Community knowledge variation, bed-net coverage and the role of a district healthcare system, and their implications for malaria control in southern Malawi

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This paper presents data on the pattern of knowledge of caregivers, bed-net coverage and the role of a rural district healthcare system, and their implications for malaria transmission, treatment, prevention and control in Chikhwawa, southern Malawi, using multi-level logistic regression modelling with Bayesian estimation. The majority of caregivers could identify the main symptoms of malaria, that the mosquito was the vector, and that insecticide-treated nets (ITN) could be used to cover beds as an effective preventative measure, although cost was a prohibitive factor. Use of bed nets displayed significant variation between communities. Groups that were more knowledgeable on malaria prevention and symptoms included young mothers, people who had attended school, wealthy individuals, those residing closest to government hospitals and health posts, and communities that had access to a health surveillance assistant (HSA). HSAs should be trained on malaria intervention programmes, and tasked with the responsibility of working with village health committees to develop community-based malaria intervention programmes. These programmes should include appropriate and affordable household improvement methods, identification of high-risk groups, distribution of ITNs and the incorporation of larval control measures, to reduce exposure to the vector and parasite. This would reduce the transmission and prevalence of malaria at community level.

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Introduction

Malaria is endemic throughout Malawi, and is the most commonly reported disease in people attending hospital and health clinic outpatient departments based upon symptomology. In 2005, it was reported that between 20-45% of all outpatients, and 50-100% of children under the age of five, were diagnosed with malaria, depending on the district.[1] In 2006, the under-five mortality rate attributed to malaria was estimated to be 122:1 000 live births, or approximately 1:8 child deaths.[2] According to the 2010 *World Malaria Report*, in 2009, one person in every three (35.7%) in Malawi was suspected of having malaria, based upon symptomology, with 6 527 malaria-attributed recorded deaths.[3] A recent World Health Organization (WHO) health statistics report states that, during 2008, annual malaria deaths per 100 000 in Malawi were 87,[4] while the data reported in the WHO *World Malaria Report* suggest it was half of that in 2009 (43:100 000). While Malawi has been making steady progress over the last decade in its efforts to tackle morbidity- and mortality-associated malaria,[3] this discrepancy is probably due to the way in which health information statistics are gathered and reported.

Chikhwawa, in southern Malawi, is one of 28 districts within the country, and the terrain presents an ideal breeding ground for mosquitoes, because of climatic and geographic conditions, especially during the rainy season. The area is characterised by marshes, and is hot (mean monthly temperature 28.4^{0}C; maximum 45.6^{0}C) and humid between the months of November-April,[3] when the majority of suspected malaria cases are recorded. Between 2004 and 2005, just over one third of all outpatients, and nine out of 10 children younger than five years, were diagnosed with malaria based on symptomatology. In Chikhwawa, morbidity- and mortality-associated malaria is second only to the neighbouring Nsanje district.[1] The number of deaths attributed to malaria in children under the age of five in Chikhwawa during this period was 132:1 000 live births, and it was thought to account for nearly 1:4 deaths overall.

Malawi is a partner to the Abuja Declaration, through which it pledges to adhere to the Roll Back Malaria framework. This sought to halve the prevalence of malaria-associated morbidity and mortality in the country by 2010, and to reduce the malaria burden by a further 50%, through a combination of preventative and curative measures by 2015.[5-6] Among these measures is a commitment to provide the most appropriate and affordable combination of personal and community protective measures to at least 60% of those who are most at risk of contracting malaria, i.e. children younger than five years of age and pregnant women. This includes the provision of insecticide-treated mosquito nets and prompt, effective treatment of malaria within 24 hours of the onset of the illness. Another commitment is that 60% of pregnant women who reside in high-risk areas, and who are at greater risk of contracting malaria, have access to intermittent preventative treatment.

Through the US President's Malaria Initiative (PMI), Malawi is also committed to meeting the 50% reduction target for deaths caused by malaria.[7-8] The aim of the PMI is to deliver proven, effective interventions to the majority of people at greatest risk by expanding access to and use of:

- Long-lasting insecticide-treated nets (ITNs)
- Indoor residual spraying with approved insecticides
- Artemisinin-based combination therapies
- Intermittent preventative treatment for pregnant women.

Areas that need urgent attention include inequity in and poor access to health care, poor availability of proper diagnosis and treatment, threats to intermittent preventative treatment due to increased drug resistance, under-utilisation of health facilities, use of home services and traditional medication.[6] One way of addressing these challenges is through community participation, which depends on people's knowledge, attitude and practices regarding malaria treatment, prevention and control.[9] It is important that those are greatest risk are empowered with knowledge, and understand the biology of the vector, aetiology, clinical features and cause of malaria, and know how to access resources to help prevent and control the disease. There is also a need to prioritise the distribution of scarce preventative and curative resources, so that they can be properly utilised.

Generally, rural communities in Malawi access their healthcare needs through the essential health package. This is a bundle of basic healthcare interventions that are provided by a multidisciplinary team of healthcare workers who work within a district health system (DHS). The DHS is defined by three levels: community, health centre, and district hospital. District hospitals and health centres focus on the delivery of secondary and primary health care services mainly, while the focus is on preventative health care utilising health surveillance assistants (HSAs) and village health committees (VHCs) at community level.[6] Local and international non-governmental organisations (NGOs) also have a significant role to play in service delivery, usually at community and health centres, e.g. through the provision of ITNs and health education. Measuring the patterns of coverage of the healthcare interventions implemented by the different levels of a DHS is essential. This would highlight areas of low coverage, and help monitor and evaluate their impact on malaria.[10]

The objectives of this study were to investigate:

- Knowledge, awareness and treatment practices of malaria, and its preventative measures
- Bed-net coverage across communities
- The impact of a district healthcare system on the promotion of malaria knowledge, and the provision of mosquito nets
- The impact of different healthcare practitioners within a DHS on the provision of knowledge and resources pertaining to malaria in Chikhwawa, southern Malawi.

Method

Sample

A two-stage survey methodology was adopted to identify a district sample of households. The first stage involved sampling of communities from villages that were strategically selected with a probability proportional to the number of enumeration areas in each traditional authority. Chikhwawa has 11 traditional authorities, and each traditional authority has a number of villages under its jurisdiction. The second sampling stage took place on the day of the intervi ews. Households were systematically chosen with equal probability sampling. Only women were eligible for interviews, and all other members of the households were asked to leave the interviewing premises to avoid interference. Mothers are normally in close contact with all family members, and carefully monitor and care for anyone suffering from ill health in the household.

Sample sizes in each household ranged from one to 13. After discarding missing and incomplete data, information on a total of 1 400 households, nested within 33 villages, was obtained for this study.

Variables

Outcome variables

The distribution of outcome variables is shown in Table I. A mother from each household was asked to list:

- The causes of malaria
- What symptoms or methods are used to identify malaria illness
- Preventative methods against malaria
- Sources of knowledge pertaining to malaria causes, symptoms, and preventative methods.

These questions were open-ended to avoid any bias. A series of dichotomous response variables on the knowledge of symptoms and preventative methods were formed by coding a required symptom or preventative method mentioned by the mother as "1", or "0" if otherwise.

Table I: Distribution of household malaria outcome variables included in the study

Variable	Category	n = 1 400	%
Malaria knowledge			
Cause of malaria	Mosquitoes	1 331	95.1
	Other	69	4.9
Symptoms	Fever	1 295	92.5
	Diarrhoea	113	8.1
	Rigors	302	21.6
	Vomiting	469	33.5
	Blood test	114	8.1
	Other	119	8.5
Preventative measures	Clear weeds or bushes	399	28.5
	Drain water	91	6.5
	Use bed net	956	68.3
	Indoor spraying	73	5.2
	Outdoor spraying	6	0.4
	Other, e.g. coils	69	4.9
Sources	Hospital personnel	1 333	80.9
	Radio	297	21.2
	Health surveillance assistant	392	28.0
	Village health committee	84	6.0
	Traditional leaders	90	6.4
	Traditional birth attendant	36	2.6
	Drama	29	2.1
	Other	10	0.7
Net ownership			
Any mosquito net	Yes	911	65.1
	No	489	34.9
Ownership ratio [mean = 0.25; range = (0-3)]	Nets per person = 0	490	35.0
	0 < nets per person ≤ 0.25	334	23.9
	0.25 < nets per person ≤ 0.40	292	20.9
	Nets per person > 0.40	284	20.3
Existence of holes	Yes	626	44.8
	No	773	55.2
Source of nets	Health facility	921	65.8
	Community distributed	176	12.6
	Bought, e.g. shop or market	231	16.5
	Other or don't know	71	5.1

Mothers were also asked to provide information on the number of bed nets used in the household. Based upon this information, a ratio variable was derived, by dividing the total number of nets by the total number of individuals in each household. A dichotomous response outcome was derived by coding any ratio above 0.25 (mean value) as "1", and "0" if otherwise.

Explanatory variables

Explanatory variables, namely maternal age, highest maternal formal schooling, relative household wealth[11] and nearest health facility, were included in the models as categorical variables. The existence of an HSA was included as a dichotomous variable, while household size was included as a continuous variable.

Analysis and estimation

Multi-level modelling was utilised to analyse the data, with households as level 1 and communities as level 2 units. A series of two-level binary logistic regression models with bed-net ownership and maternal knowledge of malaria symptoms and preventative methods as response variables were constructed to test the respondents' pattern of variation and corresponding predictor variables.

A binary regression model[12] was used to explain the probability of outcomes. Estimation was performed using Bayesian procedures in MLwiN® 2.10 software. Initial estimates to obtain prior samples were derived using second-order penalised quasi-likelihood (PQL) procedures, with restricted iterative generalised least-squares.[13] The stability of all model parameters was monitored by observing the Raftery-Lewis and the Brooks-Draper mean diagnostics.[14] The maximum number of iterations performed to achieve stability was 120 000.

Results

The distribution of the response variables included in this study are summarised in Table I. Most interviewed women (95%) correctly identified the mosquito as the vector that causes malaria in people. They identified fever (93%), vomiting (34%), rigors (22%) and diarrhoea (8%), as the main symptoms associated with malaria. A small percentage (8%) mentioned that a blood test could be undertaken at a hospital to determine if someone had malaria. On identification of sources of preventative measures, two-thirds of those questioned (68%) highlighted the use of bed nets. One-third (29%) highlighted the importance of clearing weeds and bushes. The remaining preventative measure categories were mentioned by a small number (only 7%), and included the importance of draining pools of water and the use of insecticides and anti-mosquito devices, such as coils. Most women (81%) stated that they obtained information on malaria prevention and control from hospital personnel. Approximately one in three (28%) stated that they had obtained useful information on the prevention and control of malaria from HSAs, and one in five (21%) from government health education programmes that were broadcasted over the radio. A small percentage stated that they had obtained information on malaria from the village health committee, traditional leaders, traditional birth attendants and health education through drama groups (6.5%).

Two-thirds (65%) of the women claimed to have bed nets in their households, with a mean ratio of net to household size of 0.25 nets per person per household, i.e. an average of four people to one bed net. Of the 1 399 bed nets that were physically examined, nearly one in two (45%) were found to have holes in them that were the size of a thumb. Most of the bed nets (66%) were obtained from health facilities, 17% were purchased from open markets and shops, and 13% were distributed by NGOs within the communities and by the government through VHCs. Five per cent were provided as gifts from relatives and other sources.

Table II presents data on a series of hierarchical binary logistic regression results relating to the aetiology and associated clinical signs of malaria that were identified by the women. No single factor was found to be associated with women's knowledge of mosquitoes as the source of malaria transmission. There was no variation in women's knowledge across the communities on mosquitoes being the source of malarial transmission. Close proximity to a health facility had a strong association with women's knowledge of fever. Women living in close proximity to a health facility were more likely to correctly identify fever as a symptom of malaria. Relatively wealthier (average-to-high wealth) households within communities were less likely to associate vomiting with malaria, and more likely to associate rigors as a clinical symptom, compared to those who were less wealthy. Only those in the relatively high wealth category were more likely to have mentioned rigors.

Those who had attended school were able access an HSA, and those who made use of a health facility were most likely to use a medical facility to confirm malarial illness. People with at least a secondary school education tended to make use of a health facility to confirm a suspected malaria diagnosis, compared with those who had not attended school. It was expected that those with no access to an HSA in their communities, and whose nearest health facility was a health centre, would use a health facility to verify malarial illness.

Rigors and the use of a health facility, as a means of identifying if someone was suffering from malaria, varied significantly between villages. The association of vomiting with malaria varied only marginally between villages. No differences were detected across villages in their identification of fever as a clinical symptom of malaria.

Table III presents binary logistic regression models for the clearing of weeds or bushes and use of mosquito nets as the main preventative measures identified in the communities.

Table II: Hierarchical binary logistic regression to identify determinants of household knowledge in detecting malarial illness

Predictors	Cause of malaria (%)			Symptoms (%)											
				Rigors			Fever			Vomiting			Blood test at HF[b]		
	ß	(95% CI)[a]	p-value	ß	(95% CI)	p-value	ß	(95% CI)	p-value	ß	(95% CI)	p-value	ß	(95% CI)	p-value
Age group															
15-20	(Reference group)														
21-30				0.07	(-0.42,0.55)	0.785	0.63	(-0.03, 1.29)	0.063[c]	0.01	(-0.38,0.39)	0.984	-0.53	-(1.22,0.16)	0.135
31-50				-0.07	(-0.58,0.44)	0.792	0.39	(-0.31, 1.08)	0.277	-0.34	(-0.75,0.07)	0.103	-0.14	(-0.84,0.56)	0.694
Above 51				0.21	(-0.36,0.77)	0.473	0.30	(-0.49, 1.08)	0.458	-0.29	(-0.77,0.20)	0.244	-0.15	(-0.96,0.66)	0.722
Schooling															
None	(Reference group)														
Primary				0.28	(-0.10,0.66)	0.150	0.40	(-0.12, 0.93)	0.134	0.21	(-0.11, 0.53)	0.205	-0.13	(-0.69,0.43)	0.650
Secondary				0.31	(-0.15,0.76)	0.184	0.05	(-0.60, 0.70)	0.871	0.32	(-0.07, 0.71)	0.112	0.81	(0.17, 1.46)	0.014[c]
Relative wealth															
Middle	(Reference group)														
Low				0.26	(-0.09,0.61)	0.144	0.19	(-0.36, 0.74)	0.496	-0.30	(-0.59,-0.01)	0.047[c]	-0.05	(-0.58,0.49)	0.867
High				0.44	(0.10,0.78)	0.012[c]	-0.21	(-0.75, 0.34)	0.457	-0.32	(-0.62,-0.01)	0.040[c]	0.41	(-0.09,0.92)	0.110
Presence of HSAs[d]															
Yes	(Reference group)														
No				0.17	(-0.14,0.46)	0.294	0.50	(-0.01, 1.01)	0.06[e]	-0.26	(-0.53,0.01)	0.061[e]	-0.56	(-1.07,-0.05)	0.031[c]
Health facility															
Govt[f] hospital	(Reference group)														
Health centre				-0.28	(-0.70,0.13)	0.181	0.86	(0.28, 1.44)	0.004[c]	-0.30	(-0.66,0.05)	0.097[e]	-0.68	(-1.27,0.08)	0.027[c]
CHAM[g]				-0.59	(-1.21,0.03)	0.061[e]	1.01	(0.09, 1.93)	0.032[c]	-0.37	(-0.88,0.13)	0.149	-0.27	(-1.16,0.62)	0.55
Health post				0.08	(-0.98,1.14)	0.884	-0.14	(-1.58, 1.31)	0.853	-0.09	(-1.07,0.89)	0.860	-1.39	(-3.96,1.18)	0.289
Local private clinic				0.04	(-0.60,0.68)	0.898	-0.09	(-0.99, 0.81)	0.848	0.23	(-0.33,0.79)	0.419	-0.73	(-1.73,0.27)	0.155
Community effects (u_0)[h]	0.08	(-0.14, 0.31)	0.713	0.46	(0.06,0.86)	0.025[c]	0.27	(-0.31, 0.84)	0.359	0.14	(-0.02,0.29)	0.093[e]	1.12	(0.06,2.19)	0.039[c]

a = credible interval, b = health facility, c = p-value ≤0.05, d = health surveillance assistants, e = p-value ≤ 0.10, f = government, g = Christian Association of Malawi, h = random effects at community level

Maternal age, formal schooling, relative wealth, and ease of access to an HSA or nearby health facility, were all factors that were strongly associated with the use of bed nets. Women in the age group of 31-50 years, and those above the age of 51, were less likely to mention the use of a bed net as an effective means of preventing malaria, than those between 15-20 years. It was expected that women who had attended school (primary or secondary) would identify the usefulness of bed nets as a preventative measure. Those who did not have access to an HSA in their community were less likely to mention the effectiveness of using a bed net. Similarly, those whose nearest health facility was a health centre or Christian Association of Malawi health facility were less likely to mention the importance of bed nets as a means of preventing malaria, as opposed to those whose nearest health facility was a government or rural hospital. It was marginally less probable that women who used local private clinics would mention the effectiveness of bed nets. Relative wealth was also a key factor, as it was expected that women in a low wealth category would probably not mention bed nets as a useful preventative measure, compared to those in the average-wealth category.

Maternal age, easy access to an HSA and the location of a nearby health facility were strong predictors of women who mentioned the importance of clearing weeds or bushes as a means of preventing malaria. Those aged 31-50 were more likely to have cited clearing weeds or bushes, than those aged 15-20. Women aged 21-30 were marginally more likely to have remarked on the importance of clearing weeds and bushes. It was less probable that those without an HSA in their communities would cite the clearing weeds or bushes. Those whose nearest health facilities were local private clinics tended to mention the importance of clearing weeds more than those who resided near government hospitals.

Clearing weeds or bushes and use of bed nets as preventative measures varied significantly between communities.

Table IV presents binary random and coefficient components regression models to identify factors that affect ownership of bed nets, and how the distribution of the nets varied between communities. Maternal level of schooling, relative wealth and household size were strong factors that affected distribution of the nets in the two-level random components regression model. Households with mothers who had attended school, whether primary or secondary, were expected to have bed net ratios of more than 0.25, i.e. less than four members shared a bed net. Similarly, households with average relative wealth, and those with relatively high wealth tended to have less than four members sharing a bed net. It was more probable

Table III: Binary logistic regression model to identify determinants of malaria preventative measures

Variable	Malaria preventative measure					
	Clear weeds or bushes			Use mosquito net		
	ß	(95% CI)[a]	p-value	ß	(95% CI))	p-value
Age group						
15-20	(Reference group)					
21-30	045	(-0.02,0.92)	0.059[b]	-0.38	(-0.83,0.07)	0.097[b]
31-50	0.64	(0.15,1.14)	0.010[c]	-0.67	(-1.12,-0.21)	0.004[c]
Above 51	0.23	(-0.33,0.80)	0.417	-0.74	(-1.26,-0.23)	0.005[c]
Schooling						
None	(Reference group)					
Primary	0	(-0.34,0.34)	1.00	0.46	(0.14,0.77)	0.004[c]
Secondary	-0.02	(-0.44,0.41)	0.94	0.48	(0.07,0.89)	0.021[c]
Relative wealth						
Middle	(Reference group)					
Low	0.22	(-0.94,0.53)	0.172	-0.38	(-0.68,-0.08)	0.013[c]
High	0.20	(-0.11,0.51)	0.204	-0.05	(0.37,0.26)	0.731
Presence of HSAs[d]						
Yes	(Reference group)					
No	-0.56	(-0.86,-0.26)	0.000[c]	-0.60	(-0.87,-0.32)	0.000[c]
Health facility						
Government hospital	(Reference group)					
Health centre	0.01	(-0.37,0.38)	0.975	-0.46	(-0.84,-0.08)	0.017[c]
CHAM[e]	-0.12	(-0.68,0.45)	0.688	-0.78	(-1.33,-0.22)	0.006[c]
Health post	-0.76	(-2.14,0.63)	0.284	0.35	(-0.85,1.54)	0.568
Local private clinic	0.61	(0.01,1.20)	0.046[c]	-0.61	(-1.24,0.02)	0.059[b]
Community effects (u0j)[f]	0.24	(0.03,0.45)	0.025[c]	0.26	(0.02,0.50)	0.035[c]

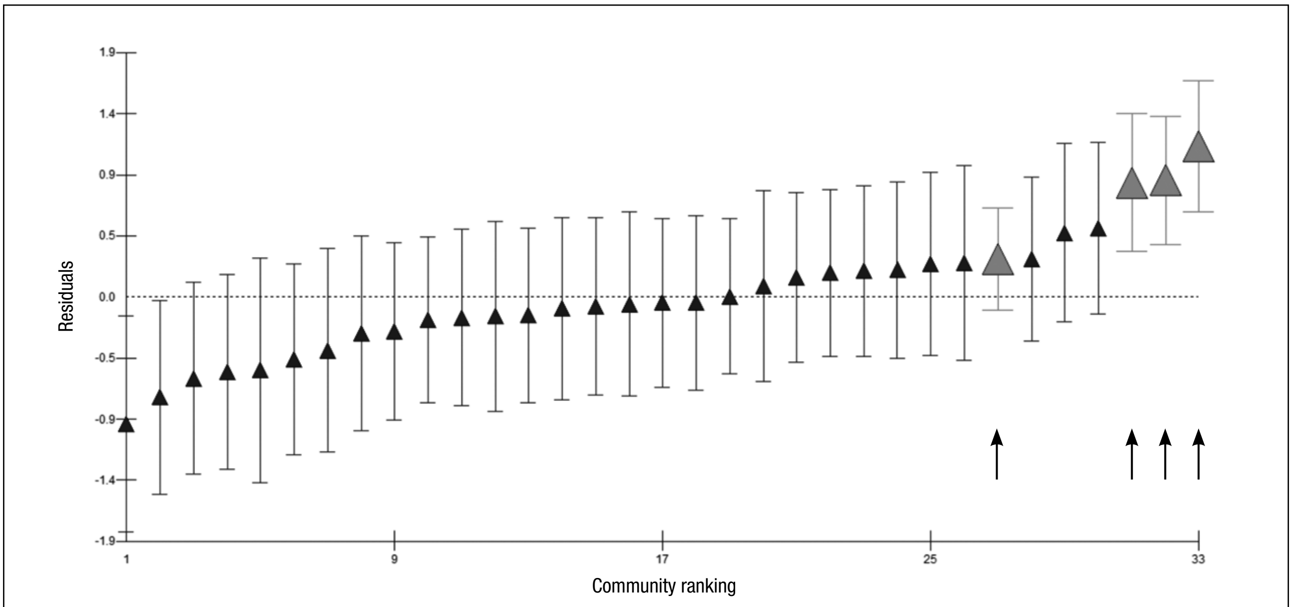
a = credible interval, b = p-value ≤ 0.10; c = p-value ≤0.05; d = health surveillance assistants, e = Christian Association of Malawi, f = random effects at community level that households with large families would have four or more members sharing a single bed net. Households without access to an HSA were marginally less likely to have less than four members to a bed net.

The number of bed nets varied greatly from community to community. This is supported by the data presented in Figure 1, which depicts community residuals significantly below, and above zero, for individual communities. Those below zero indicate markedly poorer bed-net coverage within those communities, and those above zero, a sign that those communities had better mosquito net coverage.

Table IV: Random components model to identify influences of mosquito net ownership

Variable	Mosquito net ownership								
	Two-level fixed effects model			Two-level random coefficient model					
	ß	(95% CI)[a]	p-value	ß	(95% CI)	p-value	u_{ij}[b]	(95% CI)	p-value
Age group									
15-20	(Reference group)								
21-30	-0.24	(-0.65,0.16)	0.241	0.23	(-0.66,0.21)	0.302			
31-50	-0.10	(-0.54,0.35)	0.667	-0.12	(-0.59,0.36)	0.636			
Above 51	-0.30	(-0.80,0.20)	0.199	-0.27	(-0.81,0.27)	0.319			
Schooling									
None	(Reference group)								
Primary	0.39	(0.06,0.72)	0.021[d]	0.39	(-0.06,0.83)	0.090[c]	0.42	(-0.01,0.84)	0.054[c]
Secondary	0.70	(0.30,1.10)	0.001[d]	0.75	(0.22,1.29)	0.006[d]	0.51	(-0.07,1.09)	0.088[c]
Relative wealth									
Low	(Reference group)								
Middle	0.70	(0.40,0.99)	000[d]	0.75	(0.34,1.15)	0.000[d]	0.37	(0.01,0.72)	0.043[d]
High	0.95	(0.64,1.25)	000[d]	1.06	(0.63,1.49)	0.000[d]	0.46	(-0.03,0.95)	0.065[c]
Presence of HSAs[e]									
Yes	(Reference group)								
No	-0.24	(-0.50,0.02)	0.073[c]	-0.23	(-0.52,0.05)	0.110			
Household size	-0.29	(-0.37,-0.22)	0.000[d]	-0.36	(-0.51,-0.21)	0.000[d]	0.12	(0.04,0.19)	0.002[d]
Malaria endemicity	0.22	(-0.75,1.19)	0.653	0.69	(-0.87,2.25)	0.387			
Community effects (u_{0j})	0.37	(0.09,0.64)	0.009[d]	1.47	(-0.21,3.16)	0.087[c]			

a = credible interval, b = random effects at community level, c = p-value ≤ 0.10; d = p-value ≤0.05, e = health surveillance assistants



Villages that are participating in a Scotland-Chikhwawa health initiative programme are indicated by arrows

Figure 1: A 95% credible interval caterpillar plot, showing residuals of mosquito net ownership ranked by their respective communities

Figure 1 also highlights that four particular communities were appreciably better off with regard to bed-net coverage. This is because the villages concerned are part of a Scottish-funded project on maternal health, which is currently conducting a number of health programmes which encompass the distribution of bed nets to improve the lives of the people in Chikhwawa.

Maternal schooling, relative wealth and household size have been allowed to vary across communities in a random components model, as shown in Table IV. The fixed part of the variables remains approximately the same. There is significant variation in the relationship between average wealth and bed-net ownership across the villages. Similarly, there is significant variation in the relationship between household size and bed-net ownership across the communities. However, the relationship between maternal school and bed-net ownership varies at the 10% significance level only. The distribution of bed nets also varies from community to community, at the 10% significance level only.

Discussion

Patterns of variation, due to hierarchical effects, may result because of unobserved factors in healthcare provision. This can include differences in resource allocation, socio-economic factors, or ecological and environmental issues in the communities.[10,15] A number of studies on knowledge of malaria transmission, prevention and control, and use of bed nets have been carried out in Malawi[16-18] and other parts of Africa.[19-20] However, the uniqueness of this study is that it employed multi-level analysis to account for community effects, in addition to community factors.

The view that mosquitoes are associated with the transmission of malaria was correctly held by nearly every interviewed respondent. This association is comparable elsewhere in the sampled communities, since the community variation parameter indicated no evidence of any disparities. This finding is similar to studies conducted in Mozambique,[21] Swaziland,[22] Ethiopia,[23] where the majority (> 90%) of rural respondents associated malaria with mosquito bites. However, it is in stark contrast (< 70%) to studies conducted in Ghana,[24] Kenya,[25] Tanzania,[26] and previously in Malawi, [27-29] where the association of malaria with the mosquito was not clearly identified, and was shrouded in misconception. The greater awareness among respondents in Chikhwawa may be due to the higher prevalence rate of malaria in the area, compared with that in other studies. People are bitten regularly by mosquitoes due to poor housing construction, and exacerbated by unscreened windows and doors to keep the mosquitoes out. As a result, most respondents knew of someone who had suffered from malaria at some stage, and were aware that mosquitoes transmit malaria. It is recommended that community-based intervention programmes clarify the role of the mosquitoes as a vector, and how it becomes infected as part of the aetiology of the disease and life cycle of the mosquito.

Fever was the most commonly reported clinical symptom identified by respondents that suggests that someone has malaria. This was followed by vomiting, rigors and diarrhoea. All of these symptoms have been recorded in people suffering from malaria. However, similar symptoms can be induced by a variety of infectious diseases, and not only malaria. In rural areas of Malawi and other African countries, fever remains the main symptom identified by home caregivers and clinical assistants at health centres when assessing if someone has contracted malaria, especially if it is accompanied by headaches, chills, shivering or loss of appetite.[30] It is impossible to define a unique set of clinical symptoms to accurately confirm if someone has malaria, and confirmation of infection is based on hospital diagnosis and detection of the parasite that causes malaria in the blood smears.[28] In this study, close proximity to a health facility (representing the closest approximation to a district healthcare system) and access to an HSA were found to be major influencing factors regarding household malaria diagnosis and preventative methods. Differences in basic healthcare interventions, provided by different levels of the DHS, including accessibility to HSAs, may partially explain differences in knowledge on the clinical features associated with malaria. Less than a third of the interviewed women mentioned vomiting, rigors, diarrhoea and other clinical symptoms that are associated with malaria. Similar findings have been reported by other African investigators.[24]

Use of bed nets was the method that was mentioned the most (by two-thirds of the women) as a preventative measure against malaria. This finding is similar to studies conducted elsewhere in Africa,.[21-26] However, knowledge and practice may be different. In one study conducted in Swaziland, the majority of respondents correctly identified a range of preventative measures, including the use of bed nets, but less than 50% took any personal protective measures against contracting malaria.[22] In a study conducted in Nigeria, investigators reported that while overall ITN coverage was low within the rural community, people were knowledgeable about malaria and the benefits of protection against the disease.[31]

In this study, severe poverty in the area, and the prohibitive cost of purchasing bed nets from shops and markets, may explain the negative association of relative wealth with bed-net ownership. Most people who reside in rural areas in Malawi earn less than $1 per day, while on average, the cost of a mosquito net is six times that amount. Apart from the bed nets that are distributed free of charge through government health facilities, most can be purchased at a subsidised rate (approximately $4) in shops through a social marketing programme that is co-ordinated jointly by the government and an international NGO [Population Services International (PSI)].[32] However, even at $4, the cost of bed nets is beyond the financial resources of most people who live in Chikhwawa. Their prohibitive cost has been reported as the main reason why rural communities do not purchase them in neighbouring Tanzania,[26] and is probably the case too in other African countries. In one study, conducted in a semi-urban area of Cameroon, bed-net usage was found to be as low as 3%.[34]

Young mothers were more likely to cite the use of bed nets as a preventative measure, when compared with older women. This may be because today, young mothers are more aware of the advantages of using antenatal care facilities, compared with previous years. Attendance at antenatal care clinics allows young mothers to receive health education messages on maternal and infant health. Free bed nets are also distributed to pregnant mothers at such facilities. Similarly, mothers who had access to an HSA would have had a greater opportunity of learning about malaria and the health benefits of using a bed net, and possibly receiving one as part of a community-based distribution project. The Malawi government and a US NGO (PSI) distribute free bed nets to district hospitals. Healthcare professionals within the district then distribute these to families in high-risk areas.[6]

People whose nearest health facility was a government or a rural hospital and who used a health post were also more likely to mention the use of bed nets as a preventative measure, probably because the government distributes them through the district health authorities who are housed by the district hospitals. District health authorities are in charge of the distribution of healthcare resources within their districts. Similarly, HSAs and VHCs utilise health posts or rural clinics as community-based distribution points. People whose nearest facility is a Christian Health Association of Malawi facility or a private clinic were less likely to cite the use of bed nets as a preventative measure, because these facilities charge for their services and are not utilised as distribution points for free bed nets.

Compared to earlier studies undertaken in Malawi,[29,32] the percentage of bed-net ownership found in this study (approximately 66%) was significantly higher, and in agreement with the percentage of bed-net ownership reported in rural households nationally in the 2010 Malawi Demographic and Health Survey.[33] Formal schooling, relative wealth, easy access to an HSA and household size were found to be highly significant factors related to bed-net ownership within the Chikhwawa community. Significant variation in attained school level, relative wealth and easy access to an HSA, explains the differences in impact that these variables have on bed-net coverage between communities. For example, positive relationships between formal schooling and knowledge, attitude and practices regarding malaria prevention, treatment and control have been found in other African countries.[22-23,25-26,34] People who have had the benefit of formal schooling have acquired skills, knowledge, and finances that enable them to better understand the benefits of owning bed nets and accessing healthcare facilities and resources, treatment and personnel.[35-36]

The role of HSAs in the distribution of healthcare resources may explain their positive influence on bed-net coverage. Since each household receives only one bed net, this means that within large families there are likely to be members who sleep without a bed net. This may explain the negative relationship between bed-net coverage ratios and household size. It may also explain the absence of any relationship between the increased distribution of bed nets and the prevalence of malaria in Chikhwawa. Although studies have shown an overall increase in bed-net coverage in the district in recent years, compared with previous years, there has been no marked reduction in the prevalence of malaria.

Other beliefs and misconceptions identified by respondents as methods that they used to prevent malaria included the clearance of weeds and bushes around the house, drainage of water, indoor and outdoor spraying, and mosquito coils. Clearing weeds and bushes was the second most mentioned preventative method that was highlighted by those interviewed. In Malawi, clearing weeds and bushes (thought to be associated with mosquito breeding sites) around homes is encouraged by school teachers and health officers as a means of preventing malaria. Households in contact with HSAs were also more likely to cite doing this as a protective measure. However, it is not known if HSAs advocate or endorse such methods. The removal of weeds and bushes has been reported by many investigators as an method used by respondents to prevent malaria,[24,25] although its association as a breeding site for mosquitoes has been questioned.[37-38] However, it must be noted that most African malaria vector species are indoor-resting (endophilic), which is why bush clearance as a control measure is at best negligible.[39-40]

Methods recommended by the Ministry of Health in Malawi, and cited by other investigators, as being effective in the control of man-made vector breeding sites, include management of rubbish disposal sites, improvement of house structures, use of insecticides, and dispersion of stagnant pools of water.[28-29] However, in this study, few people mentioned these methods. This may be due to a number of factors, e.g. lack of awareness of the respondents due to bias in the study (as such chores are not undertaken by women); socio-economic factors, due to the poverty that exists in the area; acceptability and health-related concerns about the use of insecticides within the home environment, and concerns expressed by health officials about the indiscriminate and improper use of insecticides. However, of most concern was the lack of awareness among the majority of respondents about the association of mosquito-breeding sites with stagnant pools of water. Similar findings were reported among rural communities in Kenya.[25] This clearly demonstrates a lack of knowledge about the life cycle of this aquatic-borne vector among respondents, as well as health-sector personnel working at village level within the Chikhwawa district healthcare service. For example, larval control programmes do not appear to be part of ongoing (malaria) health education campaign in the area, and these need to be introduced to facilitate a more holistic community-based integrated vector management programme.

Conclusion

The vast majority of respondents in this study correctly identified the main symptoms that are associated with malaria, the mosquito as the vector of the disease, and bed nets as one of the most effective methods to prevent acquiring the disease. Nevertheless, more effort should be made to promote bed-net usage among high-risk groups, by making them more affordable. The main factors that were positively associated with correct knowledge, awareness and practice of malaria transmission, prevention, treatment and control, were close proximity to a health centre or hospital, formal schooling, relative wealth, attendance at antenatal care clinics, and easy access to an HSA. However, knowledge and practice are different, and people do not always act on knowledge. There are many reasons why this may be the case, but in Chikhwawa, the main reason is one of affordability, due to prevailing poverty.

The empowerment of VHCs in rural communities through health education campaigns concentrating on the biology, aetiology, control and prevention of malaria is essential if the prevalence of the disease is to be reduced. In this study, VHCs were found to be an under-utilised resource at village level, with the potential to have a significant impact on the prevention and control of malaria and other diseases. Contact with an HSA was identified as a highly significant factor in acquired knowledge and awareness about malaria-related issues. However, currently, there is an insufficient number of these professionals to meet the needs of rural communities in the country. The Ministry of Health has a target of one HSA per 1 000 people.[41] In Chikhwawa, the ratio is one HSA per 1 494 people, or one HSA per three villages, with some villages having no access to an HSA. We recommend that the Ministry of Health, district health authorities and NGOs recruit more HSAs to provide better accessibility for communities in rural areas. HSAs are specifically outlined in the Malawi Government Roll Back Malaria project as important healthcare practitioners at community level.[6] Therefore, HSAs should be trained on malaria intervention programmes, and tasked with the responsibility of working with VHCs to develop community-based malaria intervention programmes. These programmes should include appropriate and affordable household improvement methods, such as screening of windows and doors, identification of high-risk groups, and distribution of ITNs and the incorporation of larval control measures, to reduce exposure to the vector and parasite. This would reduce the transmission and prevalence of malaria at community level.

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Ethical clearance

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