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Perinatal Mortality in Northern Rural Tanzania

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ABSTRACT

The study was conducted to investigate the association between perinatal mortality and factors relating to nutrition and infections in a rural population in northern Tanzania. A cohort of 3,618 women attending antenatal clinics was registered with background information and the results of antenatal examinations, and followed up after delivery. Stillbirths and neonatal deaths were identified and traced for an interview with the closest relatives. No information on outcome of pregnancy was obtained for seven women, and incomplete information was obtained for 99. The perinatal mortality rate was 27/1,000 births [95% confidence interval (CI) 22/1,000-33/1,000]; 44% were early neonatal deaths; and 56% were stillborn. There was an increased risk of perinatal death among babies with low birth-weight [for babies weighing 2,000-2,499 g, adjusted odds ratio (AOR) 5.8, 95% CI 2.1-15.8, babies below 2,000 g AOR 45.7; 95% CI 18.3-114.1], babies of women with a small arm circumference (below 23 cm, AOR 5.3, 95% CI 1.3-22.2), babies of women with positive VDRL serology (AOR 5.1, 95% CI 1.0-25.7), babies of mothers who had previously lost a baby (AOR 1.9, 95% CI 1.1-3.2), and among babies of nulliparous women (AOR 1.7; 95% CI 1.0-3.0). Infections and nutritional deficiencies should be addressed at antenatal clinics.

***Key words*:** Reproductive health; Perinatal mortality; Emergency obstetric care; Birth-weight; Arm circumference; Syphilis; Nutrition; Infection; Anaemia; Prospective studies; Cohort studies; Tanzania

INTRODUCTION

Perinatal deaths include stillborn babies (SB) of more than 28 weeks of gestation and deaths occurring within the first week of life (early neonatal deaths). According to the World Health Organization (WHO), it is estimated that, globally in 2000, perinatal conditions took more than 2.4 million lives, representing 4.4% of all deaths in the world (1). The perinatal mortality rate (PMR), which means number of perinatal deaths per 1,000 births, has been regarded as an indicator of the quality of prenatal, obstetric and neonatal care in an area, which also reflects the maternal health and socioeconomic environment. PMRs in developed countries with good perinatal care are below 10, whereas in sub-Saharan Africa, the PMR is usually between 40 and 120 (2).

The efforts to reduce perinatal and maternal mortality are outlined in the "Mother-Baby Package" of WHO with an integrated approach, recognizing that all pregnancies are at risk of obstetric complications, not just the 'high-risk' group (3). Still, risk factors detectable at antenatal clinics may identify women who may benefit from targeted interventions during pregnancy, particularly for infections and nutritional problems.

We have conducted a prospective cohort study among women attending antenatal clinics in Mbulu and Hanang districts in northern Tanzania. The area has a high antenatal attendance and relatively good and accessible emergency obstetric care, but no studies on perinatal mortality had been done there. Our objective was to study the association between perinatal mortality and factors relating to nutrition and infection.

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MATERIALS AND METHODS

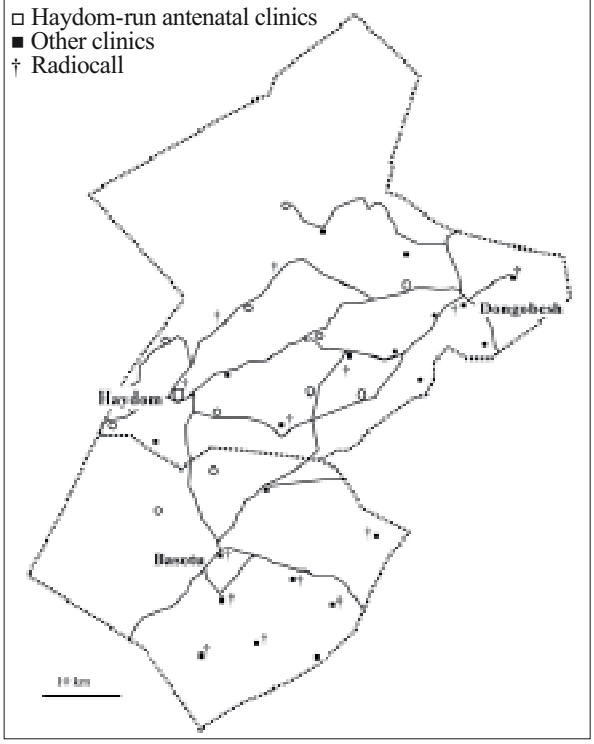
Study area

The study area was in Dongobesh division (Mbulu district) and Basotu division (Hanang district), situated in the northern highlands of Tanzania at an altitude of 1,700 (range 1,300-2,200) metres above sea-level. It is a rural area of 42 villages with an estimated population of around 143,000 (1995), most of whom were peasants with small fields and livestock. Anaemia, malaria, and urinary tract infections were common conditions among the pregnant women in this area (4,5). The prevalence of HIV infection among pregnant women was below 0.5%.

Healthcare services

The healthcare services were provided by both governmental and non-governmental institutions, all of them reporting to the District Medical Officers. The largest health facility was Haydom Lutheran Hospital, owned and run by a local church, which had an extensive mother-and-child-health (MCH) programme. In 12 surrounding villages, there were outreach 'mobile' MCH clinics operated once a month by a team from the hospital. A household survey in the area indicated that more than 90% of the women who had delivered during the previous year had attended an antenatal clinic at least once before delivery (unpublished data, 1996). The hospital had 300 beds, a maternity department caring for around 2,000 deliveries a year, a neonatal unit with oxygen concentrators and temperature regulation, and a good surgical department. The hospital budget depended partly on patient fees, but delivery admissions were offered at lower cost than other admissions (around US$ 5 for an uncomplicated delivery). An ambulance service, giving priority to obstetric cases, was coordinated from the hospital, and the cost was added to the hospital bill and paid at the time of discharge from the hospital. There were no telephones in the area, but there was a 24-hour communication system with VHF-radios placed in the hospital, in the ambulances, and in peripheral villages (Fig. 1). The solar battery-powered peripheral radios were installed in the homes of knowledgeable persons on good terms with the people. The public transport to the hospital consisted of daily bus connections via the three main roads, with unpredictable time schedules. Roads were of dirt or gravel, some of which became temporarily impassable by car after heavy rains. The distance from the selected villages to the hospital ranged from 0 to 60 km, up to 10 hours of walking. The hospital, the surrounding villages, and the district council collaborated in the construction of feeder roads, bridges, and drifts, thereby increasing the accessibility of health services.

Fig. 1. Study sites in Mbulu and Hanang districts, Tanzania



The estimated number of births in 1995 in the study area was 6,800, based on the 1988 census (6), an annual growth rate of 3.8% (7), and a crude birth rate of 47.7/1,000 (8).

Data collection

All women (5,239) attending the 13 antenatal clinics of Haydom Lutheran Hospital (HLH) between January 1995 and March 1996 were registered with name, date, address, age, ethnicity, religion, gestational age, and obstetric history. Parity was defined as the number of previous viable pregnancies, and a primipara had no prior viable pregnancy. For gestational age, we used the number of months indicated by the mother, since exact date of the last menstrual period was difficult to obtain. The estimated month of delivery was calculated based on the gestational age and date of antenatal visit. We screened for haemoglobin (Hb) concentration, malaria parasites, and urinary tract infections (UTIs). The methods and results of the screening procedures have

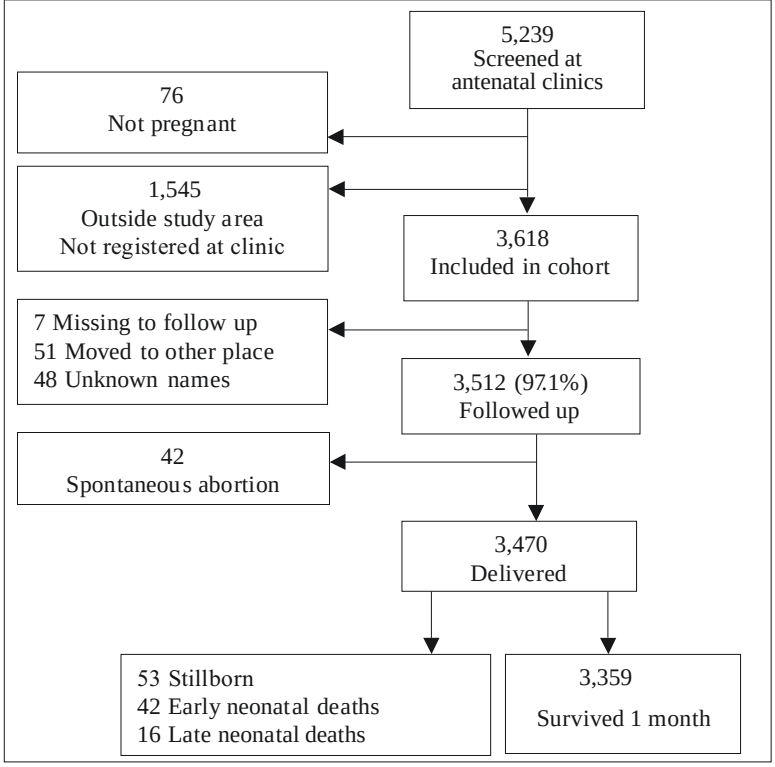
been presented elsewhere, and treatment was given free of charge according to the results (4,5). A detailed obstetric history was obtained from a sample of 640 of these attendants selected for studying anaemia (9) and for studying UTIs. The arm circumference was obtained in 454 of these 640 women and was measured to the nearest ½ cm, halfway between *olecranon* and *acromion*. Four hundred fifty of the 640 women were selected for the UTI study based on the results of their urinary examination. Three hundred twelve of the 640 women were selected for the anaemia study based on their Hb-value (aiming at roughly equal numbers in each of the Hb strata <90 g/L, 90-109 g/L, 110-129 g/L, ≥130 g/L, thus a higher representation of anaemic women in this selected group). We examined VDRL (Venereal Diseases Research Laboratory) serology on the last 146 consecutive sera available from women who were selected for the anaemia study. We were not able to perform confirmatory tests on the sera. Women with positive serology and their spouses were offered standard treatment free of charge (Benzatin penicillin 1.8 g i.m. weekly for three weeks).

Of the 5,239 women who were screened at the antenatal clinics, we excluded 77 whom we later discovered not to be pregnant, and 1,542 who were living outside Basotu and Dongobesh divisions or were registered before at another clinic (Fig. 2). The remaining 3,618 women were included in follow-up for pregnancy outcome. We knew the outcome of pregnancy for 3,512 (97.1%) of the 3,618 women in the cohort. We failed to get complete information about 106 (2.9%) women; 51 of the women had moved, 48 had registered with fictitious names that were not recognized in the villages, and 7 (0.2%) could not be traced. Compared to the 3,512 women with known survival status at one week, these 106 women had a higher proportion of nulliparae, the other background characteristics being similar.

Most women (2,180) were followed up on the first visit after delivery at the clinic, usually after one month. Information on place of delivery was recorded. Women who were primigravida, who had experienced problems during previous deliveries, or who had abnormal findings during antenatal clinic, were encouraged to deliver at the hospital, but many other women also delivered there by choice. Birth-weight was available only for the babies born at the hospital (n=774), where the babies were weighed immediately after birth with a precision of the nearest 10 g on a balance-scale. Babies born at home were recorded as small, medium, or big according to the mothers' estimates. The women who did not return with their children to the clinics were traced in their home villages and asked about the outcome of the pregnancy and time of delivery. If the child had died, we interviewed the mother or the father about symptoms and circumstances of death (verbal autopsy) for a tentative diagnosis.

ICD-10 defines 22 weeks of gestation as the starting point of the perinatal period (10). For practical reasons, we used the old definition of 28 weeks in this study, as the survival of very small pre-term babies needs facilities and skills that are not accessible in most developing countries. VDRL was done on available sera.

Fig. 2. Study participants at antenatal screening, postpartum follow-up, and status of offspring, Mbulu and Hanang districts in Tanzania, 1995-1996



Statistical methods

For data entry, we used Epi Info version 5.0 and 6.04 (11). For analysis of the data, we used SPSS version 9.0 (12). We used the odds ratio (OR) of perinatal death as an approximation of the relative risk. The adjusted ORs were obtained in multiple logistic regression analysis, with adjustments for parity and prior loss of child. Other adjustments reported in the results are not shown in the table. The estimates are given with 95% confidence interval (CI).

Ethical considerations

The research protocol was approved by the National Committee for Research Ethics in Medicine (NEM) in Norway and by the Commission for Science and Technology in Tanzania (COSTECH). Prior to the field study, the Regional Development Officer, the District Commissioners, and the leaders of wards and villages had given consent. The local people had been informed about the study through gatherings in the villages. Verbal consent was also obtained from each participant.

RESULTS

Mortality rates

There were 53 stillborn babies and 42 early neonatal deaths among the 3,470 births (Fig. 2), representing a perinatal mortality rate (PMR) of 27 per 1,000 births

Table. Risk (odds ratio, and adjusted odds ratio) of perinatal death among the offspring of women attending antenatal clinics in Mbulu and Hanang districts, Tanzania, 1995-1996

Risk factor	No.*	Deaths (%)	OR (95% CI)	AOR (95% CI) †
Demographic factor				
Age (years)				
<20	214	9 (4.2)	1.8 (0.9-3.7)	1.7 (0.8-3.8)
20-29	2,071	49 (2.4)	Reference	Reference
≥30	1,025	35 (3.4)	1.5 (0.9-2.3)	1.4 (0.8-2.6)
No information	202			
Residence (ward)				
Dong/Tumati/Bashay	584	16 (2.7)	1.5 (0.8-2.8)	1.5 (0.8-2.8)
Maghang/Maretadu	1,467	27 (1.8)	Reference	Reference
Haydom	769	23 (3.0)	1.6 (0.9-2.9)	1.6 (0.9-2.8)
Basotu/Basodesh	575	27 (4.7)	2.6 (1.5-4.5)	2.6 (1.5-4.6)
Other	117	2 (1.7)	0.9 (0.2-4.0)	1.1 (0.3-4.5)
Distance to hospital (hours)‡				
0-1	638	21 (3.3)	Reference	Reference
1-2	1,784	43 (2.4)	0.7 (0.4 -1.3)	0.7 (0.4 -1.2)
2-3	923	18 (2.0)	0.6 (0.3-1.1)	0.6 (0.3-1.1)
over 3	273	12 (4.4)	1.35 (0.6-2.9)	1.4 (0.9-2.8)
Tribe				
Iraqw	1,480	52 (3.5)	Reference	Reference
Datooga	238	11 (4.6)	1.3 (0.7-2.6)	1.3 (0.7-2.5)
Other	37	1 (2.7)	0.7 (0.1-5.7)	0.7 (0.1-5.3)
No information	1,757			
Religion				
Protestant	851	29 (3.4)	Reference	Reference
Catholic	435	16 (3.7)	1.1 (0.6-2.0)	1.1 (0.6-2.1)
Other	430	17 (4.0)	1.2 (0.6-2.1)	1.2 (0.6-2.2)
No information	1,796			
Obstetric and medical factor				
Season at delivery¶				
January-June 1995	338	3 (0.9)	0.4 (0.1-1.3)	0.6 (0.2-2.0)
July-September 1995	516	12 (2.3)	1	1
October-December 1995	633	28 (4.4)	1.9 (1.0-3.9)	1.8 (0.9-3.6)
January-March 1996	865	17 (2.0)	0.8 (0.4-1.8)	0.8 (0.4-1.8)
April-June 1996	667	19 (2.8)	1.2 (0.6-2.6)	1.2 (0.6-2.5)
July-December 1996	141	6 (4.3)	1.9 (0.7-5.1)	1,7 (0.6-4.7)
No information	352			

Contd...

Table contd...

Risk factor	No.*	Deaths (%)	OR (95% CI)	AOR (95% CI) †
Parity				
Para 0	609	20 (3.3)	1.5 (0.9-2.5)	1.7 (1.0-3.0)
Para 1-5	2,101	48 (2.3)	Reference	Reference
Para 6+	647	25 (3.9)	1.7 (1.1-2.8)	1.4 (0.8-2.4)
No information	155			
Death of previous child				
No previous death	2,405	58 (2.4)	Reference	Reference
Previous death	754	33 (4.4)	1.9 (1.2-2.9)	1.9 (1.1-3.2)
No information	353			
Spontaneous abortions				
No previous abortion	2,717	77 (2.8)	Reference	Reference
Previous abortion	397	11 (2.8)	1.0 (0.5-1.9)	0.9 (0.5-1.8)
No information	398			
Birth-weight (g)§				
≤2,500	699	18 (2.6)	Reference	Reference
2,000-2,499	47	6 (12.8)	5.5 (2.1-14.7)	5.8 (2.1-15.8)
<2,000	28	15 (53.6)	43.6 (18.1-105.0)	45.7 (18.3-114.1)
No information	2,738			
Maternal estimate of baby**				
Not small	1,365	66 (4.8)	Reference	Reference
Small baby	109	16 (14.7)	3.4 (1.9-6.1)	3.3 (1.8-6.1)
No information	2,038			
Maternal U-nitrite				
Negative	2,110	51 (2.4)	Reference	Reference
Positive	1,288	42 (3.3)	1.4 (0.9-2.1)	1.3 (0.9-2.0)
No information	114			
Maternal anaemia				
Hb <90 g/L	130	5 (3.8)	1.6 (0.5-4.3)	1.7 (0.6-4.5)
Hb 90-109 g/L	489	15 (3.1)	1.2 (0.6-2.4)	1.4 (0.7-2.6)
Hb 110-129 g/L	1,338	33 (2.5)	Reference	Reference
Hb ≥130 g/L	927	31 (3.3)	1.4 (0.8-2.3)	1.4 (0.9-2.4)
No information	628			
Maternal malaria				
Negative	2,272	60 (2.6)	Reference	Reference
Positive	520	16 (3.1)	1.2 (0.7-2.0)	1.1 (0.6-1.9)
No information	720			
Maternal VDRL status††				
Negative	125	4 (3.2)	Reference	Reference
Positive	21	3 (14.3)	5.1 (1.0-24.4)	5.1 (1.0-25.7)
No information	3,366			
Maternal arm circumference (cm)‡‡				
≥25	309	8 (2.6)	Reference	Reference
23-24.9	123	5 (4.1)	1.6 (0.5-5.0)	1.5 (0.5-4.7)
<23	22	3 (13.6)	5.9 (1.5-24.2)	5.7 (1.3-24.2)
No information	3,058			

* There were different numbers of missing values

† Adjustment for parity and prior loss of child

‡ Estimated collection time from request until arrival at hospital, based on ambulance records

¶ Estimated date of delivery was calculated using date of attendance and gestational age

§ Birth-weight was available only for hospital deliveries

** Mother's estimate of child size, categorized as small, medium, and big, in home deliveries

†† VDRL was examined in available sera in a small sub-sample selected for studying anaemia

‡‡ Arm circumference was measured in a sub-sample selected for a study on anaemia and UTI

AOR=Adjusted OR; CI=Confidence interval; OR=Odds ratio; VDRL=Non-specific test for syphilis made by Venereal Diseases Research Laboratory; UTI=Urinary tract infection

(95% CI 22/1,000-33/1,000). Altogether, there were 58 neonatal deaths among 3,417 liveborn babies, giving a neonatal mortality rate of 17 per 1,000 livebirths (95% CI 13/1,000-21/1,000). Thirty-nine percent of the deaths occurred at home, 5% at dispensary or health centre, and 51% in hospital.

Circumstances of delivery

Place of delivery was reported by most study women (n=2,274). Fifty-eight percent of them had delivered at home, 38% in a health institution, and 4% on the roadside while going to a health facility to deliver. Among the primigravidae, 66% had delivered at a health institution. Among the women delivering at home, 18% had nobody to help them, and 81% had an untrained helper, usually the mother-in-law.

Demographic factors

The women resident in Basotu/Basodesh wards had a higher risk of experiencing a perinatal death than the women in Maghang/Maretadu wards (AOR 2.6; 95% CI 1.5-4.6). Within those wards, most deaths occurred in one village, where 13 of 197 pregnant women lost the baby, corresponding to a PMR of 66/1,000. The estimated ambulance-collection time was not significantly associated with the risk of perinatal death (Table), nor was the distance from home to the hospital (not in the table). The risk of perinatal death was not significantly associated with maternal age, ethnicity, religion, and season of delivery (Table).

Obstetric risk factors

The primiparae had an increased risk of perinatal death compared to women of parity 1-5 (AOR 1.5, 95% CI 1.0-3.0). Women with high parity (6 or more prior deliveries) showed an increased risk of perinatal loss in the unadjusted analysis (OR 1.7; 95% CI 1.2-2.8), whereas the risk was not significant after adjustment for loss of a previous child and parity.

The OR was almost doubled among women who had experienced the death of a child in a previous pregnancy. The risk estimate remained after adjustment for age, parity, season, birth-weight, and living place (AOR 1.9; 95% CI 1.0-3.0). We observed no relationship between previous spontaneous abortions and perinatal death (Table).

Low birth-weight was strongly associated with perinatal death. Half of the babies with birth-weight below 2,000 g died, whereas 2.6% of the babies weighing 2,500 g and above died, corresponding to a relative risk of 20 (AOR 45; 95% CI 18.3-114). The OR estimates shown in Table did not change notably after adjustment for the other variables in the table. For babies born at home, we found a threefold increased risk of perinatal death among babies who were estimated by their mothers to be small (AOR 3.3; 95% CI 1.8-6.1).

Maternal health characteristics as risk factors

The risk of perinatal death was not significantly associated with a positive u-nitrite, anaemia, high Hb, and malaria parasitaemia in the pregnant women (Table). Women with a positive s-VDRL had a significantly increased risk of perinatal death compared to sero-negative women (Table). Adjustment for the other factors in the table had only marginal effect on the estimates. A significantly increased risk of perinatal death was observed among women with an arm circumference below 23 cm compared to 25 cm and above (AOR 5.7; 95% CI 1.3-24.2, Table).

DISCUSSION

Perinatal mortality rate

Our study estimated the PMR to be 27/1,000 births, which is lower than in other studies from Tanzania. Population-based studies have shown 82/1,000 (13), 68/1,000 (14), and 58 per 1,000 births (15), the most recent studies with the lowest estimates. The relatively low PMR in the study area was striking, but no clear scientific evidence could explain it; informal speculation could partly associate it with the health services in the study area, and their use by the population. Emergency obstetric services were better and more accessible than in many other parts of rural Tanzania. These services had a good reputation and were well-known to everybody in the area. The hospital was used by women of all socioeconomic levels, and no fees or payments were required in advance for admission. The delay in transportation may have been substantially minimized by the ambulance services, which could be requested through peripheral radio-stations. Some other areas in Tanzania have started village-based initiatives to improve emergency transportation (16).

This study included only the antenatal clinics of HLH in the area, which covered around half of the expected pregnancies in the area (Fig. 1). This is a potential source of selection bias, which could result in a too low PMR estimate. However, there was a very high antenatal

coverage in the area. The women would usually choose the clinic closest to their homes, and the choice was probably not associated with the risk of perinatal death. Therefore, we think that the estimate is quite representative for the study area.

It can be argued that some deaths were missed and led to a lower estimate of PMR. Of the 3,618 women included for follow-up, we failed to get any information about seven women (0.2%). Even if all seven experienced perinatal death, the PMR would have increased only slightly (29/1,000). Incomplete information was obtained on 99 cases (2.7%). The women who had moved to another district (n=51) were not available for complete information on the outcome of pregnancy. However, their neighbours and the village leaders were not aware of any loss of offspring among these women, and deaths were usually well-known among neighbours. Some participants, whom we failed to follow up, were not known in the village they had indicated (n=48). It was quite common in this area that some pregnant women wanted to be anonymous and, therefore, stated false name, name of husband, and address during registration at the antenatal clinics. There was a higher proportion of nulliparae among the women missing to follow up compared to those who were followed up, other background characteristics being similar. Although a few women could be missing due to the death of a mother or a child, there are no clear reasons that the risk of perinatal death should be different in this group from the rest of the cohort.

In a household survey in the study area, we found 14 perinatal deaths among 370 births, giving a PMR of 38/1,000 births (95% CI 18/1,000-57/1,000), which is consistent with our results from this prospective cohort study. The PMR among women delivering at the HLH, which was the only hospital in the study area, was 51/1,000 births in 1996 (17). The hospital-based PMR is likely to be higher than the population-based perinatal mortality in the community, since many high-risk deliveries are referred to the hospital (3). Other hospital-based studies in East Africa have shown a higher PMR than in the HLH, e.g. in rural Machakos, Kenya 65/1,000 births (18), and in Mwanza, Tanzania, 96/1,000 births (14).

The population-based rate of caesarean section (CS) was 2.0% in 1995 (17). This is lower than the WHO lower limit of 5% (3), but substantially higher than the rates reported from rural Mwanza (0.5%) (15) and Kenya (0.95%) (19). The hospital-based CS rate in 1995 was 10%. There is potential for still increasing use of emergency obstetric services in the area, and this is also underscored by the fact that around 40% of the perinatal deaths occurred at home, and 50 % of the perinatal deaths were among those who were delivered at home, consistent with findings from rural Kenya (18).

Demographic risk factors

The increased risk of PMR in the Basotu ward was confined to only one village. The PMR was double in this village compared to the others. The reason for this is not found in the data. The cause of death did not show any clue to a common causal factor. It may have been coincidental, even though it was statistically significant at the 95% confidence level.

We did not find any significant association between the distance to the hospital and perinatal death. Previous studies in Tanzania have shown that women living close to a health facility are more likely to deliver there than those living farther away (20), which was also found in our study. However, the distance need not influence the perinatal mortality if accessible transport is available to bring complicated cases from home deliveries rapidly to hospital.

Obstetric risk factors

First pregnancies and high parity have been associated with poor perinatal outcome (21-23). Our findings were compatible with these studies, and the risk estimates were comparable, although not statistically significant for nulliparae. The increased risk of perinatal death among women of high parity was partly due to confounding by the loss of previous child (significant OR 1.7 reduced to insignificant AOR 1.4, adjusting for prior loss of child, Table). This may indicate that high parity may partly be a marker of bad obstetric history and not represent an increased risk in itself. Similar results have been observed in other settings (24,25).

The women who had experienced the death of a previous child had an almost double risk of losing the child in the perinatal period. This is also shown in other studies (21,23,26), and adjustment for parity, age, and birth-weight did not affect the estimates much. The findings underscore the importance of identifying women with previous loss of child and advising them to deliver at a health facility.

Low birth-weight is one of the most important determinants of perinatal death (27), and our findings

are consistent with this. Even our data on babies from home deliveries without birth-weight measurements showed the same trend, using the mothers' estimate of the size of their babies instead of the birth-weight. Since birth-weight was available only for hospital deliveries, it raises a question of whether there was a selection of babies to the hospital with poor condition *and* low birth-weight, thereby making the OR for perinatal death among low-birth-weight babies higher than it really was for the complete cohort. There may be some truth in this assumption as preterm babies would often be born at home and brought to the hospital only if their condition was not good, and the birth-weight measured some hours after birth. If so, there would have been a selection of small babies in poor condition for analysis of perinatal death by birth-weight, and this would increase the OR for the low-birth-weight babies. Low birth-weight is not easily prevented, but needs to involve both prevention and treatment of infections (28,29), and nutritional factors (30).

Maternal health indicators as risk factors

UTIs have been associated with an increased risk of perinatal death (31). Our results were compatible with a moderately increased risk, but the associations were not significant at the 95% confidence level. Urine nitrite examination is not an effective way of identifying pregnancies at risk for perinatal death.

We did not find any statistically significant association between a maternal malaria parasitaemia and perinatal death, but our estimate was compatible with a small increased risk. Malaria is an important killer disease in this area, especially among children (32). There is, however, not always a good correlation between the level of parasitaemia and its clinical manifestations, and malaria can occur without microscopically detectable parasitaemia (33). Routine antenatal screening for malarial blood-slide does not reliably identify individuals at risk of perinatal death.

We found a significantly increased risk of perinatal death among women who had a positive VDRL serology. The increased risk was similar to that in a study from Malawi, which showed an eight-fold increased risk of perinatal death among women with active syphilis (judged by the combination of VDRL and specific *Treponema pallidum* serology) (34). The foetal hazards of syphilis are well-recognized in the literature (35). The Tanzanian national policy for antenatal care and the WHO recommend early VDRL testing of pregnant women, but it is rarely performed routinely at antenatal clinics in Tanzania. In our small sub-sample, 16% of the women examined for VDRL were positive, similar to a survey among pregnant Masai women in Kenya (36). The staff at antenatal clinics should be aware of syphilis and other sexually transmitted infections, and investment in syphilis testing and management according to the result is probably worthwhile where facilities permit. However, in our material there may be a substantial proportion of false-positive VDRL. In the study from Malawi mentioned above, more than half of the VDRL positives were negative in specific *T. pallidum* tests. Known causes of biological false-positive VDRL serology include pregnancy, malaria, hepatitis, brucellosis, tuberculosis, and typhoid fever, and all are common in this area. Thus, VDRL may be a marker not only of syphilis, but various other infections as well.

Arm circumference has been regarded as an indicator of nutritional status, as it corresponds well to pre-pregnancy body weight, and it is relatively independent of the physiological changes during pregnancy (37,38). The specificity is low, however, since a small arm circumference may also be due to other reasons, such as genetic disposition and physical activity. Women with a very small arm circumference had a significantly increased risk of perinatal death compared to the women with normal arm circumference. Some over-estimation of the effect is theoretically present as the selection of subjects for arm circumference was over-represented by anaemic women and women with urinary infections. However, no significant effect on perinatal mortality of maternal anaemia and UTI was shown in the sample, so the effect of arm circumference on perinatal death is likely not due to selection bias. Arm circumference may be a useful tool for midwives to identify pregnancies at risk. Management strategies for poor nutrition need more than micronutrient supplementation and food recommendations as the ability to follow the advice will be severely hampered by poverty.

The PMR observed in our study population was lower than in many other parts of Tanzania. It may possibly be due to the available emergency obstetric care, which was used by a large proportion of the mothers in our study. Delay may have been minimized by the existing ambulance service, where patients could request assistance by a radio-communication system. Low birth-weight was, not surprisingly, the strongest predictor of perinatal death. Maternal infections, signs of poor maternal nutrition, previous loss of child, and first

pregnancies were also risk factors for perinatal death and should be addressed at antenatal clinics.

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