THE HEALTH OF PREGNANT WOMEN IN RURAL TANZANIA

WITH SPECIFIC EMPHASIS ON ANAEMIA AND THE IMPACT OF

SOCIALLY MARKETED INSECTICIDE TREATED BEDNETS

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Prof. Dr. A. Zuberbühler

Dedicated to my family

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SUMMARY

Anaemia in pregnancy is one of the main maternal health problems globally, affecting over 50% of pregnant women in sub-Saharan Africa. Although not always shown to have a causal link, severe anaemia contributes to maternal morbidity and mortality and to poor pregnancy outcomes and infant survival. The work encompassed in this thesis describes fertility and health in pregnancy with a specific emphasis on anaemia. In addition, the applicability of ITNs for the prevention of malaria and anaemia in pregnancy is examined in more detail.

In Part II of the thesis, achieved fertility and the family building preferences of women are described. A high fertility setting is described in which there is also a high incidence of late pregnancy loss, which increases the exposure of women to poor maternal health outcomes. There were indications of an increasing desire for fertility regulation methods, especially amongst teenagers. This was evidenced principally by high levels of unmet need amongst teenagers for family planning methods, and through focus group discussions which highlighted induced abortion as a pressing concern for the health of young women.

In Part III of the thesis the magnitude of anaemia as a health problem in pregnancy is discussed. In Kilombero over three-quarters of pregnant women were anaemic, 11% severely so, which defines the area as high risk. Multiple risk factors for anaemia were present and there was a sharp seasonal peak. In this study malaria and iron deficiency were both important contributors. Unmarried women, both primigravidae and multigravidae, were at increased risk of being severely anaemic suggesting that socio-economic vulnerability also plays an important role. The relevance of pregnancy anaemia as a public health issue was underlined by our findings that, independent of other factors, anaemia in pregnancy was associated with a three-fold increase in infant mortality risk.

In Part IV the impact of socially-marketed insecticide treated nets on pregnancy and child morbidity was reported. Social marketing proved to be a highly successful tool for delivering ITNs with a rapid increase in uptake of the product. At the time of these impact surveys 61% of under two year olds and 53% of pregnant women were ITN users. This was the first evaluation of the impact of ITNs on morbidity under programme conditions. ITN use was associated with a reduction of 38% of all cases of severe anaemia in pregnancy and 63% of all cases in children under two years of age. It is recommended that ITNs be promoted at every level for use by pregnant women and children.

Women in the Kilombero Valley have a high life-time risk of dying due to pregnancy related causes, typical of the sub-Saharan Region as a whole. They are exposed to the three biggest contributors to ill health: poverty, malnutrition and infectious disease, especially malaria. Approaches for tackling these problems using complimentary strategies are discussed. However, due to the multi-level benefits of ITN use in pregnancy – through protection of the pregnant woman, her growing foetus, and subsequently impacting on infant health - insecticide-treated bednets, together with improved campaigns for highlighting the needs of pregnant women, are indicated as the principal way forward to better health.

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PART I : INTRODUCTION

CHAPTER 1: BACKGROUND

Reproduction is a natural, physiological process, which in the great majority of cases proceeds without serious complication. However, every year an estimated half a million women die as a result of complications directly attributable to childbirth (WHO, UNICEF, UNFPA, 2001), while another 15 million develop long-term disabilities. Half of these occur in a region which contributes only one fifth of global births: sub-Saharan Africa. The discrepancy between the developing and the developed world in the maternal mortality ratio (MMR) is greater than for any other major public health indicator. In developed countries the MMR is currently 12 per 100,000, compared to 1,100 deaths per 100,000 live births across sub-Saharan African. Adjusting for current fertility levels, this translates as a lifetime risk of dying of 1 in 13 for women living south of the Sahara and a 1 in 4100 risk for women in developed countries (WHO, UNICEF, UNFPA, 2001).

The causes of morbidity and mortality in pregnancy and childbirth can be direct (conditions occurring only in pregnancy), most often obstructed labour, antepartum and postpartum haemorrhage, puerperal infection, and hypertensive disorders, or indirect (diseases aggravated by pregnancy) such as anaemia, malaria, heart disease, essential hypertension, *diabetes mellitus*, and haemoglobinopathies. In many areas of sub-Saharan Africa the synergy between poor nutrition and infectious disease conspires to exacerbate some of these direct and indirect conditions. High fertility, child bearing at the extremes of the fertile years, and the poor social status of women (evidenced in part by low levels of education), increase the problem in a setting where often there is inadequate or improper health care. As indicated by the MMR an excessive loss of life, and of disability, results.

The work described in this thesis focuses on the health of pregnant women in a rural area of Tanzania with specific emphasis on anaemia. In addition, the

applicability of a tool for the prevention of malaria, one of the main causes of anaemia, is proposed for evaluation.

1.1 Background to Anaemia

Definitions

The term anaemia implies a reduction in the oxygen-carrying capacity of the blood as a result of fewer circulating erythrocytes than is normal or a decrease in the concentration of haemoglobin (Hb). Haemoglobin concentrations below which anaemia is likely to be present at sea level are usually defined as follows: children 6 months – 6 years: 11 g/dL; children 6-14 years: 12 g/dL; adult males: 13 g/dL; non-pregnant females: 12 g/dL; and pregnant females 11 g/dL. Severe anaemia in pregnancy has been defined as <7g/dL (WHO 1989).

Anaemia may result from defects at any stage of red cell and haemoglobin production or when an increased rate of red cell destruction (haemolysis) exceeds the capacity of the bone marrow to mount a compensatory increase in production. Changes in the relationships between red cell and plasma volumes may also result in a reduced haemoglobin concentration: such changes occur physiologically in pregnancy where red cell volume is increased less markedly than plasma volume. All anaemia sufferers manifest signs and symptoms attributable to tissue and organ hypoxia and the ensuing reduced metabolism. The different types, signs and symptoms of anaemia are shown in Table 1.

Prevalence

Anaemia is a major health problem worldwide affecting an estimated 2 billion people (WHO 1997), approximately 30% of the world's population. In a meta-analysis of available data using WHO threshold criteria (De Maeyer and Adiels-Tegman, 1985), the problem was found predominantly in developing regions

(especially south Asia and sub-Saharan Africa) where 36% of the total population were estimated to be anaemic compared to 8% in developed nations.

Prevalence was particularly high in pre-school children (51% in less developed and 10% in more developed regions) and in adult females (50% and 13% respectively). In pregnancy, a WHO tabulation of available data averaged the prevalence to be 56% in developing countries, ranging between 50-70% for Hb<11g/dL and 5-15% for Hb<7g/dL in sub-Saharan Africa (WHO 1992).

Table 1.1 Signs, symptoms and types of anaemia

Signs and Symptoms							
Skin	Mucous membranes	Respiratory	Cardiac	Neuromuscular	Gastrointestinal	Genitourinary	Metabolism
Pallor, Brittle nails, Dry hair	Pale	Shortness of breath, Increased respiratory rate, Fluid in base of lungs (when severe)	Increased pulse rate, Cardiac palpitation, Angina pectoris	Headaches, Dizziness, Fatigue, Tingling, Fainting, Decreased attention span	Anorexia, Diarrhoea, Constipation, Flatulence	Irregular menstruation, Decreased renal function	Increased sensitivity to cold

Types of anaemia	
Anaemia due to decreased erythropoiesis	Deficiency anaemia: iron; vitamin b12 (pernicious anaemia); folic acid Aplastic anaemia (due to depressed bone marrow activity)
Anaemia due to excessive rate of haemolysis	Haemolytic anaemia due to intra-corpuscular defects: congenital haemolytic jaundice; haemoglobinopathy (sickle cell anaemia (haemoglobin S); thalassaemia) Haemolytic anaemia due to extra-corpuscular factors: infection; auto-immune reaction;
Anaemia due to blood loss	

1.2 Anaemia in Pregnancy

The pregnant woman is more susceptible to all three types of anaemia described in Table 1 than her non-pregnant counterpart for a variety of reasons. During a normal pregnancy blood volume increases by about 50%, with a corresponding increase in red cell mass of only 18%. Consequently haemoglobin (a measure of the ratio of red cell mass to plasma volume) decreases during pregnancy due to sero-dilution; it normally falls progressively from the end of the 12th week of pregnancy until about the 34/36th week, with a return to previous levels 6-8 weeks post-partum. Either antepartum or postpartum haemorrhage may result in (or increase) severe anaemia. In the context of the developing world causes of anaemia often occur concurrently, especially when the anaemia is severe. Factors such as iron, folate and vitamin A deficiencies, hookworm infection, haemoglobinopathies (sickle cell disease, thalassaemia) infection with the human immunodeficiency virus (HIV) and, where endemic, infection with the malaria parasite are all important risk factors for pregnant women (Fleming 1989).

Anaemia contributes significantly to maternal morbidity causing incapacity from tiredness, lassitude, breathlessness and a reduced ability to work (Menendez 1995). In addition, it is a risk factor for low birth weight (Brabin 1991) which is one of the main risk factors for infant mortality (McCormick 1985). Moreover, it is estimated that anaemia may be responsible for as much as 20 per cent of all maternal deaths in sub-Saharan Africa through three main mechanisms (Ross and Thomas 1996; UNICEF 1998). Firstly, anaemia makes women more susceptible to deaths from haemorrhage by lowering their haematological reserves for blood loss, especially at birth; secondly, severe anaemia is associated with increased susceptibility to infection due to lowered resistance to disease, and finally, very severe anaemia (Hb<4g/dL) is associated with a high risk of cardiac failure, particularly during delivery or soon after, making the woman likely to die if unable to reach good health facilities immediately. Several studies have shown an association between anaemia and maternal mortality

from both hospital data and community based studies in Tanzania (Armon 1979; Mtimavalye *et al.* 1980; MacLeod and Rhode, 1998).

CHAPTER 2: MAIN CAUSES OF ANAEMIA IN PREGNANCY

2.1 Iron deficiency

Iron deficiency is the most common cause of anaemia worldwide (British Nutrition Foundation 1995). The principal cause is dietary iron deficiency (due to low iron intake or poor bioavailability, caused by high intake of iron binders such as phytate or tannins common to cereal based diets). Physiological increases in iron losses (e.g. menstrual losses, iron losses to the foetus during pregnancy, iron lost in the milk during lactation), or pathological iron losses (e.g. gastrointestinal haemorrhage), increased tissue iron requirements (e.g. during periods of rapid growth in infants, children and adolescents) or, more rarely, malabsorption of iron due to intrinsic gastrointestinal disease, are all contributors to iron deficiency anaemia.

The decline in body iron is first marked by the depletion of iron stores, which indicates the onset of iron deficient erythropoiesis. Haemoglobin synthesis starts to become impaired and haemoglobin concentration falls. Iron deficiency anaemia is characterised by microcytic-hypochromic red blood cells (figures 2.1a,b).

Iron deficiency and maternal anaemia

Iron deficiency and subsequent iron deficiency anaemia are the most prevalent nutrient deficiency problems afflicting pregnant women (Allen 1997). Iron deficiency may develop during pregnancy because of the increased iron requirements to supply the expanding blood volume of the mother and the rapidly growing foetus and placenta. The net additional iron requirements during pregnancy are estimated to be 1000 mg (British Nutrition Foundation 1995). There are generally no changes in dietary intakes of iron during pregnancy yet there are extensive changes in maternal iron metabolism to ensure effective uptake from food and delivery to the foetus. Also, the use of iron stores at this

time is suggested by lower serum ferritin levels in pre-menopausal multiparous women compared to nullipara and postmenopausal women (Milman *et al.* 1992; White *et al.* 1993). However, in the context of sub-Saharan Africa women may enter pregnancy with seriously depleted iron stores (Lamparelli *et al.* 1988). When pre-pregnancy iron stores are low the amount of iron required during the last half of pregnancy cannot easily be met by diet and the risk of iron deficiency anaemia will be high, especially toward the end of pregnancy (Taylor *et al.* 1982).

The extent to which iron deficiency alone affects maternal and neonatal health is uncertain. Interpretation of studies on the effect of iron deficiency on the mother, foetus or child is difficult because many do not consider gestation, parity, physiology of the woman, or socio-economic and nutritional confounders (British Nutrition Foundation 1995, Allen 1997). However, existing data suggest that maternal iron deficiency anaemia is associated with adverse outcomes, including abortion (Sirota *et al*. 1989), pre-term delivery and maternal mortality (Allen 1997). Currently iron-deficiency anaemia is ranked as the third leading cause of loss of disability-adjusted life years (DALYs) for women aged 15-44 worldwide (Murray and Lopez 1996).

2.2 Malaria

Malaria is a mosquito-borne protozoan disease, caused in Man by four species of the genus *Plasmodium: P. falciparum* (the most pathogenic and accounting for the majority of infections)*, P. malariae, P. ovale* and *P. vivax.* More than 2000 million people live in areas where malaria transmission occurs and mainly children and pregnant women are affected. In Africa alone it is estimated that 300-500 million clinical cases of malaria occur annually resulting in 1-2 million deaths (Breman 2001), the majority occurring in African children – approximately 1 million annually (Snow *et al.* 1999). In endemic areas children are born with maternal antibodies passed on during pregnancy and develop a degree of immunity themselves following repeated exposure to malaria infection. The most

vulnerable period occurs during the window of early childhood when maternal antibodies have waned and protective levels of immunity have not yet developed (Snow and Marsh 1998). With continued exposure, older children and adults still get infected with malaria but rarely go on to develop severe disease. Severe morbidity and death occur through two main mechanisms: severe anaemia leading to profound hypoxia and congestive cardiac failure, and cerebral malaria (English *et al.* 1996; Beales *et al.* 2000).

There are large differences geographically in malaria endemicity and in turn to the host response to the parasite, the majority of sub-Saharan Africa having moderate to high levels of transmission (figure 2.2).

Malaria in pregnant women

Compared with non-pregnant women, pregnant women are at increased risk of malaria infection and its disease consequences in settings of both low and high transmission of malaria (Brabin 1991; Menendez 1995). This is probably due to hormonal modulation of the immune response during pregnancy and is heavily compounded by increased blood volume and sequestration of the parasites in the placenta (Riley *et al.* 1989; Rasheed *et al.* 1993; Menendez 1995). The increased risk of malaria is not evenly distributed throughout parities, affecting primarily primigravidae in sub-Saharan Africa, nor throughout each pregnancy as the prevalence of infection and parasite density is generally highest in the first half of the pregnancy and decreases progressively until delivery (Nosten 1991; Brabin 1991).

In hypoendemic settings with low or unstable levels of malaria transmission, adults have relatively little acquired immunity, and people at all ages are at risk of severe disease if infected. Here, pregnant women of all parities are at 2-3 times greater risk of developing severe disease than non-pregnant women and at approximately 3 times greater risk of dying if they do develop severe disease (Luxemburger *et al.* 1997). Reports of adverse pregnancy outcomes associated

with *P. falciparum* infection have included cerebral malaria, severe haemolytic anaemia, and a high risk of miscarriage, premature delivery or neonatal death (Menon 1972; Herd and Jordan 1981; Sholapurkar *et al.*1988; Meek 1988).

In contrast, in much of sub-Saharan Africa, stable transmission of *P. falciparum* malaria is the rule. In these areas, women of childbearing age have a relatively high level of acquired antimalarial immunity. When pregnant, these women also demonstrate an increased susceptibility to *P. falciparum* manifested by a higher frequency and density of parasitaemia compared with non-pregnant women, (Brabin 1983; McGregor 1984) particularly in primigravidae. This susceptibility appears to wane with subsequent pregnancies (McGregor 1984; Brabin 1991), although some studies from highly endemic areas have reported an increased susceptibility to malaria in grand multigravidae, i.e. women with more than 5-7 previous pregnancies, compared to other multigravidae (Watkinson and Rushton 1983). Further, research from Senegal has suggested that, after controlling for use of antimalarial drugs, the pregnancy-associated increase in susceptibility to malaria persists for 60 days after delivery among women who live in areas where malaria is highly endemic (Diagne *et al.* 2000).

Despite severe disease being uncommon in pregnancy in endemic areas, *P. falciparum* infection during pregnancy is a major public health problem and the increased risk of parasitaemia has adverse effects for both mother and child. It leads to parasite sequestration in the maternal placental vascular space, with consequent infant low birth weight due to both prematurity and intra-uterine growth retardation (McGregor 1984; Brabin 1991). It has been estimated that the fatality rate of newborns with malaria-related low birth weight is 37.5% which, when adjusting for the current birth rate in sub-Saharan Africa translates as 3-17 deaths per 1,000 live births from malaria-induced LBW annually (Murphy and Breman 2001). In addition, *P. falciparum* is an important, and often underestimated, cause of severe maternal anaemia (Gilles *et al.* 1969; Shulman *et al.* 1996). It has been estimated that as many as 400,000 cases of severe

anaemia in pregnancy were caused by malaria infection in sub-Saharan Africa in 1995 (Guyatt and Snow 2001).

Malaria and maternal anaemia

Malaria causes mainly haemolytic anaemia because the parasite destroys red blood cells and causes a decrease in production of red blood cells. In cases of acute uncomplicated falciparum malaria, anaemia develops 48h after the onset of fever. The haematocrit continues to fall often up to two weeks after the parasitaemia has been cleared (Menendez 2000). Because malaria is generally asymptomatic in areas of endemic transmission screening women for malarial parasitaemia does not reveal the true burden of malaria-related anaemia as women can have placental infections despite providing negative films of peripheral blood (Desowitz and Alpers 1992; Shulman 1999a). But hospital-based studies have suggested that malaria-associated anaemia in pregnancy is an important factor (Gilles *et al.* 1969; Fleming 1970; Shulman *et al.* 1996) and some intervention trials for malaria in pregnancy have recorded an impact on severe anaemia (D'Alessandro *et al.* 1996; Shulman *et al.* 1999b). The effect has been most pronounced in women of lower gravidity, especially primigravidae (McGregor *et al.* 1983; Fleming *et al.* 1986).

Blood transfusion can be a life-saving intervention for severely anaemic women and where hospital services exist is relatively easy to administer. However, the availability and safety of blood for transfusion have been most variable in areas where malaria is endemic. With the spread of HIV infection blood transfusion has become even more hazardous, and it has been calculated that transmission by transfusion contributed about 10% to the total prevalence of HIV in sub-Saharan Africa in the mid-1980's (Fleming 1997). Interventions that prevent women reaching term with severe anaemia are urgently required.

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Figure 2.1a Normal erythrocytes

Figure 2.1b Severe iron deficiency: microcytosis and hypochromia

Figure 2.2 MARA map showing transmission intensity across Africa

CHAPTER 3: INTERVENTIONS

3.1 Iron deficiency interventions

Iron deficiency anaemia is complex and difficult to control. Dietary iron comes in two main forms, namely haem and non-haem iron, which are not equally well absorbed and used. Various dietary components adversely influence the absorption of iron from the intestine, such as tea, and other substances, such as vitamin C, enhance the absorption of iron. Parasitic disease can also contribute to the burden of iron deficiency and anaemia. Interventions aimed at preventing the problem range from the directed screening of groups known to be at high risk, to more widespread health education and general iron fortification of staple foods.

Diet

Nutrition and health education generally is an important strategy in controlling iron deficiency. In consumption of foods rich in haem-iron (as in red meat) the absorption of iron is relatively independent of other food substances. The sub-Saharan diet tends to be comprised mainly of foods containing non-haem iron and socio-economic factors may hinder moves to increase haem-rich foods in the diet. However, absorption can be enhanced by promoting foods rich in ascorbic acid (as in vitamin C rich fruits), and avoiding combining foods that inhibit non-haem iron absorption such as those high in phytates (as in cereals) and tannins (as in tea). It is known that vitamin A deficiency is often seen with anaemia and in countries where vitamin A deficiency is prevalent, iron deficiency is almost always prevalent as well (Latham 1997). The promotion of green leafy vegetables and fruits helps both.

Fortification of foods with iron

This is feasible and has been used for many decades in industrialised countries, less so in developing countries. Possibilities include wheat flour, bakery products, maize flour, salt, sugar and preserved foods. However, this strategy relies on centrally processed foods being widely consumed and does not target the most at risk people in a largely rural population who eat mainly the produce from subsistence farming.

Iron supplementation

There is little doubt that iron supplementation in pregnancy can improve maternal iron status in both industrialised and poor countries (Puolakka *et al.* 1980; Fleming *et al.* 1986; Dawson and McGanity 1987; Milman *et al.* 1991, Mahomed 2001). Increases in haemoglobin, haematocrit, mean corpuscular volume, serum ferritin, serum iron, and transferring saturation compared with unsupplemented controls are usually apparent within 3 months, and the usual depletion of maternal iron stores is reduced or eliminated when assessed by maintenance of serum ferritin and bone marrow iron (Allen 1997).

In many countries this is the main strategy for reducing iron deficiency, particularly in pregnant women, usually through antenatal clinics and using daily ferrous sulphate which is cheap and provides iron in a form that is well absorbed. The treatment must be continued for a minimum of two months. However, under field conditions the effectiveness of such iron supplementation for populations at risk remains contentious (Viteri 1998). These programmes miss pregnant women who do not attend clinic, pregnant women before their first attendance at clinic, most breastfeeding mothers and women at risk prior to becoming pregnant. Iron supplementation is also associated with poor compliance because of perceived adverse reactions such as constipation, abdominal pain and black stools. In addition, clinics often run out of tablets or health workers fail to give them out. Of particular concern is the observation that improvements in

the haemoglobin of severely anaemic women receiving iron supplementation alone are less impressive than for women with an initial Hb>10g/dL (Sloan *et al*. 1992; Vitera 1998). One explanation for this may be that in populations with lower mean haemoglobin levels anaemia has a multiple aetiology with parasitic infection also playing an important role (Rush 2000; Gallego 2000).

Prevention of helminthic infection

Hookworms (*Ancylostoma duodenale* and *Necator americanus),* which cause chronic intestinal blood loss, infect over 800 million people worldwide. Prevalence of infection increases with age in children, typically reaching maximum levels at 15-20 years and leveling off in adulthood (Bundy 1990). Infection intensity follows a similar pattern of increasing with age, but does not necessarily level off during adulthood, often continuing to increase in older adults. Treatment with mebendazole in a single 500-mg dose is effective in substantially reducing the intensity and prevalence of infection, is safe in pregnancy (beyond the first trimester) and during lactation (WHO 1995), and costs around $0.03 per dose. Where anaemia is prevalent, and hookworm prevalence is endemic (>20-30%) WHO recommend that "hookworm control be included in strategies designed to improve the health, development and nutritional status of girls and women."

Hookworm disease as a major cause of iron deficiency anaemia is related to the worm burden and faecal egg count (Roche and Layrisse 1966; Stoltzfus *et al.* 1997a) with a wide range of intensities, equivalent to burdens of 40 to 160 worms, being associated with haemoglobin levels below 11g/dL in pregnant women (Lwambo *et al.* 1992). An intervention trial in Tanzania found that treating for hookworm had greatest impact amongst people with high egg burdens at baseline, and while mean Hb remained unchanged the incidence of severe anaemia was reduced by half (Stoltzfus *et al.* 1997b). World Bank data for 1990 estimated that hookworm prevalence in pregnant women living in sub-

Saharan Africa was 32%, that is, some 7.5 million women were both pregnant and infected with at least one worm. However, a relatively small minority, an estimated 4% of pregnant women, had worm burdens of over 100 which would suggest a higher morbidity risk (World Bank 1993). As yet hookworm control programmes have been a relatively neglected strategy for anaemia control (Latham 1997).

Promotion of birth spacing strategies

Pregnancy and childbirth increase iron needs and therefore contribute to iron deficiency anaemia. Family planning education for delaying the first birth beyond age 18, when the iron requirements for personal growth are lessened, and spacing subsequent births to allow recovery of iron stores are recommended strategies for the prevention of iron deficiency anaemia together with addressing other obstetric complications e.g. obstructed labour.

3.2 Malaria interventions

Implementation of programs to prevent malaria in pregnancy has been rare (Steketee *et al.* 1996), but currently there is increasingly widespread commitment to tackle the problem (WHO 2000, Greenwood and Mutabingwa 2002). At present, the World Health Organisation recommends that pregnant women in malaria endemic areas receive a full course of anti-malarial treatment at first antenatal attendance followed by regular antimalarial chemoprophylaxis (WHO 1994). The effectiveness of this strategy has been limited by the spread of resistance to antimalarial drugs, poor compliance with routine chemoprophylaxis, and logistical and economic constraints (Robb 1999). Some of these constraints are set to be tackled by the Roll Back Malaria movement that was started in 1999 as a global initiative to address the problems of malaria. As stated above, pregnant women living in malaria endemic areas often have asymptomatic parasitaemia and as such prevention rather than treatment should be the main focus of control. A commitment has been agreed upon, and

endorsed by African Heads of State, to ensure that at least 60% of all pregnant women benefit from personal protective measures (mainly insecticide treated mosquito nets (ITNs) and at least 60% of (especially primigravidae) pregnant women have access to chemoprophylaxis or presumptive intermittent treatment (WHO 2000).

Bednets

Insecticide treated nets have been shown to increase child survival and reduce morbidity by preventing malaria in controlled research settings (Lengeler 1998). ITNs have been shown to reduce overall child mortality by between 14 and 42% in various endemic settings, making this intervention very cost-effective. Recently, in a programme setting, socially-marketed ITNs have been associated with a 27% reduction in deaths in children aged 1 month to 4 years (Armstrong Schellenberg *et al.* 2001).

At the start of this project there was contradictory evidence on the effectiveness of impregnated bednets during pregnancy. ITNs did not confer any significant reduction in parasitaemia or anaemia for pregnant women on the coast of Kenya or in Ghana (Shulman *et al* 1998; Browne *et al.* 2001). In Thailand there was marked improvement in Hb levels (Dolan *et al*. 1993), and in the Gambia nets significantly reduced parasitaemia, perinatal mortality, prematurity of newborns and increased birth-weight in primiparae in the rainy season, and improved severe anaemia in the dry season (D'Alessandro *et al*. 1996).

Currently national scaling-up of ITNs is being implemented in Tanzania with a public/private mix as a strategy to prevent malaria in children (Pricewaterhouse Coopers *et al.* 2000). More data is urgently required on the efficacy of ITNs for pregnant women in a high transmission setting, and on programmatic issues specific to ITN use in pregnancy.

Antimalarial Drugs

Chloroquine has a long history of safe use during pregnancy. However, in many areas there is increasingly wide spread resistance to the drug. In areas where chloroquine is still effective, chemoprophylaxis has been abandoned for most groups at risk, including infants and children, but it continues to be recommended for pregnant women, especially those with little or no immunity (Diagne 2000). However, compliance with this weekly prophylaxis and ensuring a regular supply remain problematic.

Bi-weekly chemoprophylaxis with 25 mg pyrimethamine and 100 mg dapsone (as Maloprim®) has been shown to increase birth weight, reduce anaemia and reduce LBW (Greenwood *et al.* 1989; Menendez *et al.* 1994). However, the effectiveness of this regimen may be limited by poor acceptance of routine chemoprophylaxis, and the drug is comparatively expensive.

Research in Malawi and Kenya to assess the efficacy of sulfadoxine-pyrimethamine (SP), given in intermittent doses (two or more) from the second trimester to early in the third trimester indicated that the treatment was very effective in reducing the rates of subsequent peripheral parasitaemia, placental infection and maternal anaemia. A trend in decreased incidence of low birth weight was also shown (Schultz *et al.* 1994; Parise *et al*. 1998; Verhoeff *et al.* 1999a; Shulman *et al.* 1999). The World Health Organisation now recommends intermittent preventive treatment with sulphadoxine-pyrimethamine in areas where *P. falciparum* is resistant to chloroquine and sensitive to sulfadoxine-pyrimethamine (WHO 2000). Malawi, Kenya and Tanzania have adopted this drug regimen as part of their national malaria-control plans.

However, despite the attractiveness of intermittent treatment with SP via the MCH system there remain a number of caveats. The benefits are reduced by HIV infection, which appears to have a detrimental effect on the efficacy of SP

(Parise *et al.*1998; Verhoeff *et al.* 1999b). There is also evidence to suggest that the efficacy of SP is reduced if taken at the same time as folate supplements (Meek et al. 1998). There is also little information from urban areas, which generally experience relatively low transmission intensities, and there has yet to be a comparison of the effectiveness of SP treatment between areas with seasonal and continuous transmission (D'Alessandro 1999). Finally, in view of the intensifying drug resistance, alternatives to SP are urgently required.

3.3 The setting for our work

Anaemia in Tanzania has been estimated to be present in about one-third of the population (Kavishe and Mushi 1993). Hospital records indicate that it is among the top ten reasons for admission in obstetric as well as in paediatric wards. In the affected populations, nutritional deficiencies, especially iron deficiency, have been implicated most (Kavishe and Mushi 1993). In a nutritional study in the Lindi District of Tanzania, 45% of all adult women were anaemic (<11g Hb/dL) and 54% of women who had delivered a baby within the past year had anaemia, with iron deficiency as the biggest contributing factor (Tatala *et al.* 1998). In Dar es Salaam, severe anaemia in pregnancy has previously been reported as the main cause of up to 20% of maternal deaths from hospital data (Armon 1979; Mtimavalye *et al.*1980). More recent findings from Dar es Salaam indicated that iron-deficiency was the predominant cause of maternal anaemia, followed by malaria (Massawe *et al.* 1999). A study of antenatal care at village level in rural Tanzania found that anaemia, malaria and anticipated obstetric problems were the most frequent occurrences requiring interventions (Moller *et al.* 1989).

Little is known about anaemia or malaria in pregnancy in Kilombero Region, Tanzania where there is intense, perennial malaria transmission. A large-scale study in Morogoro Rural District (within the Kilombero Region) found anaemia to be in the top five leading causes of death among women aged 15-49, accounting for 6% of all deaths (AMMP 1997). Other leading causes of death were

HIV/AIDS (30%), acute febrile illness (including malaria) (11%), acute diarrhoeal disease (10%) and maternal causes (8%). The maternal mortality ratio was 977 per 100,000 live births, which is considerably higher than official Tanzanian government estimates. Within Kilombero Valley itself the maternal mortality ratio was estimated using the sisterhood method to be 448 maternal deaths per 100 000 live births (Font *et al.* 2000). Between 1991-1993, the main causes of maternal death reported by the District hospital were puerperal sepsis, accounting for 35%, and 17% from haemorrhage. Deaths attributable to haemorrhage or malaria are almost certainly underrepresented as onset of severe symptoms may be sudden and followed quickly by death. It was estimated that during this period only 30% of all births occurred at hospital.

Data on morbidity and mortality collected from all the major health actors in the district indicated that malaria was the principal cause of morbidity in the District, with anaemia amongst the top ten causes (Tanner *et al.* 1991). Within the same project, in-patient statistics of the St. Francis Designated District Hospital underscored the importance of the malaria-fever-anaemia complex in the area. A placebo-controlled, randomized trial of malaria chemoprophylaxis and iron supplementation in infants has confirmed the role of malaria as the main aetiological agent of anaemia in infants in the area, accounting for about 60% of anaemic episodes (Haematocrit <0.25). Iron deficiency was estimated to account for about 30% of episodes (Menendez *et al.* 1997). Research on the use of ITNs for malaria control in children under 2 years found prevalence of anaemia (Hb<8g/L) to be 49% before implementation of the social-marketing ITN programme and 26% two years after (Abdulla *et al.* 2001). It is likely that pregnant women, as well as their offspring, suffer considerably from the burden of anaemia and malaria.

Deciphering the problems experienced in pregnancy in this rural area offers a great potential for public health impact both locally and internationally. Tools for malaria and anaemia control in pregnancy have the potential to make a

considerable impact on maternal health and pregnancy outcome and more data are urgently required from a high malaria transmission setting, as expressed by agencies such as UNICEF and WHO. This project aims to contribute to the current need for evidence on the effectiveness of bednets for the prevention of anaemia and malaria in pregnant women, and to simultaneously further our understanding of morbidity in pregnant women in the Kilombero Valley.

CHAPTER 4: STUDY OBJECTIVES

Our study had the following main and specific objectives:

1. **To describe fertility levels of women living in the DSS area**
    - What were the quantum and tempo fertility preferences of women?
    - What was the achieved fertility in terms of quantum and tempo?
    - What were the attitudes towards, and prevalence of, modern family planning use?
    - What did women perceive to be the main problems of fertility?

2. **To investigate the use by pregnant women of the health services**
    - When did women first present at mother and child health clinics (MCH)?
    - Who and what proportion used iron prophylaxis?
    - Where did women prefer to deliver their babies?

3. **To determine the prevalence of anaemia amongst pregnant women living in the DSS area and its main risk factors**
    - What was the prevalence of severe anaemia (Hb<8g\dL)?
    - What were the main risk factors and who was most at risk?
    - What was the impact of severe anaemia in pregnancy on infant survival?

4. **To determine the impact of socially marketed insecticide treated nets on pregnancy malaria and anaemia**
    - Who was currently using ITNs?
    - What was the impact of ITNs on anaemia and peripheral parasitaemia in pregnancy?

5. **Investigate the use of the KINET discount voucher system in pregnancy**
    - How many women had used the voucher?
    - What were the reasons for not using the voucher?

CHAPTER 5: METHODS

5.1 The KINET project

An investigation of anaemia in pregnancy was conducted as part of the evaluation component of a social marketing of treated bednets programme in the Kilombero Valley (KINET Project) based at the non-governmental Ifakara Health Research and Development Centre. The study area and population have been described in detail elsewhere (Armstrong Schellenberg *et al.* 1999). The area is rural and has intense, perennial transmission of malaria.

In brief, the KINET project developed a social marketing system to deliver ITNs to a widely dispersed population in over 100 villages in southern Tanzania (population 350,000). Children under five and pregnant women were specifically targeted in the implementation campaign which encompassed a range of information, education and communication materials, including 3 posters and 2 leaflets.

A discount scheme was developed to encourage uptake of ITNs by children and pregnant women and implemented through health clinics. This system was intended to increase use of treated nets in those most at risk of the severe effects of malaria. The discount vouchers, which were available at clinic, reduced the price of nets by 17% from 3000 Tanzanian Shillings (3.8 US$ in 1999) to 2500 Tanzanian Shillings (3.1 US$ in 1999).

A demographic surveillance system covering the first 25 villages to be included in the campaign (approx. 60,000 people living in 11,000 households) was started in September 1996 and is ongoing (Armstrong Schellenberg *et al.* 2002). Name, sex, date of birth, and relationships within the household were recorded at baseline. Every household is visited every 4 months by an interviewer who updates the census record by asking about in- and out- migrations, pregnancies, births and deaths. Special surveys are added from time to time, for example to

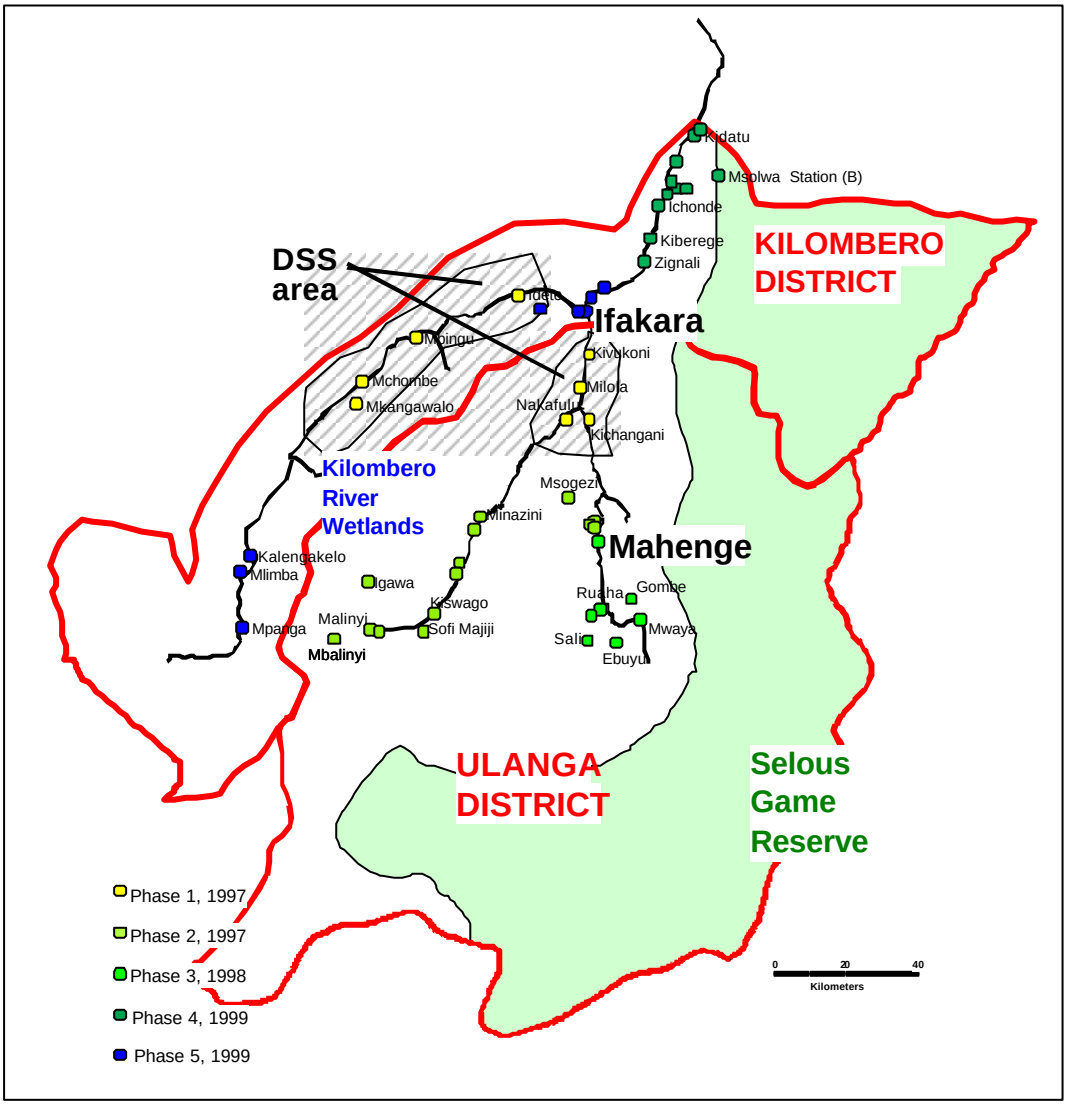
record socio-economic status for the households. The DSS provides a full sampling frame and random samples of households or individuals may be chosen for various in-depth studies. These have included the evaluation of ITNs on child survival, effects of ITNs on anaemia and malaria in young children, costing of implementation and willingness and ability to pay, insecticide resistance, and effect of treated nets on anaemia in pregnancy.

5.2 Study area and population

The fertility data for the present work was collected from a random sample of women throughout the whole DSS. The risk factors for anaemia and impact of ITNs on malaria and anaemia in pregnancy evaluation component covered six villages in Ulanga district only, Kivukoni, Mavimba, Minepa, Milola, Igumbiro and Lupiro. This area is typical of the whole implementation area in that it is in the low lying flood plain of the Kilombero River (average altitude 270m). Rice, maize and cassava are commonly grown for home consumption and fishing is common. The main agricultural exports are rice, timber and charcoal. There are no paved roads. Nine of the 25 villages included in the study area have a government health facility: in total there are 8 dispensaries and 2 health centres. Family planning services are available at all of these. There are a further 3 mission health facilities in the area which do not provide family planning services. Outside the study area, but within the range of health facilities accessed by the study population, are two hospitals. In Ifakara, the Kilombero district capital, is a well-equipped mission Designated District Hospital, and in Ulanga district's capital, Mahenge, is a more limited hospital. The mother and child health clinic services (MCH) are well developed and vaccination coverage is high with 78% of children receiving all Expanded Programme on Immunisation (EPI) vaccines by age 1 year. The area has a rainy season from November to May, although rain may fall in any month. Malaria transmission due to *Plasmodium falciparum* is intense and perennial, despite marked seasonality in mosquito densities with a peak in the rains. *Anopheles gambiae and An. funestus* are the main vectors,

with an estimated 200-300 infective bites per person per year occurring in rural areas close to Ifakara (Smith *et al.* 1993).

Figure 5.3 Kilombero and Ulanga Districts showing DSS area



5.3 Study design

Two cross-sectional studies were carried out, one to collect pregnancy history and fertility preference data within the whole DSS, and one to describe risk factors for anaemia and the impact of ITNs on pregnancy malaria and anaemia. Both studies utilised individually matched data from the DSS data base.

Fertility Survey

Data for this study were collected using qualitative (focus group discussions) and quantitative techniques (questionnaire survey) as well as through a review of the DSS data. The survey was completed during one round of DSS interviews, May to August 1999.

Focus group discussions

Four focus group discussions (FGDs) were carried out at the start of the project in order to identify local terminology, attitudes and priorities in relation to family formation (Table 1). Two FGDs were carried out at a MCH with integrated family planning services to select only family planning users, and two FGDs were carried out in a neutral setting without specific selection for family planning use amongst community members of the same village (Kibaoni). In each setting there was one group of married and one group of unmarried women. All participants had at least one child. The FGDs were all conducted in Swahili with a trained, experienced moderator who probed participants on the ideal tempo and quantum of fertility, fertility decision-makers, economic problems, problems in achieving fertility ideals, and the perceived health sector needs for women trying to plan their fertility. The discussions were taped and the tapes then transcribed and translated into English. Themes emerging from the focus group discussion were analysed by manual content analysis and where appropriate the findings were incorporated in the design of a questionnaire.

Questionnaire

A quantitative questionnaire was undertaken in all 25 DSS villages in May 1999. A random sample of approximately 1000 women aged 15-55, stratified by village, was drawn. Verbal consent was sought before proceeding with a questionnaire which included a detailed pregnancy history, ideal tempo and quantum fertility questions, history of current and ever use of family planning, and open-ended questions about the fears associated with use of modern methods.

DSS Data

Using the unique person identification numbers assigned by the DSS, additional data on socio-economic status and position in the household were extracted from the DSS files and merged with the data from the questionnaire.

Risk factors for anaemia and impact of ITNs on pregnancy malaria and anaemia

A cross-sectional study with rolling recruitment of all pregnant women within the specified study area was carried out over a period of twelve months (September 1998 to August 1999). Pregnant women were identified via the DSS reporting of pregnancies that also recorded gestation of pregnancy at the time of the last census visit. All pregnancy reports from the six study villages were considered for enrolment into the study. In order to minimise missed pregnancies due to women delivering before being enrolled in the study, priority for recruitment was given to those women at the most advanced stage of gestation.

Recruitment and consent

A nurse/midwife travelled daily by motorbike from the IHRDC into the study area to recruit the pregnant women. She spent one day per week at each of the three MCH clinics within the study area (Kivukoni, Milola Lupiro) and the remaining two days per week making home visits to women who were known to be pregnant through the DSS reporting but who had not been captured at clinic. A detailed description of the project was given and written consent obtained before proceeding with the interview.

Physical examination

Women were examined to assess gestational age by abdominal palpation. Mid-upper arm circumference (MUAC) was measured using a simple tape (Teaching At Low Cost (TALC), St Albans, UK). Weight and height of respondents was recorded from which the body mass index (BMI: kg/m^2) was calculated. Temperature was recorded using an electronic thermometer. Mother and Child Health (MCH) clinic cards were used to record use of antenatal services.

Capillary blood and stool sample collection

The haemoglobin level of each woman was determined at the time of interview using a portable β–haemoglobin photometer (Hemocue©, HemoCue AB, Ängelholm, Sweden) and women with Hb<11 g/dL given standard first line anaemia treatment (chloroquine phosphate: 10/10/5mg/kg, ferrous sulphate: 200mg twice daily, 14 days; folic acid: 5mg once daily, 14 days). Thick and thin blood films were made on site and a 1ml capillary blood sample collected from each woman into a microtainer coated with anticoagulant (EDTA) and transported back to IHRDC laboratories at 4°C. Where possible a stool sample was collected from the women and placed in a capped tube containing a formalin solution.

Women were counselled about any suspected complications detected and a travel allowance given if referral to the district hospital was required.

Questionnaire

A detailed questionnaire was administered including information about past fertility, the current pregnancy, use of health facilities, knowledge of appropriate diet in pregnancy and food taboos, use of bednets and knowledge of the KINET discount voucher scheme.

Laboratory procedures

On the same day as interview the thick blood film was stained with Giemsa and the number of malaria parasites per 200 leukocytes counted. Hookworm eggs

were detected using the formalin-ether concentration method. Results were expressed semi-quantitatively as negative, low density positive and high density positive results according to whether one or more eggs were seen in each field (40x magnification). The following day first line treatment for those testing positive for malaria (chloroquine phosphate (10/10/5mg/kg) or for hookworm (single dose 500mg mebendazole) was distributed. At the end of the recruitment period sickling tests by electrophoresis to detect Hb genotype, and slide reading to detect microcytic/hypochromic red cells as an indicator of iron deficiency were carried out for all study participants. HIV-antibodies were anonymously determined by Veronostika HIV Uni-Form II *plus O* microelisa system (Organon Teknika, Boxtel, Netherlands).

DSS Data

Using the unique person identification numbers assigned by the DSS, infants born to the pregnant women in this study were followed to 365 days and linked to the maternal data described above. A survival analysis was carried out as detailed in Chapter 9.

Sample size for ITN impact study

At the start of the project it was estimated that at least one third of pregnant women were using treated nets. A sample size of 507 women would give the study 80% power to detect a 50% reduction in severe anaemia and a 25% reduction in moderate/mild anaemia amongst women using ITNs, at the 5% significance level. It was estimated from DSS reporting in the six selected study villages that there would be approximately 700 pregnancy events in a twelve month period.

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PART II: FERTILITY IN THE KILOMBERO VALLEY

CHAPTER 6 :

Planning a family: priorities and concerns in rural Tanzania.

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Abstract

A fertility survey using qualitative and quantitative techniques describes a high fertility setting (TFR 5.8) in southern Tanzania where family planning use is currently 16%. Current use was influenced by rising parity, education level, age of last born child, breastfeeding status, a preference for longer than the mean birth interval (32 months), not being related to the household head, and living in a house with a tin roof. Three principal concerns amongst women were outlined from the findings. First that there was a large amount of unmet need for family planning services in the area, particularly amongst teenagers. Second that currently family planning is being used predominantly for spacing but fears associated with family planning often curtail use. Third that service provision is perceived to be lacking in two main areas - regularity of supply and addressing rumours and fears associated with family planning. Reproductive health interventions in the area should ultimately be more widespread and in particular abortion is highlighted as an urgent topic for further research. However, the potential for a fast and positive impact is high given the simplicity of the perceived needs of women from this study.

Introduction

There are good grounds for believing that Tanzania is headed towards a fertility transition as experienced in other East and Southern African countries (TDHS, 1996; Zaba *et al.,*1998; Kirk and Pillet, 1998; NBS, 2000). Steady, small reductions in the total fertility rate (TFR) are evident over a ten year period from 6.5 in 1988 to 5.6 in 1999, and the decline is characteristically led by more urban and educated women. Demand for children remains high at present with the average desired family size around 5 children. But steadily rising levels of modern contraceptive use nationwide (from 6% to 16% of women between 1991/2 and 1999) suggests an increasing desire to manage fertility and to reduce the currently high number of unplanned pregnancies (NBS, 2000).

In 1994 Tanzanian policy changed to allow all sexually active persons access to family planning services (MoH, 1994). Particularly this should address the inclusion of young people, and people who had not yet started child bearing. However, ever use of modern methods amongst teenage girls remains low (10% in 1999) despite the fact that 53% have been sexually active (NBS, 2000). Opposition from religious and community leaders often exacerbates the difficulties of implementing policies which aim to improve the sexual health of young people through education and provision of family planning services (Zaba *et al.*, 1998). Even within the health care system it has been suggested that some moral reluctance to provide family planning services to unmarried people exists (Zaba *et al* 1998).

During the forty-seventh session of the WHO Regional Committee for Africa (WHO, 1998) ten objectives with specific targets were set for easing the burden of reproductive illnesses for the period 1998-2007. Objective 6 is: "to reduce the levels of unwanted pregnancies in all women of reproductive age" with a specific promotion of research which "reviews or undertakes operational research on barriers to family planning services". In Tanzania it has been estimated that only 56% of the total demand for family planning is currently being met, and that

during the period 1994-1999 one in five births were not wanted or were considered untimely by the mother (NBS, 2000). A large part of the unmet need in Tanzania is due to difficulties in geographical availability and supplies (Ross, 1995). However, it has been argued that provision of family planning should reach further than the conventional boundary of access and should address knowledge, fear of side effects and social and familial disapproval of family planning at community level (Bongaarts and Bruce, 1995). This service is largely absent in Tanzania: 8 out of 10 nonusers in 1999 said they had neither been offered information nor family planning services in the last year (NBS, 2000).

In the rural Kilombero Valley area in southern Tanzania an increasing number of outlets for family planning are under development. However, despite this effort to increase service provision there is a dearth of knowledge as to the current fertility levels and, perhaps more importantly, there is little information on the desires and needs of women in this area. We therefore carried out a study to describe fertility in the area, to identify the concerns of women during the process of family formation and to identify how best they would like to be served.

Study area

This project was based at the Ifakara Health Research and Development Centre (IHRDC), in the Kilombero Valley of southern Tanzania. The Centre started a demographic surveillance system (DSS) in Kilombero and Ulanga districts in September 1996, which operates in 25 villages covering 60,000 people living in approximately 12,000 households. Information on births, deaths, in-and out migration is updated for the population every four months and from time to time special surveys are administered, e.g. socio-economic status. The DSS provides a full sampling frame for in-depth studies within the area (Armstrong Schellenberg *et al.* 2001).

Both districts are rural and subsistence farming of rice, maize and cassava is practiced; fishing is also common. Up to one-third of houses in the area have brick walls and corrugated iron roofs; many of the remainder have mud walls and thatched roofs. There are no paved roads. About 40% of the population are Muslim and 60% Christian. Each village has at least one primary school and there is one secondary school. The public health system has a network of village health workers, health posts, dispensaries, health centres and hospitals with varying quality of care. Nine of the 25 villages included in the study area have a government health facility: in total there are 8 dispensaries and 2 health centres. Family planning services are available at all of these. There are a further 3 mission health facilities in the area which do not provide family planning services. Outside the study area, but within the range of health facilities accessed by the study population, are two hospitals. In Ifakara, the Kilombero district capital, is a well-equipped mission Designated District Hospital, and in Ulanga district's capital, Mahenge, is a more limited hospital. The mother and child health clinic services (MCH) are well developed and vaccination coverage is high with 78% of children receiving all Expanded Programme on Immunization (EPI) vaccines by age 1 year.

Methods

Data Collection

Data for this study were collected using qualitative (focus group discussions) and quantitative techniques (questionnaire survey) as well as through a review of the DSS data.

Focus group discussions

Four focus group discussions (FGDs) were carried out at the start of the project in order to identify local terminology, attitudes and priorities in relation to family formation (Table 6.1). Two FGDs were carried out at a MCH with integrated family planning services to select only family planning users, and two FGDs were

carried out in a neutral setting without specific selection for family planning use amongst community members of the same village (Kibaoni). In each setting there was one group of married and one group of unmarried women. All participants had at least one child. The FGDs were all conducted in Swahili with a trained, experienced moderator who probed participants on the ideal tempo and quantum of fertility, fertility decision-makers, economic problems, problems in achieving fertility ideals, and the perceived health sector needs for women trying to plan their fertility. The discussions were taped and the tapes then transcribed and translated into English. Themes emerging from the focus group discussion were analysed by manual content analysis and where appropriate the findings were incorporated in the design of a questionnaire.

Table 6.1 Composition of Focus Group Discussions

	MCH		Community	
	Married FGD 1	Unmarried FGD 2	Married FGD 3	Unmarried FGD 4
N	10	6	8	7
Age range	20 - 32 years	19 - 37 years	19 - 39 years	19 - 24 years
Parity range	1 - 7	1 - 6	1 - 7	1
F/P users	10	6	2	3
Primary Education	9	5	8	7
Current open birth interval range	8 - 31 months	4 - 37 months	2 - 84 months	6 - 72

Questionnaire

A quantitative questionnaire was undertaken in all 25 DSS villages in May 1999. A random sample of approximately 1000 women aged 15-55, stratified by village, was drawn. The questionnaire included a detailed pregnancy history, ideal tempo and quantum fertility questions, history of current and ever use of family planning, and open-ended questions about the fears associated with use of modern methods.

DSS Data

Using the unique person identification numbers assigned by the DSS, additional data on socio-economic status and position in the household were extracted from the DSS files and merged with the data from the questionnaire.

Data analysis

FGD data were analysed manually and the topics and perspectives emerging were summarised by the author and a social science researcher.

All questionnaire data were double entered in FoxPro (Microsoft Corporation, Seattle, WA, USA) by two different data entry clerks, and any errors were corrected with reference to the original forms. Data was analysed using STATA (version 7, TX, USA). Percentages were compared using χ^2 tests. Student's t-test was used for comparing means. Logistic regression was used to calculate adjusted odds-ratios for factors influencing current family planning use where variables had a χ^2 or unadjusted OR p-value <0.1.

Results

Priorities and concerns highlighted by the focus group discussions

In response to the questions and probes of the moderator the three most important and consistent themes that were raised by the participants across the FGDs were induced abortions, the economic burden of parenting and service provision needs.

1. *Induced abortions*

The perception of an increase in the number of induced abortions

All the focus groups had strong feelings about this topic. The tone of discussion was one of a shared burden for women, and feelings of sympathy for those who found themselves with unwanted pregnancies. The main risk group was considered to be teenage girls and was most visible amongst school girls from Primary Form Five/Six students onwards. The struggle and commitment required by parents to send their children to school was emphasised, and, in the event of a pregnancy, the terrible disappointment and shame experienced by the whole family as a school girl who becomes pregnant is obliged to leave school.

> *"You may find a girl who has almost completed primary when she realises that she is pregnant. With the consent of her mother she can make private arrangements with a doctor. When it is all over she can continue with her education."* (FGD 3: married, 36 years)

Even for teenage girls who were not at school induced abortions were considered to be a growing problem. Rejection by the father, and the threat of rejection by her parents, would be adequate reason for a girl to attempt an abortion. Without the support of the mother the options open to young girls were to visit local 'grandmothers' (often traditional birth attendants) who would attempt to carry out the abortion, to drink traditional herbs, or take large quantities of chloroquine or the contraceptive pill.

> *"When a girl realises she is pregnant she will respond by drinking large quantities of chloroquine tablets to end the life of the child - or even her own life to avoid disappointing her parents."* (FGD1: Married, 29 years).

Unanimously, women considered that increases in the cost of bringing-up children (particularly food, clothes, health and education related costs) were the root cause of the increase in induced abortions.

> *" It is true that the community does not condone the practice (of induced abortion) - a person can die just trying. But some people are forced to see the sense in making such a choice and they quietly praise the girl who has successfully aborted. They consider her to be clever because she has survived a great explosion in her life."* (FGD 3: Married, 39 years)

2. *Economic burden*

The lack of shared responsibility by fathers of children

That men display a lack of responsibility towards their children and the mothers of their children was virtually unanimously agreed upon, although some concession was made for 'educated men'. It was felt that in the main men were ignorant of the cost of living.

> *"Whenever a wife complains of not having enough for her family the husband will compare today to the time he was born, when a piece of black cloth was hardly available for dressing. He will tell his wife that now, when there are a lot of clothes available everywhere, he doesn't see why he shouldn't have many children"* (FGD 3: Married, 26 years)

Within marriage it was said that the husband was the official decision-maker regarding fertility issues. All married women attending the FGDs said that at least once their preferred fertility choice had been overruled - principally this

related to the timing of births. The women were agreed that close birth intervals posed a danger to the health of both mother and child, and also made the mother less productive economically. However, most felt that avoiding pregnancy against the husband's wishes was a more dangerous behavior. Without a small baby or a new pregnancy to occupy him the man may direct his attentions and resources towards other women.

> *"When a child is five years old he can walk with me to the farm. But how does one work with a baby under three who must be carried on the back? The problem for married women is that five years is too long for a husband to agree. A woman can plan anything she likes regarding her family building but if her husband doesn't like it then it is all useless."* (FGD 2: Unmarried, 32 years)

Within the FGDs both unmarried and married women agreed that the ideal birth interval was between three and five years (with the exception of FGD 4 whose members did not want to discuss having another child). This was considered optimal for work, adequate childcare and the maintenance of health and beauty of the mother. However, some participants felt that a married woman who was not pregnant or breastfeeding was in danger of inciting jealousy in her husband.

> *"Jealousy is a big hindrance (to family planning) as the husband will think that other men can be attracted to his wife's beauty when he notices the physiological changes which occur in her when she has rested. In this case he will demand that they try for a new pregnancy immediately."* (FGD1: Married, 29 years)

The unmarried women attending the FGDs had never married. There was a striking difference between the two unmarried groups in their attitudes towards their situation. The older women (FGD 2) talked about how proud they were to be taking care of their children without the help of a man, but the younger women

(FGD 4) concentrated more on the parental disapproval, shame, and subsequent lack of choices open to them.

> *"So many things are caused by poverty. Some children are born unplanned because a girl may go to somebody to beg for a piece of soap. She will get the soap but she will have to pay for it in some way or other"* (FGD 4: Unmarried, 21 years)

However, all unmarried mothers concurred that they received no support from the father(s) of their child(ren) and being a single parent exacerbated the poverty experienced by other members of the community.

> *"The thing about being a single mother is that we have so many things to take us away from work. Because of this we are the ones who sleep hungry at night and our children are those who miss their education"* (FGD 2: Unmarried, 26 years)

3. *Service provision needs*

Improvements needed in family planning services

This topic was addressed in response to a direct question about how current family planning services could be changed. Two distinct areas were raised by the women in the FGDs. There was no apparent conflict of opinion, but not all women contributed to the topic.

The first was a lack of clear information about the methods of family planning available, with a more general discussion about which methods of family planning the FGD members thought were suitable or not. This was seen as an obstacle to building confidence in women who had already adopted a method and by some was thought to be the principal reason for discontinuation of method use. Lack of clear information also acted as a deterrent to potential family planning adopters who might hear many mixed messages. The women

said that their biggest problem was that there were many rumours within the community concerning the side effects of different methods, which were never addressed at point of service delivery. Too often women were just told not to worry.

> *"Some women find that they bleed continuously when they start using family planning and those who face this kind of experience are the ones who discourage others; always bad news travels faster than good."* (FDG3: Married 24 years).

The second problem was supply related. Irregular supplies at family planning outlets was considered to be a major obstacle. An interruption in supply was said to be of particular concern for women using family planning methods in secret. Family planning services in the area are commonly integrated within Mother and Child Health Clinics (MCH) and women often use their last child as an excuse to visit the clinic once every three months as required for hormonal supplies. Indeed some participants described complicated mechanisms for using family planning in secret such as leaving pills with a friend who would bring them with her to the well each evening when collecting water, and using code words such as 'karanga' (peanuts) between friends when discussing supplies. Repeat visits in quick succession (to check whether supplies had arrived) would arouse suspicion in the husband and become difficult to justify. In addition, the inability to get supplies from an outlet other than the regular one (for example when travelling) was raised. There was a call for services to be expanded in terms of coverage rather than the range of services provided.

> *"It would be very good if a way could be devised for services to be provided everywhere. A person may be away on a journey when the date for a repeat injection comes, yet she is likely to be denied the service because her card remains at her usual clinic. We should be able to get the service where ever we happen to be."* (FGD 1: Married, 32 years)

The quantitative analysis

Questionnaire data were collected from 1018 women. 18% (180/1018) reported no pregnancies and 20% (204/1018) had had no live birth. The quantum and tempo of fertility was found to be typical for a high fertility setting. Median age at first birth was 18 years (interquartile range 16, 20) and 92% (768/831) of women aged 20 years or over were mothers. Only 4% (4/93) of women aged 45+ remained childless. Mean preferred family size was 5 children (standard deviation (sd) 2.0). The total fertility rate (TFR) for women aged 15-49 over the three-year period prior to survey was 5.8 and the average parity of women aged 45+ years at survey was 6.0. The preferred mean birth interval was 43 months (sd 13.6) with 86% of all women wanting birth intervals over 36 months long. Actual mean birth interval length for all women was 32.5 months (sd 0.3) when valid birth intervals were restricted to those opening and closing with a live birth within 5 years (Rodriguez and Hobcraft 1980; Brass and Juarez 1983).

Current use of modern family planning methods

16% (145/914) of (non-pregnant) women were currently using a modern method of family planning: depo provera 7% (63/914), contraceptive pills 5% (42/914), condom 2% (23/914) and tubal sterilisation 2% (17/914). Variables showing evidence of an association with current family planning use are presented in Table 6.2. After adjustment, being at higher parities was the most important determinant of current family planning use. Breastfeeding status was also an important determinant with exclusively breastfeeding mothers least likely to be users. The odds of being a current user was influenced by relationship to the household head (HHH): children of the HHH were least likely to be users and women who were not immediate family members were most likely. Education level, a preference for longer birth intervals, and living in a house with a tin roof (a relative wealth indicator) were also important determinants of f/p use.

Table 6.2 Determinants of current family planning (FP) use
(women in the Kilombero Valley, Tanzania[1])

Variable	Category	Overall N[2]	% using FP	? [2] (p-value)	OR (95% CI)	Adj OR (95% CI)	LRT
Age:	15-19	168	5		1.0	1.0	0.08
	20-24	167	17		3.7 (1.7-8.1)	1.6 (0.5-4.8)	
	25-44	489	21	35.4	4.7 (2.3-9.6)	1.1 (0.3-3.6)	
	45+	90	3	(<0.001)	0.6 (0.1-2.3)	0.3 (0.05-1.7)	
Currently Married[3]	No	326	10	11.2	1.0	1.0	0.3
	Yes	588	19	(0.001)	1.9 (1.3-3.0)	0.7 (0.3-1.5)	
Parity	0	186	4		1.0	1.0	0.01
	1	146	14		3.5 (1.5-8.3)	2.6 (0.8-7.9)	
	2/5	402	22	31.0	6.3 (2.9-13.3)	4.6 (1.4-14.9)	
	6+	180	16	(<0.001)	4.1 (1.8-9.3)	7.5 (2.0-27.8)	
Last child < 3 years old	No	504	12	9.5	1.0	1.0	0.02
	Yes	410	20	(<0.001)	1.9 (1.3-2.7)	2.3 (1.1-4.8)	
Breastfeeding	Exclusive	79	5		1.0	1.0	0.005
	B'feeding + food	279	19	9.5	4.5 (1.6-12.8)	3.0 (1.0-9.1)	
	Not breastfeeding	556	16	(0.009)	3.5 (1.2-9.7)	6.4 (1.8-22.4)	
Menstruation	No last month	310	11	7.3	1.0	1.0	0.2
	Yes last month	604	18	(0.007)	1.7 (1.1-2.6)	1.4 (0.8-2.4)	
Ideal birth Interval	<31mths	132	7	9.4	1.0	1.0	0.01
	>30 mths	782	17	(0.002)	2.8 (1.4-5.8)	2.4 (1.1-5.1)	
Education	None	167	6		1.0	1.0	0.02
	Some primary	268	12	26.7	2.2 (1.0-4.4)	2.3 (1.0-5.4)	
	Complete primary (+ secondary)	479	22	(<0.001)	4.3 (2.2-8.4)	2.8 (1.2-6.5)	
Relationship to HH head[4]	Child	173	7		1.0	1.0	0.1
	Wife	457	19		2.8 (1.5-5.3)	2.7 (1.0-7.7)	
	Self	83	16	12.5	2.2 (1.0-5.1)	1.3 (0.3-4.3)	
	Other	137	15	(0.006)	2.2 (1.0-4.6)	2.6 (1.1-7.2)	
Household economics[5]	Bike +/or radio						
	Not in household	264	12	4.1	1.0	1.0	0.3
	Yes in household	460	17	(0.04)	1.6 (1.0-2.5)	1.2 (0.7-2.1)	
	Any formal work						
	No	607	14	2.8	1.0	1.0	0.8
	Yes	117	20	(0.09)	1.5 (0.9-2.5)	1.0 (0.6-1.9)	
	House has tin-roof						
	No	549	12	17.1	1.0	1.0	0.002
	Yes	175	25	(<0.001)	2.4 (1.5-3.7)	2.2 (1.3-3.6)	

[1] Additional variables tested with no evidence of an association (?^{2} and odds ratio p-value >0.1) with current family planning use were i) presence of a bednet in the household, ii)ever having experienced pregnancy wastage, iii)desired completed family size above or below the mean (5 children)
[2] Women currently pregnant not included: n=914
[3] Currently married refers to women officially married plus those co-habiting with their long-term partner
[4] Data source DSS: n=850
[5] Data source DSS: n=724

There was evidence of more deliberate use of f/p amongst women at high risk of becoming pregnant according to behavioural (currently married, not abstaining, not using the calendar method of avoiding a new pregnancy) and biological (no longer amenorrhoeic (either post-partum or induced by breastfeeding) factors. The prevalence of modern family planning use increases two-fold when only considering 'high risk for an untimely new pregnancy' women (Table 6.3).

Table 6.3 Prevalence of current family planning use according to exposure to the risk of becoming pregnant.

→ including	All non-pregnant women →	Don't want a new pregnancy →	Married →	Not fully breast feeding →	Menstruated last month →	Not abstaining →	Not using calendar method
N	145/914	129/696	102/439	99/383	72/229	66/202	65/188
% using modern family planning	15.8	18.5	23.2	25.8	31.4	32.6	34.5

Ever use

In total 45% of respondents (461/1018) had ever tried to avoid pregnancy using any means including abstinence, traditional methods and the calendar method. 29% (294/1018) of all women had ever used a modern method of contraception and 19% (57/294) of these had tried more than one modern method. 17% (170/1018) had ever tried the contraceptive pill, 13% (129/1018) depo provera,

4% (36/1018) condoms and 2% (17/1018) tubal sterilisation. 76% (109/144) of unmarried women had decided themselves to use a modern method and 15% had been advised by a nurse or doctor. Amongst married women, 46% (146/317) had decided themselves, 33% (104/317) were advised by their husband and 17% (55/317) took the advice of a nurse or doctor.

Acceptability of methods

There was a difference in perceived acceptability of each method by age group of respondent (X^2 p-value<0.001), except for the traditional method for which there was no difference by age (not shown) (Figure 6.1).

Justifications and considerations: starting a method

Women who had ever chosen to avoid a new pregnancy agreed that their main reasons for avoidance were: to ensure a birth interval of more than 24 months 65% (289/461), to finish breastfeeding the last child 41% (190/461), to take care of her own health 35% (161/461), because her husband wanted to space 16% (74/461), and to stop bearing altogether 16% (74/461). The main considerations when choosing which method to use were safety (especially referring to maintenance of future fertility) 38% (175/461), whether husband would agree with the method 13% (61/461), secrecy 11% (51/461), having no other choice 10% (46/461) and finally cost 9% (40/461). For each method individually, safety was the most important consideration with the exception of tubal sterilization only - for which preservation of the woman's health was most important. The second most important reason for choosing each method were: there being no other method available (abstinence), compliance by the husband (the contraceptive pill, the condom, traditional and calendar methods) and secrecy (depo provera).

Reasons for stopping a modern method

174 women had ever used a modern method of family planning but were no longer doing so. Their reasons for stopping were: 39% stopped because they wanted a new pregnancy, 24% stopped because they experienced side effects

(including disruption of the menstrual cycle), 10% stopped because they had no money to pay for supplies, 9% stopped because of their husband, 6% stopped because of a shortage of supplies, 4% stopped due to the fear of side effects, 4% because of an accidental pregnancy, and 3% stopped when menopause started.

Family planning fears

All women were asked what they feared most about the different modern family planning methods in turn (Figure 6.2). Fears could be summarised under five main headings. 1. The fear of a method impairing the woman's own health included the specific fears of developing cancer, stomach ulcers, increasing blood pressure, causing pain in the womb and, in the case of condoms, infection with the HIV virus. 2. A method not being nice or acceptable to use included it being difficult to keep secret, easy to forget (esp. pills), concerns that pills would not dissolve properly inside the body, that condoms would get stuck inside the vagina, or that the man would not use the condom properly. 3. Fears of method failure were exclusive to condom use. 4. Fears associated with the limitation of future fertility were almost exclusively concerned with damage done to the uterus that would not be detected until much later. This would manifest in long delays in conceiving again, destroying all the eggs inside a woman and causing infertility for some women, and causing problems in subsequent deliveries. The general consensus was that hormonal methods in particular were not suitable for all women and should not be used for prolonged periods. Median duration of use by current users of hormonal contraceptives was 7 months (interquartile range: 3,15). 5. Affecting the menstrual cycle referred to experiencing more painful menstruation, having continuous bleeding or the total absence of bleeding. Associated fears of disruption to the menstrual cycle were related to damage to future fertility potential, and to discovery of family planning use by the husband.

Unmet need

Despite these fears, there was a striking unmet need for modern methods of family planning, especially amongst teenagers (Table 6.4). Approximately three

times the number of current users in age groups over 19 years said that they would use family planning if it were more easily accessible to them. For unmarried teenagers this figure was 6 times higher (45 vs 7 women) and 11 times more married teenagers would like to use family planning than currently were doing so (22 vs 2).

Table 6.4 Unmet need for family planning

(Percent of women who currently use family planning compared to the percent who answered 'yes definitely' to the question "Would you currently choose to use a method of family planning if it were more easily accessible?")

Unmarried					Married				
	N	Current family planning users	Would use	% Change		N	Current family planning users	Would use	% Change
15-19	148	5	31	26	15-19	39	5	56	51
20-29	106	14	52	38	20-29	278	19	58	40
30-39	51	14	41	27	30-39	218	21	53	32
40+	43	12	21	9	40+	135	8	34	26

Figure 6.1 Acceptability of family planning method by age of woman

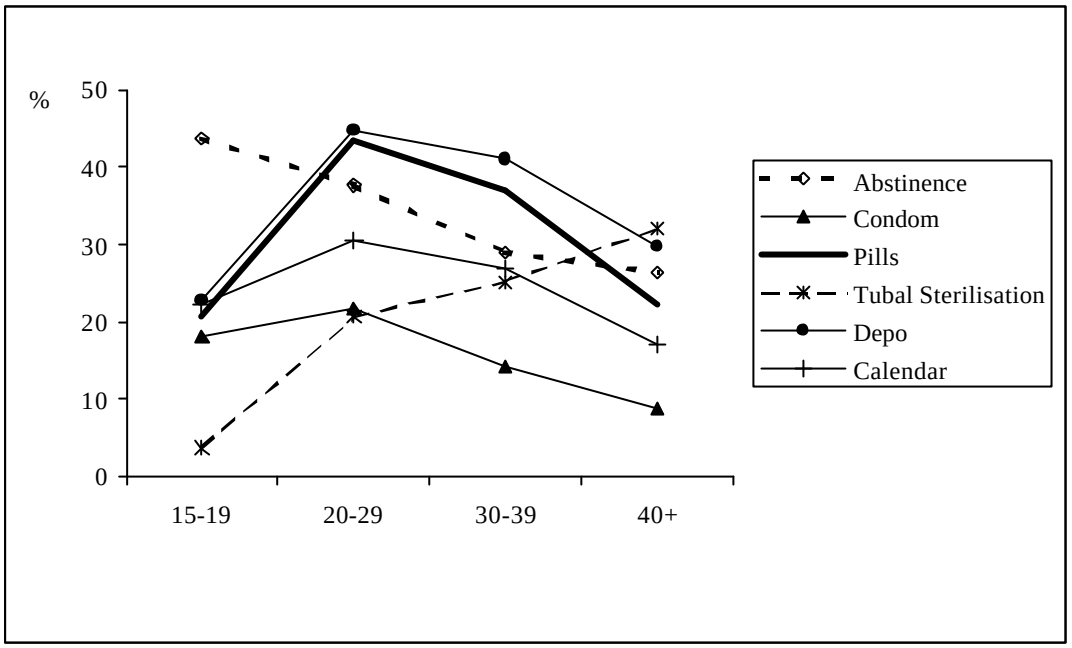
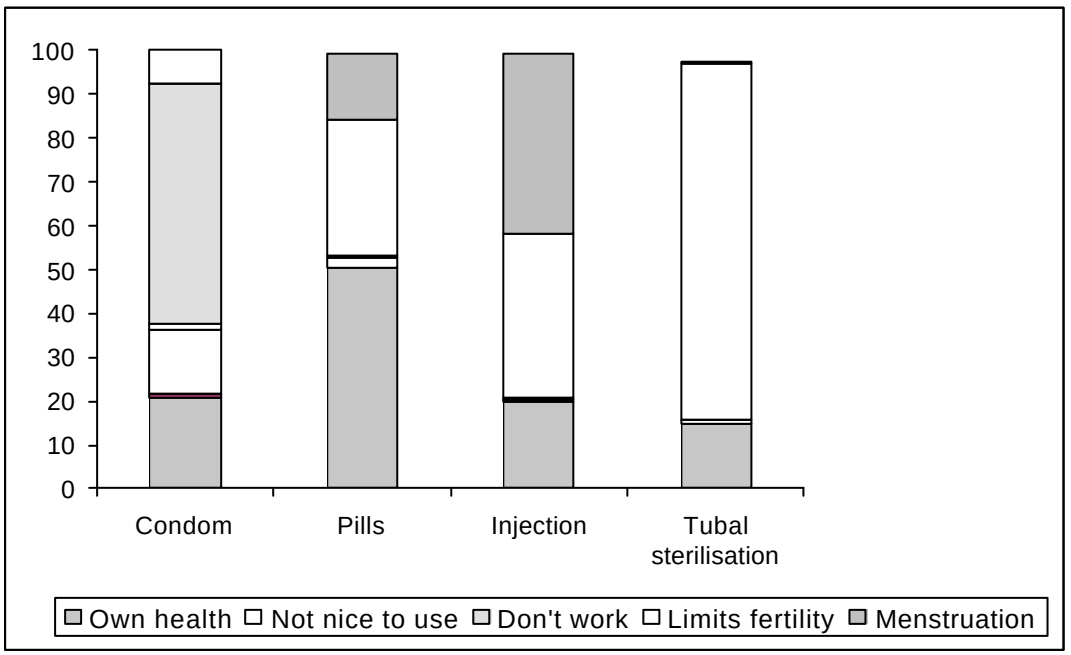


Figure 6.2 Fears associated with different methods of family planning



Discussion

This study on the priorities and concerns of family formation amongst women living in two districts in rural Tanzania has found that the current tempo and quantum of fertility is typical for a high fertility setting and use of modern contraceptives is low. Four principal areas have been highlighted, namely the unmet need of teenagers, the adoption of family planning for spacing, the obstacles and fears associated with family planning use at the community level, and obstacles in service provision.

Unmet need for family planning and a strong desire to control birth intervals was evident from both the qualitative and quantitative data, and was particularly urgent amongst teenagers. They were clearly experiencing pregnancy (32% (60/187) were either mothers or currently pregnant) and 50% (30/60) of teenage mothers were not married. In addition, in the FGDs the women raised concerns about a perceived increase in induced abortions amongst teenagers. These concerns were not investigated in the questionnaire since although abortion in Tanzania is legal on maternal health grounds, in this area, which is strongly influenced by both the Catholic church and by Islam, it is an especially sensitive topic. It was considered inappropriate to investigate induced abortions using such a broad questionnaire, however the topic deserves further research.

The relevance of addressing the family planning needs of teenagers in this area should not be underestimated simply because it is the norm for women to start bearing children at early ages. The increased risk of infant mortality associated with teenage motherhood and with short birth intervals (which often arise from unplanned pregnancies) has been well described (Pebley and Millman 1986). Further, there is a current emphasis in reproductive health literature on the changing needs of teenagers in this era of HIV transmission (Bongaarts and Cohen, 1998). An additional problem that is not always linked to reproductive health strategy is that of malaria and it's associated anaemia. These are highly

prevalent in this study area as in many sub-Saharan environments. It is well established that malaria and anaemia have deleterious effects on the health of both the mother and the newborn, and that these effects are most pronounced amongst primigravidae (Gilles *et. al.,* 1969; Brabin, 1991). The effectiveness of preventative public health tools (such as insecticide treated nets and iron prophylaxis) would be maximised if used early or even pre-pregnancy, and as such the planning of pregnancy should be seen as an appropriate goal for workers across the health sector.

The second major issue raised by this study is that at present family planning is used predominantly for spacing in this high fertility setting. The data from the FGDs showed a strong preference for birth spacing of 3-5 years and the quantitative data showed rising prevalence at middle parities, rising prevalence according to risk of exposure via the proximate determinants of fertility, and short median duration of use. This pattern has been recorded as typical in other sub-Saharan settings (Caldwell, 1992; Ross and Frankenberg, 1993; Bledsoe *et. al*., 1994). However, the adoption of family planning for spacing during the early stages of fertility transition should not contradict unmet need for family planning amongst women who have yet to start bearing. Even in such a rural setting we have found evidence that women have a relatively sophisticated approach to choosing and using the methods available to them. Family planning use should be equally as dynamic for women pre-pregnancy as it is during their childbearing years.

The single biggest fear of family planning use was the extent to which it could damage and as such limit a woman's future fertility potential (37% of all responses). However, the positive influence of the socio-economic variables on family planning use - increasing education, preference for long birth intervals and living in a house with a tin roof - may be indicative of a changing response to fertility regulation (Freedman, 1979; Ross and Frankenberg, 1993). Marital status had little impact on family planning adoption after adjustment for other

factors. 10% (89/914) of all the non-pregnant mothers in this study had never married and their family planning prevalence was similar to currently married mothers (18% (16/89) vs 20% (111/552). However, both the qualitative and quantitative data showed that men have a strong influence over fertility decisions and some women were using family planning in secret. The fact that fathers wanted to be the fertility decision-makers but were not inclined to contribute to the economics of childcare was considered too sensitive to address directly in the questionnaire. Open-ended questions about reasons for choosing different methods of family planning and reasons for stopping methods of family planning did highlight the need for secrecy amongst women and the influence husbands had over fertility behaviour. Fertility behaviour according to marital status in this area should be investigated further.

There were clear differences in perceived acceptability of methods for women at different age groups. Most strikingly older women were less likely than younger women to accept abstinence, the calendar method and condoms. Acceptability of hormonal methods followed a very similar pattern to that of a typical age-specific fertility schedule in a high fertility setting - they were thought to be most acceptable by women in the middle of childbearing with depo provera also acceptable to women at the end of child bearing. However, it is difficult to say whether such perceptions stem from the women themselves or from service providers. The perceived low acceptability of hormonal methods for young women in particular is likely to be strongly influenced by reluctance of the service providers to encourage family planning use in this group.

Service delivery problems together with fear of (or actual) side effects accounted for 44% of all the reasons given by women who had stopped using modern family planning. Only 39% stopped because they wanted a new pregnancy. Fears or rumours of problems associated with family planning use were highlighted in both data sources. In light of the apparent unmet need for services this problem should be addressed with more accessible community education in conjunction

with better information at point of delivery. Family planning providers have an essential role to play in dispelling local myths about family planning use by preparing women realistically for the physical changes they might experience when adopting a new method. A concerted effort by reproductive health actors now could make a large difference to the way in which women manage their fertility in the area.

In summary this study has highlighted real concern amongst women for the good reproductive health of teenagers in this high fertility, rural setting. Some cultural problems have been identified which are perceived to exacerbate the difficulties women face when building a family in this setting. But perhaps most importantly, a clear message of unmet need for more widely accessible family planning services, together with information that specifically addresses rumours and fears, has been delivered and should be invested in as a priority.

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CHAPTER 7:

Demographic and socio-economic determinants of abortion in Tanzania.

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Working paper

Introduction

Of all clinically diagnosed pregnancies 15-20% end in spontaneous abortion, predominantly in the first trimester (Abouzahr & Ahman, 1998). The biological determinants of pregnancy loss are well documented (Simpson & Carson, 1993; Mascie-Taylor, 1996) and in Tanzania these are likely to include malaria, schistosomiasis, genital TB, amoebiasis, and sexually transmitted infections. However, there is a paucity of data for identifying high risk groups in the community. We analysed the pregnancy histories of women in a rural area to assess the prevalence and demographic and socio-economic determinants of abortion (spontaneous or induced not distinguished).

Participants, methods, and results

A study to determine fertility levels and preferences was done using a simple random sample drawn of women aged 15-55 resident within a demographic surveillance system in Ulanga and Kilombero Districts, southern Tanzania (Armstrong Schellenberg 2002). Pregnancy histories were recorded as well as socio-economic status markers, family building preferences and family planning histories.

Evidence of an association was sought between pregnancies reported to have ended in abortion and maternal socio-economic or demographic variables (see footnote to table). All variables with a $?^2$ p-value <0.1 were entered in a logistic regression model, adjusting for total pregnancies experienced by interview. Statistical significance in the final model was defined as a likelihood ratio $?^2$ p-value <0.05.

Of 1018 women interviewed 838 reported at least one pregnancy (3457 pregnancies in total). Overall fertility was high with a total fertility rate of 5.8 and low levels of childlessness (4% (7/178) of women aged =40 years). Almost one third (31%, 260/838) of all women who had at least one pregnancy reported an abortion. One in 50 (2%, 78/3457) of all pregnancies were reported to end in

stillbirth, and 8% (273/3457) ended in abortion. There was indirect evidence of gross underreporting of first trimester abortions: typically 80% of all spontaneous abortions occur before 13 weeks gestation (Abouzahr & Ahman, 1998) but here they accounted for only 33% (91/273) of all reported. 5% (182/3457) of second and third trimester pregnancies ended in abortion which is twice the 'natural' rate.

In bivariate analysis there was evidence of an association between events ending in abortion and five maternal factors (table). In multivariate analysis, older age at termination of pregnancy, previous pregnancy wastage and being the child of the household head remained independent determinants (table).

Table 7.1 Demographic and socio-economic factors associated with a pregnancy event ending in pregnancy loss[†]

		N*	% experiencing abortion	χ^2 (p)	Adjusted OR[‡] (95% CI)	LRT χ^2 (p)
Age at termination of pregnancy	< 40 years	3331	8	10.1	1.0	5.1
	≥ 40 years	89	17	(0.001)	2.5 (1.1-5.3)	(0.02)
Pregnancy order of event	1st - 3rd	2082	8		1.0	
	4th - 6th	966	7		0.9 (0.6-1.3)	1.3
	7th - 9th	335	8	16.8	0.8 (0.4-1.4)	(0.7)
	10th - 14th	74	20	(0.001)	0.6 (0.2-1.6)	
Preceded by pregnancy waste	No	3201	7	62.3	1.0	20.0
	Yes	256	21	(<0.001)	2.6 (1.7-3.8)	(<0.001)
Child of household head	No	2968	7	4.9	1.0	4.1
	Yes	177	12	(0.02)	1.7 (1.0-2.9)	(0.04)
Ever used modern family planning	Yes	1228	6	6.9	1.0	3.0
	No	2229	9	(0.008)	1.3 (1.0-1.7)	(0.08)

* N=3457 except: 1)age at event N=3420, 2)child of HHH N=3145.

† The following maternal variables were tested for an association with pregnancy loss (?^{2} p-value <0.1): current age, number of pregnancies by interview, ever use of family planning, relationship to household head, ownership of bike or radio or livestock or mosquito net, living in a house with a tin roof, living with formally employed persons, marital status, education level, preferred completed family size, preferred birth interval.

‡ Final model includes variables shown in table, adjusting for total number of pregnancies experienced by interview.

Comment

We have shown a high prevalence of second and third trimester pregnancy loss in this area of Tanzania, and evidence that first trimester abortions were grossly underreported. Older maternal age has been found as an independent risk factor as reported in other settings (Anderson *et. al*., 2000). The negative impact of previous pregnancy wastage seen in this study is compatible with some but not all findings in other settings (Abouzahr & Ahman, 1998; Everett, 1999). In this context the finding suggests damage or obstruction to the fallopian tubes, uterus or vagina due to infections such as genital TB, schistosomiasis, and sexually transmitted infections (Mascie-Taylor, 1996).

The odds of a pregnancy ending in abortion were almost doubled for women who were living in a household where the household head was a parent. Since there is no plausible biological explanation for this it is possible that there might be a higher prevalence of induced abortions in this group, 91% of whom were unmarried. Focus group discussions during the design phase of this project indicated that the frequency of induced abortions was perceived to be increasing in the area, especially amongst schoolgirls due to familial disapproval. Women living with a parent as household head were more likely to report experiencing an abortion at a health facility than other women (48% (10/21) vs 26% (56/217): $?^2$ 4.5, p-value 0.03). Given the morbidity and mortality implications of unsafe abortion in a resource poor setting - and the potential for interventions (Abouzahr & Ahman, 1998) - this topic deserves further research.

Acknowledgements

We would like to thank the women who participated in the study. Dr H Mshinda the Director, and the staff of the Ifakara Health Research and Development Centre for facilitating the study, Drs F Lwilla and P Mbena (Kilombero and Ulanga District Medical Officers) and the MCH Kibaoni clinic staff. We are grateful to Prof. Marcel Tanner for his support.

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PART III: ANAEMIA IN PREGNANCY

CHAPTER 8:

Anaemia in pregnancy in southern Tanzania.

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Summary

Anaemia in pregnancy is associated with maternal morbidity and mortality and is a risk factor for low birth weight . Of 507 pregnant women recruited in a community cross-sectional study in southern Tanzania 11% were severely anaemic (Hb<8g/dL). High malaria parasitaemia (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. Being recruited in the late dry season was associated with a six-fold increase in the risk of being severely anaemic compared to being recruited in the early dry season. Women with severe anaemia were more likely to present at MCH early than women not identified as severely anaemic, they were more likely to seek medical attention outside the MCH, and to report concerns about their own health. Pregnancy related food taboos in the area restrict principally the consumption of fish and meat. Effective malaria and iron interventions are available but are not currently in place: improvements in delivery mechanisms of interventions are urgently required. Additionally, opportunities for contacting target groups beyond the clinic environment need to be developed.

Introduction

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 (DeMeyer 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). Severe anaemia in 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). A study in Malawi found anaemia to be significantly associated with maternal death (McDermott *et al.,* 1996). In addition, maternal anaemia is a risk factor for infant mortality (Marchant *et al., submitted*) and for low birth weight (Deleron *et al.,* 1989; Brabin, 1991) which in itself is an important risk factor for infant mortality (McCormick, 1985, Guyatt and Snow 2001).

Pregnant women are more likely than non-pregnant women to be anaemic for a variety of reasons including haemodilution and increased demand on iron and folate stores. In sub-Saharan Africa malaria, iron deficiency (often exacerbated by hookworm infection), other nutritional factors, sickle cell disease, and increasingly infection with the human immunodeficiency virus are also important risk factors for anaemia in pregnant women (Fleming 1989).

A large-scale study in southern Tanzania estimated a high maternal mortality ratio: 977 per 100,000 live births, with anaemia amongst the top five causes of death (AMMP, 1997). In the Kilombero Valley, more than 40% of children have severe anaemia (Hb<8g/dL) (Menendez *et al.,* 1997, Abdulla *et al.,* 2001). In this study we quantify the problem of, and risk factors for, anaemia amongst pregnant women in Kilombero. In addition, use of health services and local dietary restrictions are examined with a view to facilitating the targeting of pregnancy anaemia control measures.

Materials and methods

Study area

The methodology and setting of this study have previously been described (Armstrong Schellenberg *et al.,* 1999; Marchant *et al*., 2002). In brief it was conducted in Ulanga District, southern Tanzania, in the Kilombero River valley. The area is rural and the population consists of mainly subsistence farmers (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 to May). Data from local health services indicate malaria as the principal cause of morbidity, with anaemia amongst the top ten causes (Tanner *et al.,* 1991). There are three Mother and Child Health clinics (MCH) in the study area (Kivukoni, Milola and Lupiro) and one Health Centre (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 twelve months (Sept 1998-Aug 1999). Pregnant women were identified using the demographic surveillance system (DSS) which was established in 1996 by IHRDC/KINET and includes approximately 60,000 people living in 25 villages (Armstrong Schellenberg *et al.,* 2001).

A nurse traveled daily into the study area to identify and recruit the pregnant women. A detailed description of the project was given and written consent obtained before proceeding with the interview. A detailed questionnaire was administered including information about socio-economic status, fertility, use of health facilities, food taboos and use of insecticide treated nets (ITNs). All work was conducted in Kiswahili, which is widely spoken in the study area. Each woman was seen only once.

Clinical examinations

Women were examined to assess gestational age by abdominal palpation. Mid-upper arm circumference (MUAC) was measured using a simple tape (Teaching At Low Cost (TALC), St Albans, UK). Weight and height of respondents was recorded from which the body mass index (BMI: kg/m^2) was calculated. Mother and Child Health (MCH) clinic cards were used to record use of antenatal services.

The haemoglobin level of each woman was determined at the time of interview using a portable β–haemoglobin photometer (Hemocue©, HemoCue AB, Ängelholm, Sweden) and women with Hb<11 g/dL given standard first line anaemia treatment (chloroquine phosphate: 10/10/5mg/kg, ferrous sulphate: 200mg twice daily, 14 days; folic acid: 5mg once daily, 14 days). Thick and thin blood films were made on site and a 1ml capillary blood sample collected from each woman into a microtainer coated with anticoagulant (EDTA) and transported back to IHRDC laboratories at 4°C. Where possible a stool sample was collected from the women and placed in a capped tube containing a formalin solution.

Laboratory procedures

On the same day as interview the thick blood film was stained with Giemsa and the number of malaria parasites per 200 leukocytes counted. Hookworm eggs were detected using the formalin-ether concentration method. Results were expressed semi-quantitatively as negative, low density positive and high density positive results according to whether one or more eggs were seen in each field (40x magnification). The following day first line treatment for those testing positive for malaria (chloroquine phosphate (10/10/5mg/kg) or for hookworm (single dose 500mg mebendazole) was distributed. At the end of the recruitment period sickling tests by electrophoresis to detect Hb genotype, and slide reading to detect microcytic/hypochromic red cells as an indicator of iron deficiency were

carried out for all study participants. HIV-antibodies were determined by Veronostika HIV Uni-Form II *plus O* microelisa system (Organon Teknika, Boxtel, Netherlands).

Data analysis

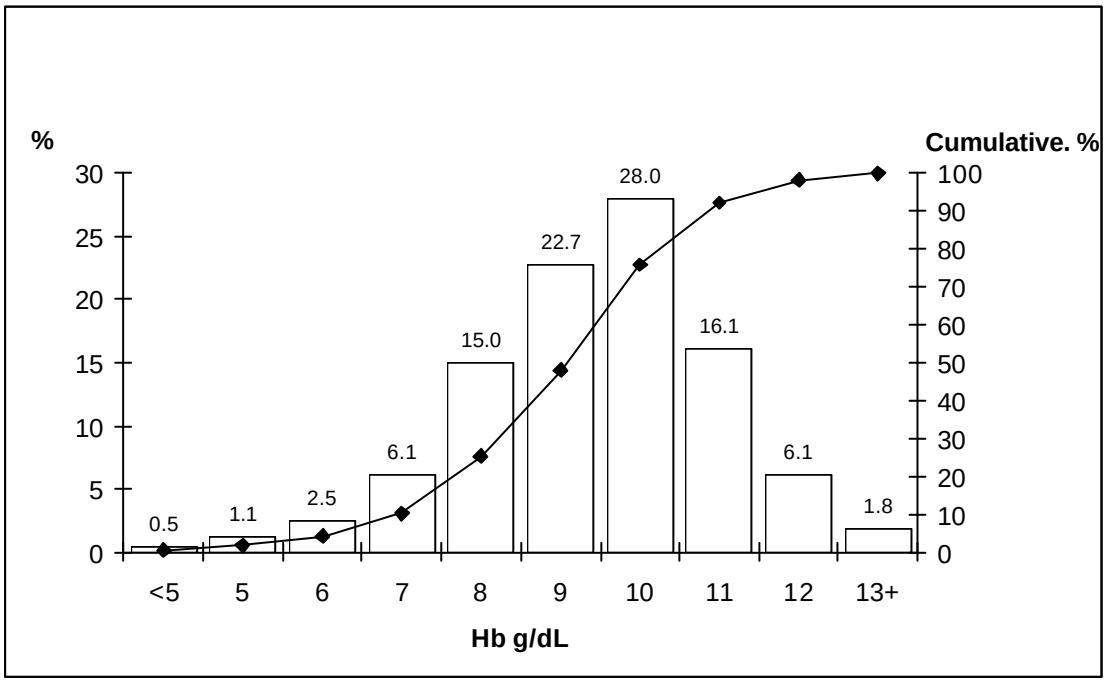
Data entry and consistency checks were done in Foxpro version 2.6 (Microsoft Corporation, Seattle, USA). Data analysis was done in Stata version 7 (Stata Corporation, Texas, USA). Proportions were compared using χ^2 tests. Fishers exact was used where cells had less than 10 observations. Geometric mean parasite densities were calculated and t-test was used for comparison of continuous variables. Logistic regression was used to calculate odds ratios (OR) and their 95% confidence intervals (CI). Factors associated with severe anaemia, with χ^2 p-values <0.1, were examined by multiple logistic regression, with anaemia as a dichotomous response variable. Severe anaemia was defined as Hb<8g/dL. Statistical significance in the risk factors model was defined as a likelihood ratio p-value <0.05. Season was divided into three periods according to rainfall data (made available by C Golding from Kilombero Valley Teak Company, Tanzania). Recruitment started in the late dry season (September to November), followed by the rainy period (December to May), and early dry period (June to August).

Results

During the study period, 671 pregnant women were identified. Of these, 507 (75%) were recruited. The 164 missing women were made up of 97 (14%) who had already delivered, 36 (5%) who moved away before they could be recruited to the study, 14 (2%) who had miscarried, 14 (2%) who could not be traced and 3 (0.4%) who died before recruitment. Mean gestational age was 30 weeks for both primigravidae and multigravidae. Sickle cell trait (AS genotype) was found in 14% (70/507) of women who had similar morbidity and socio-economic characteristics to those without the sickle cell trait (data not shown) and therefore they have been included in the analysis.

Prevalence of and main risk factors for severe anaemia

Figure 8.1 Distribution of haemoglobin levels (Hb) in pregnant women.



A questionnaire together with complete anthropometric, haemoglobin and laboratory data was obtained from 413/507 women who form the basis of the risk factor analysis. The distribution of haemoglobin levels is shown in figure 8.1.

The prevalence of and main risk factors for severe anaemia are shown: table 8.1. 11% (44/413) of women had Hb<8g/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 the late dry season (OR 6.2, CI (2.3-16.4) were independent determinants of severe anaemia. There was no evidence of a direct association between iron deficiency and hookworm: prevalence of iron deficiency amongst women with no hookworm was 25% (73/287), low egg burden 21% (24/113) and high egg burden 27% (11/40): χ^2 p=0.6. However, there was evidence that high egg burden exacerbates iron deficiency anaemia in this setting. The prevalence of severe anaemia amongst women with iron deficiency increased to 45% (5/11) for women with high egg burdens: χ^2 p=0.01.

Women who had never married were three times more likely to be severely anaemic than ever married women (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. There was no difference in prevalence of severe anaemia for primiparous women by marital status (never married 19% (7/37) and ever married 18% (7/39): χ^2 p=0.9). There was, however, significantly more severe anaemia among never married multiparous women than among ever married multiparous women (never married 30% (7/23) and ever married 7% (24/341): χ^2 p<0.001).

Table 8.1 Prevalence of and main risk factors for severe anaemia‡

	N	% Severe anaemia	χ2 (p)	Adjusted OR§ (95% CI)	LRT χ2 (p)
All women	413	11%	-	-	-
Malaria					
Negative	288	9	5.4	1.0	5.7
<median† density	60	12	(0.06)	1.3 (0.5-3.5)	(0.05)
>median density	65	18		2.3 (1.0-5.7)	
Hookworm					
Negative	265	9	4.4	1.0	2.0
Low egg burden	109	10	(0.10)	0.9 (0.4-2.0)	(0.3)
High egg burden	39	21		2.0 (0.7-5.4)	
Iron deficiency					
No	313	9	3.9	1.0	5.1
Yes	100	16	(0.04)	2.4 (1.1-4.9)	(0.02)
Season					
Early dry (June-Aug)	197	8	19.4	1.0	16.6
Late dry (Sept-Nov)	145	25	(0.001)	6.2 (2.3-16.4)	(0.0002)
Rainy (Dec-May)	71	8		1.0 (0.4-2.4)	
Age-group					
15-19 years	93	18	11.7	1.0	3.5
20-29 years	189	11	(0.008)	0.8 (0.3-2.1)	(0.3)
30-39 years	113	4		0.3 (0.08-1.3)	
40+ years	18	11		1.2 (0.2-7.8)	
Gravidity					
Multigravidae	341	9	7.0	1.0	0.13
Primigravidae	72	19	(0.008)	0.9 (0.3-2.2)	(0.7)
Marital status					
Ever married	357	9	10.7	1.0	4.9
Never married	56	23	(0.001)	2.9 (1.1-7.5)	(0.02)
Access to cash					
Own income	257	8	11.7	1.0	1.8
Household income	113	11	(0.003)	1.2 (0.5-2.5)	(0.3)
No access	43	26		1.9 (0.7-5.1)	

†median malaria parasites: 1180/ul
‡Other variables tested with no association with Hb<8g/dL were MUAC, BMI, HIV status, education status
§ Model adjusts for trimester as well as for the variables shown in the table

Access to cash was assessed according to whether the woman had her own income (i.e. some financial autonomy), whether there was household income (i.e. woman had access to pooled household money only), and no access to cash at all. Primigravidae and teenagers were more likely than other women to report having no access to cash at all (data not shown). The access to cash variable showed seasonal fluctuation with more respondents having no access during the late dry season than at any other time: late dry 33% (24/72), rains 7% (13/198), early dry 4% (7/170): χ^2 p<0.001.

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

Evidence of health seeking behaviour during pregnancy

To minimize responder bias, use of health services is reported for women recruited at 30 or more weeks gestation (table 8.2). Surprisingly there were no discernable differences between maternal characteristics to indicate a preference for home or hospital birth by different groups. Median first attendance at MCH was 24 weeks gestation (interquartile range 21, 27) and there was evidence to suggest that high risk groups were making the best use of antenatal services. Primigravidae were more likely to attend MCH earlier than multigravidae (58% v. 39%, χ^2 p=0.01), as were severely anaemic women compared to not severely anaemic women (75% (25/33) v. 41% (114/279), χ^2 p=0.03). Additional health care was sought formally (at a dispensary, hospital) by 33% (103/312) of women, informally (shops) by 17% (52/312) and not at all by 50% (157/312). Only 17% of severely anaemic women had not sought additional health care during their pregnancy, compared to 52% of women who were not identified as severely anaemic (χ^2 p=0.01).

Table 8.2 Use of health services during pregnancy.

	Total	Intends to deliver at home		First visit to MCH earlier than average†		No additional health care sought	
	N‡	%	χ^2 (p)	%	χ^2 (p)	%	χ^2 (p)
Age 15	66	74	0.5	48	7.5	59	
Age 20	144	72	(0.9)	45	(0.05)	50	3.1
Age 30	91	73		32		45	(0.3)
Age 40+	11	64		64		45	
Primigravidae	53	68	0.6	58	6.5 (0.01)	60	4.6
Multigravidae	259	73	(0.4)	39		48	(0.03)
HB<8g/dL	33	67	0.2	75	5.3	17	5.6
HB≥8g/dL	279	73	(0.6)	41	(0.03)	52	(0.01)
BMI < 18.5	9	67	0.1	22	1.5	78	5.3
BMI ≥ 18.5	301	72	(0.7)	43	(0.2)	50	(0.02)
MUAC < 221mm	45	64	1.6	33	1.7	64	4.1
MUAC ≥ 221mm	265	74	(0.2)	44	(0.1)	48	(0.04)
Own cash access	193	72	0.1	40	1.2	44	11.8
HH cash access	74	74	(0.9)	45	(0.5)	68	(0.003)
No cash access	45	71		49		49	
Prim education	234	72	0.02	44	0.7	47	3.1
No education	78	73	(0.8)	38	(0.3)	59	(0.07)
Ever Married	269	73	0.1	42	0.3	56	0.6
Never Married	43	70	(0.6)	47	(0.5)	49	(0.4)
Early Dry (June-Aug)	110	72	0.1	29	14.0	46	5.2
Late Dry (Sept-Nov)	88	74	(0.9)	55	(0.001)	44	(0.07)
Rainy (Dec-May)	114	72		45		59	

† Early to first visit MCH defined as < the median 24 weeks gestation

‡ Restricted to women at ≥ 30 weeks gestation at interview

39% (195/492) of women who had already visited the MCH had taken iron prophylaxis. There was no evidence that any group of women was more likely to receive iron from MCH staff 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, this result is limited by the cross-sectional nature of the study.

For all women, when asked "what are the biggest difficulties you face this pregnancy" 65% (331/507) mentioned at least one unprompted problem. The most frequently stated were in relation to the woman's own poor health (54% 179/331), including 18% (60/331) who reported feeling weak or tired. A lack of money was mentioned by 32% (106/331) of respondents, and the difficulty of carrying out adequate economic activities whilst pregnant by 25% (83/331). 24% (79/331) 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 women who did not mention this as a problem (11% (13/119) v. 3% (8/212) χ^2 6.5 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. A total of 954 responses were given from the 2028 possible, with 69% of 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, dagaa). Meat was the second most frequently mentioned food (33%, 314/954) including both farm animals (chicken, cow, pig, goat, rabbit) and bush meat (zebra, hippo, porcupine, buffalo, hartebeast, guineafowl). In order of importance the other top foods to avoid were 'leftovers' (7%, 68/954), sugar cane (4%, 42/954), eggs (4%, 34/954) and cassava root (3%, 29/954). Table 8.3 lists the main and specific effects said to result from eating these foods whilst pregnant.

Table 8.3 Main effects to the child, the mother, and on delivery believed to result from eating foods reported as taboo during pregnancy in the Kilombero Valley

Food type	Affects the child	Affects the mother	Affects the 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, produce alot 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, alot 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	Alot of faeces, alot of amniotic fluid, difficult delivery
Sugar cane	Child born with tremors, causes leprosy, child will be late to walk	-	Alot 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	Alot of faeces at delivery

Discussion

We have shown that severe anaemia is a major problem for pregnant women in this area of Tanzania. Our data suggest that anaemia is multifactoral with high malaria parasitaemias, iron deficiency and high hookworm egg burdens all contributing. Taboos which deter the consumption of haem-rich foods probably exacerbate these problems. The groups most at risk are unmarried women: both the teenage primigravidae with no access to cash income and unmarried multigravidae.

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

There is strong evidence from Africa to support the use of iron prophylaxis as a means of increasing maternal haemoglobin and birth weight (Mahomed, 2001). Limited adherence to iron supplementation is often thought to be a major reason for the low effectiveness of wide-scale anaemia prevention programs. However, in Dar es Salaam, Tanzania, Massawe *et al.* (1995) concluded that irregular and inadequate supplies of haematinics to antenatal clinics was the most important obstacle to the implementation of the anaemia prevention programme. In our setting only 38% of women who had attended MCH had been given ferrous sulphate, with no indication of preferential distribution to high risk groups. In addition, women receive only a two week supply which is almost certainly inadequate as an intervention. The distribution of iron and folic supplementation in this setting needs urgent attention.

In areas of stable malaria transmission, most infections are chronic and asymptomatic and as such treating only those with fever or clinical illness would 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 underestimated. A recent review concluded that the failure to implement known antimalarial interventions antenataly contributes substantially to the estimated 75,000-200,000 infant deaths which are associated with malaria infection in pregnancy annually (Steketee *et. al.* 2001). Further, a meta-analysis of data on malaria related severe anaemia in pregnancy has extrapolated that in sub-Saharan Africa there may be up to 10,000 malarial anaemia-related maternal deaths per year (Guyatt and Snow 2001). A follow-up of infants born in our study revealed that, even after controlling for other factors, the infants born to women we identified as severely anaemic were three times more likely to die in infancy than infants born to women without severe anaemia (Marchant *et al, submitted*).

Increasingly there is evidence to support the use of insecticide treated bednets (ITNs) as a tool to control malaria and improve anaemia status in pregnancy. Within our study area socially-marketed ITNs were shown to have a protective efficacy of 38% (CI 5-59) for high density malaria parasitaemias, and a protective efficacy of 12% (CI 2-21) for mild anaemia and 38% (CI 4-60) for severe anaemia (Marchant *et al.,* 2002). African leaders have called for 60% of children and pregnant women to be protected by effective personal protection measures (largely ITNs) in Africa by the year 2005 (Roll Back Malaria, 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 wide spread resistance to chloroquine the WHO (2000) now recommends that, through the MCH antenatal service, pregnant women receive intermittent preventive treatment with sulfadoxine-pyrimethamine (SP)

based on research from Malawi and Kenya (Schultz *et al.,* 1994; Shulman *et al.,* 1999). 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 resistance to the drug appears to increase rapidly (Ronn *et al*., 1996).

Overall attendance at MCH clinics in this setting is very high with 99% of all women 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 ITNs preferably from conception and intermittent treatment by the start of the second trimester. In this population only 11% (54/507) had attended MCH by the 16th week of pregnancy, 27% (138/507) by 20 weeks; median gestation at first attendance was 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 Immunisation Days (which occur during the late dry season in Kilombero 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 a related issue - high risk groups for emergency care during delivery, especially those at the extremes of childbearing age and those anaemic, could be sensitized to the importance of access to obstetric care during delivery.

Our data does provide some cause for optimism for the implementation of interventions. Women who were identified as severely anaemic were also those most likely to have attended MCH earlier, and to have sought additional health care outside the MCH. They were also the women most likely to report to our nurse interviewer that they were concerned about their health. As such, it could be said that these women recognised their need for care and pursued the limited avenues available to them to get it. The success in uptake of socially-marketed insecticide treated nets in the area has already demonstrated that people are

willing and able to invest in their own health (Marchant 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 health care policy.

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CHAPTER 9:

Anaemia in pregnancy and infant survival in Tanzania.

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Working paper

Summary

The impact of severe anaemia in pregnancy on infant survival in malaria-endemic regions is poorly understood. We used a demographic surveillance system to link morbidity and socio-economic status data for 301 pregnant women to the survival to 365 days of their singleton babies. The mortality rate for infants born to women who had been severely anaemic in pregnancy (Hb<8g/dL) was 2.9 (95% CI 1.1, 7.6, p=0.03) times that of infants born to women with Hb above this level. Prevention of anaemia in pregnancy may lead to an improvement in infant survival.

Materials, Methods and Results

Women in developing countries account for 95% of anaemic pregnancies in the world. The contribution anaemia makes to maternal morbidity and mortality and its association with low birth weight in sub-Saharan Africa is well documented (Shulman, 1999; Guyatt & Snow, 2001). In contrast, the impact of maternal anaemia on infant mortality in a developing country context is inconclusive (Xiong *et. al.*, 2000) and reviews of the topic highlight the need for more research (Xiong *et. al*., 2000; Allen, 2000, Scholl & Reilly, 2000). In particular there is a lack of data from settings where the burden of anaemia is high and a large number of women reach term with severe anaemia.

We investigated infant mortality amongst a cohort of babies born to women for whom haemoglobin levels were measured in a cross sectional survey during pregnancy conducted in 1999 (Marchant *et. al.*, 2002). Haemoglobin levels were determined in 507 pregnant women using a portable β–haemoglobin photometer (Hemocue©, HemoCue AB, Ängelholm, Sweden). Women with Hb<11 g/dL were given standard first line treatment (chloroquine phosphate: 10/10/5mg/kg, ferrous sulphate: 200mg twice daily, 14 days; folic acid: 5mg once daily, 14 days). From the 507 pregnant women, 301 live singleton births were traced using a demographic surveillance system (DSS) and a survival analysis carried out.

The morbidity and socio-economic characteristics of the mothers of these 301 babies were similar to those of the 206 mothers with twin births or whose birth outcome was unknown (data not shown). However, mothers of babies in the survival analysis were older (mean age 27 years, (95% confidence interval 26,28) vs 24 years (95% CI 23,25): t-test p-value <0.001). They had a higher mean gestational age at recruitment to the cross-sectional study (31 weeks (95% CI 31,32) vs 29 weeks (95% CI 28,30): t-test p-value <0.001), and were more likely to have been recruited earlier in the cross-sectional study than women whose babies were not included in the survival analysis (data not shown).

Evidence of an association was sought between infant survival to 365 days and maternal anaemia during pregnancy. Potential confounders related to socio-economic and demographic status and other risk factors for anaemia were assessed (table). Variables associated with child survival (log rank test or Mantel-Haenszel estimate of the rate ratio, p-value <0.10) were further analysed using Cox proportional hazards regression. Confounding was assessed for each potential confounder in turn through comparison of adjusted and unadjusted estimates of the Cox hazard ratio (HR): if these varied by more than 10% the variable was regarded as a confounder. The assumption of proportional hazards was tested using Schoenfeld residuals. Model fit was assessed using Cox-Snell residuals. This work was part of the evaluation of a social marketing project of insecticide treated nets in the Kilombero Valley (KINET) in southern Tanzania (Marchant *et. al.*, 2002).

Of the 301 singleton infants traced, 11 died within 28 days of birth and in total 22 died within the first year of life. A further 28 migrated out of the study area before their first birthday. The infant mortality rate for the cohort was 84.2/1000 child-years (95% CI 55, 128). Of the variables analysed (see footnote to table), there was some evidence of an association between infant mortality and severe maternal anaemia (Hb<8g/dL), maternal age, gravidity, and marital status. Infant

mortality rates and unadjusted and adjusted hazard ratios for these four variables are shown in the table.

Severe anaemia was associated with an almost three-fold increase in infant mortality after adjustment for age, gravidity, marital status, gestation and timing of recruitment (HR 2.9, 95% CI 1.1, 7.6, p=0.03). The Kaplan-Meier survivor functions, adjusted for maternal age, for children born to anaemic and non-anaemic women are shown in the Figure.

Comment

An inherent limitation of our cross-sectional data on health in pregnancy is that previous history and subsequent events are unknown. Women found not to be anaemic in the cross-sectional study may have become so later in pregnancy. However, as 209/301 (70%) of participants were already in the third trimester of pregnancy this is unlikely to have had a major effect on the results.

Severe anaemia was found in 55/507 (11%) of pregnant women. The health consequences to the mother of anaemia at the time of delivery may be compounded by the adverse effects of maternal anaemia on the young foetus, manifested by an increased infant mortality rate. Preventative interventions are required to tackle maternal anaemia which, in this setting, is caused principally by malaria and iron deficiency. Insecticide treated nets were associated with a protective efficacy of 38% (95% CI 4,60) for severe anaemia in pregnancy in this population: the commitment to increase coverage is ongoing both at local and national level in Tanzania (Marchant *et. al*., 2002). Numbers were too small to assess a direct impact of ITN use in pregnancy on infant survival, although the hazards ratio was in the right direction: HR 0.6 (95% CI 0.3, 1.4). Given the burden of malaria related anaemia in this setting other malaria control measures in pregnancy such as intermittent treatment with sulfadoxine-pyrimethamine should be considered (Guyatt and Snow, 2001). The distribution and adequate supply of iron prophylaxis needs urgent attention at the clinic level. Only 94/301

(31%) women received iron prophylaxis from the antenatal clinic services and it is likely that the standard two week treatment of 200mg ferrous sulphate twice daily, and 5mg folic acid, daily, is inadequate as an intervention. Mechanisms for targeting more women with iron, earlier in pregnancy, and for longer, need to be explored.

In conclusion, our finding of a three-fold increase in infant mortality for babies born to women with severe anaemia in pregnancy reinforces anaemia in pregnancy as a priority area of concern. Interventions tackling this problem may help to improve child survival as well as reducing maternal morbidity and mortality.

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Table 9.1 Infant mortality rates per 1000 child-years at risk and hazard ratios by maternal age, severe anaemia, gravidity and marital status[1].

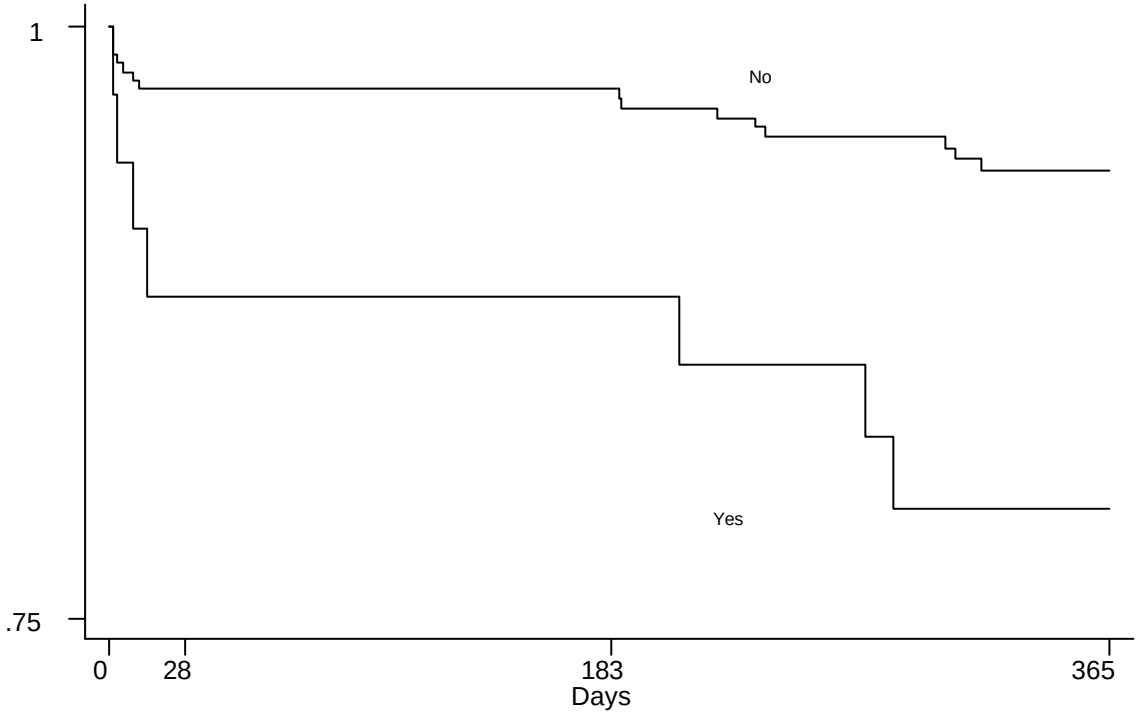
		Births N	Deaths N	Child-years at risk	Infant Mortality Rate (95% CI)	Unadjusted Hazard Ratio (95%CI)	Adj Hazard Ratio[†,§] (95% CI)	LRT χ^2 (p)
All women		301	22	261.1	84.2 (55.4, 127.9)	-	-	-
Age	15-19 yrs	55	9	38.6	233.0 (121.2, 447.8)	1.0	1.0	5.3
	20-29 yrs	136	7	124.6	56.1 (26.7, 117.8)	0.2 (0.09, 0.7)	0.3 (0.08, 1.1)	(0.14)
	30-39 yrs	98	4	88.2	45.3 (17.0, 120.7)	0.2 (0.06, 0.6)	0.3 (0.06, 1.3)	
	40-49 yrs	12	2	9.6	207.2 (51.8, 828.8)	0.9 (0.2-4.4)	1.1 (0.2, 7.2)	
Hb	No	266	15	232.3	64.5 (38.9, 107.1)	1.0	1.0	4.4
<8g/dL	Yes	35	7	28.8	243.4 (116.0, 510.6)	3.7 (1.5, 9.1)	2.9 (1.1, 7.6)	(0.03)
Gravidity	Multigravidae	253	15	226.0	66.3 (40.0, 110.1)	1.0	1.0	0.01
	Primigravidae	48	7	35.0	199.7 (95.2, 418.9)	2.8 (1.1, 6.9)	1.0 (0.3, 3.8)	(0.9)
Marital	Ever married	264	17	233.4	72.8 (45.2, 117.1)	1.0	1.0	0.03
status	Never married	37	5	27.6	180.9 (75.3, 434.6)	2.3 (0.9, 6.3)	0.9 (0.2, 3.0)	(0.8)

[1] Maternal variables analysed were Hb level, HIV serostatus, P. falciparum parasitaemia, iron deficiency (microcytic hypochromia), hookworm status, mid-upper arm circumference (MUAC), body mass index (BMI), age, parity, gestation at recruitment, education level, use of an ITN during pregnancy, use of iron prophylaxis during pregnancy (distributed by MCH and/or project), marital status, access to cash, length of preceding birth interval, premature birth (<37 weeks) based on gestational age at recruitment to the cross-sectional survey and subsequent birth date.

[†] Adjusting for age, Hb<8g/dL, gravidity, marital status, gravidity and time of recruitment

[§] Assumption of proportional hazards for final model: χ^2=0.86, p=0.99

Figure 9.1 Kaplan-Meier survival functions for infants according to presence or absence of maternal severe anaemia (Hb<8g/dL) during pregnancy



PART IV: BEDNETS FOR THE PREVENTION OF ANAEMIA

CHAPTER 10:

Socially-marketed insecticide-treated bednets improve malaria and anaemia in pregnancy in southern Tanzania. ***Marchant T, Armstrong Schellenberg JRM, Edgar T, Nathan R, Abdulla S, Mukasa O, Mponda H, Lengeler C***

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Summary

Pregnant women are at high-risk for malaria. Many insecticide treated net (ITN) programmes are currently ongoing or planned in African countries yet there is little evidence of impact of ITN use in pregnancy on malaria and anaemia. We report on a 12-month community cross-sectional study of the uptake of socially-marketed ITNs and their impact on malaria and anaemia in pregnancy, plus a discount voucher system which aimed to increase coverage in pregnancy.
53% of pregnant women used ITNs. The protective efficacy (PE) for parasitaemia was 23% (CI –2 – 41). Multiparous ITN users had a two-fold decrease in parasite density compared to multiparous none-ITN users (625 compared to 1173 parasites per microlitre: p=0.01). ITNs had a PE of 12% (CI 2-21) against mild anaemia and a PE of 38% (CI 4-60) against severe anaemia (Hb<8g/dL). There was a trend in the prevalence of severe, mild and no anaemia, and of high density, low density and no malaria infection by ITN status. Recently-treated nets were most effective at preventing malaria and anaemia (prevalence of mild anaemia was 68% compared to 82% for those without nets (p=0.002; prevalence of malaria was 22% compared to 33% for those without nets (p=0.02). Knowledge and reported use of the discount voucher system were low: further qualitative research is ongoing.
A modest impact of ITNs on pregnancy malaria and anaemia was shown in our high malaria transmission setting. The development of ITN programmes for malaria control should include pregnant women as a specific target group.

Introduction

Plasmodium falciparum malaria is the most important parasitic disease in sub-Saharan Africa, where stable transmission is common. In these areas, women of child-bearing age have a high level of acquired antimalarial immunity but pregnant women represent the most at-risk adult group. This is probably due to hormonal modulation of the immune response during pregnancy, compounded by increased blood volume and sequestration of the parasites in the placenta (Riley *et al.* 1989; Menendez 1995). Compared with their non-pregnant counterparts, the increased susceptibility of pregnant women to *P. falciparum* malaria is manifest in a higher frequency and density of parasitaemia (McGregor *et al.* 1983; Brabin 1983) particularly in primigravidae (Steketee 1989). This increases the risk of abortion, stillbirth, prematurity, intra-uterine growth retardation, and infants of low birth-weight (Brabin 1991; Menendez 1995; Steketee *et al.* 1996). Malaria is also an under-recognised cause of severe anaemia in pregnancy where transmission is endemic since it is often asymptomatic (Shulman 1999).

At present, the World Health Organisation (WHO) recommends that pregnant women in malaria endemic areas receive a full course of anti-malarial treatment at first antenatal attendance followed by regular antimalarial chemoprophylaxis (WHO 1994). The effectiveness of this strategy has been limited by the continuing spread of resistance to antimalarial drugs, poor compliance with routine chemoprophylaxis, and logistical and economic constraints within health services. Many countries have no clear policy for malaria control in pregnancy (Robb 1999).

Insecticide treated nets (ITNs) have been shown to substantially reduce both mortality and malaria morbidity in children in the African setting (Lengeler 2001). However, trial data of ITN impact on malaria-related morbidity in pregnant women is more scarce and contradictory (Dolan *et al.* 1993, D'Alessandro *et al.* 1996, Shulman *et al.* 1998).

Given the demonstrated impact of ITNs in children there is a major international move to implement ITN programmes on a large scale in Africa. Pregnant women have been specifically designated as a high-risk group and recently African leaders have called for 60% of children and pregnant women to be protected by effective personal protection measures (largely ITNs) in Africa by the year 2005 (Roll Back Malaria 2000). There is currently a need for demonstrating the impact of ITNs under programme situations, since it can not be assumed that the impact observed under trial conditions can be replicated in the frame of large-scale programmes (Lengeler and Snow 1996). In our setting a study by Abdulla *et al*. (2001) has demonstrated a considerable impact of ITNs in reducing parasitaemia and anaemia in children using social marketing (an approach using marketing techniques to promote and distribute socially beneficial interventions rather than a commercial product).

Here we report a study of the use of socially-marketed ITNs amongst pregnant women, and the subsequent impact on malaria and anaemia in pregnancy. In addition, use of an ITN discount voucher system was assessed as a means of targeting specific groups in a population for the uptake of ITNs.

Materials and methods

Study area

This study was conducted at the Ifakara Health Research and Development Centre (IHRDC), in the Kilombero Valley in southern Tanzania. The area is rural and has intense perennial transmission of malaria (Smith *et al.* 1993). Data from local health services indicate malaria as the principal cause of morbidity, with anaemia amongst the top ten causes (Tanner *et al.* 1991).

The research was one component of a social-marketing project for insecticide-treated nets (KINET) which is described in detail elsewhere (Armstrong Schellenberg *et al.*, 1999). Pre-treated nets and insecticide (branded “Zuia Mbu”

meaning *prevent mosquitoes*) were being promoted, distributed and sold using public and private outlets. There was intense promotion of the home insecticide net treatment kits (subsidised price $0.50 in 1999).

Discount voucher system amongst pregnant women

Figure 10.1 Discount voucher to reduce the price of a socially-marketed ITN used during the KINET implementation of ITNs.

Name and address of recipient were recorded (left) and whether a pregnant woman or a child (right).

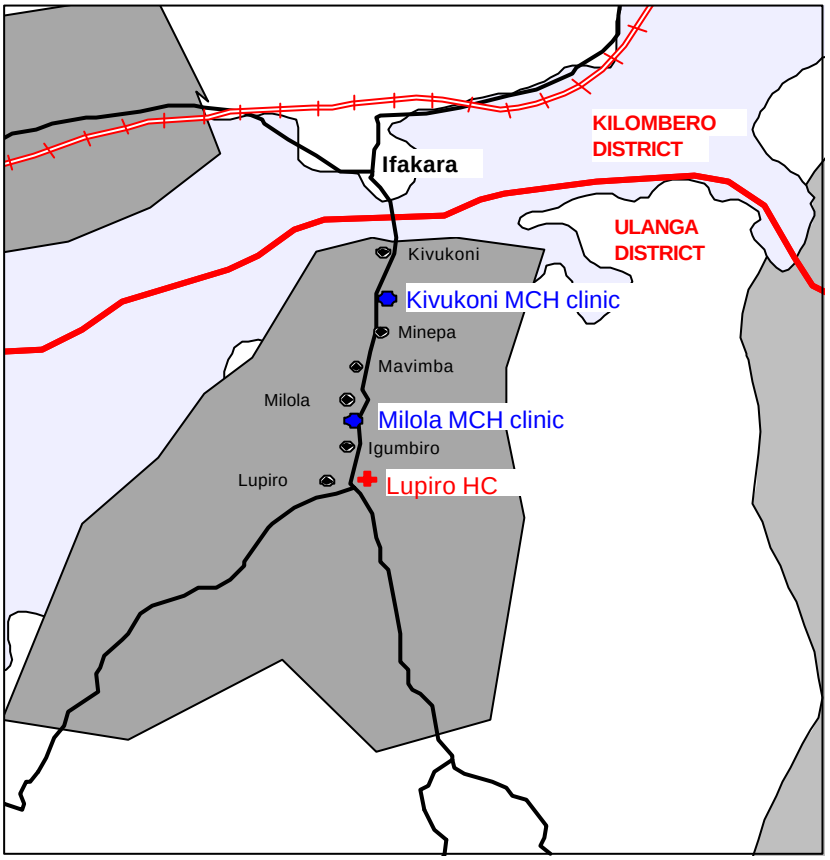
A voucher system to promote the use of ITNs amongst pregnant women and children under five years of age was put in place by the KINET project through MCH clinics (figure 10.1). Vouchers reduced the price of the project nets by 17%: equivalent to 3.1 US dollars in 1999 versus the full price of 3.8 US dollars in 1999. All pregnant women and mothers of children under five years of age who presented at MCH clinics within the study area were eligible to receive such a voucher. The aim was to facilitate their access to ITNs and to provide a structured opportunity for the promotion of ITNs to this high-risk group. Protecting pregnant women was also felt to be crucial for protecting infants, who usually sleep with their mothers. Vouchers could be used at any official project

net outlet. Net outlet retailers then returned the vouchers to the project for reimbursement and were given a small handling fee.

Demographic Surveillance system (DSS)

Figure 10.2 Map of the study villages.

DSS area (shaded), roads (solid line), railway (crossed lines), and Selous game reserve (grey shading). MCH = Mother and Child Health, HC = Health Center.



A demographic surveillance system (DSS) covering the first 25 villages to be included in the project (approx. 65,000 people living in 11,000 households) was started in September 1996 and is ongoing (Armstrong Schellenberg *et al.* 2001). Name, sex, date of birth, and relationships within the household were recorded at

baseline. Each household is visited every 4 months by an interviewer who updates the census record by asking about in- and out- migrations, pregnancies, births and deaths. Special surveys are added from time to time, for example to record household socio-economic status, and this provided the framework for the present study.

Recruitment and consent

A cross-sectional study with rolling recruitment of all pregnant women within six villages close to IHRDC (figure 10.2) was carried out over a period of twelve months (September 1998 to August 1999). Pregnant women were identified by DSS interviewers at routine 4-monthly visits to each household, when each woman was asked the approximate gestation of pregnancy. All pregnancy reports from the six study villages were eligible for enrolment into the study. Women were often in their third trimester before they reported their pregnancy, so in order to minimise missed pregnancies due to women delivering before being enrolled in the study, priority for recruitment was given to those women in the later stages of pregnancy.

A nurse-midwife traveled daily into the study area spending one day per week at each of the three MCH clinics. On two days each week home visits were made to women identified by the DSS as being pregnant but who had not been identified at a clinic. A detailed description of the project was given and written consent obtained before proceeding with the interview. A questionnaire was administered including information about socio-economic status, fertility, use of health facilities, use of nets and knowledge of the social marketing discount voucher system. All field work was conducted in Swahili, which is widely spoken in the study area. Each woman was seen only once.

Clinical examinations

Each respondent was examined to assess gestational age. Women were given advice by the study nurse about any suspected complications that were detected during the examination and travel allowances given if referral to the district hospital was required. Presence or absence of a pre-treated socially-marketed net or any other net was confirmed during the physical examination of women recruited in their own homes, or when delivering drugs to the homes of women recruited at the clinic.

The haemoglobin level of each woman was determined at the time of interview using a portable β–haemoglobin photometer (Hemocue©, HemoCue AB, Ängelholm, Sweden) and women with Hb<11 g/dL given standard first line treatment (ferrous sulphate (200mg twice daily) and folic acid (5mg once daily) for two weeks). A thick and thin blood film were made on site and a 1ml capillary blood sample collected from each woman into a microtainer coated with anticoagulant (EDTA) and transported back to IHRDC laboratories at 4°C.

Laboratory procedures

On the same day as interview the thick blood films were stained with Giemsa and the number of malaria parasites per 200 leukocytes counted. The following day results were available and first line treatment (chloroquine phosphate (10/10/5mg/kg) for women positive for malaria was distributed. Sickling and red cell morphology tests were also carried out: the results will be presented elsewhere.

Data processing and Statistical analysis

All data were entered twice and consistency checks were done in Foxpro version 2.6 (Microsoft corporation, Seattle, USA). Data analysis was done in Stata version 6 (Stata Corporation, Texas USA). Proportions were compared using χ^2

tests. Geometric mean parasite densities were calculated and Student's t-test was used for comparing means. Logistic regression was used to calculate adjusted odds-ratios for factors influencing ITN ownership and use with age, gravidity, marital and education status, access to cash and household work status entered in a multivariate model for prediction of ITN use. Protective efficacies for the use of ITNs were calculated as (1-relative risk) x100.

A household was defined as those people the respondent is currently living with, normally comprised of immediate family members. All respondents said that they lived in households where self-owned land was farmed. Household economic activities were categorised as (1) only working on own farm; (2) working on own farm and on other farms during the planting/harvest seasons; (3) working on own farm and owning a shop or kiosk; (4) working on own farm and on other farms and owning a shop or kiosk.

ITN "non-users" could both be women not using a net at all or women using an untreated net. Unfortunately, it is not yet possible to test the netting for insecticide content in the field (Drakeley *et al*. 1999), and the responses regarding the treatment of nets other than the KINET nets could not be validated.

Results

Study population

During the study period, 671 pregnant women were identified. Of these, 507 were interviewed, and 505 (75%) had complete data on ITN use. The 164 missing women were made up of 97 (14%) who had already delivered, 36 (4%) who moved away before they could be recruited to the study, 14 (2%) who had aborted, 14 (2%) who could not be traced and 3 (0.4%) who died before recruitment. Mean gestational age was 30 weeks.

The demographic and socio-economic characteristics of the study population and their associations with ITN use in pregnancy are shown in table 10.1.

Table 10.1 Association between demographic and socio-economic factors and insecticide-treated nets (ITN) use in the Kilombero Valley

OR=odds ratio. CI=confidence interval

	Variable	Women N (%)	ITN Use %	Predictors of ITN use Crude OR (CI)	Adjusted OR[1] (CI)
	All women	505 (100)	53		
Age	15-19 years	115 (23)	40	1.0	1.0
	20-29 years	235 (46)	57	2.0 (1.2-3.1)**	1.4 (0.8-2.5)
	30-39 years	136 (27)	56	1.9 (1.1-3.1)*	1.3 (0.7-2.5)
	40-49 years	19 (4)	47	1.3 (0.5-3.8)	1.0 (0.3-2.9)
Gravidity	Primigravida	89 (18)	40	1.0	1.0
	Multigravida	416 (82)	55	1.8 (1.1-2.8)*	1.1 (0.6-2.1)
Education	No education	127 (25)	46	1.0	1.0
	Primary education	378 (75)	55	1.4 (0.9-2.1)	1.4 (0.9-2.1)
Income	No access to cash	50 (10)	40	1.0	1.0
	Household cash only	136 (27)	51	1.5 (0.8-3.0)	1.5 (0.7-3.4)
	Own cash income	319 (63)	55	1.8 (1.0-3.3)*	1.7 (0.9-2.8)
Marital Status	Not married	86 (17)	40	1.0	1.0
	Married/co-habiting	419 (83)	55	1.8 (1.1-3.0)**	1.6 (0.9-2.8)
Household Economic Activity	Seasonal farm work	247 (49)	47	1.0	1.0
	Own farm only	103 (20)	55	1.3 (0.8-2.1)	1.4 (0.8-2.3)
	Shop/kiosk	91 (18)	60	1.6 (1.0-2.7)*	1.6 (0.9-2.6)
	Seasonal farm work + shop	64 (13)	58	1.5 (0.8-2.6)	1.3 (0.7-2.3)
Season	Late dry (Sept-Nov)	94 (19)	51	1.0	1.0
	Rainy (Dec-May)	220 (43)	48	0.8 (0.5-1.4)	0.8 (0.5-1.4)
	Early dry (Jun-Aug)	191 (38)	59	1.4 (0.8-2.2)	1.2 (0.7-2.2)

*p=<0.05; **p=<0.01

[1] age, gravidity, education and marital status, income, economic activity and season were included in the multivariate model

More women were using ITNs during the last three months of the project (early dry season), as expected given the on-going promotion of ITNs. 81% (407/505) of pregnant women lived in households where there was at least one net. 57% (289/505) of women were living in households where there was at least one ITN,

66% of these (191/289) having only one ITN, 26% (75/289) two ITNs, and 8% (25/289) three or more. 53% (266/505) of respondents said that they themselves regularly slept under an ITN and 53% (142/266) of these ITNs had been treated less than six months previously. Median time since last washing an ITN was 6 weeks (interquartile range 3 to 14 weeks).

ITN use and purchasing power

ITN use in pregnancy was positively associated with being aged between 20-39 years, being multiparous, having own cash income, being married or co-habiting, and living in a household where there was a shop or kiosk ($p<0.05$). Having some primary education was also associated with ITN use with borderline significance ($p=0.06$).

When all variables in Table 10.1 were put into a logistic regression model no single variable achieved significance at the 5% level. However, the adjusted odds ratios for primary education (OR 1.4), having own cash income (OR 1.7), being married (OR 1.6), and living in a household where there was a shop or kiosk (OR 1.6) were close to significance and differed little from the crude odds ratio. Multiparous women were more likely to have their own cash income than primiparous (66% vs 47%: χ^2 test: $p=0.001$) and were more likely to be married (89% vs 53%: χ^2 test: $p<0.001$). When asked what the main reason was for not using an ITN, 92% (465/505) of women said lack of money was the main obstacle.

When asked who was most likely to provide the money to buy an ITN within the household, 88% (334/379) of those currently married said their husband, and the remainder of those currently married said they themselves were the most likely to find the money. Amongst co-habiting women 53% (21/40) said they were the most likely person followed by their partner 30% (12/40) or a parent 17% (7/40). 44% of those not currently in a union (39/86) would use their own money and

48% (41/86) thought their parents were most likely to provide the money to buy an ITN; 7% (6/86) felt that no-one would buy an ITN.

ITNs and malaria in pregnancy

29% (147/505) of women had peripheral parasites on the day of interview. Parasitaemia was twice as common in primigravidae compared to multigravidae (56% vs 23%: p<0.001) and more common in second trimester pregnancies compared to third trimester (35% vs 25%: p=0.02).

Fewer ITN users had parasitaemia than ITN non-users (25% vs 33%: p=0.06) (table 10.2). When analysing the impact of ITNs on women who had been exposed to malaria, defined as those women currently positive for malaria together with those who had taken malaria treatment in the last month (compared to those negative for malaria who had not taken malaria treatment), the difference reached statistical significance. The protective efficacy for any parasitaemia was 23% (CI -2-41).

There was a trend in prevalence of high density, low density and no parasitaemia by ITN status with ITN users having fewer low and high density infections compared to ITN non-users (χ^2 test for trend: p=0.02). ITNs were most effective in reducing high density infections: the RR of having a high density infection was 0.62 (CI 0.41-0.95) for ITN users compared to non-users, giving a protective efficacy of 38% (CI 5-59)(table 10.2).

Geometric mean parasite densities (parasites/ul) were lower among ITN users compared to non-users (936 (CI 691-1247) vs 1404 (CI 1021-1917): t-test p-value: 0.06. There was an almost two-fold decrease amongst multiparous ITN users (625 (463-836) vs 1173 (795-1717): t-test p-value: 0.01.

ITNs and anaemia in pregnancy

77% of women (387/505) had mild anaemia (Hb<11g/dL) and 11% (55/505) had severe anaemia (Hb<8g/dL).

ITN users had less mild anaemia than non-users: 72% compared to 82%: p=0.01. There was a trend in prevalence of severe, mild and no anaemia by ITN status (table 10.2) with ITN users having less mild and severe anaemia than none users (χ^2 test for trend: p=0.01). ITNs were effective in reducing both severe (Hb<8g/dL) and mild (Hb>7.9g/dL<11g/dL) anaemia: the RR of having severe anaemia was 0.62 (CI 0.40-0.96) and of having mild anaemia was 0.88 (CI 0.79-0.98) for ITN users compared to non-users (table 10.2). The use of an ITN therefore reduced the risk of mild anaemia by 12 % (CI 2-21) and the risk of severe anaemia by 38% (CI 4-60).

Table 10.2 Parasitaemia and anaemia status by insecticide treated nets

	ITN users (N=266) N (%)	ITN non-users (N=239) N (%)	χ^2 (p-value)	RR (95% CI)
Malaria prevalence by ITN use				
Malaria positive	68 (25)	79 (33)	3.4 (0.06)	0.77(0.59-1.02)
Malaria exposed[+]	77 (29)	89 (37)	3.9 (0.04)	0.78(0.61-0.99)
Parasite density by ITN use				
No parasites	199 (75)	161 (67)		1.00
Low density[1]	37 (14)	35 (15)		0.88(0.58-1.34)
High density[2]	30 (11)	43 (18)	4.7 (0.02[*])	0.62(0.41-0.95)
Anaemia prevalence by ITN use				
Hb<11g/dL	192 (72)	195 (82)	6.2 (0.01)	0.88(0.80-0.97)
Anaemia status by ITN use				
None (>11 g/dL)	74 (28)	44 (18)		1.00
Mild (>7.9<11 g/dL)	167 (63)	165 (69)		0.88(0.79-0.98)
Severe (<8 g/dL)	25 (9)	30 (12)	6.0 (0.01[*])	0.62(0.40-0.96)

[+] Exposed = parasite positive or taken malaria treatment in last month.
[1] Low density: < median 1081 parasites/ul
[2] High density: ≥ median 1081 parasites/ul
[*] χ^2 test for trend

Impact of ITNs as a function of time since last net treatment

Time since last treatment was the lesser of the time either since a net was last treated or the time since purchase of a KINET pre-treated project net.

The prevalence of both malaria and mild anaemia were lowest in women sleeping under nets treated less than 6 months ago, followed by those women sleeping under nets treated more than 6 months ago, and greatest amongst women not using ITNs (table 10.3).

Table 10.3 Malaria and anaemia status by time since last net treatment

	ITN treated less than six months ago (N=142)	ITN treated more than six months ago (N=119)	No ITN (N=246)	χ^2 test for trend (p-value)
Prevalence				
Malaria positive %	23	28	33	5.2 (0.02)
Hb<8g/dL %	9	9	13	1.2 (0.2)
Hb<11g/dL %	68	76	82	9.4 (0.002)

Discount voucher system amongst pregnant women

All women were asked about the discount voucher system: only 28% (141/505) of all women had heard of it. Only 10 women (2% of all women, 7% of those who had heard about the system) said that they had been given a discount voucher. Of these ten, 8 had already used the voucher at the time of interview. Of the remaining 131 women who had heard about the voucher system but had not been given one, 83 said they did not want one because they could not afford the discounted price, and 32 said they didn't need an ITN (of whom 29 were currently using an ITN). Only 5% (8/141) of those who had heard about it said they had not understood how to use a voucher.

Vouchers were a new concept for the population under study. However, given the high attendance at MCH clinics amongst the study participants (97%), it is surprising that only 28% had ever heard about the voucher system. Promotion activities included posters, leaflets, 6-monthly training of IEC resource people in each village, singing dancing theatre groups, video shows, football tournaments and loud speaker publicity, and coverage was expected to be high.

Indeed, the voucher return rate for the KINET implementation area as a whole was 96.5% (7720/8000 vouchers issued between September 1997 and August 2000). 86% of vouchers issued within this study area (1035/1200), during this study period, were used. However, we were unable to find how many of the discounted ITNs were used by eligible persons. Within the DSS area a cluster sample survey of child health was conducted during the final month of this study (August 1999) (*Mushi pers. comm.*). The study found that 44% of mothers of children under 5 years had heard about the system and 13% had used a voucher to buy an ITN, which figures are considerably higher than those found amongst pregnant women in this study (28% and 2% respectively).

Therefore, one must look for alternative explanations for the findings in this topic. There was circumstantial evidence from the KINET field team that there were problems in the community regarding the voucher system including MCH clinic staff being reluctant to distribute vouchers and even trying to sell the vouchers for their full discount amount. Other reports included shop-keepers refusing to accept vouchers, and vouchers being sold to 'non-eligible' people. It was suggested that as a result of these problems there was a general reluctance in the community to discuss the voucher system. These issues have been qualitatively investigated by the social scientist of the project and analysis is currently on-going. Preliminary findings indicate that some MCH staff did not fully understand the voucher system, many women had heard about it but were not sure how to get a voucher, there was some confusion over eligibility, there were occasional reports of sales agents not wanting to participate in the scheme,

and some women felt that other economic burdens had priority over purchasing an ITN (Mushi *pers. comm.)*. It is likely that in this study the low knowledge and subsequent user rates were attributable to a combination of MCH staff giving vouchers to mothers with young children more than to pregnant women and respondents giving false statements perhaps in the hope of receiving a new voucher or because their voucher had been used by other people.

Discussion

We have found that ITNs reduce anaemia and the prevalence and density of malaria parasitaemia in pregnancy in an area of intense and perennial malaria transmission. Most importantly, ITNs reduce the prevalence of high parasitaemia and severe anaemia by more than one third. This finding supports studies done in other malaria transmission settings (Dolan *et al.* 1993; D'Alessandro *et al.* 1996) with the exception of that from Kilifi in Kenya (Shulman *et al.* 1998).

Table 10.4 summarises key published findings to date of the impact of ITNs on malaria and anaemia in pregnancy. Only endpoints presented in more than one study are shown. In all four studies, severe anaemia was lower in the ITN user group than the non-users although only significantly so in The Gambia dry season study. Mild anaemia was significantly reduced in Tanzania and Thailand (all three sites, based on the incidence of hematocrit <30%) and not reported for The Gambia. A reduction in peripheral parasitaemia was seen in Tanzania (p=0.06), from the Thai site with the highest transmission intensity, and in the rainy season Gambian study. In the Kenya study the effect of ITNs did not reach statistical significance for any endpoint.

In this study ITNs were being compared to no ITNs and as such the comparison group may have included untreated nets which confer limited protection to the user (Lengeler 2001); this is certain to have resulted in a conservative protective efficacy estimate. However, it should be noted that the protective efficacy for

severe anaemia and malaria infection is biased towards older age-groups since young women were least likely to be ITN users and most likely to be severely anaemic or parasitaemic.

Two behavioural changes which deserve attention to optimise the impact of ITNs during pregnancy are apparent. First is the timing of health seeking behavior during pregnancy. Typically in this setting women are secretive about a new pregnancy until well into the second trimester: this makes detection of early pregnancies problematic. In our study only one quarter of respondents presented at clinic before 20 weeks gestation. Malaria infection rates are highest in the first half of pregnancy and decrease progressively until delivery (Brabin 1991) and therefore the impact of a malaria prevention tool is not optimised unless used throughout pregnancy. For ITNs this may be achieved over time, once coverage is high in women of child-bearing age, and using an ITN has become normal practice. This, however, was not yet the case in the early phase of our implementation programme.

Second is retreatment of ITNs. Women sleeping under the most recently treated nets had less anaemia and less malaria than those sleeping under nets treated more than 6 months previously. This is particularly pertinent given that the median interval between ITN washes was 6 weeks. Despite intense promotional efforts, re-treatment of nets was found to be low (Armstrong Schellenberg *et al.* 2001). The development of permanently treated nets will address this but in the mean time programmes need to continue promoting and subsidising net re-treatment to both maintain and increase coverage.

The social marketing of ITNs in Tanzania has proven to be a powerful method of implementing a public-health tool for the main risk groups. Research on the use of socially-marketed ITNs for malaria control in children has found an impact on both mortality (Armstrong-Schellenberg *et al.* 2001) and morbidity (Abdulla *et al.* 2001). Now there is evidence that in this setting pregnant women too are

protected by ITNs delivered in this way. In this environment mothers generally sleep with their youngest child and multigravidae may have a net for that child rather than to specifically protect themselves during a new pregnancy. Abdulla *et al.* (2001) found that 61% of children were sleeping under ITNs which is consistent with findings from this study where 55% of multigravidae were using ITNs. Perhaps ITNs could be marketed with a stronger emphasis on their protective benefits during pregnancy for both the mother and unborn child and, given new evidence of continued increased susceptibility to malaria of mothers up to 60 days postpartum (Diagne *et al.* 2000), subsequently for both mother and infant after birth.

Uptake of the treated nets has been fast (coverage was estimated to be less than one third at the start of project and is currently around 60%). However, data from this study would suggest that there are areas in which promotion and targeting could be improved. Women who lived in households where labour on other people's land was one of the main economic activities were less likely to be ITN users. In this area of Tanzania, planting and harvesting main crops are the traditional domain of women even during pregnancy. Farms ('shambas') may be a long distance from home. During peak activity workers tend to sleep in very small, permeable temporary shelters on the farm and the internal geometry does not suit a normal sized net. Currently in Tanzania research is underway to estimate how many person-years are lived in the 'shamba' annually, and what the seasonal patterns are. A low cost treated 'shamba' net has been piloted in Rufiji, Tanzania, and proved to be popular under field conditions (de Savigny *pers. comm.*).

The majority of the population was able and willing to buy the good quality ITNs that the KINET programme marketed. However, equity must be considered when delivering a public-health tool via social marketing. Indeed, in this study 92% of pregnant women who did not use an ITN said that lack of money was the main problem. This issue is especially pertinent in Tanzania where national

scaling-up of ITNs is being implemented with a public/private mix as a strategy to prevent malaria in children (Pricewaterhouse Coopers *et al.* 2000).

Furthermore, our results show the importance of targeting all sectors of the population when promoting the use of ITNs by pregnant women and children: most women said that their husband or another family member was most likely to purchase a net in their household. We were not able to say conclusively from this study whether a system such as the discount voucher system, delivered via MCH clinics and as such targeted mainly at women, was an effective means of redressing the economic balance for the poorest. Perhaps the low usage of discount vouchers seen in this study was a reflection of women not being the main ITN purchasers. The qualitative research on discount vouchers within the KINET project may reveal more effective avenues to pursue.

Our findings clearly show the impact of ITNs on maternal anaemia and parasitaemia in this area of high transmission. A great additional benefit of protecting expectant mothers is the protection of the newborn children who almost always sleep with their mother in this setting. Both arguments make up a convincing case for including pregnant women as a main target group for ITN promotion.

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CHAPTER 11:

Impact of an insecticide treated net programme on malaria morbidity in children under two years of age in Tanzania: community cross-sectional study. ***Abdulla S, Armstrong Schellenberg JRM, Nathan R, Mukasa O, Marchant T, Smith T, Tanner M, Lengeler C***

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Abstract

Objective: To assess the impact of social marketing of insecticide treated nets on malaria parasitaemia and anaemia in children under two years of age in an area of high malaria transmission.

Design: Annual cross-sectional data were collected at the beginning of the social marketing campaign and subsequent two years. Net ownership and other risk and confounding factors were assessed using a questionnaire. Blood samples were taken from the children to assess prevalence of parasitaemia and haemoglobin levels.

Study participants and main outcome measures: A sample was drawn of children under two years of age living in 18 villages in the Kilombero river plain, Southwestern Tanzania. The presence of any parasitaemia in the peripheral blood sample, and anaemia classified as haemoglobin of less than 8 g/dl were main outcomes.

Results: There was a rapid increase in net ownership (from 58 to 83%) and treated net ownership (from 10 to 61%). There was an overall increase in the mean haemoglobin (from 8.0 to 8.9 g/dl) of the study children in the successive surveys. Overall, the prevalence of anaemia in the study population decreased from 49% to 26% in two years of implementation. Treated nets had a protective efficacy of 63% (95% CI: 38, 77) on the prevalence of parasitaemia, and 63% (95% CI: 27, 82) on anaemia.

Conclusions: These results demonstrate that insecticide treated nets have a substantial impact on morbidity parameters when distributed in a public health setting.

Introduction

Several studies have shown a positive correlation between malaria parasitaemia and anaemia, and that parasitaemia is the primary cause of anaemia in very young children in Africa (Kitua *et al.* 1997). As a result, anaemia is very frequent in young children in high transmission areas since malarial infections are the norm. Assessment of the impact of chemoprophylaxis in Tanzanian infants indicated that over 60% of the anaemia could be due to malaria in this age group (Menendez *et al.* 1997). The emergence and spread of parasite resistance to commonly used antimalarials has exacerbated the problem of anaemia in Sub-Saharan Africa (Bloland *et al.* 1993).

Hopes for malaria and malarial anaemia control have recently been revitalised by the demonstration that insecticide treated nets can reduce morbidity and mortality. A summary of randomised controlled trials showed an average protective effect of about 50% on mild malaria episodes in stable malaria areas. Moreover, protective effects were shown on the prevalence of high parasitaemia (31%) and overall mortality (19%). A modest improvement in packed cell volume (2%) and weight gain was also observed in children sleeping under treated nets (Lengeler, 1998). Large scale implementation of ITNs is underway in a number of African countries (Anonymous, 1999).

It is not known whether the impressive impact of treated nets in the frame of well controlled randomised controlled trials can be replicated under programme conditions (Lengeler & Snow, 1996). We report the first impact assessment of a large scale treated net social marketing (an approach using marketing techniques to promote and distribute socially beneficial interventions rather than a commercial product) programme on morbidity indicators in children under two years of age in a highly endemic area of Tanzania.

Methods

Study area and population

Social marketing of treated nets started in the frame of Kilombero Net Project (KINET) (Schellenberg *et al.* 1999a) in 1997, covering the Kilombero and Ulanga Districts (population 350,000) in Southwestern Tanzania. Nets and insecticide (branded "Zuia Mbu") are now being promoted, distributed and sold using public and private outlets, and a system of community door-to-door distributors. The retail price of the treated nets was 5.0 US Dollars. While this amount was a non-negligible part of the average annual income in this community, experience shows that a majority of the residents were both willing and able to pay this amount (Schellenberg *et al.* 1999a). The impact of the programme on morbidity and mortality indicators is being monitored in 18 villages under demographic surveillance (DSS). Population characteristics of this area of very high perennial malaria transmission have been described elsewhere (Tanner *et al.* 1991). Moderate anaemia (PCV< 25%) and severe anaemia occur in 61% and 14% of children under five years admitted at the local St Francis District Hospital (Schellenberg *et al.* 1999b). Chloroquine resistance is common: 65% of malaria infections do not clear within one week of chloroquine treatment (Hatz *et al.* 1998).

Design

Three annual cross-sectional surveys where conducted in a sample of children under two years of age living in the DSS area (Schellenberg *et al.* 1999a). The first survey was done at the time of launching the social marketing campaign in June 1997, and two other surveys were carried out at the same period (June to August) in the subsequent two years. A simple random sample was selected from the DSS database for the first survey, and a two-stage random sampling (sampling 6 villages then sampling children from these) was done for the subsequent surveys. A different sample was selected for each survey.

Procedures

The selected children were visited at home and a verbal consent obtained from the parent or guardian. A questionnaire was applied to assess treated net use and other potential risk factors. A physical examination was performed, and temperature, weight and height measurements were also taken. A finger prick blood sample for haemoglobin estimation and parasitological assessment was then taken. Haemoglobin was measured using the portable HemoCue® (HemoCue AB, Ängelholm, Sweden) kit. Slides were stained in Giemsa and reading was done (without the microscopists knowing the net status) using standard procedures as described elsewhere (Schellenberg *et al.* 1999b). An inspection of the children's sleeping places to assess net use was only done in 1999 because this was strongly perceived as an intrusion in their privacy.

Anaemia was classified as haemoglobin level below 8.0 g/dl since this is the level that has been associated with increased mortality (Stoltzfus, 1997) and is consistent with earlier studies in the area (Menendez *et al.* 1997). Parasitaemia and splenomegaly were classified as either present or absent. Use of treated nets was categorised based on the respondent's answers on ownership and if they were "ever treated" or "not treated". There are currently no simple ways to assess insecticide content on the nets in the field.

Data analysis

Analysis was done for all the three cross-sectional surveys combined. The impact of the nets on haemoglobin level, anaemia, parasitaemia and splenomegaly was estimated using multiple linear and logistic regression models taking into account the village cluster sampling for year 2 and 3, using robust regression approaches in STATA® (STATA Corp.). The effect of different time points of observation (surveys) was included as one of the explanatory variables.

Other factors considered in the multivariate models included use of the net, condition of the net, age, sex, ethnicity, religion, nutritional status, access to the

dispensary, shops and covered wells. Treatment history and attitudes toward health seeking were also included, as were factors related to the family size and income.

Results

We identified 985 eligible children. 16 mothers refused consent and 142 could not be traced at their homes. Therefore, mothers and guardians of 827 children were interviewed during the three cross-sectional surveys. 68 children were over twenty four months old at the time of sampling, and the net status was not known for 11 children, and therefore only 748 (91%) children were included in the analysis. Children analysed and those not analysed had similar proportions of anaemia and reported ownership of nets (data not shown).

We observed an increase in the mean haemoglobin level from 8.0 to 8.9 g/dl and a decline in the proportion of children with anaemia (49% to 26%), any parasitaemia (63% to 38%) and splenomegaly (86% to 49%), during the successive surveys (Table 11.1). The proportion of children having any net increased from 58% to 83% and those having treated nets increased dramatically during the 3 years (from 10% to 61%) indicating a rapid uptake of the socially marketed treated nets, especially in the first year of the implementation (Table11.1).

Net ownership and use

Predictors of net ownership (Table 11.2) included family income, those with high income (fourth quartile) being about 3 times more likely to have a bed net than those with low income (first quartile). This was expected as the treated nets were being sold. By the end of the 2nd year of implementation only 16% of the children were without a net. Children with no access to piped or covered wells i.e. not at the centre of the villages, were less likely to have nets (Table 11.2). Mothers that mentioned that they would advise their neighbours to send their sick children to a formal health facility were more likely to have nets for their own children (OR=2.3 Likelihood Ratio Test-χ^2, p value=0.048). This might reflect an association between health seeking patterns or perceptions about the value of the formal health system and the decision to have a net or not.

Observation of sleeping places for 171 children in 1999 revealed that, among those who claimed to be using nets, 92.9% (117/126) had a net hanging at the sleeping place. For all 9 children who had a missing net at the sleeping place, we were shown a net claimed to be used. Among those that claimed not to be using nets, 17% (8/45) had a net hanging at the sleeping place. These observations indicated that reported ownership and use provided a reasonable basis for defining bed net status.

Health impact of treated nets

We observed a protective efficacy (defined as 1-odds ratio × 100) on the prevalence of parasitaemia of 63% (95% CI:38 to 77%) and 51% (95% CI: 0 to 76) for treated and untreated nets respectively, when compared with children without nets (Table 11.3). Parasite prevalence was also related to ethnic group, religious affiliation, use of the net in the previous month and age of the child, with the prevalence in those more than 1 year of age being four times higher than those below 7 months. This is consistent with earlier studies in the same area, which demonstrated that prevalence of parasitaemia increased with age (Kitua *et al.* 1996; Smith *et al.* 1999).

The mean haemoglobin level was 7.7 g/dl (95% CI:7.4 to 7.9) for those without nets, 8.6 g/dl (95% CI:8.3 to 8.8) for untreated nets and 9.2 g/dl (95% CI: 9.0 to 9.3) for treated nets. Multiple regression analysis showed that there was an increase of haemoglobin of 1.3 g/dl (95% CI: 0.8 to 1.7) for those with treated nets and 1.1 g/dl (95% CI: 0.5 to 1.7) for those with untreated nets compared to those with no nets. Considering the classification of anaemia, a protective efficacy of 37% (95% CI:-46 to 73%) for untreated nets and 63% (95% CI:27 to 82%) for treated nets was observed. Those classified as stunted or as having no access to covered wells were more likely to be anaemic (Table 11.4). If the cut-off level for anaemia was set at 11g/dl, untreated nets had a protective efficacy of 78% (95% CI:29 to 93%) and treated nets of 82% (95% CI:42 to 94%). Parasitaemia was associated with anaemia: children with high parasitaemia had lower mean haemoglobin compared to those who had no or few parasites (χ^2-trend, $p<0.001$). Lastly, nets had also a high impact on prevalence of splenomegaly with a protective efficacy of 71% (95% CI:39 to 87%) for untreated nets and 76% (95% CI:52 to 88%) for treated nets.

For children without nets, their prevalence of anaemia remained relatively stable over the study period (between 49% and 58%) and this was also the case for the prevalence of parasitaemia (between 68% and 71%). This suggests that there were no major changes in the malaria situation during the period under evaluation.

Table 11.1 Characteristics of children surveyed in 3 cross-sectional surveys (1997-1999)

Year	1997	1998	1999	Overall
Selected	325	330	330	985
Interviewed*	269 (82.8)	291 (88.1)	267 (80.9)	827 (84.0)
Analysed*	240 (73.9)	269 (81.5)	239 (72.4)	748 (75.9)
Mean age in months‡	14.2 (3.3 to 26.4)	13.5(3.0 to 24.7)	15.4 (2.4 to 25.5)	14.4 (2.4 to 26.4)
Males	122 (50.8)	137 (50.9)	113 (47.3)	372 (49.7)
Mean haemoglobin§	8.0 (0.12)	8.9 (0.10)	8.9 (0.10)	8.6 (0.07)
Anaemia (< 8 g/dl)¶	118 (49.2)	83 (31.0)	62 (26.1)	263 (35.3)
Parasitaemia**	151(62.9)	126(46.8)	90 (37.8)	367(49.1)
Splenomegaly**	207(86.3)	144 (53.5)	117 (49.0)	468 (62.6)
No net	100 (41.8)	49 (18.2)	40 (16.7)	189 (25.3)
Untreated net	116 (48.3)	64 (23.8)	53 (22.2)	233 (31.1)
Treated net	24 (10.0)	156 (58.0)	146 (61.1)	326 (43.6)

Percentages in brackets except where indicated
* Percentage of the total selected
‡ Range in brackets
§ Standard errors in brackets
¶ Classified as Hb ≤ 8 g/dl
** Classified as present or absent

Table 11.2 Predictors of bed nets ownership (Logistic regression analysis

The final model also included ethnic origin of the child)

Variable	numbers with nets (%)	Adjusted odd ratio (95% CI)	LRT-χ^{2} [a] (ρ-value)
Income categories (quantiles of total family income)			
1st quantile of income	125 (66.8)	1*	
2nd quantile of income	130 (70.7)	1.25 (0.59 to 2.66)	
3rd quantile of income	143 (73.3)	1.13 (0.74 to 1.72)	
4th quantile of income	164 (89.1)	2.74 (1.58 to 4.75)	8.89 (0.031)
No access to covered wells ‡	191 (78.0)	0.61 (0.41 to 0.90)	3.90 (0.048)
Advice care at health facility§	387 (83.4)	2.27 (1.38 to 3.72)	3.90 (0.048)
Advice care at traditional healer§	1 (33.3)	0.12 (0.01 to 1.07)	2.97 (0.085)
Immunised	376 (84.1)	1.92 (0.86 to 4.29)	3.38 (0.066)
Mother educated	395 (79.0)	1.59 (0.85 to 3.00)	3.15 (0.076)

a Likelihood ratio test χ^{2}
* Comparison group
‡ piped clean water classified under covered wells
§ place where guardian of study child advises neighbour to sent child sick with fever

Table 11.3 Impact of nets on prevalence of any parasitaemia

(Logistic regression analysis: The final model also included stunting, no access to covered wells and sex).

Variable	Numbers with parasitaemia (%)	Geometric mean parasite density	Adjusted odd ratio (95% CI)	LRT-χ^{2} [a] (ρ-value)
No net	132 (69.8)	4404	1*	
Untreated nets	115 (49.6)	2890	0.49 (0.24 to 1.00)	
Treated nets	120 (36.9)	2745	0.38 (0.23 to 0.62)	8.75 (0.013)
Use of net in the last month	107 (34.0)	3291	0.53 (0.35 to 0.79)	6.69 (0.010)
Ethnic group				
Ndamba	49 (36.0)	3901	1*	
Pogoro	76 (66.7)	3423	3.78 (1.62 to 8.87)	
Hehe	42 (43.3)	4315	1.53 (0.74 to 3.16)	
Others	209 (51.1)	3070	2.48 (1.27 to 4.84)	14.63 (0.002)
Age category				
0 – 6 months	17 (28.3)	2040	1*	
7 – 12 months	106 (43.3)	2710	3.00 (0.95 to 9.44)	
13 – 18 months	114 (55.9)	4111	3.64 (1.31 to 10.14)	
> 18 months	140 (56.5)	3622	4.85 (1.57 to 14.96)	13.4 (0.004)
Religion				
Other religion	52 (40.9)	4434	1*	
Muslim	157 (58.8)	2967	2.40 (1.32 to 4.35)	
Catholic	159 (45.3)	3404	1.54 (1.00 to 2.37)	8.85 (0.012)

a Likelihood ratio test χ^{2}

* Comparison group

Table 11.4 Impact of treated bed nets on prevalence of anaemia (Hb £ 8 g/dl)

(Logistic regression analysis: The final model also included distance to a shop, use of the net in previous month, immunisation status, age and sex of the child)

Variable	Numbers with anaemia (%)	Adjusted odd ratio (95% CI)	LRTχ^{2} [a] (ρ-value)
No net	103 (54.5)	1*	
Untreated nets	90 (38.8)	0.63 (0.27 to 1.46)	
Treated nets	70 (21.5)	0.37 (0.19 to 0.73)	9.58 (0.008)
Stunted(Z-score≤ -3)	109 (51.2)	2.53 (1.66 to 3.84)	12.95 (< 0.001)
No access to covered wells [‡]	87 (35.5)	1.95 (1.24 to 3.07)	7.64 (0.006)
Religion			
Other religion	40 (31.5)	1*	
Muslim	112 (42.0)	1.80 (0.97 to 3.36)	
Catholic	113 (32.2)	0.96 (0.58 to 1.58)	7.31 (0.026)
Advice care at health facility[§]	125 (26.9)	0.45 (0.19 to 1.11)	4.12 (0.042)
Mother educated	179 (35.7)	1.53 (0.87 to 2.68)	2.93 (0.087)

a Likelihood ratio test χ^{2}
* Comparison group
‡ piped clean water classified under covered wells
§ advice neighbour to sent child sick with fever to a formal health facility

Discussion

These results have demonstrated that the social marketing approach of distributing insecticide treated nets was very successful and resulted quickly in more than 80% of children under two years of age having access to a net. Our results suggest an overall impact of social marketing of treated nets on health outcomes in the community, with an improvement of mean haemoglobin levels (from 8.0 to 8.9 g/dl) and a decline in the total proportion of children with anaemia (from 49% to 26%), parasitaemia or splenomegaly. The treated nets had an apparent individual protective efficacy of over 60% on the prevalence of anaemia, parasitaemia and splenomegaly. In this study untreated nets were also found to be protective. Overall, most of the changes occurred in the first year of implementation.

These efficacy estimates are higher than those from most controlled trials (Table 11.5). It is therefore pertinent to question whether this finding may be the result of residual confounding despite the effort made to control for it. This is especially so because our comparison group was made up of children who did not own nets (non-adopters) in the same community. The tools used to measure confounding factors like social-economic status and health seeking may not be sensitive enough to allow for proper control of confounding. However, factors related to the dynamics of the malaria infection and the associated disease presentation may also explain this finding. For example, it has been observed that variations in transmission strongly affect the estimates of morbidity and mortality in very young children (Marsh & Snow, 1999). Therefore at a given transmission intensity the age of the study participants may be crucial in determining the level of protection. Our finding of high impact in children under two years is in line with other studies that included very young children (Table 11.5).

Lower impact estimates than ours were observed in a randomised study near Ifakara in a similar age group (Fraser-Hurt *et al.* 1999). This may be due to fact that our study covered a larger geographical area and included study children with a lower average haemoglobin (average haemoglobin of those without nets 7.7 g/dl vs. 8.7 g/dl , t-test =3.9: p=0.0001). It is probable that more anaemic children are more likely to benefit from the intervention.

We conclude that treated nets distributed through a social marketing programme setting were effective and produced a rapid and high impact on parasitaemia and anaemia prevalence in children under two years of age. This strategy has high potential in the control of malaria in Sub-Saharan Africa.

Table 11.5 Impact of treated net materials on anaemia in controlled trials in s-S Africa

Country : Year of Publication	Entomological inoculation rate[a]	Age (months)	Impact on anaemia	
			Mean difference [b]	Protective efficacy
Control: with untreated nets				
Gambia: (D'Alessandro *et al.* 1995)	1 to 10	12 to 48	0.1	
Gambia: (Snow *et al.* 1988)	1 to 10	12 to 108	0.9	
Gambia: (Snow *et al.* 1987)	1 to 10	12 to 108	0.2	
Gambia: (Alonso *et al.* 1991) *	10	6 to 72	0.5	
Control : Without nets				
Sierra Leone: (Marbiah *et al.* 1998)	35	3 to 72	1.8	
Ghana: (Binka *et al.* 1996)	100 to 1000	6 to 59	0.4	
Kenya: (Sexton *et al.* 1990)	300			
Burkina Faso:(Habluetzel *et al.* 1997)	300 to 500	6 to 59	0.5	
Tanzania: (Premji *et al.* 1995)*(<33 pcv)	300 to 700	6 to 40	0.7	49.1
Tanzania: (Njunwa *et al.* 1996)*‡(<32 pcv)	>300	0 to 108		69.7
Tanzania: (Fraser-Hurt *et al.* 1999)	>300	5 to 24	0.4	
Tanzania : This study (<24 pcv)	300§	2 to 26	1.5	73.2

a Estimate applicable to the period before insecticide treated nets were introduced or the control group in the trial
b Mean haemoglobin difference in g/dl
* Non-randomized controlled trials
‡ Impact estimate of the peak transmission season
§ Description of malaria situation provided in reference 7

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PART V: DISCUSSION AND CONCLUSIONS

CHAPTER 12. DISCUSSION

12.1 Exposure to the risks associated with pregnancy

The work encompassed in this thesis describes a female population experiencing high levels of fertility and associated morbidity risks. Maternal mortality for the population has previously been estimated to be 448 maternal deaths per 100 000 live births (Font *et al.* 2000) which, given the underlying total fertility rate (TFR) of 5.8, translates as a life-time risk of dying from maternal causes in Kilombero of 1 in 39. It is likely that this is a conservative risk estimate since one third of the women we interviewed had also experienced pregnancy loss which does not contribute to the TFR. 10% of all the pregnancies recorded did not end in a livebirth and there was evidence to suggest pregnancy loss was underreported (chapter 7). As such, while the TFR stands as a good indicator of the number of live births a woman is likely to have in her lifetime (given period conditions), it also represents the minimum probable frequency of exposure to maternal morbidity and mortality risks.

12.2 Anaemia in pregnancy

Our research was not designed to encompass the whole range of possible pregnancy related morbidity and mortality risks in this setting, but rather focused on anaemia and its main risk factors. While further investigations into other maternal health topics have now been indicated and are justifiable (below) the focus on anaemia was most pertinent given the broad spectrum of health outcomes it is associated with, and the potential for public health impact with available interventions.

Definition of severe anaemia

In East African settings where malaria is endemic it is not unusual for over three-quarters of the pregnant population to be anaemic (Hb<11g/dL) (Verhoeff *et al.* 1999a; Shulman *et al.*1998): as such anaemia is the normal condition and

comparisons between people and places may not be revealing. From a public health perspective it is important to establish criteria that identify the most severely affected populations to enable the appropriate directing of interventions and, while not perfect, a simple dichotomous definition is useful to track improvements in risk groups. Currently WHO define Hb<7g/dL as indicating severe anaemia in pregnancy, however throughout this research we have used Hb<8g/dL for two main reasons. First, while it is clear that women with even mild anaemia are affected by its associated morbidity, the impact on maternal mortality and poor birth outcomes has most consistently been found at the cut offs of <7-8g/dL (Rush 2000; Gallego 2000). The dichotomous definition of severe-not severe using Hb<7g/dL therefore could incorrectly categorise women at high risk as being 'healthy'. Secondly, at present the magnitude of the problem of severe anaemia in a given place is assessed by population prevalence cut-offs: an area with low prevalence of severe anaemia is indicated by a prevalence of <1%, moderate by 1-9%, and high risk areas by a population prevalence of >10%. However, even in populations where multiple risk factors for anaemia are prevalent, the percent with Hb<7g/dL rarely exceeds 7% (Stoltzfus 1997). Kilombero would be categorized as an area of moderate risk with 5% prevalence of Hb<7g/dL, despite 11% prevalence of Hb<8g/dL. In addition, as in many other settings there was seasonal fluctuation in the prevalence of severe anaemia (Fleming 1970; Bouvier *et al.* 1997 Verhoeff *et al.* 1999a) and in the late dry season 11% of pregnant women had a Hb<7g/dL. Finally, our cut-off of Hb<8g/dL was associated both with malaria and iron deficiency and with subsequent infant survival and as such has important public health implications.

A plethora of risk factors

Malaria and iron deficiency, both potentially preventable, were indicated as the main risk factors for severe anaemia in our population of pregnant women. However, many of the other known risk factors were also present: hookworm infections, HIV, food insecurity (15% of women had a MUAC score indicative of

severe malnutrition in pregnancy (James *et al.* 1994)), high fertility, relatively short birth intervals, and it was evidenced by the high proportion of women recruited whilst working in the fields that women continued to do hard physical labour throughout pregnancy.

Food insecurity

In our research one quarter of women said they didn't get enough food to eat: this was surprising in the fertile Kilombero valley, although a link between food shortages and pregnancy anaemia in Tanzania has been reported before (Msolla and Kinabo, 1997; Patterson *et al.* 2001). In a subsistence setting food security may be affected by many different parameters including the incentive for growing a crop, shortage of land (environmental degradation, unsuitable land, unequal distribution of land), poorly irrigated land, pests, a shortage of affordable inputs (labour, fertilizers, seeds, tools, transport), and the occurrence of environmental disasters (e.g. El Nino) (King and Burgess 1992; WHO 2002). Cultural norms also play a role in equitable household food distribution and food taboos for different groups (Bentley *et al.* 1999). In a multi-country study WHO is currently exploring the extent of food insecurity in different regions with a view to developing mechanisms to address this problem which is one of the main underlying causes of malnutrition (WHO 1999). Tackling these issues are pertinent to improving the nutrition status of women and their health in two principal ways. First, to interrupt the perpetuation of the nutrition-infection cycle as infection can incite a loss of appetite, increase nutrient needs or decrease absorption of nutrients, and malnutrition itself can cause infection by decreasing resistance of tissues and making the immune system less effective. As a result there may be more severe illness and slower recovery times. Secondly, poor nutrition throughout the life cycle, from fetal development to adulthood has an important impact on reproductive health by affecting the growth potential of women, including height and pelvic size (Rush 2000). An insufficient pelvis may necessitate delivery by cesarean section, which if not performed can lead to

several days of obstructed labour, and may result in the death of the mother through infection and exhaustion, and death of the foetus.

Use of health services

Of particular concern is the timing of first presentation for antenatal care and the poor effectiveness of the current iron prophylaxis strategy (chapter 8). Specific strategies to try to address these problems, including nurturing more involvement from the private sector, improving service delivery and health education strategies are discussed below. However, it is pertinent to state the demographic context of MCH services in Tanzania. Despite decreases in the annual growth rate, population momentum will ensure that the number of women seeking antenatal care will increase substantially over the next two decades. The Tanzanian female population in the 15-49 years age-group is projected to almost double from approximately 8 million currently to over 15 million in 2025 (U.S. Census Bureau 2002). It is not yet clear whether health sector reforms and redistribution of funds towards district level management will be adequate to both improve basic services and accommodate such a population increase.

HIV infection

This study did not reveal an association between severe anaemia and HIV infection. However, it is the more advanced stages of HIV infection and AIDS which are most commonly described as risk factors for anaemia and we did not have data on disease progression in this population, nor whether incidence is increasing or has already stabilised. However, 8% prevalence in the pregnant population has important implications for interventions in maternal and child health.

Severe anaemia has been found in this context to be due in part to poor nutrition. The extent to which maternal nutritional status affects disease progression and vertical transmission of HIV is not clearly understood but work from Tanzania has suggested that improved nutrition could reduce foetal infection by improving the

systemic immune function of the mother and/or reducing the rate of clinical, immunological, or virological progression of disease in the mother (Fawzi 2000). Further research on this strategy is still required (Duggan and Fawzi 2001).

Malaria infection, already established as a risk factor for severe anaemia, has been shown to occur more frequently in women infected with HIV (Steketee *et al.* 1996; Verhoeff *et al*. 1999b). The efficacy of SP as an intervention against malaria and anaemia in pregnancy is reduced in the presence of HIV infection and where prevalence is above 10% the treatment regimen should be increased to 4 monthly doses from around 20 weeks instead of one dose in the second and one in the third trimester (Meek *et al.* 1998; Parise *et al.* 1998). Further, deaths from severe malarial-anaemia are increasing because of concerns about blood transfusions in communities where infection with HIV is high (Greenwood and Mutabingwa 2002).

It has been estimated that 1800 HIV infected infants are born every day in the developing world where mother-child transmission rates are as high as 35% (UNAIDS 2000). With anti-retroviral therapy and appropriate care the rate can be reduce to fewer than 5% (Rutstein 2001; McIntyre and Gray 2002). Significant advances in anti-retroviral therapy with Nevirapine have been made and the makers of the drug have announced that they will provide it free of charge to programs in the developing world (Guay 2001). Many countries, including Tanzania, are currently debating implementation, but the infrastructure and use of health service barriers are the same as for other maternal health interventions (e.g. drug supply logistics and low proportions of women delivering at hospitals), and are further complicated by the acceptability of HIV testing (Guay 2001; McIntyre and Gray 2002). Operational research in Cote d'Ivoire found that with additional, dedicated staff voluntary testing and counseling for HIV was feasible and acceptable through MCH services, but overall success was limited because particularly HIV positive women did not return for their results (Msellati *et al.*

2001). Innovative operational strategies in maternal health care are urgently required.

12.3 Study design

Both our studies were cross-sectional. As such they were able to make a rapid assessment of the factors under study and at minimal cost. At a descriptive level, and with little access to data from previous work on fertility and health in pregnancy from the area, the approach was valid. It was important to establish the frequency of the principal outcomes under study and to identify the main risk factors associated with them (chapters 6, 8, 10). Further, it was anticipated that other areas of public health interest would emerge from the data (chapters 7,9) and suggestions for further research are expanded upon below. The principal limitation of the fertility study was its inability to differentiate between induced and spontaneous abortions. However, as noted by previous researchers (Font *et al.* 2000) this is a delicate subject in the area and probably not suitable for inclusion in a broad based questionnaire.

The nature of a cross sectional study prohibits the investigator from quantifying unforeseen events which preceded the data collection but which may have influenced the outcome: e.g. use of health interventions. Instead the researcher relies on current knowledge of the subject, together with knowledge of the local environment, in order to develop a survey instrument which adequately includes all known risk factors and confounders. In this research focus group discussions, a pilot study for anaemia prevalence, and data on reporting of pregnancies and use of ITNs from the IC-DSS were all used to maximize the relevance of the survey techniques employed.

A bias which all studies are susceptible to is misclassification due to imperfect measurement of exposure variables. In our study, for example, there may have been peripheral blood tests which tested negative for malaria parasitaemia for

women who had placental parasites. This would have lead to a non-differential (since there is no evidence to suggest that these 'false negatives' are more likely to appear for one group than another) under- estimation (since some cases attributable to malaria might have been missed) of malaria impact on anaemia. In our study women were recruited in the community and seen only once with no mechanism for follow-up at delivery. Women in the area are often assisted by informal persons at delivery and some even remain in the fields throughout. This limitation proved to be a hindrance to another aspect of data collection in the original study design: birth weight. Birth weight was to be recorded at the DSS survey interview subsequent to delivery. This may have been up to 16 weeks after the birth. Not surprisingly, this yielded scanty and poor quality data – either because the mother herself was not present to be asked at that time, because birth weight had not been recorded at all, or because birth weight was 'guestimated' or recorded at various times after delivery. Consequently birth weight could unfortunately not be included in the analysis.

Pregnancy outcome data, or placental data, would have required a very different study design. Cross-sectionally recruiting only women who said they wanted to deliver at health facilities would be one option, but would introduce important selection biases to the study (e.g. health seeking women, high risk women) and would have necessitated a considerably larger population base: when asked as part of the questionnaire only 24% of women said they wanted to deliver at a health facility. Font *et al.* (2000) estimated that up to 30% of all births in the area occurred at the district hospital; our pregnancy history data showed that 57% of all live births reported were born at a health facility. A hospital based case control study would have been subject to similar problems of bias. Such an approach was found not to be useful for assessment of ITN impact amongst children in the same setting (Abdulla *et al.* 2002). A cohort study would probably yield more reliable data but requires a considerably greater investment.

It is difficult to make a definitive diagnosis of iron deficiency in pregnancy (Carriaga *et al.* 1991). Iron deficiency is characterized by microcytic and hypochromic red cells on a thin film. This method of detection is increasingly useful as a detector of iron deficiency as haemoglobin levels drop, and has a high specificity for severe cases (Evatt *et al.* 1992). It has already been reported to be a good indicator of severe iron deficiency in this setting (Menendez *pers. comm*.; Massawe *et al.* 1999a) second only to bone marrow aspiration which is highly invasive. Serrum ferritin concentration <15 µg/L is an indirect indicator of the degree of iron sufficiency, but in people with acute or chronic disease that results in anaemia, the serum ferritin concentration can increase to about 50 µg/L despite an absence of iron stores, thus underestimating iron deficiency (Evatt *et al.* 1992; Mockenhaupt *et al.* 1999). Serum transferrin receptor is a reliable indicator for iron deficiency (Verhoef 2001) but only in the absence of haemolysis (as typical in malaria infection). It was not found to be of benefit in addition to blood slide reading for microcytic and hypochromic red cells in studies on infants in Ifakara (Menendez *pers. comm.*). Neither serum iron (<13 µmol/L) nor iron-binding capacity (an indirect measure of transferrin) are useful methods of detecting iron deficiency where malaria is prevalent (Evatt *et al.* 1992). In summary, it is likely that iron deficiency was underestimated by our red cell morphology method, but that it probably had a high specificity for severe cases associated with anaemia.

In conclusion, our study proved to be a viable approach to estimate the main risk factors for anaemia in pregnancy in this setting, despite limitations in measures of the explanatory variables.

12.4 ITNs for the prevention of anaemia and malaria in pregnancy

At the inception of this research the evidence to support the use of ITNs by pregnant women was both contradictory and sparse. An impact on anaemia and parasitaemia was found in an area of low malaria transmission (Thailand) and a

highly seasonal area (Gambia), but not in an area of moderate perennial transmission (Kenya) or hyperendemic perennial (Ghana) (Dolan *et al.* 1993; D'Alessandro *et al.* 1996; Shulman *et al.* 1998; Browne *et al.* 2001). It deserves comment that the Ghana study only included women who had previously attended the study clinic and as such were susceptible to the selection biases described above. In addition, it reported data from a cluster intervention i.e. it compared pregnant women living in clusters with and clusters without ITNs, even though it was indicated that only half of the women in the intervention cluster were actually ITN users (Guyatt 2001). A trial in Kenya has reported results of a similar magnitude to our own for maternal morbidity, and additionally found that use of ITNs in pregnancy had a positive impact on the health of the neonate (ter Kuile *pers. comm.*). This results in three out of five trials demonstrating clear improvements in health for pregnant ITN users, and one of the two which did not show an impact may have missed the true effect.

Wide spread implementation of ITN programmes means that a randomized controlled trial is no longer an appropriate assessment approach for ITN efficacy. Our data, from a hyperendemic perennial setting (chapter10), has now shown clear improvements in the malaria and anaemia status of pregnant ITN users under programme conditions. Improvements to the health of pregnant women attributable to ITN use have now been established under programme conditions.

From a programme perspective an important issue which was underlined by our research was the importance of retreating mosquito nets with insecticide. Pregnant women sleeping under the most recently treated nets had the lowest rates of anaemia and parasitaemia (chapter 10). However, net treatment rates in the KINET project were low amongst both owners of pre-treated nets and untreated nets, despite intense promotion campaigns. The explanation may lie partly in unrealistic expectations of the product to prevent all mosquitoes and all malaria; addressing this will require more sophisticated education messages

(Armstrong Schellenberg *et al.* 2002). The introduction of nets with long lasting insecticide treatment may prove to be the long term answer.

In the current climate of increasing drug resistance, when deaths from malaria and severe anaemia are rising, personal protection methods for malaria control are increasingly called for. Currently wide spread advocacy is gaining momentum for improved access to ITNs for the most vulnerable groups: pregnant women and children under 5 years of age (WHO 2000). A meta-analysis yielding a single estimate of efficacy of ITNs in pregnancy may be a useful promotion tool to this end. However, its interpretation will be limited by the impact of the intensity of infection across geographical areas and the (as yet unquantified) impact of ITNs on the dynamics of transmission over time within areas, and also by the poorly understood complexity of loss of acquired immunity during pregnancy, especially for primigravidae.

Target groups

Targeting specific groups of a population for ITNs with public resources rather than hoping to achieve blanket coverage is probably important for two main reasons. First, to make sure that those most susceptible to the disease have the best chance of being protected, and secondly that institutions financing the intervention have a well defined population to reach and a strong incentive for investment.

In sub-Saharan Africa the target groups of pregnant women plus children under five are so inextricably linked that it is hard to conceive that one group suffers due to the inclusion of the other. Few children sleep alone in this setting and most sleep with their mothers, particularly those under two years of age. The KINET work found a high concordance between multigravidae sleeping under treated nets and children under two sleeping under treated nets (chapter 10). Increasingly there is strong evidence of multiple-level benefits associated with the inclusion of pregnant women as a target ITN user group.

At the first level of benefits maternal morbidity has been shown to be improved with reductions in parasitaemia and severe anaemia (Dolan *et al.* 1993; D'Alessandro *et al.* 1996; Marchant *et al.* 2002; Ter Kuile *pers. comm*.); further there are implications for a reduction in maternal anaemia-related mortality. In this context, of particular importance is the inclusion of primigravidae. It is well established that this group suffers the most serious consequences of malaria and its associated anaemia (Brabin 1991). In addition, these predominantly teenage women have least access to the financial means necessary to invest in health and often have low status within their communities (WHO 2001). Although subtle, their inclusion as a target group within national campaigns could help to draw them into contact with health services earlier and to legitimize their needs both within their own families and at health service provider levels.

On the second level of benefits is the growing evidence which supports improvements in birth weight and a reduction in the number of infants born premature or small for gestational age following use of ITNs during pregnancy (D'Alessandro *et al.* 1996; Ter Kuile *pers. comm*.). Third, there may be an as yet unquantified reduction in overall infant mortality attributable to use of ITNs in pregnancy. Numbers were too small to assess a direct impact of ITN use in pregnancy on infant survival in our study (chapter 9), although the hazards ratio was in the right direction: HR 0.6 (95% CI 0.3, 1.4). Finally, the fourth level of benefits to emerge from use of ITNs in pregnancy is that new-borns whose mothers sleep under an ITN immediately benefit from the protection ITNs confer against malaria associated child morbidity and mortality (Abdulla *et al.* 2000; Armstrong Schellenberg *et al.* 2001). Parallel to these multiple benefits is the fact that it is mothers and not infants who are consumers and decisions makers regarding ITNs and as such the inclusion of pregnant women as a main target group compliments strategies for increasing coverage in children.

Equity

An example of an inequality in health is poor access to an intervention for a whole population. Inequities in health – for example between men and women, or rich and poor – refer to unfair and remediable inequalities. That the poor suffer from malaria in Tanzania is not an inequality since within such malarious regions people from relatively wealthy households also frequently suffer from the disease (Sachs & Malaney 2002). The problem lies in the inequitable access and use of preventative and curative measures against malaria.

The KINET project successfully tackled both inequality, by subsidising ITNs for the whole population within the study area, and some important aspects of inequity. Through its public/private partnership it was able to address the access and opportunity barrier by putting high quality ITNs and net treatment services in the most remote areas. In addition, the voucher system was a way of exploring the means to redress the actual monetary cost for the poor and to some extent the gender imbalance by explicitly promoting use by pregnant women. As discussed in Chapter 10 and in the paper by Mushi *et al.* (2002) vouchers were an important IEC tool within the ITN campaign. However they did not satisfactorily address improved access for the poorest in that they were susceptible to the top-down effect of economic subsidy when the rich benefit more than the poor in that the poorest women did not have the access to cash required to purchase a net even with the discount voucher. It should be reiterated that, since malaria affects both the rich and the poor in Tanzania, the voucher campaign did not fail as a method to reduce inequality, only it did not prove to be of special advantage to the poorest women whom it was hoped would benefit.

In the context of national scaling-up of ITNs the experience of KINET has important implications. Currently the international community is committed to implementing ITN programmes which address equity for the main target groups while leaving production and supply largely in the hands of the sustainable

private sector (Roll Back Malaria 2002). The potentially beneficial role of a voucher system within such a model is clear. The vouchers continue to play a part as an IEC tool, highlighting the benefits of ITN use and the needs of pregnant women concurrently. In addition, the private sector is supported through demand creation and, if targeting is successful, markets in more rural areas should open up. However, there is a real risk that the difficulties associated with the district-level voucher scheme implemented within the KINET project will be apparent at national level and strategies need to be adjusted accordingly. There are three main areas for concern.

The first is the length of the chain of people required for successful implementation. Vouchers must be put in place, MCH personnel, the community and individual pregnant women must understand the system and use it appropriately, ITN vendors must accept the vouchers for their full value, without adjusting the price of the net, and then be able to quickly redeem them. Apart from the vendor who may not have made a sale without a reduction in price, there is only one real beneficiary along this chain – the pregnant woman. Intense and prolonged efforts will be required in motivation and education of all the members of the chain. Intense publicity of how pregnant women should be using antenatal services and what they can expect from the service is essential. Reducing the stages from voucher distribution to ITN sale would be advantageous.

The second issue is to ensure that the voucher has such a value that it's success is not hampered by the poverty of the highest risk groups, especially poor primigravidae, for whom the remaining balance may still be too high. Specific IEC messages highlighting the health benefits to the family of protecting these women from malaria need to be developed. This leads to the final, and related point, that not all ITN purchasers are women. Our study found that the majority of women would ask a parent or partner to buy them a net and would not themselves be the purchasers. This obviously has implications for targeting all

equity efforts through MCH clinics which men have no access to. Net outlets and publicity materials must remain in a gender-unbiased domain.

In summary, subsidies to the whole population are not feasible in either the short or the long term. In many cases it is likely that they will not be necessary anyway once market forces are stimulated, as evidenced by the rapid uptake of ITNs in the frame of the KINET project. Complimentary, evidence-based target groups have been identified for subsidy and a method of improving access for these groups has been proposed. This approach has already been found to have some pit-falls which undoubtedly must be allowed for. However, with adequate attention given to promotion, even in rural areas, the inequality of access to a malaria prevention tool will be addressed; the extent to which equity will be improved remains to be seen.

12.5 Complimentary interventions for malaria and anaemia in pregnancy

The prevention of malaria and anaemia in pregnancy needs to be addressed with a package formula. ITNs are an essential starting point for this but other complimentary tools could potentially combine to place a country like Tanzania out of the moderate to high risk category for severe anaemia in pregnancy and into one of low to moderate risk.

Iron and SP delivered through MCH clinics

The evidence to support intermittent treatment with SP in pregnancy and distribution of daily iron prophylaxis, together with some negative factors, have already been summarised (chapter 1). In this setting we have found that often drug supplies to MCH clinics were irregular and inadequate (iron phrophylaxis (chapter 8) and family planning supplies (chapter 6). In addition 'leakage' out of public and into private hands has sometimes been found to constitute a major obstacle in implementation of interventions at clinic level (Williams 2001). In Dar es Salaam researchers found that simply by ensuring an adequate supply of

haematinics and malaria prophylaxis at MCH clinics the proportion of women with severe anaemia in pregnancy was reduced by 57% (Massawe et al. 1999b). Improving MCH delivery mechanisms has obvious implications for immediate improvements in health, although the way in which health services are used still remains crucial.

Improved detection of severe cases at the MCH

In the current situation where some women present late for antenatal care there is an essential need to improve detection of severe cases. We found that women with severe anaemia were more likely to seek health care than women without severe anaemia (chapter 8), but inevitably some will arrive too late in pregnancy for an effective reversal in haemaglobin before delivery and will require referral. The WHO have developed a haemoglobin colour scale which is inexpensive and easy to use and has a high sensitivity for severe cases of anaemia (Gosling *et al.* 2000; Verhoef 2001). However, even this simple method requires training of personnel and a drop of blood from the patient. Subsequently it has implications for cost and HIV cross-infection. An even more basic method was developed in Kenya where pallor testing was combined with morbidity screening questions with sensitivity and specificity for severe anaemia of 84% and 92% respectively (Shulman *et al*. 2001). Our finding that severely anaemic women were more likely to report health problems than other women suggests that screening of this sort could be usefully employed *in conjunction* with routine interventions.

Health promotion for use of health services

A health promotion strategy to encourage more widespread understanding of what should be expected from antenatal care would be beneficial: making the process of health care delivery a more interactive procedure. In our study a leaflet was developed and delivered at community level which outlined basic antenatal attendance procedures and highlighted primary health messages for pregnant women. Informal evaluation of the leaflet suggested that it was

extremely well received and copies were requested both by MCH clinic staff, and male and female community members.

The WHO is currently fostering investment in better communications approaches to encourage 'healthy behaviour', using a combined approach to target the infectious diseases TB, HIV, and malaria (WHO 2002). Certainly the IEC campaigns instrumental in scaling-up ITNs (above) should be a welcome development.

Health promotion for food combining

Dietary advice is given at MCH clinics where women are advised by posters to eat more meat and fish, green leafy vegetables (for iron and vitamin A), and to eat as wide a variety of foods as possible. While these are valid messages to give they may not be practical in settings where overall food supply is limited and choice is a luxury. Food insecurity issues are probably beyond the reach of a maternal anaemia prevention campaign. However, simple messages about food combining which enhance nutrient intake (e.g. not to drink tea (which contains tannins) with meals to improve iron absorption) could easily be devised, are quite easily adapted for national distribution, and allow the maximum benefit to be made of existing diets.

12.6 Integrated Management of Pregnancy and Childbirth (IMPAC)

In 1987 the WHO and UNICEF launched The Safe Motherhood Initiative. It has been noted in reviews of this initiative that not enough progress has been made towards the goals of reducing maternal and infant mortality and the provision of access to reproductive health services for all who need it (WHO 2001). The factors cited as reasons why the Safe Motherhood Initiative did not achieve its intended goals and objectives were 1)that some recommended interventions had not been effective 2) inadequate attention was given to the impact of HIV/AIDS, 3) some interventions which were known to be effective had not been

implemented and 4) vulnerable populations such as adolescents and unmarried women had been overlooked. Further, it describes weaknesses in health systems which have limited the potential for success of the Safe Motherhood Initiative, many of which are common to our setting and are discussed above (WHO 2001).

In response IMPAC has now been launched as a comprehensive package of norms, standards and tools for adaptation at national and district level as appropriate. Its intention is to promote effective evidence-based interventions targeting the major causes of maternal and newborn morbidity and mortality including access to antenatal care, normal delivery care by a skilled attendant, guides for prevention and treatment of complications in pregnancy (including anaemia), neonatal care, family planning advice, and the management of STI's. Currently it is being implemented in ten countries – including Nigeria, Ethiopia, Uganda and Mozambique in sub-Saharan Africa.

The principals of IMPAC can just as easily be applied to Tanzania: identify the principal problems, develop strategies that focus on effective evidence-based interventions, and analyse the health systems requirements for implementation. It is hopeful that the findings from this thesis, in highlighting some of the main aims of IMPAC, will be of benefit to health care policy planners to improve the maternal health setting in the Kilombero Valley and beyond.

CHAPTER 13 CONCLUSIONS

In conclusion, this project has revealed a high fertility setting where poverty, malnutrition and infectious disease are all prevalent. While these issues probably affect the population as a whole, their impact in pregnancy is of particular relevance given that where they inhibit improvements in maternal health they affect the health of their offspring concurrently. The main findings from our research were:

- women are exposed to all the high risk aspects of fertility – child bearing at both extremes of the reproductive years, high rates of late pregnancy loss, frequent births;
- particularly young women have a desire for more control over their fertility but have difficulty accessing services;
- women tend to be late to use antenatal services and most deliveries take place away from health services making interventions more problematic,
- malaria, hookworm, HIV, iron deficiency and anaemia were all prevalent, and malaria and iron deficiency the most important contributors to severe anaemia;
- the infants born to women with severe anaemia in pregnancy had a three-fold mortality risk compared to infants born to women not severely anaemic;
- socially marketed ITNs proved to be a useful tool to prevent severe anaemia, reducing 38% of all cases in pregnancy and 63% in children under two;

In summary, the prevention of anaemia in pregnancy has great potential for improving the quality of life of both women and their offspring, and the impact of insecticide treated nets, together with direct health promotion, must be capitalized upon.

Implications for further research

The work encompassed in this thesis has inevitably raised more questions. Following are suggestions for the most pressing issues to be investigated.

Implications for basic research

Anaemia and infant survival

At which stage of the reproductive cycle does severe anaemia have its biggest impact on poor pregnancy outcomes and on infant survival? Implication: targeting of interventions for biggest health impact.

Spontaneous pregnancy loss

What is the magnitude of this problem at different gestations and what are the prinicipal risk factors? Implication: reducing maternal morbidity and mortality associated with pregnancy loss outside the reach of health services.

Induced abortions

What is the magnitude of this problem and what methods are most commonly employed? Implication: targeted interventions for family planning, and for improving the safety associated with unsafe abortion practices.

Implications for operational research

Delivery of drugs via MCH

What are the real obstacles to delivery of haematinics and malaria prophylaxis via MCH clinics? To what extent do non-compliance, poorly motivated staff, interrupted supplies play a role? Implication: maximize benefits of pre-existing interventions.

Implications for practice

Targetting and equity

What is the most effective way of improving equity for the most vulnerable groups? Implication: more efficient utilisation of funds for target groups.

Use of insecticide treated nets in pregnancy

How important is it for pregnant women to use ITNs early if not pre-pregnancy? Implication: maximizing the benefit of ITNs as an intervention.

Detection of severe anaemia

What is the most useful and least resource consuming method to detect severe anaemia at the MCH? Implication: reduce the number of women reaching term with severe anaemia and as such have an impact on maternal mortality.

Reproductive health and teenagers

Teenagers have a number of needs which are not currently being addressed and pre-pregnancy they are largely outside the health care system. They do not have easy access to family planning. There may be an increase in induced abortion amongst this group. What are the main barriers to accessing this group, how can they be overcome? Implication: improve adverse outcomes associated with unplanned pregnancies and poor access to health information and care.

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