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DETERMINANTS OF CHILD MORTALITY IN A RURAL UGANDAN COMMUNITY
F. Kaharuza, MBChB., MMed(O/G)(MUK), Lecturer, Child Health and Development Centre, Makerere University, P.O. Box 6717, Kampala, Uganda and Department of Epidemiology and Social Medicine, University of Aarhus, Vehnnelyst Boulevard 6, DK-8000 Aarhus C, Denmark, S. Sabroe, MD, Associate Professor, Department of Epidemiology and Social Medicine, University of Aarhus, Velmelyst Boulevard 6, DK-8000 Aarhus C, Denmark and F. Scheutz, PhD, DrPH. Senior Associate Professor, Department of Community Oral Health and Pedodontics, University of Aarhus, Vennelyst Boulevard 9, DK-8000 Aarhus C, Denmark

Request for reprints to: Dr. F. Kaharuza, Department of Epidemiology and Social Medicine, University of Aarhus, Vennelyst Boulevard 6, DK-8000 Aarhus C, Denmark.

# DETERMINANTS OF CHILD MORTALITY IN A RURAL UGANDAN COMMUNITY

F. KAHARUZA, S. SABROE and F. SCHEUTZ

## ABSTRACT

***Objective:*** **To estimate the rate of and risk factors associated with child mortality in rural eastern Uganda.**
***Design:*** **A community based cross-sectional study using the preceding birth technique - a robust method of obtaining information of survival of the previous child.**
***Setting:*** **A rural district in Eastern Uganda.**
***Participants:*** **In total, 2888 multigravidae were interviewed in April and May 1999.**
***Main outcome measure:*** **Number of deaths among children born alive.**
***Results:*** **The under-two child mortality rate was 108 per 1000 livebirths. The annual child mortality was 82 per 1000 child-years of risk. Child mortality was associated with low parental education, being born to adolescent mothers or mothers aged 35 or more. Unconditional logistic regression showed that children born to uneducated parents had a doubled risk of not celebrating their second birthday. It was three times more likely for a child to die in the neonatal period than in the first year of life. Child mortality risk decreased by 4% and 6% for every year of education attained by mothers and fathers, respectively. Parity, residence and marital status were not associated with excess risk of child mortality. Seasonal mortality followed the El Nino rainfall pattern. Finally, there were geographical differences in child mortality although this was not statistically significant.**
***Conclusion:*** **Monitoring trends in child mortality at district level can be done using the preceding birth technique in antenatal settings. Maternal education, an important predictor of child survival should be included in routine data collection at clinics.**

## INTRODUCTION

Uganda's under-five mortality rate of 147 per 1000 live births is among the highest in East Africa(1,2). Comparative analysis of Ugandan data shows that child mortality has changed over time. It decreased by 9% from 1960-1975, increased in 1975-1985 by 9% and decreased again by 10-14% in the 1990's(1,2). These variations were due to civil strife in the 1980's, and the subsequent peace and economic recovery in the 1990's. The in-country regional and district differences in child mortality are most likely due to different distribution of risk factors associated with child mortality(3). Studies consistently show that low maternal education is associated with increased child mortality(4,5). The association of other socio-demographic factors such as maternal age and parity varies among the populations studied(6).

In Uganda, the few regional or district-based child mortality studies have focussed on the association between nutrition and child mortality in North and Southwest Uganda(7,8) and HIV/AIDS infection and child mortality in Central Uganda(9). Data on child mortality are collected either from censuses carried out every ten years or from representative surveys such as the Demographic and Health Survey(3). This information has a limited role in effective planning for child survival programmes at district level as it describes events that occurred five to ten years before the survey date.

The ongoing decentralisation of health services requires up-to-date information on child survival for effective regional and district planning of child survival programmes(10). The objective of the present study was to estimate the child mortality rate in a rural district in Eastern Uganda and to identify important determinants of child mortality. The study would therefore provide data for monitoring child mortality trends in this rural population.

## MATERIALS AND METHODS

*Study setting:* The study was carried out in Bunyole health sub-district, Tororo District, situated about 260 km east of Kampala, the capital city of Uganda. Bunyole is administratively divided into six subcounties and 21 parishes and had a projected mid-year population of 134900 in 1999. In 1995, the eastern region had a total fertility rate of 7.4 children per woman, an infant mortality rate of 98 deaths per 1000 live births and an under-five mortality of 176 deaths per 1000 live births(3).

*Study design:* A cross-sectional survey was carried out in April and May 1999 in this area to recruit pregnant women for a cohort study on child spacing, child survival and maternal health.

*Data collection:* Data were collected through house-to-house interviews on a predetermined date in all parishes. All pregnant women and those who had delivered during the month of the survey were eligible for recruitment. Twenty local female health workers were trained for one week to collect the data using a pretested questionnaire. Training included translating the questionnaire into the local language, back-translation of the questionnaire to English and using a gestation age calculator designed for the study. Interviewers used a field manual to maintain consistency of data collection while two supervisors monitored the data collection process by spot checks and monitoring the interviews.

*Outcome:* Child mortality was estimated by the preceding birth technique, where mothers are asked about the outcome of the previous births and whether the children born are still alive or not. This is a recommended method of estimating child mortality in countries without a proper vital registration system(11). It has been validated by comparing its mortality estimates with those obtained using direct estimates(12) and used in many field surveys(13), antenatal and clinic settings(14,15). Respondents were also asked about the date and outcome of the last pregnancy, the status of the child if born alive and the date of death, had the child died. The date or month of birth and date of death were recorded and used to estimate the age at death of the children. Abortion, stillbirth, singleton live birth and twin pregnancy outcomes were also recorded.

*Explanatory variables:* Maternal age was reported or estimated by using a chronology of local and national events developed with the interviewers and confirmed with elders in the area. Maternal age at delivery was defined as the completed years at the time of delivery. Mothers' ages were categorised into five-year age groups. Parity was recorded into three groups; low parity (2-3 children), medium parity (4-5 children) and high parity (6 or more children). Formal education was categorised into none, lower primary (1-4 years), upper primary (5-7 years) and secondary (8 or more years). A couple's education was defined by the highest class attained by either one of the couple. Marital status was defined as married monogamous, polygamous union or single. Residence in one of the six subcounties that form the study base was also considered as an explanatory variable.

*Data management and statistical analysis:* Data were entered and analysed using EPI INFO 6.04 (Center for Disease Control 1994) and STATA 6.0 (StataCorp 1999). We imputed missing data on maternal age (n=43) using the mean age of the mothers of the same parity. Missing data on husband's age was included as a separate category in the analysis. Graphical assessment for heaping of maternal age was carried out. The under-two child mortality was estimated as a proportion of deaths of children born alive. This proportion of immediately preceding births dying before the second birth date approximates well with the probability of dying before the second birthday on a standard life table if the birth interval is approximately 30 months(11). Neonatal mortality rate was estimated as the proportion of children who died before one month of age. Infant mortality was computed as number of children born alive and died before one year of age while the post neonatal mortality is the arithmetic difference between infant mortality and neonatal mortality. The annual child mortality rate was computed using the total deaths of children born in 1997 and 1998 and the person-time-at-risk calculated from the month of birth for all children born in those two years before the survey date. Descriptive analysis for seasonal variation of child mortality was done by plotting proportion of deaths and monthly rainfall patterns for the two years before the survey date.

The association between each of the explanatory variables and child mortality was expressed as a crude odds ratio (OR). Logistic regression models were used to estimate the adjusted odds ratio for each risk factor and child mortality. Reference categories used in the models were secondary education, monogamous union and maternal age group 30-34 years (the group with the lowest mortality). Only variables considered a priori to be associated with child mortality and those that were significant at $p<0.25$ were selected for the full main effects model. Two separate models were fitted, one with both maternal and husband's education and another with couple's education as a composite variable for education. Variables were then excluded in the model if they were not significant ($p>0.05$) and the significance of the variable in the model tested using the log-likelihood ratio test. The final models' goodness-of-fit was tested using the Hosmer-Lemeshow test statistic(16). Ethical clearance for this study was given by the Uganda National Council for Science and Technology, and verbal consent for the interview was obtained from the mothers.

## RESULTS

Of the estimated 19632 households in the study area, 75.2% were visited. We identified 16550 women of reproductive age (15-49 years) of whom 19.3% were pregnant or had delivered in the month of the survey. Interviews were carried out with 99.3% of the pregnant mothers.

*Overall characteristics of study population:* The mean maternal age was 26.2 years. Table 1 shows that about one-third of mothers had no formal education while about one-third were in polygamous union. About 30% of the mothers were either adolescents or above 35 years, and 43% of the mothers were either primigravidae or had six or more pregnancies. Adverse pregnancy outcomes occurred in 4.5% of the pregnancies; 3.3% as abortions and 1.2% as stillbirths. The abortion rate was 36 per 1000 pregnancies and stillbirth rate 14 per 1000 deliveries. Of the 30 sets of twins, 12 sets were both alive, 11 both dead and one sibling was alive in seven sets. Primagravidae (n=458), adverse pregnancy outcome (n=157), twin pregnancy (n=30), and mothers with missing outcome or missing child status data (n=19) were excluded from the subsequent analysis.

*Early childhood mortality:* Of the 2888 singleton children born alive at the most recent birth, 10.8% had died at the time of the interview (Table 2). Thus, the child mortality rate for singleton births was 108 per 1000 live births. Including twins gave a higher mortality of 116 per 1000 live births. About 93% of the deaths occurred before the age of two. The estimated annual under-two child mortality rate was 82 per 1000 child years of risk. Deaths were three times more likely to occur in the neonatal period than in the post-neonatal period. About three-quarters (34 of the 46 neonatal deaths) occurred in the first week of life.

**Table 1**

*Distribution of selected maternal characteristics of 3552 pregnant women*

| Characteristic | Number of respondents | % |
|---|---|---|
| Total | 3552 | |
| *Current maternal age (years)* | | |
| 14-19 | 723 | 20 |
| 20-24 | 1109 | 31 |
| 25-29 | 881 | 25 |
| 30-34 | 477 | 13 |
| 35-49 | 360 | 10 |
| *Current gravidity* | | |
| Prime gravida | 458 | 13 |
| Gravida 2 | 462 | 13 |
| Gravida 3 | 597 | 17 |
| Gravida 4 | 477 | 13 |
| Gravida 5 | 457 | 13 |
| Gravida 6 | 372 | 10 |
| Gravida 7+ | 727 | 20 |
| *Maternal education* | | |
| None | 1200 | 34 |
| Lower primary (P1-P4) | 978 | 28 |
| Upper primary (P5-P7) | 1123 | 32 |
| Secondary and above | 251 | 7 |
| *Marital status* | | |
| Monogamous | 2049 | 68 |
| Polygamous | 1042 | 30 |
| Single | 88 | 2 |
| *Husbands education* | | |
| None | 369 | 10 |
| Lower primary (P1-P4) | 727 | 20 |
| Upper primary (P5-P7) | 1391 | 39 |
| Secondary and above | 745 | 21 |
| Do not know/missing | 320 | 9 |
| *Last pregnancy outcome* | | |
| Single livebirth | 2892 | 81 |
| Single stillbirth | 44 | 1 |
| Abortion | 113 | 3 |
| Twins | 30 | 0.8 |
| Not pregnant | 458 | 13 |
| Missing | 15 | 0. 4 |
| *Current status of child* | | |
| Alive | 2611 | 88 |
| Dead | 341 | 12 |

**Table 2**

*Mortality rates of children born to 2888 mothers*

| Period | No. of deaths | Mortality rate |
|---|---|---|
| *Mortality (per 1000 live births)* | | |
| Childhood mortality | 314 | 108 |
| Neonatal mortality | 46 | 16 |
| Infant mortality | 215 | 74 |
| Post-neonatal mortality | | 58† |
| Annual mortality rate (per 1000 child-years) | 2225 | 82‡ |
| | | Monthly death proportion* |
| Age at death (months) | | |
| *Neonatal* | *46* | *46* |
| 1 - 6 | 79 | 13 |
| 7 - 12 | 90 | 15 |
| 13 - 24 | 73 | 6 |
| 25 - 36 | 17 | 1 |
| 37+ | 6 | 0.3 |
| Missing | 3 | – |
| Total | 314 | |

*Assumes proportional risk of death per month; †Arithmetic difference between neonatal and infant mortality
‡1982 children contributed 2737 child-years of risk

*Risk factors for child mortality:* Table 3 shows factors associated with mortality as a proportion of all livebirths. Child mortality was highest among adolescent mothers, among mothers above 35 years old and among uneducated couples. The proportion of deaths reduced after six or more years of mothers education. Single mother families also had a higher mortality rate than monogamous or polygamous households. There were subcounty mortality

**Table 3**

*Early child mortality by selected individuals and community characteristics in 2888 singleton live births*

| Characteristic | Children Total born alive | dead | Mortality per 1000 live births (95% CI) |
|---|---|---|---|
| *Mothers age at birth (years)* | | | |
| <19 | 687 | 82 | 119 (96 - 146) |
| 20 - 24 | 979 | 107 | 109 (90 - 131) |
| 25 - 29 | 737 | 76 | 103 (82 - 127) |
| 30 - 34 | 299 | 25 | 84 (55 - 121) |
| 35 - 49 | 186 | 24 | 129 (84 - 186) |
| *Current gravidity* | | | |
| Gravida 2 | 421 | 52 | 124 (94 - 159) |
| Gravida 3 | 561 | 59 | 105 (81 - 134) |
| Gravida 4 | 455 | 43 | 95 (69 - 125) |
| Gravida 5 | 425 | 42 | 99 (72 - 131) |
| Gravida 6 | 363 | 45 | 124 (92 - 162) |
| Gravida 7+ | 663 | 73 | 110 (87 - 136) |
| *Marital status* | | | |
| Monogamous | 1929 | 206 | 107 (93 - 121) |
| Polygamous | 911 | 102 | 112 (93 - 134) |
| Single | 46 | 6 | 130 (49 - 263) |
| *Maternal education* | | | |
| None | 995 | 126 | 127 (107 - 149) |
| Primary 1 | 65 | 9 | 138 (65 - 247) |
| Primary 2 | 163 | 21 | 129 (82 - 190) |
| Primary 3 | 302 | 32 | 106 (74 - 146) |
| Primary 4 | 271 | 29 | 107 (73 - 150) |
| Primary 5 | 299 | 34 | 114 (80 - 155) |
| Primary 6 | 290 | 28 | 97 (65 - 137) |
| Primary 7 | 305 | 24 | 79 (51 - 115) |
| Secondary+ | 198 | 11 | 56 (28 - 97) |
| *Fathers education grouped* | | | |
| None | 310 | 44 | 142 (105 - 186) |
| P1 - P4 | 602 | 75 | 125 (99 - 154) |
| P5 - P7 | 1139 | 124 | 109 (91 - 128) |
| Secondary+ | 585 | 43 | 74 (54 - 98) |
| Not mentioned | 252 | 28 | 111 (75 - 157) |
| *Couple's education grouped* | | | |
| None | 286 | 40 | 140 (102 - 186) |
| P1 - P4 | 577 | 74 | 128 (102 - 158) |
| P5 - P7 | 1360 | 150 | 110 (94 - 128) |
| Secondary+ | 665 | 50 | 75 (56 - 98) |
| *Residence by subcounty* | | | |
| Budumba | 354 | 39 | 110 (80 - 148) |
| Busaba | 350 | 43 | 123 (90 - 162) |
| Busolwe | 363 | 37 | 102 (73 - 138) |
| Butaleija | 742 | 89 | 120 (97 - 146) |
| Kachonga | 547 | 60 | 110 (85 - 139) |
| Mazimasa | 532 | 46 | 86 (64 - 114) |

**Table 4**

*Multivariate logistic regression analysis showing the association of individual and community characteristics and child mortality as crude and adjusted odds ratio (OR) and (95% confidence intervals) for 2888 live birth*

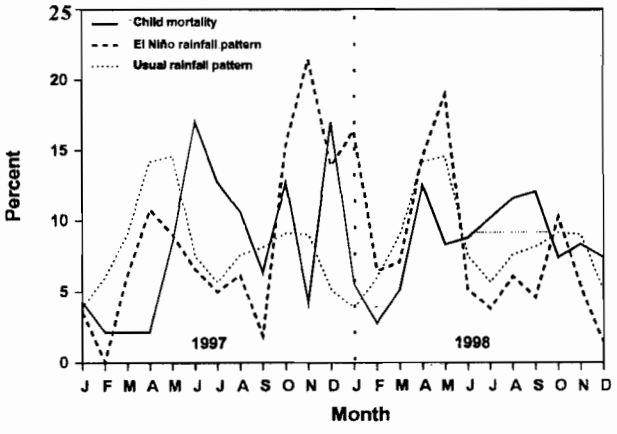
| Characteristic | Crude OR (95% CI) | | Model 1* Adjusted OR (95% CI) Full model | | Final model | | Model 2† Adjusted OR (95% CI) Final model | |
|---|---|---|---|---|---|---|---|---|
| *Maternal education* | | | | | | | | |
| Secondary | 1 | 1 | 1 | | 1 | | | |
| Upper primary | 1.8 | (0.9 - 3.5) | 1.6 | (0.8 - 3.1) | 1.6 | (0.8 - 3.1) | | |
| Lower primary | 2.2 | (1.1 - 4.2) | 1.8 | (0.9 - 3.5) | 1.8 | (0.9 - 3.5) | | |
| None | 2.5 | (1.3 - 4.7) | 2.0 | (1.0 - 3.9) | 2.0 | (1.0 - 3.8) | | |
| *Husbands education* | | | | | | | | |
| Secondary | 1 | 1 | 1 | | 1 | | | |
| Upper primary | 1.5 | (1.1 - 2.2) | 1.4 | (0.9 - 2.0) | 1.4 | (0.9 - 2.0) | | |
| Lower primary | 1.8 | (1.2 - 2.7) | 1.5 | (1.0 - 2.3) | 1.5 | (1.0 - 2.3) | | |
| None | 2.1 | (1.3 - 3.3) | 1.8 | (1.1 - 2.8) | 1.8 | (1.1 - 2.8) | | |
| Missing | 1.6 | (1.0 - 2.6) | 1.3 | (0.8 - 2.3) | 1.4 | (0.8 - 2.3) | | |
| *Couples education* | | | | | | | | |
| Secondary | 1 | | | | | | 1 | |
| Upper primary | 1.5 | (1.1 - 2.1) | | | | | 1.5 | (1.1 - 2.1) |
| Lower primary | 1.8 | (1.2 - 2.6) | | | | | 1.8 | (1.2 - 2.6) |
| None | 2.0 | (1.3 - 3.1) | | | | | 2.0 | (1.3 - 3.1) |
| *Maternal age at delivery* | | | | | | | | |
| 14 - 19 years | 1.5 | (0.9 - 2.4) | 1.8 | (1.0 - 3.2) | 1.8 | (1.0 - 3.2) | 1.8 | (1.0 - 3.3) |
| 20 - 24 years | 1.3 | (0.9 - 2.1) | 1.7 | (1.0 - 2.9) | 1.7 | (1.0 - 2.8) | 1.7 | (1.0 - 2.9) |
| 25 - 29 years | 1.3 | (0.8 - 2.0) | 1.4 | (0.9 - 2.3) | 1.4 | (0.9 - 2.2) | 1.4 | (0.9 - 2.3) |
| 30 - 34 years | 1 | | 1 | | 1 | | 1 | |
| 35 - 49 years | 1.6 | (0.9 - 2.9) | 1/5 | (0.8 - 2.8) | 1.5 | (0.8 - 2.8) | 1.5 | (0.9 - 2.8) |
| *Current gravidity* | | | | | | | | |
| Gravida 2-3 | 1 | | 1 | | 1 | | 1 | |
| Gravida 4-5 | 0.8 | (0.6 - 1.1) | 0.9 | (0.6 - 1.3) | 0.9 | (0.6 - 1.3) | 0.9 | (0.7 - 1.3) |
| Gravida 6+ | 1.0 | (0.8 - 1.3) | 1.2 | (0.8 - 1.8) | 1.2 | (0.8 - 1.8) | 1.3 | (0.8 - 1.9) |
| *Marital status* | | | | | | | | |
| Monogamous | 1 | | 1 | | | | | |
| Polygamous | 1.1 | (0.8 - 1.4) | 1.1 | (0.8 - 1.4) | | | | |
| Single | 1.3 | (0.5 - 3.0) | 1.3 | (0.5 - 3.1) | | | | |

*Model 1 includes maternal and husbands' education †Model 2 has couples education

differences, but these were not statistically significant. Further analysis suggests that parishes that are more populous have lower mortality than those with lower population destiny. Unconditional logistic regression analysis suggests that maternal age, maternal education and paternal education were independently associated with child mortality (Table 4). Maternal and fathers' education were included as independent variables in the model because they were not correlated (Pearson's correlation coefficient r=0.20). Children born to uneducated mothers were two times more likely to die before their second birthday than children born to mothers with secondary education. For children whose father's educational status was unknown, the mortality risk estimate was in-between that obtained for husband's lower and husbands upper primary education. However, most of the uneducated mothers did not know their husband's educational level. Using couple's education showed a significantly increased child mortality risk for all levels of education but had no effect on the other factors. Fitting a model with single years of mother's education showed that a one-year increase in education reduced the children's mortality risk by 7%. This risk reduction reduced to 4% when adjusted for maternal age, parity and husband's education. Similarly, a yearly increase in husband's education reduced the risk by 7% and 6% when adjusted for other risk factors. The adjusted odds ratio of child death of children born to adolescent mothers and older mothers increased to 1.8 and 1.5 respectively. Parity and marital status were not significantly associated with child mortality.

**Figure 1**

*Correlation between rainfall pattern (as percent of annual rainfall) and child mortality (as percent of annual mortality) (n=263)*




*Seasonal patterns of mortality:* Uganda experienced increased and prolonged rains caused by the El Nino Southern Oscillation weather phenomenon in 1997 and 1998. Usually, a bimodal pattern of rainfall exists with a main rainy season from March to June and shorter rainy season from August to November. Figure 1 presents the relation between rainfall and mortality of children in 1997 and 1998 in Tororo. There was a one-month time lag between high monthly rainfall and child mortality. A high proportion of child deaths also followed the unusual peak rainfall in November and December, 1997.

## DISCUSSION

This community-based study which was based on more than 90% of all pregnant women at the time (n=2888), shows that child mortality in this rural area of Uganda is still high. The proportion of pregnant women seen was similar to the expected proportion of pregnant women in developing countries(17). Child mortality was highest among children born to adolescent mothers, to mothers above 35 years, or to parents with no formal education. The highest risk of child death occurred among children born to uneducated parents.

Restricting the sample to pregnant women, thus excluding non-pregnant women whose children had died, primiparas, maternal mortality cases, and orphans from either maternal mortality or HIV/AIDS infection may bias the mortality estimates for the whole population. Using locally based female community health workers as interviewers may have improved both the case ascertainment and quality of data as women were more likely to talk about pregnancy to health workers from the same community. Although underreporting of births, deaths, or abortions is a common problem with birth history data, this recall problem is not expected to significantly influence these results because the study focussed on the most recently concluded pregnancy or child death. Misclassification of stillbirth and early child death was minimised by asking specific questions about these outcomes.

Other studies have shown that child mortality is high in first births(6). In this study, high first birth mortality is reflected in the proportion of children dead among women pregnant for the second time. However, we found no excess risk in this group.

The role of parental education on child mortality conforms with other studies, which have shown that it has an independent effect on child mortality(5,6,8,18,19). Parental education is considered as a socio-economic indicator, as a reflection of parental health-related behaviour and the ability to improve child survival(20). Father's education should also be considered since fathers in Uganda usually control the resources in the home or make decisions on child care.

The association between rainfall and child mortality is in accordance with other studies showing a seasonal pattern with more deaths occurring in the rainy season(21,22). A study done in Western Uganda during the El Nino period showed an increase of malaria incidence to epidemic proportions with the change in the climatic pattern(23). Rainy seasons tend to be times of increased risk of malaria transmission and diarrhoeal disease in the population, increased stress owing to factors such as food shortages, and heavy agricultural labour demands especially among the women, both of which directly affect child survival.

Under-two child mortality is a better indicator for impact of health interventions than infant and child mortality, since most child health interventions target the children under two years of age. With the decentralisation of health care services, local health unit workers and district health managers require simple but robust monitoring tools to generate data for use in decision-making, for tracking quality and performance of services and assessing the consequences of health sector reforms. The preceding birth technique is such a tool that could be introduced in routine data collection in the district. The baseline child mortality rate generated from currently pregnant mothers that can be used later in monitoring mortality (and health status) trends for this district. Although this study recruited mothers in a household survey, these questions are routinely asked at health units during the antenatal visits, which are attended by more than 90% of pregnant mothers(3). The simplicity in analysis of the information would make this a feasible tool to use at the health units and in the community. There are, however, two main limitations. For the method to be useful, it requires a sample size of at least 1000 mothers.

The annual rate of mortality for the under-two may be a good indicator for mortality trends, but it is more difficult to estimate in a clinic or a community setting for it requires computing the person-years at risk.

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