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# Assessing the impact of health programmes using household surveys in Mali

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Health planners are turning more frequently to the data collected in large-scale household demographic and health surveys for information on health needs, and for assessment of the impact of health interventions. Measuring the effects of the use of health services on the mortality of young children is a complex scientific problem because of the wide range of potential confounding variables. Using data from a household demographic and health survey in 1985, in the twin towns of Mopti and Sevaré in central Mali, this paper shows the extent to which antenatal care, assistance at birth, immunization and access to water supplies and sanitation of different types affect early childhood mortality.

The effects of antenatal care and immunization on mortality are clearly positive. The risks of dying by the type of assistance at birth are complex because of strong selection effects. No clear relationship between mortality and water and sanitation arrangements emerged. The most important finding is the strong positive effect of pregnancy monitoring on child survival, a striking result given the modest health services then available to mothers. The problem of distinguishing 'programme' and 'non-programme' effects remains.

## Introduction

Household surveys are widely used in developed and developing countries alike to describe recent levels and trends in mortality and morbidity. Whilst there is a large literature on the analysis of the mortality component, especially on applications in the Third World (Hill and David 1988; UN 1983a, 1984), the examination of the morbidity data and the ancillary information on service use and health-related behaviour is at a much less developed stage (Kroeger 1983; Ross and Vaughan 1986). Major health and demographic survey progammes are now under way in many Third world countries (Institute for Resource Development 1987; League of Arab States 1989; UN 1983b). Their aims are various but the principal reason for the recent growth of interest in information collected through household surveys is the demand for more scientific population-based information on health needs and priorities, as well as for more rigorous evaluation of health interventions of all kinds, be they immunization programmes or broader, community-based schemes which may have complex goals in addition to the improvement of health. These demands are creating new problems for both data collection and interpretation. There is a need to specify as quickly as possible a few key proxy variables which can be used to detect early changes in attitudes and behaviour. These may be the necessary precursors of changes in the outcome variables related to sickness and mortality.

One of the general questions posed by those concerned with the evaluation of health programmes is whether changes in say, infant mortality or the mortality of 1–4 year olds are acceptable as measures of the effectiveness or otherwise of programme effects (Ewbank 1984; Koenig et al. 1989; Rashad 1989). Significant changes in one of these major variables may be difficult to measure in the short-term, and even more difficult to link with a particular input in the form of a health programme in the longer term (Chen et al. 1981; Mosley 1986). Instead, indicators of health status or measures of change in some of the 'process' variables may be preferable as signs of the effect of a particular health intervention. This implies that we need to consider more carefully the measurement of health-related behaviour and health service use. Elaborate research designs have been produced in an attempt to answer the basic question: How much of the measured improvement in mortality can be attributed to the specified health intervention? Much more use can be made of information from household surveys not only for evaluation but also for the periodic 'calibration' of the routinely collected sources. Here, we illustrate how data from a relatively simple household health and population survey in central Mali can be used to inform health planners and professionals about priorities and needs.



## Mortality and health in central Mali

There is good evidence to suggest that levels of childhood mortality have been exceptionally high in the Mopti region of Mali for a long time. The survey conducted by the French 'Mission Socio-économique' in 'le delta intérieur du Niger' during 1958–61 revealed that in the 1940s and 1950s, at least half of all children were dying before their fifth birthday (Mission Socio-Economique 1961). The 1961 national demographic survey, although less detailed, indicated that these levels were higher than elsewhere in Mali (Mali 1965). Unfortunately, the 1976 census omitted the key questions on children ever-born and surviving. The questions on births and deaths in each household in the year before the survey which were included have been shown to produce serious under-estimates of mortality before the census (Mali 1985; Traoré et al. 1989). A series of rural surveys in the Mopti region conducted during 1981–2 showed that childhood mortality amongst the Fulani of the Mopti region, the dominant ethnic group of the inner Niger flood zone, had remained at about the same level as that indicated by the 1956–8 surveys (Figure 1; Hill 1985; Hill et al. 1982). These recent surveys all included full birth histories which show that mortality rates for 1–4 year olds were especially high, a common feature of mortality patterns in much of West Africa (Blacker et al. 1985). The most detailed national survey so far, the 1987 Mali Demographic and Health survey, shows once again the two essential features of childhood mortality in Mali – the high levels prevalent in the Mopti region and the high ratio of the mortality of 1–4 year olds to the mortality of infants (Table 1).

**Table 1.** Estimates of childhood mortality in Mali 1977–86

| | 1000.q 1 0 | 1000.q 4 1 | 1000.q 5 0 |
|---|---|---|---|
| Region | | | |
| Kayes, Koulikoro | 125 | 176 | 279 |
| Sikasso, Ségou | 126 | 137 | 246 |
| Mopti, Gao, Tombouctou | 172 | 251 | 380 |
| Bamako | 73 | 100 | 165 |
| Mali | 131 | 170 | 279 |

*Source*: Enquête Démographique et de Santé au Mali 1987, Table 6.4.

The mortality estimates from the different sources, including the 1985 survey of the towns of Mopti and Sevaré discussed in detail here, are summarized in Figure 1. Childhood mortality remains high in the Mopti region and there is no sign of improvement in the rural areas or even in the two towns of Mopti and Sevaré. Mortality levels in the Niger flood zone ('le delta intérieur) remain exceptionally high: about half of all Fulani children born there die before their fifth birthday.

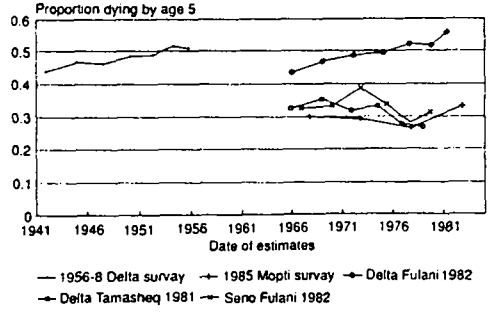


**Figure 1.** Childhood mortality trends in the Mopti region of Mali 1942–1983

Mortality in the twin towns of Mopti and Sevare is nonetheless lower than in the surrounding rural areas. Life tables calculated for the five year period before the birth histories were collected in 1985, indicate that the infant mortality rate in the two towns was about 130 per 1000 and that one-third of children were dying before age five. By comparison, for the Fulani groups resident in the Niger flood zone, infant mortality rates were about 220 per 1000. The central

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question is: what factors are responsible for the improved survival chances of children in Mopti and Sevaré compared with those for children in the surrounding rural area? Are the health facilities in the towns the key ingredient, or is the explanation more to do with better living standards, housing or sanitation arrangements?

To answer such questions, we turn to the 1985 survey data, particularly the birth history data which contains the information on the dates of birth and death (where applicable) of all the children in the survey. Life tables can be readily constructed from these data for all the recorded births, but in order to examine the effects of household variables on child mortality, most of the analysis was concentrated on the survival of the last born child.

## The survey of Mopti and Sevaré

The survey of a sample of 2243 households in the two neighbouring towns of Mopti and Sevaré (total populations estimated as 47 000 and 22 000 respectively) was undertaken with the collaboration of the Ministry of Health and the Sahel Institute, both to examine the value of including some health questions in a household interview, and to provide baseline data in advance of a much enlarged immunization programme together with an accompanying primary health care package. In 1985, there were large numbers of destitute people living in temporary huts and tents on the edge of the built-up urban area ('la population flottante'). To allow separate analysis of the health and demographic characteristics of this group, these households were over-sampled at the request of the Malian authorities. All the results presented here, however, have been weighted to produce figures which are representative of the total populations of the two towns.

The questionnaires were much simpler than those used by other demographic and health surveys, but the same sorts of questions on health and the use of health services were asked. The 1985 survey consisted of two main questionnaires, one enquiring about characteristics of the dwelling and about the demographic attributes of the household members, answered by the head of household. A second questionnaire was completed by a female interviewer for every woman of reproductive age and included a full maternity history, as well as a number of more detailed questions on the health and care of the last born child. This structure is typical of many health and populations surveys being conducted or planned in developing countries.

## Data analysis

The file of last born children from Mopti-Sevaré contained 2548 cases which is too few for analysis using life tables with more than two or three control variables. To simultaneously adjust for the effects of some of the many factors which influence childhood mortality, two different approaches are commonly used. One involves the use of proportional hazards models (Trussell and Hammerslough 1983) or other multiple regression techniques such as logistic regression. An alternative and simpler method is to reduce the number of confounding variables to a minimum and to calculate the relative risks of dying for just a few well defined sub-groups of the population. This latter approach seemed more appropriate for the analysis of the Mopti-Sevaré data for two reasons. One is that the population of the two towns was relatively homogeneous with reference to education (86% had never been to school), and to income (generally poor). The socio-economic status of households could be quite effectively described using a two-fold division of educational status combined with a three-fold division of wealth (Table 2). After some tests, it was found that the ownership of one or more household possessions (a radio, a refrigerator, a moped, and a dresser or chest of drawers), effectively discriminated the poor from the slightly better off. A second reason for the simple approach to the data analysis is that many of the health measures whose effect on child survival was being examined are also categorical variables with only two or three levels. For example, the type of assistance received at birth, the place of delivery or the immunizations received are all simple variables of this type.

To compare mortality among children exposed to different health interventions and household circumstances, the relative risk (R) of dying for the last born children within these groups was calculated using the 1(x) function of the life table (the cumulative probability of dying between birth and age x) constructed from the birth



Table 2. Social class categories used in the analysis

| Education of mother | Codes | Index of wealth: No possessions (0) | One possession (1) | Two or more possessions (2) |
|---|---|---|---|---|
| No schooling | (0) | A (lowest) | B | C |
| Some schooling | (1) | D | E | F (highest) |

The possessions used in the index of wealth were ownership of a radio, a refrigerator, a moped or a dresser/chest of drawers.

histories. As both education and social class are controlled for in the analysis, the relative risk of dying following exposure to any variable can be summarized for the six sub-groups shown in Table 2 by a weighted average relative risk.

## Anticipated effects of specific factors

### Prenatal and postnatal care

Pre- and postnatal care has a potentially large impact on neonatal mortality, as has care at delivery (Jelliffe and Jelliffe 1987; WHO 1986a). To estimate the impact of such interventions in Mopti and Sevaré, the relative risks of dying before the ages of 1 month and 5 years were calculated. This was carrried out for groups of women exposed to different types of pregnancy monitoring (doctor, nurse, 'other' or none) and for women assisted at birth by different types of attendant (doctor, midwife, traditional birth attendant, mother or 'other'). (Information was also available about place of birth but this was so strongly related to the type of assistance at birth that separate analysis of place of birth would have been pointless). If effective, interventions before and at the time of birth would be expected to have their greatest impact on mortality in the first month of life; the relative risk, (R), of surviving up to five years, was included simply to act as a comparison.

### Immunization

The main use of the immunization information in this study was in calculating the relative risk of dying associated with a lack of immunization, that is, the risk of dying among those receiving no immunization, relative to the risk of dying among the immunized. Given the importance attached to immunization, coverage levels were calculated for the four vaccines for which information was available by dose and age. Following World Health Organization (WHO) guidelines (WHO 1986b), children were divided into those fully covered (receiving the requisite number of doses for each vaccine by the age of two) and those receiving only partial or no cover. Coverage levels for each of the four vaccines were then calculated, as were drop-out rates for polio and DPT vaccination. Such figures are of particular use in evaluating the progress of any immunization campaign.

To analyse the impact of immunization upon child survival, a summary variable covering all four vaccinations was computed, dividing children into those receiving 'full' immunization, 'partial' immunization and no immunization at all. 'Full immunization' means immunized with the four major antigens (BCG, polio, DPT and measles) according to WHO recommendations (WHO 1986c).

Although life table analysis was confined to those 'partially immunized' and those receiving 'no immunization', the proportion 'fully immunized' with all four vaccines was of particular interest in its own right. Indeed, it is now customary to calculate such an overall figure wherever possible (WHO 1986c) as it provides a useful single figure to describe overall levels of immunization. Additional analysis included cross-tabulations of the health care interventions named, with variables such as mothers' age and education, and with each other.

### Household water supply and sanitation

Exposure to the many bacterial, viral and parasitic pathogens that cause diarrhoeal disease is mediated by a household's water supply and toilet facilities. The impact of such facilities on childhood mortality in Mopti and Sevaré was estimated by calculating the relative risk of dying among children exposed to these different facilities at 0–6 months, 0–12 months and 0–5 years. The risk of dying was expected to decrease over these age groups amongst those with good water and sanitation if water and sanitation did indeed have an independent impact on child survival after controlling for the effects of education and wealth.

## Results

### Impact of antenatal care on child mortality

Over half the women in the study (58%) had been 'monitored' at least once during pregnancy and in general, their offspring had a lower neonatal mortality rate than children from 'unmonitored' pregnancies, when examined without controlling for education and social class. The exception to this was the group whose pregnancy had been 'monitored' by an unspecified 'other' person. Their offspring had a higher neonatal mortality level than even the 'unmonitored' group. Numbers were small in this 'other' group, however, and the exact type of monitoring was not specified. The risk of dying in the 'unmonitored' pregnancy group was therefore compared with each of the other delivery groups in turn.

Comparison of 'unmonitored' with 'monitored' pregnancies suggested that pregnancy monitoring was associated with a significant reduction in neonatal mortality, even when controlling for education and social class (relative risk = 1.52; Table 3). Such a simple comparison is misleading however, in that mortality reductions varied considerably according to the person monitoring the pregnancy. In cases where either a doctor or nurse 'monitored' the pregnancy, neonatal mortality was significantly lower than for 'unmonitored' pregnancies (relative risk = 1.66; Table 3). The risk of neonatal death among children of 'unmonitored' pregnancies was, for example, twice as high on average as that among those 'monitored' by a doctor ($p < 0.05$).

**Table 3.** Relative risk of dying (R) for children whose mothers did or did not make use of antenatal care

| Social class | Ages of children <1 month R | Ages of children >5 years R |
|---|---|---|
| A (lowest) | 1.27 (0.66–2.43) | 1.24 (0.95–1.63) |
| B | 2.12 (0.84–5.36) | 1.59* (1.12–2.28) |
| C | 3.85* (1.06–13.92) | 1.99** (1.24–3.21) |
| D | 4.07 (0.67–24.62) | 1.85 (0.76–4.50) |
| E | ... | 1.35 (0.46–3.95) |
| F (highest) | 3.20 (0.12–84.25) | 4.19** (1.56–11.22) |
| Weighted average | 1.66* (1.04–2.65) | 1.52** (1.26–1.83) |

*Notes*: See Table 2 for explanation of social class divisions.
* = $p < 0.05$ ** = $p < 0.01$
... = insufficient cases for analysis.
95% confidence limits in brackets.

Monitoring by a nurse was associated with an even greater reduction in neonatal mortality, although the differential mortality between pregnancies 'monitored' by a doctor and those 'monitored' by a nurse was not large or statistically significant. In comparison, the data provided no evidence to suggest that the monitoring of pregnancy by persons other than a doctor or nurse was associated with any improvement in survival.

Similar associations between pregnancy monitoring and mortality were also noted beyond the neonatal period, suggesting that pregnancy monitoring was not the sole cause of the increased survival. If this had been the case, the relative risk of dying among children of 'unmonitored' pregnancies would be much greater during the first month of life than from age 0–5 years. The results are, however, impressive, especially as women who were 'monitored' may have been the ones who had problems in their pregnancies. In this case there would have been an over-representation of high risk cases in the 'monitored' group. Despite this possibility, a substantial reduction in mortality was still noted



in the 'monitored' group (despite the extremely basic nature of the medical services), and the full benefits of pregnancy monitoring may well be being underestimated.

### Impact of care at delivery on child mortality

Preliminary analysis of the data (without controlling for education and social class) showed an unexpectedly high level of neonatal mortality among those born in hospital or delivered by a doctor (around 40 per 1000 births in both cases). Such high risks of dying in the neonatal period, given that infant mortality was about 130 per 1000, suggests that births in hospitals or attended by a doctor are those which develop or are likely to develop complications. The effect of health interventions at the time of birth cannot therefore be realistically calculated for these deliveries. It would be enlightening to know why so few women opted to give birth in hospital, the results at this stage suggesting that the only motivation strong enough to persuade a woman to accept a hospital-based birth is the sudden complication of a pregnancy or a delivery.

Exploratory data analysis also revealed a strong association between place of, and assistance at, birth. Almost all midwife-assisted births (97.7%) took place in a clinic: 86.5% of deliveries assisted by a doctor occurred in hospital, and 98.2% of births attended by an 'untrained' assistant (traditional birth attendant (TBA), mother or 'other') occurred outside any health centre. With such a strong relationship between place of birth and assistance at delivery, there was little to be gained by detailed analysis of the effects of both variables. Care at delivery was therefore analysed in detail using 'assistance at birth' status, as this information was more detailed than that given for place of birth. Early analysis (prior to controlling for education and class) showed a lower level of neonatal mortality for midwife-assisted births than for any other births, and so the risk of dying among other neonates was compared with the risk for midwife-assisted births.

Among those delivered by an untrained assistant (Table 4), the risk of dying in the first month was significantly greater than among the 'midwife' group ($R = 2.16$, $p < 0.001$). Inclusion of TBAs in the category of 'untrained assistant' was not strictly correct as an estimated 23% of Mali's TBAs are trained (WHO 1986d). Despite the training of some TBAs and the extensive practical experience of others, the risk of neonatal mortality was found to be 2.24 times greater among TBA deliveries than among midwife deliveries, although this result was not statistically significant. The risk of neonatal death was even higher in cases where the pregnant mother had received no assistance at birth – 2.66 times greater than for children delivered by a midwife ($p < 0.01$).

**Table 4.** Relative risk of dying (R) for children delivered by an untrained assistant versus a midwife

| Social class | Ages of children <1 month R | Ages of children <5 years R |
|---|---|---|
| A | 2.59** (1.30–5.14) | 1.73** (1.31–2.30) |
| B | 1.82 (0.69–4.78) | 2.06** (1.43 –2.97) |
| C | 1.21 (0.35–4.21) | 2.13** (1.21–3.75) |
| D | 3.63 (0.63–20.89) | 2.51* (1.01–4.48) |
| E | ... | 1.34 (0.40–4.48) |
| F | ... | ... |
| Weighted average | 2.16** (1.32–3.52) | 1.89** (1.55–2.31) |

*Notes*: Deliveries by a doctor are excluded. See text for explanation. See Table 2 for explanation of social class divisions.
* = $p < 0.05$ ** = $p < 0.01$
... = insufficient cases for analysis.
95% confidence limits in brackets.

Delivery by a midwife was associated not only with a reduction in neonatal mortality when compared with untrained assistance at birth, but also with a significant reduction in childhood mortality (0–5 years of age). As previously explained, this suggests that care at delivery is not the sole cause of the mortality differentials identified.

Overall therefore, a clear pattern of improved survival was identified among children whose mothers had been 'monitored' by a doctor or nurse during pregnancy, and who were assisted

at childbirth by a midwife. It is impossible to conclude from these results that care received before and during delivery causes such reduction in mortality, but the reductions are so large that the overall findings are encouraging. Moreover, these calculations only measure the association of pre- and postnatal care with the mortality of live-born children. Antenatal and postnatal care also reduces the stillbirth rate and maternal morbidity and mortality (Ebrahim 1985; Kwast 1989) – a particularly important consideration in West Africa, where the maternal mortality rate is very high, an estimated 700–1000 maternal deaths per 100 000 live births (Graham et al. 1989). The overall benefits of very simple pre- and postnatal interventions are thus likely to be much greater than these results suggest.

**Immunization coverage levels and drop-out rates**

Remarkably few children were fully vaccinated against any of the six EPI diseases (Figure 2). BCG coverage was by far the highest with 42.3% of children under age two fully vaccinated. Vaccination coverage levels were much lower for vaccines which could not be given at birth. This suggests that, in most cases, vaccination is not the result of a mother's active efforts to have her child immunized, but is simply a by-product of unrelated contact with health services. Given that 57% of mothers gave birth in a clinic, it was not surprising to find that a vaccine which is given at birth (BCG, for instance), was most commonly received, as contact with health services is far less frequent or widespread after childbirth. High dropout rates for DPT and polio vaccination also suggest that vaccination (61% and 56% respectively do not complete the course) may be a product of an unrelated contact with the health services, or it may be a reflection of the irregular supply of vaccines in central Mali.

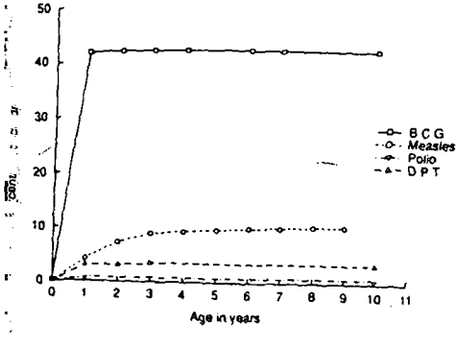


Figure 2. Immunization coverage by the age of the child

Although drop-out rates are very high in Mopti and Sevaré, the overriding problem is not the proportion who drop out from a course of DPT or polio inoculations, but the large proportion not presenting for any such vaccinations (91% and 96% of all children respectively). The lower proportion of children protected against measles (7.3% of those under two years old) is worrying because of the prevalence of the disease in tropical Africa. Indeed, at the time of the survey, there was a measles epidemic and 42% of last born children ill during the fortnight before interview were reported to have measles. In Bamako, a partially successful immunization campaign had prevented some transmission of measles in 1983 and 1984, but in 1985, a new epidemic coupled with an enlarged population of susceptible children led to a huge rise in measles and overall death rates (Fargues and Ouaidou 1988). Data from Guinea-Bissau, from Senegal and from other comunities stress the lethal effect of measles in crowded conditions such as prevail in Mopti and Sevaré (Aaby 1989).

**Impact of immunization on childhood mortality**

Immunization was associated with a considerable reduction in the risk of dying – more so than with any other intervention studied. Since only 7 children (0.3%) were fully immunized for age against all six EPI diseases, the risk of dying among children receiving no immunization was compared with those receiving at least some immunization (so the comparison was between those with no immunization and those with partial immunization).

The risk of dying among children not immunized ranged from twice to nearly eight times as high as that among partially immunized children (for results where $p < 0.05$). When averaged over the different social classes, the risk of dying was approximately three times as high – this risk varying little over the different age groups analysed (Table 5). This similarity across age groups suggests that immunization alone cannot account for the improvement in survival, otherwise the relative risk of dying in the first six months would be lower. During this period, children are protected against many immunizable diseases by



**Table 5.** Relative risk of dying for children with no imunization compared with those partially immunized

| Social class | Age of children: 0–5 months | 1–11 months | 0–2 years | 0–5 years |
|---|---|---|---|---|
| A | 4.34** (2.56–7.35) | 4.88** (3.17–7.52) | 3.26** (2.27–4.70) | 3.84** (2.77–5.33) |
| B | 1.84 (0.96–3.54) | 2.27** (1.43–4.25) | 1.97** (1.33–2.93) | 2.18** (1.50–3.18) |
| C | 3.64** (1.60–7.07) | 2.45** (1.41–4.25) | 2.84** (1.77–4.57) | 2.64** (1.65–4.23) |
| D | 3.88* (1.06–14.26) | 3.40* (1.06–10.85) | 5.68** (2.14–15.07) | ... |
| E | 10.22 (1.10–94.83) | 7.19 (1.29–40.01) | 2.85 (1.00–8.10) | 2.26 (0.92–5.51) |
| F | 5.08 (0.93–27.94) | 5.97 (1.55–22.97) | 7.81 (2.17–28.11) | 5.92 (2.60–13.50) |
| Weighted average | 3.35** (2.39–4.68) | 3.29** (3.21–3.38) | 2.85** (2.27–3.55) | 3.01** (2.45–3.69) |

*Notes*: For explanation of the social class divisions, see Table 2.
* = $p < 0.05$ ** = $p < 0.01$
... = insufficient cases for analysis.
95% confidence limits in brackets.

the presence of maternal antibodies. Nonetheless, the improvement in survival for those immunized is so large as to be very encouraging.

These results appear to contradict suggestions that vaccination has a minimum impact on survival because of competing risks. Such suggestions have, however, been based on the assumption that malnutrition increases the case fatality rate of infectious diseases and hence that malnourished children saved by vaccination are likely to die from alternative diseases. Aaby's alternative hypothesis is that crowding and age are more important determinants of the measles case fatality rate where measles is concerned (Aaby 1988). Even a moderately effective measles vaccination programme would then have a real impact on survival rates by reducing the number of measles infections, raising the mean age of attack and impeding the clustering of cases.

As with antenatal care and interventions at the time of delivery, it is not possible to conclude that improvements in survival noted here are caused solely by immunization. These gains are so large however, that at least some of the improvement is likely to be a result of immunization and the results are highly encouraging.

## Water supply and sanitation

**Impact of water supply on child mortality**

It has often been postulated that the amount of water available to a household is inversely correlated with mortality, since the health benefits derived from the hygienic use of water are not only for direct consumption, but also for washing, cooking, bathing and hand washing (Esrey et al. 1985; Feachem 1984; Feachem et al. 1978). Utilizing public sources of water frequently necessitates queuing and long labourious journeys and, it is thought, are thus used less for washing than more convenient, private sources. It was therefore surprising to find on an initial examination without controls, that water from private standpipes was associated with higher mortality than water from wells and public standpipes. The risk of dying, using other water supply groups was then compared with the risk of dying in the 'public standpipe' group.

After controlling for education and social class, there was little evidence to suggest that the type of water supply had an impact on child mortality. The few findings that were statistically significant supported the initial observation - namely that water from taps and private standpipes was associated with an increased risk of dying. Overall however, the results were inconclusive - bar the finding that water from pools or the river, not surprisingly, was associated with a significantly greater risk of dying than water from public standpipes.

These results do not suggest however, that water supply has no impact on childhood mortality - only that the type of water supply does not appear to be associated with differentials in child mortality. Many water-related diseases, although all potentially transmitted by drinking contaminated water, are also 'water-washed' - that is, their 'incidence will fall following increases in the volume of water used for hygienic purposes, irrespective of the quality of that water' (Feachem et al 1978). If diarrhoeal and other infectious diseases are primarily water-washed in Mopti and Sevaré, then the water quality is of little importance in determining childhood mortality, and the quantity, availability, convenience and reliability of the water supply may be more important. Moreover, respondents only stated the type of water supply in the household and were not asked what water supply they actually used or how they stored water.

Information only on the *type* of water supply may therefore be a poor guide to the overall effects of water supply on childhood mortality, as the incidence of water-related diseases is also determined by a wide variety of other factors, such as water storage arrangements (Conteh et al. 1990). In The Gambia, the connection between diarrhoea and quality of water in the household was also shown to be quite weak, partly because young children drink from a variety of sources and not just their own household's water supply (Pickering et al. 1986).

### Impact of sanitation on child mortality

Toilet facilities were classed in three categories - flush, WC, latrine and 'other'. Virtually all households had a latrine and other types of toilet facilities were comparatively uncommon. As a result, comparison of mortality risks associated with different toilet facilities proved very difficult and was limited to the categories 'latrines' and 'other' (mainly none) facilities. Even then, the risk of dying for children in households with no latrine, relative to those with a latrine, could only be calculated for uneducated classes in the lower two social groups (Table 6).

**Table 6.** The relative risk of dying for children in households without a latrine compared to those with a latrine

| Social class | Ages of children 0–6 months | < 1 year | < 5 years |
|---|---|---|---|
| A | 1.24 (0.75–2.05) | 1.54* (1.02–2.34) | 1.59* (1.18–2.14) |
| B | 0.80 (0.14–4.54) | 0.79 (0.24–2.55) | 0.68 (0.28–1.62) |
| Weighted average | 1.20 (0.74–1.94) | 1.43 (0.97–2.12) | 1.46** (1.10–1.93) |

*Notes:* See Table 2 for explanation of the social classes. There were too few cases for an analysis using social classes C to F.
* = $p < 0.05$ ** = $p < 0.01$

Despite the unequal distribution of cases between different 'toilet facility' groups, latrines were on average associated with a statistically significant reduction in childhood mortality when compared with 'other' toilet facilities, both amongst those with the lowest education and social class and overall, in the 0–5 year age group. Whilst the relative risk of dying among those with no latrine in some cases increased as larger age intervals were considered, it would be rash to conclude that toilet facilities were the cause of the observed differentials in mortality.

Therefore, very little can be concluded from this analysis of water and sanitation facilities, especially as the information related only to the facilities available to a household and not necessarily the ones used in practice. Badly fouled latrines may deter people from using them, but no details are available here about either the hygienic condition, construction or design of latrines - all of which influence the use of latrines and their impact upon childhood mortality (WHO 1983).

## Discussion

Several interesting patterns of child-care behaviour emerged during this study. As was



expected, health services were used far more by women in higher educational and social classes, but surprisingly, did not vary much among women of different ages. Only in the very highest age groups (45–54 years) were there any discernible reductions in health care usage. Over 50% of women in the 50–54 age group, for example, did not have their last pregnancy (resulting in a live birth) 'monitored', despite the greatly increased risks linked with childbearing in later years. It is possible however, that their last birth occurred several years ago, when the risks were less and the available health facilities fewer. In contrast residential status was associated with health care use. Recent arrivals in Mopti and Sevaré received far less medical care than more long standing residents. Obviously these and other socio-economic characteristics interact with each other, but these results do highlight the particular need for access to health care for recent arrivals living in the squatter settlements around Mopti and Sevaré.

More important perhaps, the results suggested a consistency in health behaviour. One group of mothers make use of all or most of the limited facilities available, whilst a second group are rarely in contact with the health services. Mothers who were 'monitored' during pregnancy by a doctor or nurse for example, also tended to take advantage of other available health services. Certain mothers thus appear to 'care' better for their children than others, regardless of their living conditions. Although a division between 'good' and 'poor' mothers would be very subjective and difficult, some grouping of mothers according to health behaviour would be needed in a future study if the impact of specific health interventions was to be evaluated in detail. Evaluation of health interventions was also limited in this study by the type of analysis used. Confounding variables other than education and social class such as duration and district of residence could been taken into account if some form of multiple regression had been used.

Despite the limitations of the approach adopted in this project, the results are both interesting and valuable. Even after controlling for the main confounding variables, (education and social class), pregnancy monitoring, trained assistance at birth and immunization were all strongly associated with a much reduced risk of dying during childhood. Monitoring of pregnancy and assistance at delivery by a midwife were associated with roughly a halving of mortality risk. Immunized children were approximately three times less likely to die before the age 5 than were non-immunized children. These improvements in survival are highly encouraging, especially as they are associated with very basic, inexpensive interventions. There was no evidence to suggest for example, that monitoring of pregnancy by a doctor was preferable to monitoring by a nurse - the latter being a much cheaper alternative for health planners.

Monitoring of pregnancies appears to be a particularly promising intervention with considerable improvements in survival despite the possible over-representation of high-risk cases in the 'monitored' group. The reductions in mortality among those children delivered by a midwife were also encouragingly high, especially since virtually all these births occurred in clinics with very basic facilities. Such interventions before and during delivery probably account for the comparatively low infant mortality rates in Mopti and Sevaré, as they are used by a substantial number of women. At least 59% of children were delivered by a trained assistant, for example, as compared with an average in Africa of 44% (Kwast 1989).

In contrast, childhood mortality between age 1–4 years is extremely high and may be partially explained by the very low vaccination coverage levels in the towns. With such a large improvement in survival associated with immunization, and such low coverage levels at present, immunization is an intervention which particularly warrants attention and has much potential for reducing childhood mortality in Mopti and Sevaré.

Contrary to initial expectations, water supply and sanitation in general did not appear to be associated with child mortality. This may be a reflection of the type of questions used in the survey which may have been too simplistic to arrive at an accurate assessment.

Overall, the results suggest that large improvements in child survival in places like Mopti and Sevaré can be achieved through the use of very simple, basic interventions such as pregnancy

monitoring, trained assistance during childbirth and immunization, The rather modest quality and nature of the services provided suggests that a part of their effect must be through indirect mechanisms, encouraging at least one set of mothers to adopt patterns of behaviour which have a positive effect on the health and survival of their children. These mothers may have had some special attributes which in this study we have been unable to describe fully, but circumstantial evidence suggests that the health services are having an indirect but positive effect on health.

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