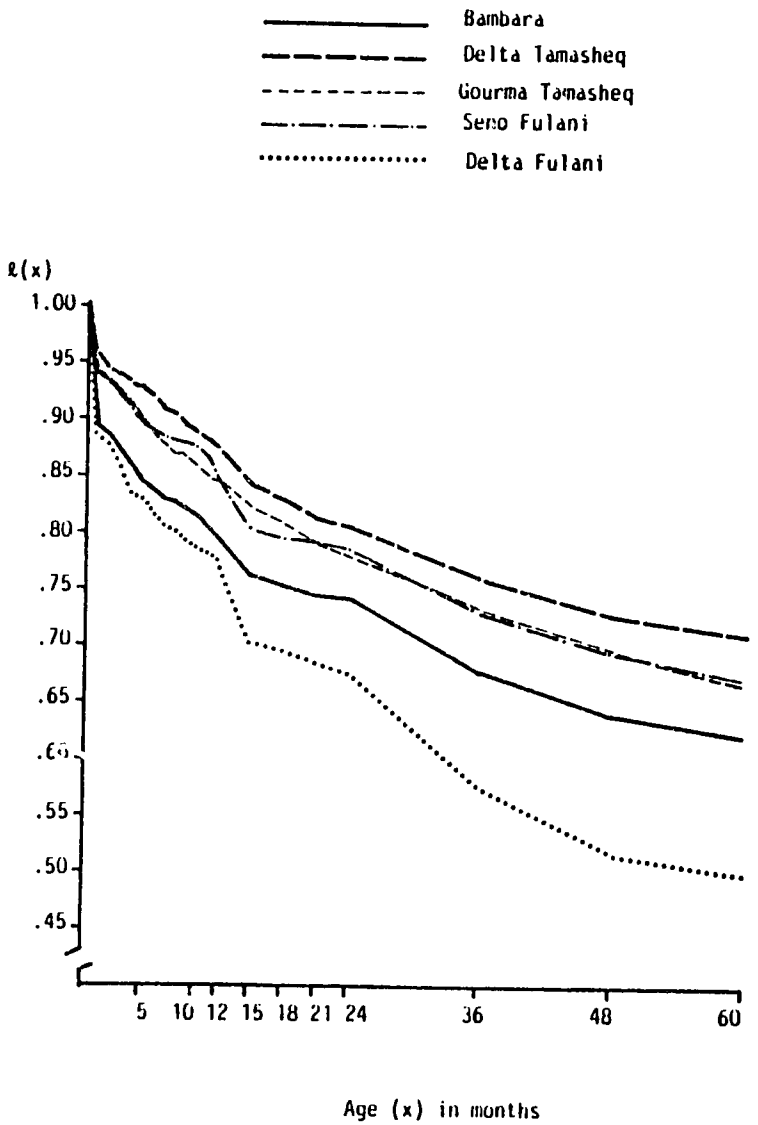
Child mortality levels

The most robust and succinct measure of child mortality is the cumulative proportion surviving to selected ages, the ℓ_x values from the life tables. (The uncorrected life tables themselves are attached in Appendix A). These values are less prone to errors due to mis-reporting of either or both the birth dates and the ages at death of the children, than age-specific death rates or q_x values calculated for short intervals. In Table 9, we present ℓ_x values for intervals of varying length up to 10 years of age and Figure 7 is a graph of the same data. The overall levels of mortality, with between a third and a half of all children dying before their fifth birthday, are very high by international standards and can

TABLE 9 : CUMULATIVE PROPORTIONS SURVIVING TO SELECTED AGES OF CHILDHOOD BY ETHNIC GROUP

AGE (x) IN MONTHS	ETHNIC GROUP ℓ (x)				
	BAMBARA (1)	DELTA TAMASHEQ (2)	DELTA FULANI (3)	SENO FULANI (4)	GOURMA TAMASHEQ (5)
3	.871	.940	.856	.917	.925
6	.839	.923	.819	.891	.894
9	.820	.895	.794	.878	.869
12	.796	.875	.778	.849	.845
15	.763	.842	.704	.805	.823
18	.754	.827	.697	.798	.808
21	.745	.813	.686	.792	.792
24	.743	.805	.675	.785	.780
36	.679	.762	.577	.730	.732
48	.640	.727	.521	.695	.696
60	.624	.713	.501	.677	.674
120	.592	.664	.464	.628	.604
Number of Deaths	2664	924	2218	1124	1322

Figure 7: Cumulative proportions surviving upto age 5, ℓ(x), by months for each ethnic group



only be compared for level with the data from the 1950s and 1960s and early 1970s from Ngayokheme and Keneba. Rutstein's more recent estimates for Senegal as a whole, using data from the maternity histories contained in the 1978 fertility survey, indicate a value for ℓ_5 = 0.738, a good deal better than for rural Mali (Rutstein 1983). The value for Senegal is also the worst child mortality shown for the twenty nine countries for which data were available to Rutstein from the World Fertility Survey programme.

The relative position of the five groups does not change when we consider survivorship up to several ages (Table 9) but there are some sharp contrasts between the groups for certain age sections.

The large differences in the neo-natal mortality rates, using the correc or the uncorrected figures in Table 8 are remarkable. Particularly striking is the difference between the Delta Tamasheq and the Delta Fulani. Neo-natal mortality is a reflection of two sets of factors - one concerning the health and welfare of women during their pregnancies, the other concerning conditions and techniques used during and immediately after the delivery. Our impression is that women in agricultural and agro-pastoral societies have to work harder at all times of the year, but especially during the weeding and harvesting season, and this may have an adverse effect on the birth weight of the infant if the mother is poorly nourished. Treatment of the umbilical cord varies widely between and within the groups but it seems that the Kel Tamasheq are less likely to apply dung to the cord than other groups, and may thus incur lower risks of tetanus. Both these suggestions might be a partial explanation of the higher neo-natal mortality rates amongst the Bambara and the Delta Fulani. There appear to be very few systematic differences in delivery techniques between the groups but there may be differences in care during the immediate post-natal period, covering, for example, early feeding practices.

Unfortunately, we lack the much needed data on birth weights to answer some of these questions concerning early infant deaths.
The proportion of all infant deaths occurring in the first month for the samples in Mali, all of which are affected by the heaping of age at death around the twelfth month, range from 33 per cent amongst the Delta Tamasheq to 51 per cent amongst the Bambara. Data from the Kenya fertility survey in 1979 indicate an overall level of infant mortality of 106 per

thousand, and that 43 per cent of infant deaths reported in the survey occurred in the first month of life (Mott, 1982; Table 3). The proportions of neo-natal deaths amongst all infant deaths cannot be taken too seriously either for Kenya or for rural Mali because of age at death misreporting in both cases.

For child mortality in the post neo-natal period and thereafter, we turn to mortality measures of broader age groups shown in Tables 10 and 11. For the first six months, the spread of mortality experience is quite wide amongst the five main groups (Table 10, column 1). For the succeeding period between six and eighteen months, the differentials collapse except for the relatively high levels maintained by the Delta Fulani. Mortality between the eighteenth month and the fifth birthday is also quite similar for three groups, the Bambara, Gourma Tamasheq and the Séno Fulani, with the extremes represented on the one hand by the Delta Fulani (high mortality) and on the other, although less extremely, by the Delta Tamasheq (low mortality).

At least at the level of the five groups, our findings directly contradict our anticipated results but before considering some reasons for this, we turn briefly to look at differences by social class and zone.

The probabilities of dying by social class and zone are shown in Table 11 for the same three age ranges as used in Table 10. The table is quite complex and a simple summary of its meaning may be valuable:

(a) For Bambara, the more isolated and arid arrondissement of Doura has higher child mortality for the first two age groups, lower for the third. This is an unclear result.

(b) There appear to be some differences in child mortality between the Fulbé and the Rimaibé of the Delta for the first and last age groups shown, with the Rimaibé faring worse than the Fulbé.

(c). In case of the Séno Fulani, the Rimaibé display higher mortality levels than the Fulbé for the latter two age groups, although the number of births for this group is less than one thousand (Table 11 - figures in parentheses).

TABLE 10 : CHILDHOOD MORTALITY MEASURES FOR UNCONVENTIONAL AGE GROUPS BY ETHNIC GROUP AND ZONE (NUMBERS OF BIRTHS IN PARENTHESES)

ETHNIC GROUP	$1000._{6/12}q_0$ (1)	$1000._1q_{6/12}$ (2)	$1000._{3.5}q_{1.5}$ (3)
BAMBARA	161 (6657)	102 (5539)	172 (4216
DELTA TAMASHEQ	77 (3099)	104 (2699)	138 (2057)
DELTA FULANI	181 (3646)	149 (2913)	281 (1765)
SENO FULANI	109 (2863)	105 (2449)	152 (1757)
GOURMA TAMASHEQ	106 (3681)	96 (3156)	165 (2418)

Note: No corrections have been made for the under-reporting of neo-nat deaths indicated in Table 8.

TABLE 11 : CHILDHOOD MORTALITY MEASURES BY SOCIAL CLASS AND ZONE FOR UNCONVENTIONAL AGE GROUPS (NUMBER OF BIRTHS IN PARENTHESES)

MORTALITY MEASURE

ETHNIC GROUP CLASS AND ZONE	$1000._{6/12}q_0$ (1)	$1000._1q_{6/12}$ (2)	$1000._{3.5}q_{1.5}$ (3)
BAMBARA	161 (6657)	102 (5539)	172 (4216)
DOURA	170 (4359)	112 (3592)	161 (2746)
MONNIMPE	142 (2298)	83 (1947)	192 (1470)
DELTA TAMASHEQ	77 (3099)	104 (2699)	138 (2057)
NOBLES	91 (1687)	113 (1456)	147 (1105)
IKLAN+ INHADEN	59 (1412)	92 (1243)	127 (952)
DELTA FULANI	161 (3648)	149 (2912)	281 (1765)
FULBE	170 (1617)	145 (1283)	250 (797)
RIMAIBE	189 (2031)	151 (1629)	305 (969)
SENO FULANI	109 (2865)	104 (2454)	151 (1761)
FULBE	113 (2128)	97 (1831)	132 (1345)
RIMAIBE	96 (738)	125 (623)	211 (416)
GOURMA TAMASHEQ	106 (3681)	96 (3156)	165 (2418)
NOBLES	123 (809)	139 (677)	193 (493)
LOW STATUS ILLELAN	122 (1215)	94 (1025)	187 (771)
IKLAN	86 (1657)	78 (1454)	138 (1155)

(d) Amongst the Delta Tamasheq, the Iklan have a consistently better level of child mortality than the nobles in all three columns of Table 11.

Why findings differ from expectations

Using ℓ_5 from Table 9 as a summary measure of the actual level of childhood mortality, we can compare our predictions with the data:

Ethnic group & zone	Anticipated ranking	Actual ranking
Bambara	2	4
Delta Tamasheq	4	1
Delta Fulani	1	5
Séno Fulani	3	3
Gourma Tamasheq	5	2

(1 = lowest level of childhood mortality; 5 = highest level).

The major surprise is the very heavy child mortality of the Delta Fulani, the group we predicted would have the best level of child survival. Conversely, the relatively low levels of child mortality for both groups of Tamasheq are also surprising. Clearly, both our ranking and the assumptions on which they were based were seriously in error. One general conclusion we might draw from our results and their comparison with expectations is that the relative disadvantages of the pastoral way of life are much exaggerated. Further, it seems that the critical factor affecting child survival in the populations surveyed is not the general availability of food. This was one of the underlying premises on which our assumptions were based. Rather, it seems to be a matter of the availability of selected foods, particularly milk, suitable for the feeding of young children. A complicating factor throughout is exposure and susceptibility to infection. Here, we appear to have grossly under-estimated the importance of this factor, especially in the delta. Comparison of the relative positions of the two Fulani groups would tend to bear this out since it is the poorer, more marginal Séno Fulani who have the lower child mortality compared to the Fulani who are permanently resident in the delta. This relationship is not true of the two Tamasheq groups, but the test is not so strong in this case because the Delta Tamasheq leave the delta for an important part of the year.

Anything further we say on the reasons for the differences in the observed and the actual ranking is purely speculative since we have no precise measurements of the significance of the four groups of factors identified above, but the following points based on the data are worth noting:

- the relatively low mortality of the two groups resident in the semi-arid zone east of Mopti (the Séno Fulani and the Gourma Tamasheq);
- the heavy mortality of the one population permanently resident in the delta (the Delta Fulani);
- the low mortality of the Delta Tamasheq, who, despite their dry season sojourn in the seemingly unhealthy environment of the delta, contrive to keep more of their children alive than any other group.

IV. CONCLUSIONS AND IMPLICATIONS

(a) Our first conclusion is that the quality of the birth history data collected in a single round survey amongst such populations with almost no precise idea of western calendar years or months can be sufficiently good for a detailed analysis of child mortality using life table techniques. This is important for the design of future studies of child mortality in West Africa. Multi-round surveys are always more expensive, more complicated to run, and require longer to produce results than single round surveys. We believe that a description of child mortality in the form summarized in the foregoing tables and graphs should provide enough demographic detail for most health and nutrition planners. To be fair, however, the multi-round or continuous survey does make possible the collection of data on two key pieces of information beyond the reach of the single round survey; these are the data on birth weights of the new born, and on the causes of child deaths.

(b) Our main substantive finding, in addition to the establishment of the levels and age pattern of infant and childhood mortality by ethnic group and zone, is that in the groups surveyed in rural Mali, the age pattern of child mortality with the exception of the Delta Fulani is different from the distinctive pattern identified by Cantrelle and Garenne for parts of rural Senegal and Gambia. In other words, we have not found in four

of the samples in rural Mali the extremely high mortality of one to three year olds identified in Sene-Gambia.

(c). As a result of this less extreme pattern of childhood mortality found in rural Mali, the correspondence of the partial life tables for Mali to any of the appropriate standard models, (say Brass's African standard or the Princeton South model life tables with high mortality), is much closer than Garenne indicated with reference to the Sene-Gambian data. One implication of this finding is that the indirect methods for estimating child mortality from the cumulative numbers of children ever born and surviving will provide a reasonable approximation to the true level of infant and child mortality in these populations. Some evidence for this was presented in Table 4.

(d). From a practical standpoint, the high level of mortality of children in all five groups is a serious problem. Clearly, it would be hard to find fault with any intervention designed to lower child mortality, but the demographic evidence suggests that it may be cost-effective to concentrate on two critical periods in the lives of young children. The first of these two high risk periods appears to be in the first month of life, as the high neo-natal mortality rates for most groups (shown in Table 8) indicate. For all the groups, it seems worthwhile finding out more about traditional delivery techniqs, care of the umbilical cord and infant feeding practices during the first few weeks of life. A factor of prime importance will be the frequency of pre-maturity or low weight-for-age births in the populations, since this will strongly influence neo-natal mortality.

The second high risk period, certainly for the agricultural and agro-pastoral communities shown in Figure 4, occurs between the tenth and fifteenth month of life. There could be difficulties associated with transferring children from a diet based on breast milk to other foods. Certainly, the risks of infection during this period increase in other populations due to contaminated foods and the decline of the passive immunity acquired through the mothers' milk. Again, there is a need for information on this critical period amongst the populations studied; one possibly fruitful line of enquiry would be to ask why the crisis at the end of the first year is less pronounced amongst the pastoral Kel Tamasheq than amongst the other groups. Such an enquiry might produce some suggestions for a few low cost interventions designed to lower child mortality generally but especially at the critical periods indicated in Figures 4 and 5.

(e). Finally, some explanation of the excessive mortality of one to three year-old Fulani children resident in the delta is required. Preliminary results of a study of the nutritional status of Delta Fulani children shows that almost none was below standard when assessed in terms of weight for age or weight for height (Wagenaar-Brouwer, 1983). Factors other than nutrition such as exposure to infections, must be increasing the risks of dying amongst these young children.

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Appendix A: Life Tables (both sexes together) calculated from the uncorrected birth history data

1. Bambara

(Months)	P(x)	d(x)	q(x)	ℓ(x+1)	m(x)
0.0	7282.0	754.0	0.1035	0.8965	0.1092
1.0	6500.0	68.0	0.0105	0.8871	0.0105
2.0	6411.0	119.0	0.0186	0.8706	0.0187
3.0	6261.0	106.0	0.0169	0.8559	0.0171
4.0	6125.0	58.0	0.0095	0.8478	0.0095
5.0	6033.0	60.0	0.0099	0.8393	0.0100
6.0	5935.0	53.0	0.0089	0.8318	0.0090
7.0	5847.0	35.0	0.0060	0.8269	0.0060
8.0	5771.5	49.0	0.0085	0.8198	0.0085
9.0	5684.5	38.0	0.0067	0.8144	0.0067
10.0	5597.0	83.0	0.0148	0.8023	0.0149
11.0	5456.0	45.0	0.0082	0.7957	0.0083
12.0	5340.0	220.0	0.0412	0.7629	0.0140
15.0	5045.5	60.0	0.0119	0.7538	0.0040
18.0	4931.5	55.0	0.0112	0.7454	0.0037
21.0	4827.5	16.0	0.0033	0.7429	0.0011
24.0	4670.0	402.0	0.0861	0.6790	0.0075
36.0	3941.5	227.0	0.0576	0.6399	0.0049
48.0	3386.5	83.0	0.0245	0.6242	0.0021
60.0	2612.5	133.0	0.0509	0.5924	0.0009
120.0	1513.0	37.0	0.0245	0.5779	0.0004
180.0+	557.0	34.0	0.0610	0.5427	**

2. Delta Tamasheq

(Months)	P(x)	d(x)	q(x)	ℓ(x+1)	m(x)
0.0	3218.5	130.0	0.0404	0.9596	0.0412
1.0	3071.5	42.0	0.0137	0.9465	0.0138
2.0	3012.0	21.0	0.0070	0.9399	0.0070
3.0	2973.5	22.0	0.0074	0.9329	0.0074
4.0	2937.5	18.0	0.0061	0.9272	0.0061
5.0	2906.0	14.0	0.0048	0.9228	0.0048
6.0	2874.5	41.0	0.0143	0.9096	0.0144
7.0	2814.0	18.0	0.0064	0.9038	0.0064
8.0	2780.5	31.0	0.0111	0.8937	0.0112
9.0	2733.0	16.0	0.0059	0.8885	0.0059
10.0	2694.5	20.0	0.0074	0.8819	0.0075
11.0	2645.0	23.0	0.0087	0.8742	0.0087
12.0	2570.5	96.0	0.0373	0.8416	0.0127
15.0	2440.0	44.0	0.0180	0.8264	0.0061
18.0	2373.5	40.0	0.0169	0.8124	0.0057
21.0	2299.0	23.0	0.0100	0.8040	0.0034
24.0	2188.0	118.0	0.0539	0.7609	0.0046
36.0	1904.5	86.0	0.0452	0.7266	0.0038
48.0	1658.0	32.0	0.0193	0.7126	0.0016
60.0	1252.5	86.0	0.0687	0.6636	0.0012
120.0	673.0	18.0	0.0267	0.6459	0.0005
180.0+	240.5	17.0	0.0707	0.6002	**

APPENDIX A (cont..)

3. Delta Fulani

x (Months)	P(x)	d(x)	q(x)	ℓ(x+1)	M(x)
0.0	[illegible]	[illegible]	[illegible]	0.8836	0.1180
1.0	3986.0	[illegible]	0.0135	0.8768	0.0134
2.0	3921.0	[illegible]	0.0232	0.8564	0.0235
3.0	3810.0	[illegible]	0.0213	0.8382	0.0215
4.0	3705.5	[illegible]	0.0102	0.8296	0.0103
5.0	3646.5	[illegible]	0.0126	0.8191	0.0127
6.0	3584.0	[illegible]	0.0156	0.8063	0.0157
7.0	3511.0	[illegible]	0.0071	0.8006	0.0071
8.0	3467.0	[illegible]	0.0078	0.7944	0.0078
9.0	3425.5	[illegible]	0.0064	0.7893	0.0064
10.0	3390.5	[illegible]	0.0074	0.7835	0.0074
11.0	3352.5	[illegible]	0.0075	0.7776	0.0075
12.0	3278.0	[illegible]	0.0949	0.7038	0.0332
15.0	2913.5	[illegible]	0.0093	0.6973	0.0031
18.0	2859.5	[illegible]	0.0168	0.6856	0.0056
21.0	2790.0	[illegible]	0.0151	0.6753	0.0051
24.0	2665.0	[illegible]	0.1448	0.5775	0.0130
36.0	2120.5	[illegible]	0.0971	0.5214	0.0085
48.0	1765.0	[illegible]	0.0385	0.5013	0.0033
60.0	1586.5	[illegible]	0.0736	0.4644	0.0013
120.0+	540.0	38.0	0.0704	0.4317	**

4. Seno Fulani

(Months)	p(x)	d(x)	q(x)	ℓ(x+1)	M(x)
0.0	[illegible]	[illegible]	0.0591	0.9409	0.0609
1.0	3064.5	25.0	0.0082	0.9332	0.0082
2.0	3029.5	54.0	0.0178	0.9166	0.0180
3.0	2962.0	45.0	0.0152	0.9027	0.0153
4.0	2904.5	24.0	0.0083	0.8952	0.0083
5.0	2863.0	14.0	0.0049	0.8908	0.0049
6.0	2832.5	19.0	0.0067	0.8849	0.0067
7.0	2803.5	8.0	0.0029	0.8823	0.0029
8.0	2786.5	14.0	0.0050	0.8779	0.0050
9.0	2761.5	12.0	0.0043	0.8741	0.0044
10.0	2742.0	28.0	0.0102	0.8652	0.0103
11.0	2703.0	52.0	0.0192	0.8485	0.0194
12.0	2620.5	136.0	0.0519	0.8045	0.0178
15.0	2449.5	21.0	0.0086	0.7976	0.0029
18.0	2401.5	18.0	0.0075	0.7916	0.0025
21.0	2350.5	20.0	0.0085	0.7849	0.0028
24.0	2270.5	158.0	0.0696	0.7303	0.0060
36.0	1981.0	84.0	0.0424	0.6993	0.0036
48.0	1757.0	57.0	0.0324	0.6766	0.0027
60.0	1382.0	99.0	0.0713	0.6284	0.0012
120.0+	543.5	43.0	0.0791	0.5787	**

5. Gourma Tamasheq

(Months)	p(x)	d(x)	q(x)	ℓ(x+1)	M(x)
0.0	3928.0	227.0	0.0578	0.9422	0.0595
1.0	3669.5	25.0	0.0068	0.9358	0.0068
2.0	3618.5	40.0	0.0111	0.9254	0.0111
3.0	3555.0	43.0	0.0121	0.9143	0.0122
4.0	3493.0	34.0	0.0097	0.9054	0.0098
5.0	3434.5	44.0	0.0128	0.8938	0.0129
6.0	3364.5	37.0	0.0110	0.8839	0.0111
7.0	3301.0	37.0	0.0112	0.8740	0.0113
8.0	3242.0	19.0	0.0059	0.8669	0.0059
9.0	3211.5	24.0	0.0075	0.8624	0.0075
10.0	3173.0	34.0	0.0107	0.8532	0.0108
11.0	3109.0	28.0	0.0090	0.8455	0.0090
12.0	3027.5	82.0	0.0271	0.8226	0.0092
15.0	2878.0	52.0	0.0181	0.8077	0.0061
18.0	2771.0	54.0	0.0195	0.7920	0.0066
21.0	2680.0	40.0	0.0149	0.7802	0.0050
24.0	2535.5	157.0	[illegible]	0.7318	0.0053
36.0	2216.5	109.0	0.0492	0.6959	0.0042
48.0	1958.5	60.0	0.0306	0.6745	0.0026
60.0	1528.5	160.0	0.1047	0.6039	0.0018
120.0	913.5	51.0	0.0558	0.5702	0.0010
180.0+	379.0	56.0	0.1478	0.4860	**

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