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Malaria infection among pregnant women attending antenatal clinics in six Rwandan districts

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Summary

OBJECTIVES The aim of the study was to assess the knowledge, attitude and practices of pregnant women towards malaria and their association with malaria morbidity.
METHODS Cross-sectional malaria survey of 1432 pregnant women attending six health centres, each of them situated in a specific health district in Rwanda from September to October 2002.
RESULTS The overall prevalence of malaria infection was 13.6% and all infections but two were caused by *Plasmodium falciparum*. The six health districts were significantly different in terms of malaria prevalence, which varied between 11.5% and 15.4% in four and was <5% in the other two districts. The prevalence of anaemia and splenomegaly mirrored that of malaria infection. In three districts, the prevalence of infection was significantly higher in primigravidae than in secundigravidae and multigravidae ($P = 0.01$), while in two others it did not vary with parity. Bed net use was low – only 13.1% of the women had at least one bed net at home and 8.3% of them slept under it – and significantly different between districts. Most women knew that malaria might have serious consequences for their pregnancy and that insecticide-treated bed nets are useful for malaria prevention. However, the bed net market price [1525 Rwandan Francs (RFr), approximately 1.6€] was much higher than that considered as affordable and acceptable (389 RFr, approximately 0.3€).
CONCLUSION Malaria in pregnancy is a major problem in Rwanda, even in the districts of low transmission. Bed net use among pregnant women is low. The option of providing free insecticide-treated bed nets to pregnant women should be explored and possibly implemented; it could rapidly increase bed net use and earlier attendance to antenatal clinics with clear benefits for the women's health.

keywords malaria, pregnancy, cross-sectional, anaemia, bed nets, Rwanda, KAP survey

Introduction

Malaria is one of the major health problems in Rwanda and the commonest reason for attendance at health facilities. According to the 2001 surveillance data ('Programme National de Lutte et de contrôle de Paludisme; PNLP), 43% of all episodes of illnesses and 43% of all deaths are due to malaria. However, malaria transmission is not homogenous, it is stable with seasonal peaks in the valleys and unstable in the hills, with some epidemic-prone districts (Rwagacondo *et al.* 2003). Pregnant women have a higher risk of malaria infection and this negatively affects the outcome of pregnancy. Such risks depend on endemicity: in pregnant women with little or no pre-existing immunity because they live in areas of little or no transmission, malaria can evolve towards severe disease and is associated with a high risk of maternal and perinatal mortality; foetal and perinatal loss can be as high as 60–70% (Brabin 1983; McGregor *et al.* 1983; Nosten *et al.* 1999; Shulman & Dorman 2003). In highly endemic areas where pregnant women have acquired malaria immunity, infection is associated with maternal anaemia, low birth weight (LBW) and stillbirth. Placental malaria reduces birth weight by 55–310 g and is responsible for up to 35% of preventable LBW in malaria-endemic areas (Kramer 1987; Newman *et al.* 2003a).

Moreover, LBW is more frequent in primigravidae with placental malaria than those without (Nosten *et al.* 1999) and is the most important cause of infant mortality, responsible, in Africa, for at least 13% of all infant deaths (McCormick 1985; Murphy & Breman 2001). A recent review analysing the malaria population attributable risk for anaemia (3–15%), LBW (8–14%) and infant mortality (3–8%) estimated that each year between 75 000 and 200 000 infant deaths are associated with malaria infection in pregnancy (Steketee *et al.* 2001). Perinatal mortality caused by malaria may be around 25–80/1000 per year. In endemic countries, regardless of parity, the risk of stillbirth is twofold in women with placental malaria (Van Geertruyden *et al.* 2004).

In Rwanda, pregnant women have a 1.6–4.9 times higher risk of being hospitalized (Hammerich *et al.* 2002) but there are still few data on the burden of malaria in pregnancy. We report here, the results of a cross-sectional survey carried out among pregnant women attending antenatal clinics (ANC) in six Rwandan health districts of variable malaria endemicity.

Material and methods

Six health districts located in areas of different malaria endemicity namely Gakoma, Nyanza, Bugesera, Kabaya, Gisenyi and Humure were selected (Figure 1). Within each district, one health facility was randomly selected. Pregnant women attending the corresponding ANC were sequentially enrolled if informed consent was given and until the required sample size was obtained. Information on socio-economic status, knowledge, attitudes and practices concerning malaria was collected by administering a pre-defined questionnaire. A full clinical examination was carried out and a blood sample for packed cell volume (PCV) and parasitaemia collected. Thick and thin blood films were stained with Giemsa. Parasite density was determined on the basis of the number of parasites per 200 white blood cells (WBC) on a thick blood film assuming a total WBC count of 8000/μl. PCV was measured by microhaematocrit centrifugation. Thick blood films were considered negative if no parasites were seen for 200 WBC. Anaemia was defined as a PCV <30%. Parasitaemic and anaemic women were treated with a full course of amodiaquine + sulfadoxine–pyrimethamine (the first-line treatment) and with haematinics, respectively.

Data were checked twice by the supervisor and coordinator of the survey, double-entered and validated using EPI Info (version 6.04b; Centers for Disease Control and Prevention). Statistical analysis was carried out with STATA (version 6; Stata Corporation). For proportions, univariate analyses were performed using the chi-square ($P < 0.05$) or Fisher's exact test (for cross-tabulations with an expected value in any cell ≥5); Student's *t*-test was used to compare continuous variables. Non-parametric tests (Wilcoxon or Kruskal–Wallis) were used for non-normally distributed variables. Univariate analyses and multivariate analyses were performed using linear and logistic regression for the main variables of interest. Variables representing independent risk factors or influencing the model significantly were maintained.

Results

A total of 1432 women, between 227 and 251 per district/health facility, were enrolled and examined in

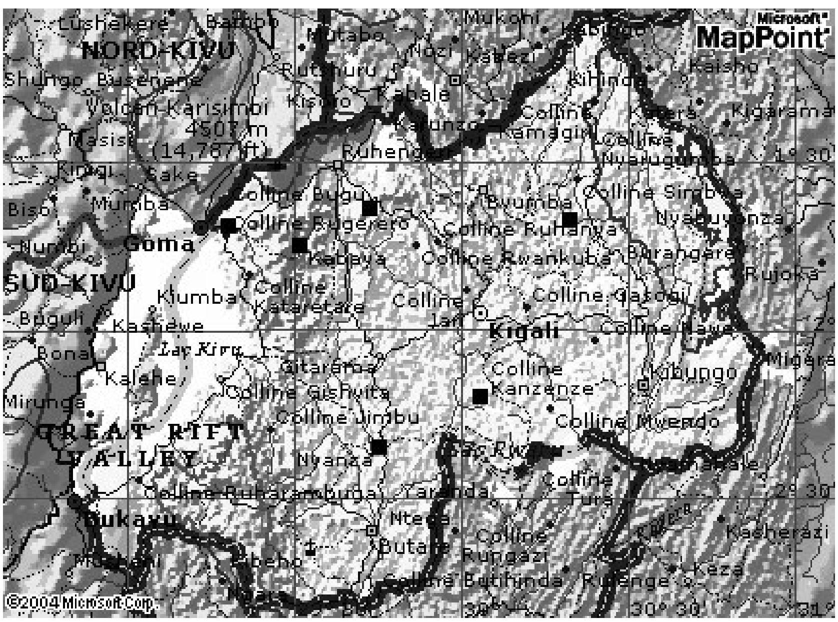

Figure 1 Location (■) of health districts where the survey was carried out.

Table 1 Sociodemographic characteristics, parity and bed net use by district

	Health districts							
	Bugesera	Gakoma	Gisenyi	Humure	Kabaya	Nyanza	Total	*P*-value
Median age in years (interquartile range)	25 (21–30)	28 (24–33)	26 (22–32)	27 (23–33)	26 (22–32)	28 (23–34)	27 (22–32)	<0.001
Able to read [% (*n*/N)]	60.7 (142/234)	57.1 (137/240)	57.8 (144/249)	59.3 (134/226)	49.8 (119/239)	71.4 (172/241)	59.3 (848/1429)	<0.001
Farmer [% (*n*/N)]	99.2 (233/235)	97.9 (235/240)	80.3 (195/243)	98.2 (221/225)	97.1 (232/239)	95.8 (228/238)	94.7 (1344/1420)	<0.001
Husband farmer [% (*n*/N)]	89.2 (199/223)	96.3 (210/218)	67.0 (198/236)	93.1 (158/216)	88.4 (198/224)	86.1 (180/209)	86.4 (1146/1326)	<0.001
Median daily salary farmer (95% CI)	300 (250–300)	250 (200–250)	300 (300–300)	200 (200—200)	150 (150–150)	300 (300–300)	250 (250–250)	<0.001
Month of gestation first ANC visit (median)	6	6	7	6	6	5	6	0.018
Primigravidae [% (*n*/N)]	20.0 (47/235)	18,0 (44/240)	20.3 (51/251)	16.7 (38/227)	15.9 (38/239)	19.7 (48/241)	18.6 (266/1433)	0.77
Secundigravidae [% (*n*/N)]	18.7 (44/235)	14,6 (35/240)	15.1 (38/251)	15.0 (34/227)	19.3 (46/239)	14.6 (36/241)	16.2 (233/1433)	–
Multigravidae (three or more) [% (*n*/N)]	61.3 (144/235)	67.4 (161/240)	64.5 (162/251)	68.3 (155/227)	64.9 (155/239)	65.7 (157/241)	65.5 (934/1433)	–
≥1 bed net/household [% (*n*/N)]	23.5 (54/230)	10.4 (23/221)	16.5 (36/218)	2.5 (5/196)	4.7 (9/192)	18.3 (43/236)	13.1 (170/1295)	<0.001
Individual bed net use [% (*n*/N)]	14.5 (34/235)	7.1 (17/240)	9.2 (23/250)	0.9 (2/225)	3.4 (8/239)	14.1 (34/241)	8.3 (118/1430)	<0.001

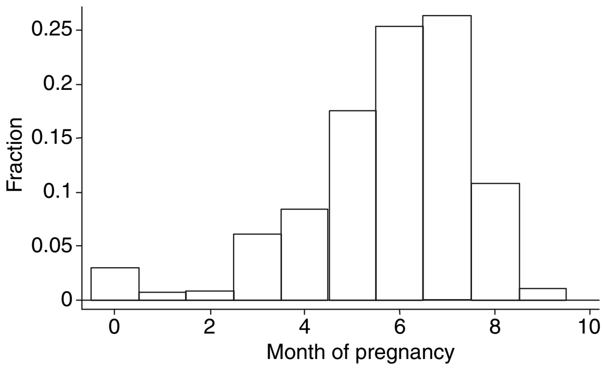

Figure 2 First ANC visit by month of pregnancy.

September–October 2002. The median age was 27 years (Table 1). Most of the women were married (91.4%), farmers (95%) [like their husbands (86.6%)] and 59% of them were able to read. Besides age, all the above variables were significantly different between the six health districts ($P < 0.05$).

Two-thirds (65.5%) of the women were multigravidae, 18.3% primigravidae and 16.2% secundigravidae. Most (70%) were in the third trimester of gestation and for a large part of these (48%) this was the first ANC they attended (Figure 2). A minority of women (5%) attended the ANC in the first trimester of pregnancy. Almost 6% of the women reported a previous abortion, 3.2% a previous stillbirth/foetal death and 3.9% mentioned a premature delivery in the past 2 years.

Malaria was a well-known disease: 97.2% knew about it and over two-thirds had received information on this subject mainly at the health centre, through the radio or the health animators (Table 2). The majority of women (83.7%) knew that malaria might have serious consequences for their pregnancy, although most (78.9%) mentioned abortion as the major problem. When having malaria, the majority of women (76%) attended a health facility, including 15% hospitalized during the last clinical episode, while 12% had obtained treatment from a pharmacy.

Sixty-seven per cent of women stated that they knew how to protect themselves against malaria and of these 75.2% mentioned bed nets (Table 2); overall half of the women (50.6%) were aware that bed nets can protect them against malaria. However, bed net use was low – only 13.1% had at least one bed net at home and 8.3% slept under it – and significantly different between districts, with Humure and Kabaya districts having the lowest percentage (Table 1). A large proportion of women (81.7%) knew of the existence of insecticide-treated bed nets (ITN), that

Table 2 Knowledge, attitude and practices towards malaria

Variable (*n*)	%
Know malaria (1427)	97.2
Received information on malaria (1401)	68.1
From (952)	
Radio	49.3
Television	0.7
Health centre	59.7
Health animator	24.4
Neighbours	8.3
Administrative authorities	4.4
Church	0.6
Others	1.8
Known clinical signs of malaria (1426)	
Fever	73.1
Headache	48.5
Asthenia	30.1
Arthralgia	22.0
No appetite	12.3
Vomiting	30.4
Know how they get malaria (1418)	80.8
Groups most affected by malaria (1404)	
Children under 5 years	47.2
Pregnant women	63.4
Know malaria has consequences for the pregnancy (1432)	83.7
Cited consequences (1362)	
Abortion	78.9
Premature delivery	5.9
Infant death	1.9
Maternal death	1.4
Congenital malaria	4.2
LBW	0.8
Retarded growth of the baby	0.6
Infant anaemia	0.2
Maternal anaemia	0.8
Bleeding	0.2
Severe malaria	0.15
Other (not stated)	5.0
Know means of protection (1378)	67.3
Means cited (927)	
Bed net	75.2
Chemoprophylaxis	0.7
Wood	0.2
Early closure of doors and windows	16.2
Drying stagnating waters	38.3
Deforestation	39.7
Live away from marshes	2.7
Others (not stated)	15.4

they were beneficial in protecting against malaria (94.8%) and that they should be re-treated at regular intervals with insecticide (80.7%), although few (19.5%) knew how to do it. Women owning a bed net had spent, on average, 1525 Rwandan Francs (RFr) (approximately 1.6€) to buy it with large individual differences (range: 100–9000 RFr). Such prices were higher than that considered as affordable and acceptable: 389 RFr (range: 20–5000 RFr) (approximately 0.3€). After adjustment, bed net use was associated with literacy rate, profession (including husband's profession) and health education (Table 3). Literate women used twice as many bed nets while farmers (the majority) used them significantly less than those doing other professions. As the use of bed nets varied significantly between districts, the variable 'district' was maintained in the multivariate analysis.

Table 3 Risk factors associated with bed net use (multivariate analysis with logistic regression)

Risk factor	Adjusted odds ratio	95% CI	*P*-value
Able to read	1.94	1.09–3.30	0.02
Not a farmer	15.93	4.10–61.99	<0.001
Received health education	1.48	0.94–1.24	0.13

During the last malaria clinical episode, 71.9% had been unable to work and the mean duration of incapacitation was 21.6 days (95% CI 20.2–23.0). A farmer (the majority of the participants) earns on the average 242.4 Rfr/day (95% CI 238.9–245.9). Expenditures linked to a malaria episode were significantly lower when women attended the local pharmacy instead of the health centre (Figure 3).

Gakoma and Nyanza had the highest malaria prevalence, 15.4% and 13.7%, respectively, while in Gisenyi and Kabaya the prevalence was lower than 5%. As expected the overall prevalence of infection was significantly higher in primigravidae than in secundigravidae and multigravidae ($P = 0.01$). After adjustment, primigravidae and secundigravidae had a 78% and 15% higher risk of being infected than multigravidae respectively. However, in three districts (Nyanza, Gisenyi and Kabaya) such variance was not apparent. The mean PCV was 36.4% (95% CI 36.0–36.7) and 11.8% of the women were anaemic (Table 4). Prevalence of anaemia reflected the difference in malaria prevalence between districts and was higher in primigravidae than in secundigravidae and multigravidae ($P = 0{,}035$). Spleen rate followed the same pattern as malaria prevalence but it did not vary according to gravidity (Table 4). Parasitaemia, gravidity and district were significant risk factors for anaemia and were maintained in a multivariate analysis. Women with peripheral parasitaemia had a 75% higher risk of being anaemic; this risk decreased with increasing parity (Table 5).

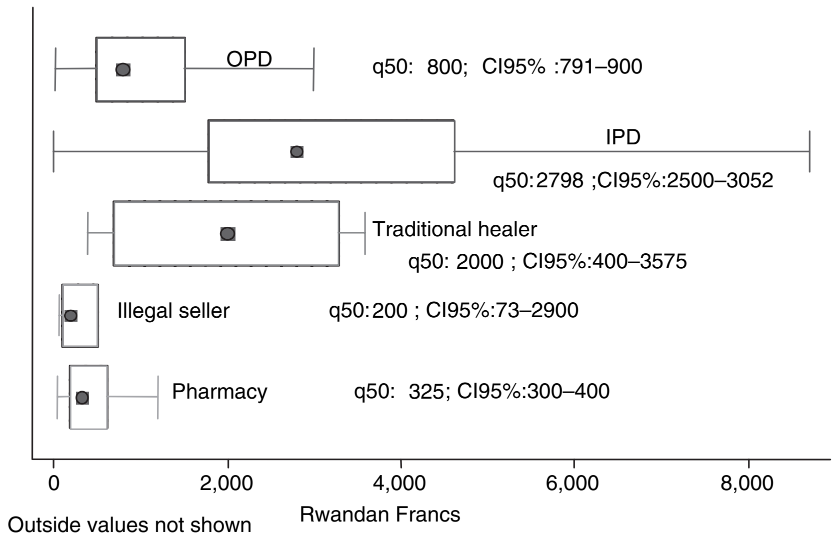

Figure 3 Cost of a previous malaria episode among the pregnant women interviewed.

Discussion

Prevalence of malaria infection in pregnant women attending the ANC varied significantly between districts and ranged between 1.7% and 15.4%. Similar figures have been reported from Ethiopia, where two areas of malaria transmission, one stable and the other unstable, were compared (Newman *et al.* 2003b). According to the prevalence of malaria infection, four districts can be defined as having stable transmission, all those whose prevalence is above 10%, while in two districts transmission seems to be much lower and might be defined as unstable. The figures reported for the four districts are typical of malaria-endemic areas, where the prevalence among pregnant women can vary between 10% and 65% (Steketee *et al.* 2001). As expected, the risk of infection was higher among primigravidae and secundigravidae in three of the four districts with the higher prevalence. The results obtained in Nyanza, where the prevalence of infection in primigravidae is similar to that in multigravidae but higher in secundigravidae, are unexpected and might be due to the epidemic character of the area. Increased malaria prevalence in first pregnancies can be attributed to a fall in the recovery rate of infection from early in gestation (first trimester) which could be related to infection-specific and immunological factors. Indeed, in subsequent pregnancies, the degree of immunity developes as a result of infection in the previous pregnancy. An infection in which *P. falciparum* parasites are able to sequester in the placenta and adhere to chondroitin sulphate A on syncytiotrophoblast (Fried & Duffy 1996), increases the recovery rate and therefore reduces the prevalence. Therefore, pregnant women of different parity have the same risk of acquiring a malaria infection but multigravidae rapidly eliminate it. This is also supported by the similar spleen rates found among women of different parity from the same district. The districts of Gisenyi and Kabaya do not show major differences in the prevalence of infection among women of different parity. This confirms that, in these two districts, malaria transmission is much lower than in the others and all pregnant women have a similar risk of infection as they have acquired little immunity prior to their pregnancy. At low incidence with less than one malaria infection per pregnancy, a proportion of primigravidae remain uninfected and as a result should have greater susceptibility as multigravidae (McGregor 1987). The prevalence of anaemia mirrors that of malaria, as it is higher in the four districts with the prevalence of infection above 10%. Again, in these same districts, anaemia is more frequent among primigravidae than in multigravidae while such a difference is not found in the two other districts (Gisenyi and Kabaya) with a lower malaria transmission. Such findings confirm that, even if anaemia in pregnancy might be caused by several conditions such as iron deficiency, often more extreme in areas of high hookworm prevalence (Verhoeff *et al.* 1999), folate deficiency (Fleming 1989) or human immunodeficiency virus (HIV) infection (Van den Broek *et al.* 1998), malaria plays an important role and its control would have a major impact on the women's health.

Considering the low use of bed nets among pregnant women, let alone that of ITN, and that the national malaria control programme does not promote any other preventive intervention for this high risk group

Table 4 Prevalence of infection, splenomegaly and anaemia by district [% (*n*/*N*)]

Study site	Gakoma (*N* = 240)	Nyanza (*N* = 241)	Bugesera (*N* = 235)	Humure (*N* = 227)	Gisenyi (*N* = 251)	Kabaya (*N* = 239)	Total (*N* = 1433)	*P*-value
Malaria infection								
Primigravidae	31.8 (14/44)	10.4 (5/48)	19.2 (9/47)	15.8 (6/38)	2.0 (1/51)	2.6 (1/38)	13.5 (36/266)	<0.001
Secundigravidae	8.6 (3/35)	30.6 (11/36)	9.0 (4/44)	14.7 (5/34)	7.9 (3/38)	2.2 (1/46)	11.6 (27/233)	0.002
Multigravidae	12.4 (20/161)	10.8 (17/157)	9.7 (14/144)	9.9 (15/155)	4.9 (8/162)	1.3 (2/155)	8.1 (76/934)	0.003
All parities	15.4 (37/240)	13.7 (33/241)	11.5 (27/235)	11.5 (26/227)	4.8 (12/251)	1.7 (4/239)	9.7 (139/1433)	<0.001
P-value	**0.003**	**0.005**	0.193	0.390	0.426	0.810	**0.015**	
Splenomegaly								
Primigravidae	31.8 (14/44)	12.5 (6/48)	10.6 (5/47)	7.9 (3/38)	2.0 (1/51)	0.0 (0/38)	10.9 (29/266)	<0.001
Secundigravidae	34.3 (12/35)	19.4 (7/36)	9.1 (4/44)	5.8 (2/34)	0.0 (0/38)	2.2 (1/46)	11.2 (16/233)	<0.001
Multigravidae	30.4 (49/65)	28.0 (44/157)	11.1 (16/144)	3.9 (6/155)	1.9 (3/162)	0.7 (1/155)	12.7 (119/933)	<0.001
All parities	31.2 (75/241)	23.7 (57/241)	10.6 (25/235)	4.9 (11/227)	1.6 (4/251)	0.8 (2/239)	12.1 (174/1433)	<0.001
P-value	0.902	0.070	0.930	0.559	0.695	0.501	0.635	
Anaemia (N)	226	238	230	208	249	230	1381	
Primigravidae	30.9 (13/42)	20.8 (10/48)	23.4 (11/47)	15.6 (5/32)	5.9 (3/51)	0.0 (0/37)	16.3 (42/257)	0.001
Secundigravidae	21.9 (7/32)	19.4 (7/36)	13.6 (6/44)	12.5 (4/32)	10.5 (4/38)	0.0 (0/44)	12.4 (28/226)	0.050
Multigravidae	19.1 (29/152)	14.8 (23/155)	9.9 (14/141)	9.6 (14/146)	8.1 (13/161)	1.3 (2/149)	10.5 (95/904)	<0.001
Overall	21.7 (49/226)	16.7 (40/239)	13.3 (31/232)	11.0 (23/210)	8.0 (20/250)	0.9 (2/230)	11.9 (165/1387)	<0.001
P value	0.255	0.538	0.058	0.508	0.726	0.578	**0.035**	

Bold indicates $P < 0.05$.

Table 5 Risk factors for anaemia among 1387 pregnant women (mulitvariate analysis with logistic regression)

Risk factor	Adjusted odds ratio	95% CI	*P*-value
Malaria infection	1.74	1.10–2.75	0.01
Gravidity	0.79	0.65–0.96	0.01
District	0.80	0.73–0.89	<0.001

(intermittent preventive treatment with sulfadoxine–pyrimethamine (SP) is not implemented because of high SP resistance found in some sentinel sites), the prevalence rate found in this survey probably reflects the true burden of malaria infection among pregnant women in the different districts. Actually, it is probably higher, as pregnant women were recruited among those attending the ANC, a self-selected group whose awareness of the disease and attendance to health facilities might be better than that of all pregnant women.

Bed net coverage was very low and significantly associated with health education and other socioeconomic factors. This is not surprising considering the large difference between the market price of a bed net and what women considered as affordable and acceptable. The large majority knew that malaria might have serious consequences on the outcome of pregnancy and that bed nets, and more specifically ITN, are a good means of protection. The impact of malaria combined with the knowledge of the pregnant women are a good basis for intervention with bednets and regular (re-)impregnation. In absolute terms their price in Rwanda is not high (1.6€) but it is clearly unaffordable for the large majority of women. An approach tried in Tanzania is to provide a voucher to pregnant women attending antenatal clinics (ANC) with which they can then buy an ITN at a discounted price (Mushi *et al.* 2003). Major problems identified with this approach were that many of the women who had received the voucher did not use it because of lack of cash and that it seemed to have benefited households with a better socioeconomic status rather than those with a poorer status (Mushi *et al.* 2003). An alternative approach is to distribute free ITN to all pregnant women attending ANC. Often dismissed as not feasible because of the substantial financial commitment required from donors and the belief that free ITN would be sold or not used by pregnant women, this approach was tried in Kenya where 70 000 bed nets and the corresponding insecticide kits were successfully distributed through the existing health system (Guyatt *et al.* 2002). One year after the distribution, the majority of women were still using them (Guyatt & Ochola 2003). In Kenya the cost of distributing bed nets to cover all ANC was estimated at US$5.8 million per year, a large but not impossible sum to find when considering the increased resources available for malaria control and the huge potential benefits (D'Alessandro & Coosemans 2003). In Rwanda, this approach might be the way forward, particularly when considering that pregnant women do not receive any intermittent preventive antimalarial treatment and that in malaria-endemic areas management of clinical cases is not sufficient to prevent the adverse effects of malaria. The impact of such a strategy goes even beyond disease control as clinical malaria episodes have a huge impact on the population income (in terms of actual expenses and days lost). Living in malaria-endemic regions places an economic burden on households and leads to further impoverishment. Households living in endemic malarial regions are less likely to have access to economic opportunities and may have to modify agricultural practices and other household behaviours to adapt to their disease environment. Data from Vietnam demonstrated that reductions in malaria incidence through government-financed malaria control programmes can contribute to higher income for all households in endemic areas (Laxminarayan 2004).

In conclusion, malaria in pregnancy is a major problem in Rwanda, even in the districts of low transmission. Two well-known preventive measures are ITN and SP intermittent preventive treatment. In Rwanda, unfortunately, SP resistance is so high that it was decided not to introduce intermittent preventive treatment. Hopefully, alternatives to SP will soon be available so that such intervention could be implemented. ITN use is still extremely low despite the fact that they can substantially reduce the incidence of malaria parasitaemia and severe malaria anaemia, the prevalence of placental malaria and that of LBW, even where malaria transmission is intense (Ter Kuile *et al.* 2003). In Rwanda, the option of providing free insecticide-treated bed nets to pregnant women attending the ANC should be considered.

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