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Anaemia during pregnancy in southern Tanzania

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Anaemia in pregnancy is associated with maternal morbidity and mortality and is a risk factor for low birthweight. Of 507 pregnant women recruited in a community, cross-sectional study in southern Tanzania, 11% were severely anaemic (<8 g haemoglobin/dl). High malarial parasitaemia [odds ratio (OR) = 2.3] and iron deficiency (OR = 2.4) were independent determinants of anaemia. Never having been married (OR = 2.9) was the most important socio–economic predictor of severe anaemia. A subject recruited in the late dry season was six times more likely to be severely anaemic than a subject recruited in the early dry season. Compared with the women who were not identified as severely anaemic, the women with severe anaemia were more likely to present at mother-and-child-health (MCH) clinics early in the pregnancy, to seek medical attention beyond the MCH clinics, and to report concerns about their own health. Pregnancy-related food taboos in the study area principally restrict the consumption of fish and meat. Effective anti-malaria and iron-supplementation interventions are available but are not currently in place; improvements in the mechanisms for the delivery of such interventions are urgently required. Additionally, opportunities for contacting the target groups beyond the clinic environment need to be developed.

About 24 million women in sub-Saharan Africa are pregnant at some time during the course of a year and it has been estimated that two-thirds of all pregnant and half of all non-pregnant women in Africa are anaemic (DeMaeyer and Adiels-Tegman, 1985; WHO, 1992). Anaemia contributes significantly to maternal morbidity, causing incapacity from tiredness, breathlessness and a reduced ability to work (Menendez, 1995). There is also evidence that anaemia is related to the risk of maternal mortality (Brabin *et al.*, 2001); severe anaemia during pregnancy has been reported as the main cause of up to 20% of maternal deaths in some hospital series in sub-Saharan Africa (Armon, 1979; Mtimavalye *et al.*, 1980) and 11%–13% in community-based studies (Boerma and Mati, 1989). In addition, maternal anaemia is a risk factor for low birthweight (Deleron *et al.*, 1989; Brabin, 1991), which is an important risk factor for infant mortality (McCormick, 1985; Guyatt and Snow, 2001).

For a variety of reasons, including haemodilution and increased demand on iron and folate stores, pregnant women are more likely to be anaemic than non-pregnant women. In sub-Saharan Africa, malaria, iron deficiency (often exacerbated by hookworm infection), other nutritional factors, sickle-cell disease and, increasingly, infection

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with HIV are also important risk factors for anaemia among pregnant women (Fleming, 1989).

The results of a large-scale study in southern Tanzania indicated a high mortality ratio of about 977 maternal deaths/100,000 live births, with anaemia amongst the top five causes of the maternal deaths (Anon., 1997). In the Kilombero Valley, Tanzania, >40% of children have severe anaemia, as indicated by haemoglobin (Hb) concentrations of <8 g/dl blood (Menendez *et al.*, 1997; Abdulla *et al.*, 2001). The main aims of the present study were to quantify the problem of (and risk factors for) anaemia amongst pregnant women in Kilombero. In addition, the use of the health services and local dietary restrictions were examined, with a view to facilitating the targeting of measures for reducing anaemia during pregnancy.

SUBJECTS AND METHODS

Study Area

The methodology and setting of this study have already been described (Armstrong Schellenberg *et al.*, 1999; Marchant *et al.*, 2002). In brief, the investigation was conducted in Ulanga district, in the Kilombero River valley in southern Tanzania. The area is rural and the population mainly consists of subsistence farmers, who grow rice, maize and cassava. It is an area of intense perennial transmission of malaria (Smith *et al.*, 1993), with a peak during the rainy season (November–May). Data collected by local health services indicate that malaria is the principal cause of morbidity, with anaemia amongst the top 10 causes (Tanner *et al.*, 1991). Within the study area are three mother-and-child-health (MCH) clinics (at Kivukoni, Milola and Lupiro) and one health centre (at Lupiro).

Recruitment and Consent

A cross-sectional study was carried out, with rolling recruitment of all pregnant women from six villages close to the Ifakara Health Research and Development Centre (IHRDC), over a period of 12 months (September 1998–August 1999). Pregnant women were identified using the demographic surveillance system (DSS) established in 1996 by the IHRDC and the Kilombero Net Project (KINET). This system covers approximately 60,000 people living in 25 villages (Armstrong Schellenberg *et al.*, 2002).

A nurse travelled daily into the study area to identify, recruit and interview the pregnant women. A detailed description of the project was given and written consent obtained before proceeding with each interview. The detailed questionnaire used to record information included questions about socio-economic status, fertility, use of health facilities, food taboos and use of insecticide-treated bednets (ITN). Access to cash was assessed according to whether the interviewee had her own income (i.e. some financial autonomy), had access to pooled household money only or had no access to any cash. All interviews were conducted in Kiswahili, which is widely spoken in the study area, and each subject was interviewed only once. Ethical clearance was obtained from the IHRDC and the Tanzania Commission of Science and Technology.

Clinical Examinations

At the time of the interview, each subject was examined by abdominal palpation, to assess gestational age. Mid-upper arm circumference (MUAC) was measured using a simple tape [Teaching-aids At Low Cost (TALC), St Albans, U.K.]. The weight and height of each subject were recorded and used to calculate body mass index (BMI) in kg/m^2. MCH clinic cards were used to record use of the antenatal services.

The Hb concentration in the blood of each subject was also determined at the time of interview, using a portable β-haemoglobin photometer (Hemocue®; HemoCue AB, Ängelholm, Sweden). Any woman found to have <11 g Hb/dl was given the standard

first-line treatment for anaemia in the study area: chloroquine phosphate (10, 10 and 5 mg/kg, on days 0, 1 and 2, respectively), ferrous sulphate (200 mg twice daily for 14 days) and folic acid (5 mg once daily for 14 days). Thick and thin bloodsmears were made on site and a 1-ml sample of capillary blood was collected from each woman, into a Microtainer® coated with EDTA (BD, Franklin Lakes, NJ), and transported back to the IHRDC laboratories at 4°C. Subsequently, each of these whole-blood samples was centrifuged and the cell pellet and supernatant plasma were then stored separately at −20°C, for later Hb genotyping and HIV testing, repectively (see below).

Whenever possible, a stool sample was also collected from each subject and placed in a capped tube containing 10% formalin solution.

Laboratory Procedures

On the same day as the corresponding interview, the thick bloodsmear was stained with Giemsa and the number of malarial parasites/200 leucocytes was counted. These counts were converted into parasite densities (parasites/μl) assuming each subject had 8000 leucocytes/μl. Hookworm eggs were detected in the stool samples after formalin–ether concentration. Results for the hookworms were expressed semi-quantitatively, as negative, low-density positive (one egg/field, at a magnification of ×400) or high-density positive (more than one egg/field). The following day, the relevant first-line treatments for those found to have malarial parasitaemias (10, 10 and 5 mg chloroquine phosphate/kg on days 0, 1 and 2, respectively) or hookworm (500 mg albendazole as a single dose) were distributed.

At the end of the recruitment period, sickling tests to detect Hb genotype by electrophoresis, slide reading to detect microcytic/hypochromic red cells as an indicator of iron deficiency, and ELISA for HIV seropositivity (Veronostika HIV Uni-Form II *plus O* microELISA system; Organon Teknika, Boxtel, Netherlands) were carried out for all the subjects.

Data Analysis

Data were entered and checked for consistency using version 2.6 of the Foxpro software package (Microsoft, Seattle, WA) and analysed using Stata version 7 (Stata, College Station, TX). Proportions were compared using χ^2 tests; Fisher's exact test was used where cells had fewer than 10 observations. Geometric mean densities of the malarial parasites (parasites/μl) were calculated and then compared, like all the continuous variables, using Student's *t*-tests. Logistic regression was used to calculate odds ratios (OR) and their 95% confidence intervals (CI). Factors associated with severe anaemia (i.e. those giving *P*-values of <0.1 in the χ^2 tests) were examined by multiple logistic regression, with anaemia as a dichotomous response variable. Severe anaemia was defined as an Hb concentration of <8g/dl. A malarial parasitaemia was considered high-density if it exceeded the median value (1180 parasites/μl). Iron deficiency was indicated by the presence of both hypochromic and microcytic erythrocytes. In the risk-factors model, a likelihood ratio with a *P*-value of <0.05 was taken to be statistically significant. The study year was divided into three seasons according to rainfall data kindly provided by C. Golding of the Kilombero Valley Teak Company; recruitment started in the late dry season (September–November), ran through the rainy period (December–May) and ended in the early dry period (June–August).

RESULTS

Although 671 pregnant women were identified during the study period only 507 (75%) were recruited. Of the 164 non-recruited women, 97 had delivered, 36 had moved away, 14 had miscarried, 14 could not be

traced and three had died before they could be recruited. None of those asked to participate refused. Mean gestational age at interview, both for primigravidae and multigravidae, was 30 weeks. The sickle-cell trait (AS genotype) was found in 14% (70) of the recruited women but these women showed similar patterns of morbidity and had similar socio–economic characteristics to those without the sickle-cell trait (data not shown) and were therefore included in the data analysis.

Prevalence of Severe Anaemia and the Associated Main Risk Factors

The risk-factor analysis was based on the 413 recruited women from whom complete anthropometric, haemoglobin and laboratory data were obtained. The distribution of Hb concentrations is shown in the Figure. The prevalence of severe anaemia and the associated main risk factors are summarized in Table 1. Forty-four (11%) of the 413 women had <8 g Hb/dl. After adjustment, high-density malaria parasitaemia (OR = 2.3; CI = 1.0–5.7), iron deficiency (OR = 2.4; CI = 1.1–4.9) and recruitment during the late dry season (OR = 6.2; CI = 2.3–16.4) appeared as independent determinants of severe anaemia. There was no evidence of a direct association between iron deficiency and hookworm infection, the prevalences of iron deficiency being 25% (73/287), 21% (24/113) and 27% (11/40) amongst the women with no hookworm eggs, low egg burdens and high egg burdens in their stools, respectively ($P = 0.6$). However, there was evidence that high burdens of hookworm eggs did exacerbate iron-deficiency anaemia in the study setting: the prevalence of severe anaemia amongst those with iron deficiency was particularly high [45% (5/11)] for the women with high egg burdens ($P = 0.01$).

Women who had never married were three times more likely to be severely anaemic than those who had ever married (OR = 2.9; CI = 1.1–7.5). The increased risk for teenagers and primigravidae indicated by the bivariate analysis disappeared after adjusting for other factors, although the never married women in this study were predominantly young primigravidae (data not shown) and inter-relationships are difficult to disentangle.

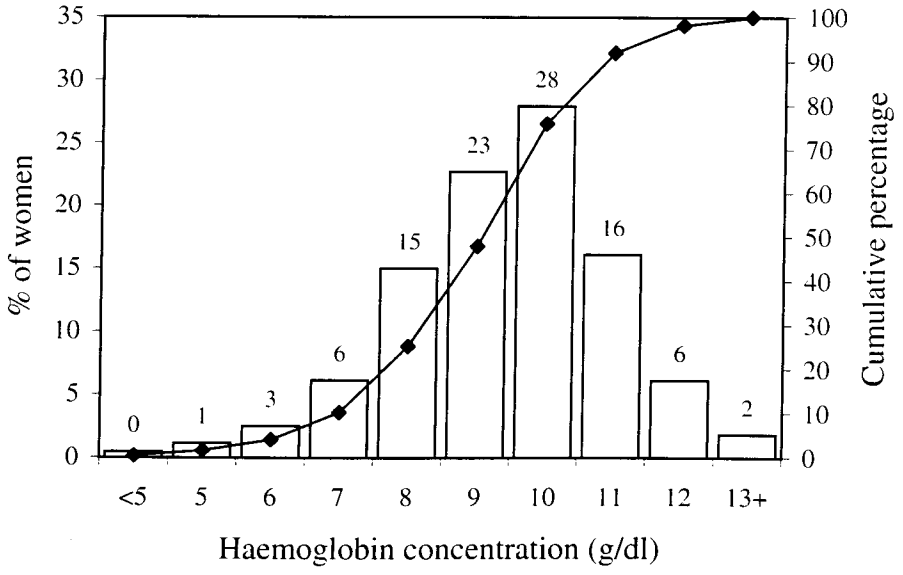

FIG. Haemoglobin concentrations amongst the pregnant women, showing actual (□) and cumulative (◆) percentages of the study population.

TABLE 1. *Prevalence of severe anaemia and the associated main risk factors**

	N	Prevalence of severe anaemia (%)	χ^2	*P*	Adjusted odds ratio and (95% confidence interval)†	χ^2	*P*
All women	413	11	–		–	–	
MALARIA							
Negative	288	9	5.4	0.06	1.0	5.7	0.05
Median density or lower‡	60	12			1.3 (0.5–3.5)		
Higher than median density	65	18			2.3 (1.0–5.7)		
HOOKWORM							
Negative	265	9	4.4	0.10	1.0	2.0	0.3
Low egg burden	109	10			0.9 (0.4–2.0)		
High egg burden	39	21			2.0 (0.7–5.4)		
IRON DEFICIENCY							
No	313	9	3.9	0.04	1.0	5.1	0.02
Yes	100	16			2.4 (1.1–4.9)		
SEASON OF RECRUITMENT							
Early dry (June–August)	197	8	19.4	0.001	1.0	16.6	0.0002
Late dry (September–November)	145	25			6.2 (2.3–16.4)		
Rainy (December–May)	71	8			1.0 (0.4–2.4)		
AGE (years)							
15–19	93	18	11.7	0.008	1.0	3.5	0.3
20–29	189	11			0.8 (0.3–2.1)		
30–39	113	4			0.3 (0.08–1.3)		
>39	18	11			1.2 (0.2–7.8)		
GRAVIDITY							
Multigravidae	341	9	7.0	0.008	1.0	0.13	0.7
Primigravidae	72	19			0.9 (0.3–2.2)		
MARITAL STATUS							
Ever married	357	9	10.7	0.001	1.0	4.9	0.02
Never married	56	23			2.9 (1.1–7.5)		
ACCESS TO CASH							
Own income	257	8	11.7	0.003	1.0	1.8	0.3
Household income	113	11			1.2 (0.5–2.5)		
No access	43	26			1.9 (0.7–5.1)		

*Other variables tested but found to have no association with severe anaemia were mid-upper arm circumference, body mass index, HIV status and educational status.
†The model used included adjustments for trimester as well as for the variables shown in the table.
‡The median level of parasitaemia was 1180 parasites/μl.

There was no significant difference in the prevalences of severe anaemia between the primiparous women who were or had been married [18% (7/39)] and the primiparous women who had never married [19% (7/37); $P = 0.9$]. However, severe anaemia was significantly more common among the multiparous women who had never married than among the multiparous women who were or had been married [30% (7/23) *v.* 7% (24/341); $P < 0.001$].

Primigravidae and teenagers were more likely than the other women to report having no access to any cash (data not shown). The access-to-cash variable showed seasonal fluctuation ($P < 0.001$), the proportion of

the respondents recruited during the late dry season who had no access being larger [33% (24/72)] than that of the respondents recruited during the rains [7% (13/198)] or early dry season [4% (7/170)].

There was no evidence of an association between severe anaemia and MUAC, BMI, HIV serostatus or educational status (data not shown).

Evidence of Health-seeking Behaviour During Pregnancy

To minimize responder bias, use of health services is reported only for women recruited at $\geqslant 30$ weeks' gestation (Table 2). Surprisingly, the characteristics of those who preferred a home birth appeared similar to those who preferred a hospital birth. The median gestational age at first attendance at an MCH clinic was 24 weeks (interquartile range = 21–27 weeks) and there was evidence indicating that the high-risk groups were making the best use of the antenatal services available. For example, primigravidae generally attended the MCH clinics earlier than the multigravidae (58% and 39% attending by the 24th week of gestation, respectively; $P = 0.01$), and severely anaemic women were more likely to attend a clinic by the 24th week of gestation than those who were not severely anaemic [75% (25/33) *v.* 41% (114/279); $P = 0.03$]. Additional healthcare had been sought formally (at a dispensary or hospital) by 33% (103/312) of the women, informally (at shops) by 17% (52/312), and not at all by 50% (157/312). Only 17% of the severely anaemic women had not sought additional healthcare during their pregnancy, compared with 52% of the women who were not identified as severely anaemic ($P = 0.01$).

Of the women who had already visited an MCH clinic when they were interviewed, 39% (195/492) had taken iron prophylaxis. There was no evidence that any group of women was more likely to receive iron from staff at the MCH clinics than another. There was no difference in prevalence of severe anaemia between users and non-users of iron prophylaxis, even after adjusting for trimester (data not shown). However, the significance of this result is limited by the cross-sectional nature of the study.

Among the 331 women (i.e. 65% of the 507 interviewees) who mentioned at least one unprompted problem when asked 'what are the biggest difficulties you face this pregnancy?', the most frequently stated problems related to the woman's own poor health [54% (179/331)], including feeling weak or tired [18% (60/331)]. A lack of money was mentioned by 32% (106/331), and 25% (83/331) said they found it difficult to carry out adequate economic activities whilst pregnant. Seventy-nine (24% of the 331) said that one of their main problems was not having enough food to eat. Women whose primary concern was about their own health had a significantly higher prevalence of severe anaemia than the women who did not mention this as a problem [11% (13/119) *v.* 3% (8/212); $P = 0.01$].

Food Taboos Specific to Pregnancy

Women were asked to state up to four foods that were specifically taboo during pregnancy, and then to give their reasons for each choice. Overall, 954 responses were given from the 2028 possible, with 69% of the women mentioning at least one food type. In total, 24 different foods were mentioned. Most frequently cited was fish [39% (372/954)], including various types available locally [*ngogo*, *ndipi*, *kambale* (catfish), *ndunguwila*, *mjongwa* and *dagaa*]. Meat was the second most frequently mentioned food [33% (314/954)], including both farm animals (chicken, cow, pig, goat and rabbit) and bush meat (zebra, hippopotamus, porcupine, buffalo, hartebeest and guineafowl). In order of importance, the other top foods to avoid were 'leftovers' [7% (68/954)], sugarcane [4% (42/954)], eggs [4% (34/954)] and cassava root [3% (29/954)]. Table 3 lists the main and specific effects said to result from eating these foods whilst pregnant.

TABLE 2. *Use of health services during pregnancy*

Characteristic	N*	% intending to deliver at home	χ^2	P	% visiting MCH for the first time earlier than average†	χ^2	P	% seeking no additional healthcare	χ^2	P
AGE (years)										
15–19	66	74	0.5	0.9	48	7.5	0.05	59	3.1	0.3
20–29	144	72			45			50		
30–39	91	73			32			45		
>39	11	64			64			45		
GRAVIDITY										
Primigravidae	53	68	0.6	0.4	58	6.5	0.01	60	4.6	0.03
Multigravidae	259	73			39			48		
SEVERE ANAEMIA										
Yes	33	67	0.2	0.6	75	5.3	0.03	17	5.6	0.01
No	279	73			41			52		
BODY MASS INDEX (kg/m^2)										
<18.5	9	67	0.1	0.7	22	1.5	0.2	78	5.3	0.02
⩾18.5	301	72			43			50		
MID-UPPER ARM CIRCUMFERENCE (mm)										
<221	45	64	1.6	0.2	33	1.7	0.1	64	4.1	0.04
⩾221	265	74			44			48		
CASH ACCESS										
Own income	193	72	0.1	0.9	40	1.2	0.5	44	11.8	0.003
Household income	74	74			45			68		
No access	45	71			49			49		
EDUCATION										
Primary	234	72	0.02	0.8	44	0.7	0.3	47	3.1	0.07
None	78	73			38			59		
MARITAL STATUS										
Ever married	269	73	0.1	0.6	42	0.3	0.5	56	0.6	0.4
Never married	43	70			47			49		
SEASON OF RECRUITMENT										
Early dry (June–August)	110	72	0.1	0.9	29	14.0	0.001	46	5.2	0.07
Late dry (September–November)	88	74			55			44		
Rainy (December–May)	114	72			45			59		

*Restricted to women who had a gestational age of at least 30 weeks at interview.
†An 'early' first visit to a maternal-and-child-health (MCH) clinic was one made no later than the median value of 24 weeks' gestation.

TABLE 3. *Main effects on the child, mother and delivery that pregnant women in the Kilombero Valley believe to result from eating foods reported as taboo during pregnancy*

	Effects on the:		
Food type	Child	Mother	Delivery
Fish	Child takes on the characteristics of a fish (spitting/breathing), fish bones hurt the foetus	Causes nausea, hurts abdomen	Late delivery, child won't want to be born, a lot of amniotic fluid
Farm meat	Child takes on the characteristics of the animal (jumpy, spots, colouring), child's navel will be slow to heal, causes leprosy, hurts the foetus	Causes nausea	Late delivery, difficult/long delivery, a lot of faeces at delivery
Bush meat	Child takes on the characteristics of the animal (e.g. stripes, size), child's navel will be slow to heal, hurts the foetus	–	Late and/or difficult delivery, child will not want to be born
Leftovers	Hurts the foetus	Hurts abdomen, makes stomach bloated, feel hungry, get very large	A lot of faeces, a lot of amniotic fluid, difficult delivery
Sugarcane	Child born with tremors, causes leprosy, child will be late to walk	–	A lot of amniotic fluid, difficult delivery, abdominal pain, waters break early
Eggs	Child born without hair	–	–
Cassava	Hurts the foetus, baby won't want to be born, baby born with peeling skin, no meconium, baby born with hydrocele	Causes flatulence, hurts abdomen, causes constipation, big tummy	A lot of faeces at delivery

DISCUSSION

Severe anaemia is clearly a major problem for pregnant women living in Ulanga district. The present data indicate that their anaemia is multifactoral, with malarial parasitaemias, iron deficiency and hookworm infections all contributing. Taboos which deter the consumption of haem-rich foods probably exacerbate the problem. Unmarried women were at particularly high risk of severe anaemia. It was surprising that the increased risk of severe anaemia for primigravidae seen in the bivariate analysis was not evident in the multivariate model. However, the group identified as 'unmarried' was a mix of teenage primigravidae with no access to cash income and unmarried multigravidae. It was apparent that not being married was a strong indicator of vulnerability in this setting for all women, and not only for primigravidae.

Cross-sectional observational studies such as that described here have the limitation that the outcome recorded may not be a direct result of the exposure variables measured on the same day. Weaknesses in the measures of exposure variables employed may also have biased the present results. However, despite these limitations, the findings that malaria and iron deficiency are major contributors to severe anaemia, and that high hookworm burdens exacerbate iron-deficiency anaemia are in line with the results of other studies of anaemia in pregnancy in East African settings (Shulman *et al.*, 1996; Huddle *et al.*, 1999; Ndyomugyenyi and Magnussen, 1999; Verhoeff *et al.*, 1999).

There is strong evidence from Africa to support the use of iron prophylaxis as a means of increasing birthweight and maternal haemoglobin (Mahomed, 2001). Limited adherence to iron supplementation is often

thought to be a major reason for the low effectiveness of wide-scale anaemia-prevention programmes. However, Massawe *et al.* (1995) concluded that it was the irregularity and inadequacy of supplies of haematinics to antenatal clinics that formed the most important obstacle to the implementation of the anaemia-prevention programme in Dar es Salaam, Tanzania. Only 39% of the pregnant women interviewed in the present study after they had attended an MCH clinic had been given ferrous sulphate, with no indication of preferential distribution to the high-risk groups. In addition, women given ferrous sulphate in Ulanga district generally receive only a 2-week supply, which is almost certainly inadequate as an intervention. The supply and distribution of iron and folic supplementation in this setting need urgent attention.

In areas of stable malaria transmission, most malarial infections are chronic and asymptomatic and the antimalarial treatment of only those with fever or clinical illness does not adequately tackle the problem. In pregnancy, prevention rather than treatment should be the predominant focus of malaria management, the importance of which should not be under-estimated. In their recent review, Steketee *et al.* (2001) concluded that the failure to implement known antimalarial interventions antenatally contributed substantially to the estimated 75,000–200,000 infant deaths which are associated with malarial infection in pregnancy annually. Further, the results of a meta-analysis of data on malaria-related severe anaemia in pregnancy indicate that, each year in sub-Saharan Africa, there may be up to 10,000 maternal deaths related to malarial anaemia (Guyatt and Snow, 2001). A follow-up of infants born to the present subjects revealed that, even after controlling for other factors, the infants born to the women identified as severely anaemic during pregnancy were three times more likely to die in infancy than infants born to women without severe anaemia (unpubl. obs.).

Increasingly, there is evidence to support the use of insecticide-treated bednets (ITN) as a tool to control malaria and improve anaemia status in pregnancy. Within the present study area, socially marketed ITN were popular and 53% of pregnant women were users. ITN were shown to have protective efficacies of 38% (CI = 5%–59%) for high-density malarial parasitaemias, 12% (CI = 2%–21%) for mild anaemia and 38% (CI = 4%–60%) for severe anaemia in this population of pregnant women (Marchant *et al.*, 2002). African leaders have called for 60% of children and pregnant women to be protected by effective personal protection measures (largely ITN) in Africa by the year 2005 (Anon., 2000). Large-scale ITN programmes are currently being implemented as malaria management for children in Africa and the target group should be broadened to include pregnant women.

In areas where there is widespread resistance to chloroquine the World Health Organization (2000) now recommends that, through the MCH antenatal service, pregnant women should receive intermittent preventive treatment with sulfadoxine–pyrimethamine (SP). This recommendation is largely based on the results of research in Malawi and Kenya (Schultz *et al.*, 1994; Shulman *et al.*, 1999). In East Africa, Uganda, Malawi, Kenya and Tanzania have already adopted this drug regimen as part of their national malaria-control plans, although alternatives to SP will inevitably be required as the proportion of infections that are resistant to this drug combination appears to increase rapidly (Ronn *et al.*, 1996).

Overall attendance at MCH clinics in Ulanga district was very high, with 99% of all the interviewees having attended at least once, and over half [56% (176/312)] at least three times, by their 30th week of pregnancy. However, interventions against both iron deficiency and malaria in pregnancy are needed as early as possible: iron prophylaxis and ITN preferably from conception and intermittent SP treatment by the start of the

second trimester. In the present study population, only 11% (54/507) of the women had attended an MCH clinic by the 16th week of pregnancy and only 27% (138/507) by the 20th week, the median gestational age at first attendance being 24 weeks. Efforts need to be made to encourage high-risk groups to attend clinic earlier. In addition, better out-reach services, through community groups or perhaps via National Immunization Days (which occur during the late dry season in Kilombero, thus coinciding with the period of highest anaemia prevalence), need to be developed, with health-education packages addressing preventative measures, including diet. At these meeting points, the high-risk groups for emergency care during delivery (especially those at the extremes of childbearing age and the anaemic) could also be sensitized to the importance of access to obstetric care during delivery.

The present results do provide some cause for optimism for the implementation of interventions. The women who were identified as severely anaemic were also those most likely to have attended an MCH clinic early in their pregnancies and to have sought additional healthcare outside the MCH system. They were also the women most likely to report to the interviewer that they were concerned about their health. It appeared that these women recognized their need for care and pursued the limited avenues available to them to get it. The success in uptake of socially marketed ITN in the area has already demonstrated that people are willing and able to invest in their own health (Marchant *et al.*, 2002). Now more efforts need to be made in making the tools for good maternal health available. The development of operational mechanisms for these interventions should become a priority component of healthcare policy.

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