Acta Tropica 175 (2017) 71–77

Contents lists available at ScienceDirect

Acta Tropica

journal homepage: www.elsevier.com/locate/actatropica

Assessment of individual and household malaria risk factors among women in a South African village

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ARTICLE INFO

Article history:
Received 7 October 2015
Received in revised form 2 December 2016
Accepted 9 December 2016
Available online 10 December 2016

Keywords:
Malaria
Risk factors
Malaria among women
Malaria elimination
South Africa

ABSTRACT

There is need to understand how various malaria risk factors interact at the individual, household and community levels, as well as wider contexts, in order to guide the design and implementation of effective and more comprehensive control strategies. Using a cross-sectional approach, this study investigated various malaria risk factors among residents of Mgedula Village, a malaria-endemic community located in Jozini Local Municipality, UMkhanyakude District, South Africa from May to August 2014. Data from 121 randomly sampled women were collected using close-ended questionnaires. The women were aged between 18 and 40 years; and had been residents in the study area for five years or more. A multivariable logistic regression model was used to measure the association between a history of malaria infection in the previous 12 months and various potential risk factors. The results showed that practicing animal husbandry (OR 20), residing in household structures that had not been sprayed (OR 16.7) and cross-border movement (OR 14.3) were greatly associated with malaria infection. Other factors that were significantly associated with this infection included illiteracy (OR 9.1), having a largely populated household (OR 6.1) and low income (OR 1.65). Individuals with a history of malaria infection were less likely to lack basic malaria-related knowledge (OR 0.58), to have negative attitude towards malaria (OR 0.29) and also to have poor malaria practices (OR 0.3). There was no association between a malaria episode and residing at a long distance from the health facility. Indoor residual spraying indicated a notable reduction of malaria risk at the community level. However, other socio-economic, geographical and socio-demographic factors interacted at different levels to increase this risk among different individuals and households. To achieve malaria elimination by the year 2018, these aspects should be considered when developing and implementing elimination strategies at the individual, household and community levels, among high-risk populations.

1. Introduction

Malaria is a key public health threat with approximately half the global population estimated to be at risk of the disease (Singh et al., 2014). Affecting mostly children and pregnant women, malaria burdens are mostly reported in sub-Saharan Africa, the region accounting for over 81% of the global number of cases and 91% of the global malaria–related mortality (Singh et al., 2014; Mendis et al., 2009). A number of measures to control and eliminate the disease have been put in place at local, national and global settings (Mendis et al., 2009). Malaria control programmes, which mainly operate at the national, provincial and district levels have been established in all malaria-endemic countries.

In South Africa, malaria is still endemic in Limpopo, Mpumalanga and KwaZulu-Natal Provinces that border Zimbabwe, Mozambique and Swaziland, with approximately 6 million people in the country living under malaria risk (Maharaj et al., 2012). However, by adopting the National Malaria Elimination Programme with a target to eliminate the disease by the year 2018, South Africa has made notable progress in reducing its morbidity and mortality. Progress has particularly been noted between the years 1999 and 2011, within which reported malaria cases were reduced by 91% and malaria-related mortality was reduced by 81% (Maharaj et al., 2012). Ecological changes, an increase in immigrants in and out of highly infested areas, poorly implemented surveillance systems and degradation of healthcare infrastructures are some of the factors that have been reported as contributing to the current malaria

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http://dx.doi.org/10.1016/j.actatropica.2016.12.007
0001-706X/

burden in South Africa's endemic areas (Hlongwana et al., 2009; Morris et al., 2013).

KwaZulu-Natal Province has reported great progress in the fight against malaria, with a reduction of up to 54 cases per 1,000,000 population at risk reported in 2013 from 4 718 reported cases per 1,000,000 population at risk recorded in 2000 (KwaZulu-Natal Department of Health, 2014). In 2013, the province recorded a lower malaria burden than Mpumalanga and Limpopo, which reported 919 and 437 cases per 1,000,000 population at risk, respectively (KwaZulu-Natal Department of Health, 2014). Malaria cases in KwaZulu-Natal are mainly reported in three districts, namely UMkhanyakude, Zululand and uThungulu, with the former accounting for up to 80% of the total number of cases in the province (Morris et al., 2013).

Assessing the various malaria risk factors and investigating their interaction at various levels have played key roles in designing and implementing comprehensive measures directed at preventing, controlling and eliminating malaria (Somi et al., 2007). Factors assessed include gender; malaria-related knowledge, attitude and practices; mobility and travel; ethnicity; occupation; socio- economic status; and type of household structure (Krefis et al., 2010; Stefani et al., 2011). Other factors include literacy level of the household head; size of the household; number of rooms used for sleeping; proximity of household structure to vector-breeding site(s); presence of livestock and other domestic animals, among others (Woyessa et al., 2013; Chirebvu et al., 2014). Recently, additional efforts have been made to investigate the influence of climatic factors on the rates of malaria infection and transmission (Ermert et al., 2011; Berrang-Ford et al., 2012). However, a large proportion of the studies investigating malaria risk factors do not usually consider the wide range of factors, which makes results more prone to confounding effects due to factors that are not included in the analysis. Cross- border movement has been the major malaria risk factor in the endemic communities of Jozini Local Municipality due to their proximity to the Republic of Mozambique and Republic of Swaziland (Maharaj et al., 2012).

A number of factors such as diminished immunity (especially during pregnancy) and reduced access to health services have been shown to predispose women to a greater risk of malaria infection (Shulman and Dorman, 2003). Malaria prevention among women of child-bearing age is of prime concern because the disease has been associated with maternal anaemia, low birth weight delivery as well as maternal and perinatal mortality (Marchant et al., 2011). Therefore, understanding the malaria risk factors among women of child-bearing age is one of the important ways, through which effective measures can be designed and implemented in order to halt the perilous effects of the disease.

Malaria elimination in UMkhanyakude District has particularly been hampered by human cross-border movements due to the district's geographical location, bordering the highly endemic countries of Mozambique and Swaziland (KwaZulu-Natal Department of Health, 2014; World Health Organization, 2009). There is great contrast between South Africa and Swaziland, in comparison to Mozambique, regarding their positions on the malaria-control continuum. Although South Africa and Swaziland are currently in the pre- elimination phase and target elimination by 2018 and 2015 respectively, Mozambique is still in the control phase (Maharaj et al., 2012).

Progress in the fight against malaria in South Africa has largely been attributed to Indoor Residual Spraying (IRS) using Dichlorodiphenyltrichloroethane (DDT) (Mendis et al., 2009). Based on a mosaic IRS strategy, the KwaZulu-Natal Provincial Malaria Control Programme is currently using DDT to spray traditional structures (un-painted walls made of materials like straw, mud, clay and dung) and also maintaining the use of pyrethroid (deltamethrin) to spray modernized structures (KwaZulu-Natal Department of Health, 2014). Other key strategies implemented by the control programme in KwaZulu-Natal are household and community dissemination of malaria-related knowledge, aimed at improved modification of malaria-related attitudes and health-seeking behaviour;

and proper case management, entailing prompt diagnosis, followed by proper treatment using artemisinin-based combination therapies (ACTs), as recommended by the World Health Organisation (WHO) (Mendis et al., 2009; Maharaj et al., 2012; KwaZulu-Natal Department of Health, 2014).

UMkhanyakude District records the greatest number of malaria cases in KwaZulu-Natal Province. Still, no recent study has assessed malaria risk factors at the individual and household levels in this district, particularly not in the endemic communities of Jozini Local Municipality. It is against this background that this study was conducted and aimed at investigating a variety of malaria risk factors among women in Mgedula Village, Jozini Local Municipality in 2014, in order to provide the Malaria Control Programme (MCP) with information that may guide the development and implementation of more comprehensive measures targeted at households and individuals that are at the highest malaria risk. It was important to focus on women because their particular vulnerability to malaria, most especially when pregnant; they are also, in most cases, directly responsible for the wellbeing of other family members, particularly children, who also are highly vulnerable to malaria. Women are also assumed to be more knowledgeable of household day-to-day activities and can thus be used as proxies for the general household malaria-related perceptions and practices (Singh et al., 2014). We hypothesized that a history of previous malaria infection would not be associated with various individual and household risk factors among the women.

2. Materials and methods

2.1. Study setting and location

The study was conducted in Jozini Local Municipality in the north-western part of UMkhanyakude District, which is situated in the north-eastern part of KwaZulu-Natal Province, one of the three malaria-endemic provinces in South Africa. According to the census conducted in 2011 UMkhanyakude district (about 12 800 km2 in size) has a population of 625 846 people and is bordered by uThungulu District, Zululand District, the Indian Ocean, the Republic of Mozambique and the Republic of Swaziland (UMkhanyakude District Municipality, 2011).

The study site within the Jozini Local Municipality (Fig. 1), Mgedula Village (*isiGodi*), is located in the low-lands of the municipality in close proximity to the borders of the Republics of Swaziland and Mozambique.

2.2. Study design and data collection

An observational cross-sectional survey was conducted between May and August 2014 among 121 randomly selected women aged between 18 and 45 years who had been residents for five years or more. This sample size was calculated at the 95% confidence level, with a ± 9% estimated precision and a 0.5 expected odds of occurrence. One hundred and twenty one households were randomly selected (using the software package Stata/IC, version 13.0) from a sample frame (irrespective of the gender of the household head). Of the 121 selected households, 23 were headed by women and 98 by men. One woman was recruited from each of the 121 randomly selected households for inclusion in the study. From households headed by women, the household heads were recruited, and a female household head proxy was recruited from

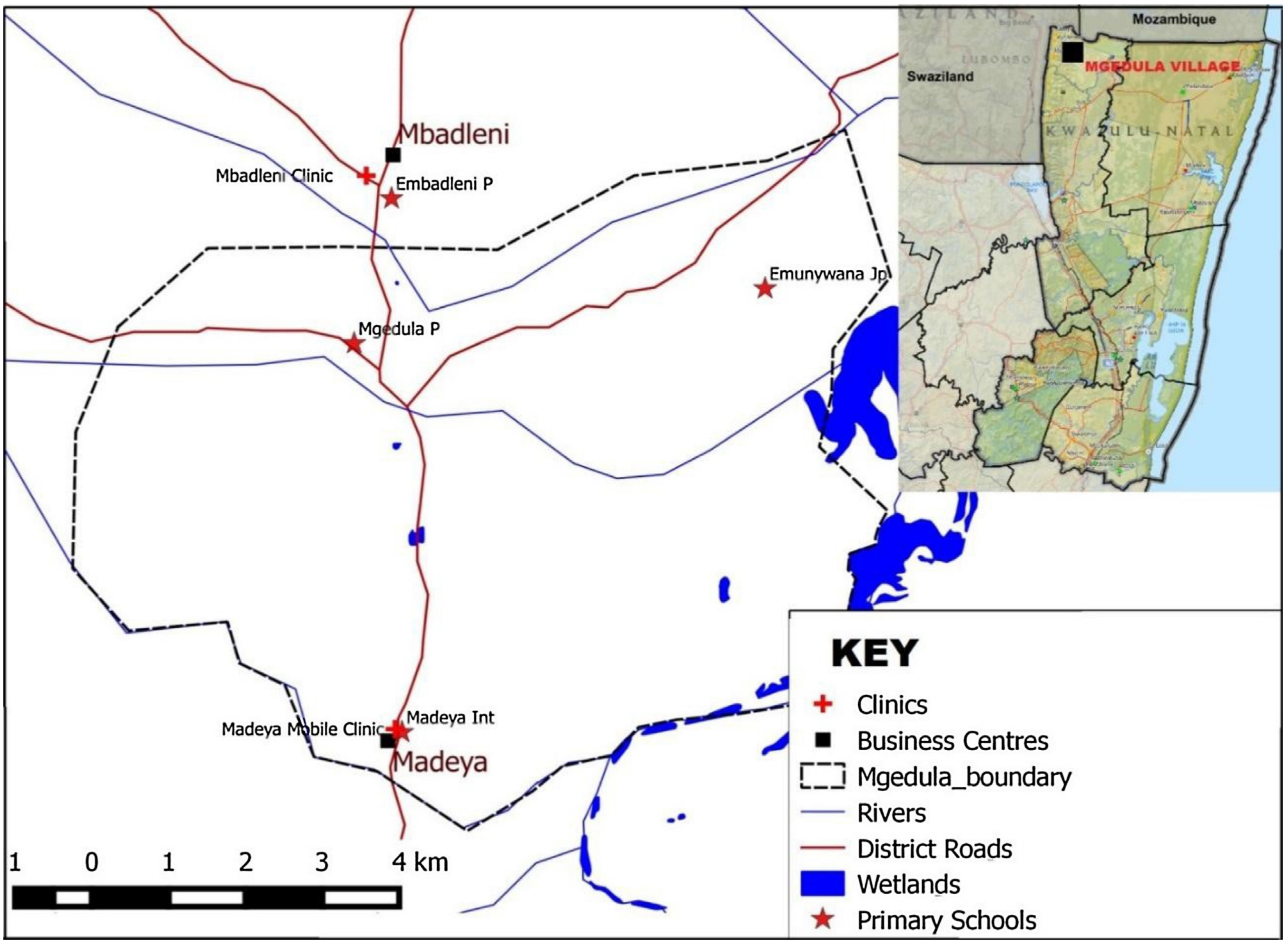

Fig. 1. Map of Mgedula Village showing physical features and its position on the map of KwaZulu-Natal Province.
The map developed by the researcher assisted by a technologist specialized in Geographic Information System (GIS).

each selected man-headed household. The sample frame was a list of 1 421 household numbers developed and annually updated by the MCP to guide IRS coverage.

Data were collected through interviews, which were conducted by five extensively trained community research assistants. Interviews were carried out using a close-ended questionnaire which had been translated from English to *isiZulu*, and pretested in a pilot study involving ten conveniently selected women from Ndumo, a village adjacent to the study area. The questionnaire was made up of four thematic sections. The first one was aimed at collecting individual and household demographic and social-economic data and potential malaria risk factors. The second was aimed at collecting data about the level of basic knowledge about malaria, while the third collected data about malaria-related attitude and the fourth solicited information on malaria-related practices and health-seeking behaviour.

2.3. Data processing and analysis

The independent variable was 'history of previous malaria infection in the past 12 months' from the time of data collection. Potential risk factors for malaria infection were measured as dependent variables and these included individual factors like illiteracy, low income level, cross-border movement to Swaziland or Mozambique in the previous 12 months, lack of adequate malaria-related knowledge, negative attitude towards malaria and poor malaria-related practices; and household factors such as practice of animal husbandry, having a large number of household members (size of family), living far from the health facility and the household structure not having been sprayed. Individuals were classified as illiterate if they reported not having received any formal education or not having completed primary level of education; as of a low-level income if their gross monthly income was R 1 000 (about USD 80) or less and residing in a structure whose walls and roof were predominantly made of traditional material; having a large household if their family was made of four or more members; and far from a health facility if their household structure was located more than two km from a health facility.

Women who failed to mention at least three signs and symptoms of malaria, not knowing at least two ways of preventing and controlling malaria and also not associating malaria transmission with bites from a mosquito were categorised as being without basic malaria-related knowledge. Individuals were classified as having negative malaria-related attitudes, if they were unable to recognise malaria as a life-threatening disease; disagreed that malaria is curable by timely diagnosis and proper adherence to prescribed treatment from health facilities; and did not considered themselves at risk even if they did not apply preventative measures. Individuals were categorised as with poor malaria-related practices if they did not apply at least one measure for preventing themselves against malaria transmission.

The data were first entered into Microsoft Excel spreadsheets and then imported into the Stata/IC, version 13.0 software for analysis. Bivariate association between history of malaria episode and each of the potential risk factor was measured using the Pearson Chi-square test. This was followed by calculating the age-adjusted pooled Mantel-Haenszel maximum likelihood odds ratio (OR) estimate, and also the multivariate-adjusted ORs use of the multivariable logistic regression model. Prior to calculating the ORs, data of ordinal variables were dichotomised into binary data. For example, the literacy level was dichotomised into literate (individuals who had completed at least primary level of education) and illiterate (those who had never received any formal education); and distance to a health facility was dichotomised as short (four km or less) and far (more than four km). Confounding was determined as a relative difference of 15% between crude ORs and ORs adjusted for predefined covariates without signs of effect modification. For each estimated association, the level of statistical uncertainty was measured and presented at the 95% confidence interval and a *p*-value.

3. Results

All women selected for the study consented to participate in the study. Ninety three percent of the participants (N = 121) were aged between 21 and 40 years and most of them (44%) had completed primary school education, with younger ones (aged between 18 and 25 years) being more likely to have obtained formal education (OR 3.06, 95% CI 1.19–8.14, P = 0.0098). Only 42% of the participants (N = 121) reported that their monthly income was more than R 1 000 and government financial assistance was reported as the major source of household income. The women's major characteristics (including possible confounding factors) are reported in Table 1.

History of previous malaria infection within 12 months prior to data collection was reported by 5.8% (N = 121) of the participants. Out of the 121 study participants, 25% had not attained any formal education, 63% belonged to the low income group, 6.6% had crossed the national border to either Mozambique or Swaziland in the previous 12 months and 15% had not had their household structure sprayed.

The majority of the participants (64%, N = 121) were classified as having adequate basic knowledge about malaria. In this group, 63% mentioned at least two ways by which malaria can be prevented and controlled, 80% were able to mention at least three malaria symptoms and 62% of the women associated malaria transmission with mosquito bites. Seventy eight percent were categorised as having a positive attitude towards malaria. In this group, 76% agreed that "it is very important for a malaria patient to complete the malaria dosage as prescribed by the physician"; 97% agreed that they were at risk for malaria if they did not apply proper control measures; and 88% agreed that "malaria is a serious and life-threatening disease if not properly treated". Seventy seven percent of the participants (N = 121) reported practicing at least one way in which to clear mosquito breeding areas, prevent mosquito bites and/or kill mosquitoes. These subjects were thus classified as having good malaria-related practice. Some of the reported practices included draining of stagnant water, use of mosquito repellents, closing doors and windows at night, use of gauze wire mesh in the windows, use of insecticide treated nets (ITN) and use of insecticide spray such as Doom©. Table 2 shows proportions of each measured potential risk factors among the study participants and Table 3 shows a bivariate analysis measuring the association (using ORs) between potential risk factors and a history of previous malaria infection.

All measured potential risk factors showed no significant association with a history of malaria episodes before adjusting for potential confounders, and even after adjusting for age. However, multivariate analysis indicated significant associations between a history of malaria infection and all the risk factors except distance to a health facility. The odds for malaria infection were nine times higher among illiterate women compared to those of the literate group (OR 9.1, P > 0.000), close to twice higher among those with a low income (OR 1.7, P > 0.009) and 14 times higher among those having crossed the national border to either Mozambique or Swaziland at some time (OR 14.3, P > 0.000). Individuals with little or no knowledge on malaria (OR 0.58, P > 0.006), those with a nega-

Table 1
Distribution of the characteristics of women in Mgedula Village in 2014.

Characteristic	Frequency (N = 121)	Proportion (%)
Age in years		
18–20	8	6.6
21–30	57	47.1
31–40	56	46.3
Level of education attained		
No formal education	30	24.8
Primary education	53	43.8
Secondary education and higher	38	31.4
Relationship to the household head		
Household head	23	19.0
Spouse/Partner	28	23.1
Daughter	42	34.8
Sister	20	16.5
Others	8	6.6
Household Size (Number of members)		
I1	4	3.3
2–3	14	11.6
4–5	27	22.3
6 or more	76	62.8
Income Source for Head of Household		
Livestock or crop farming	6	5.0
Cash employment	5	4.1
Sale thatching grass/reeds	26	21.5
Vending/hawking	5	4.1
Seasonal piece jobs	10	8.3
Government social welfare support	45	37.2
Government financial assistance	31	25.6
Others	4	3.3
No response	3	2.5
Monthly Income for Head of Household		
Less than R 1000	70	57.8
Between R 1000 and R 3000	42	34.7
More than R 3000	3	2.5
Don't know	2	1.7
No response	4	3.3
Distance from house to health facility		
Less than 1 Km	9	7.4
Between 1 Km and 4 Km	78	64.5
4 Km and more	34	28.1

Table 2
Potential malaria risk factors among women in Mgedula Village, Jozini Local Municipality in 2014.

Potential risk factor	Frequency (N = 121)	Proportion (%)
Low income	76	62.8
Traditional household structure	42	34.7
Illiteracy	30	24.8
Large household size	103	85.1
Practice animal husbandry	5	4.1
Cross-border movement	8	6.6
Distant from health facility	68	56.2
Inadequate malaria knowledge	44	36.4
Negative malaria attitudes	27	22.3
Poor malaria practices	28	23.1
Structure not sprayed	18	14.9

Table 3
Associations between malaria risk factors and cases of history of malaria episodes among women in Mgedula Village in 2014.

	History of malaria infection			
Potential risk factor	Exposed cases	Crude OR	2	p > |z|
Low income	5	1.51	0.24	0.63
Traditional household structure	1	0.30	1.37	0.24
Illiteracy	3	2.42	1.30	0.25
Large household size	5	0.41	1.10	0.29
Farming	1	4.54	1.93	0.16
Cross-border movement	1	2.55	0.71	0.40
Distant from health facility	3	0.70	0.05	0.82
Inadequate malaria knowledge	2	0.69	0.19	0.66
Negative malaria attitudes	1	0.56	0.27	0.60
Poor malaria practices	2	1.35	0.12	0.73
Structure not sprayed	1	0.95	0.00	0.96

*OR denotes odds ratio, 2 Pearson chi-square test value and P > |z| the *P*–value of the level of significance.

tive attitude towards malaria (OR 0.29, P > 0.003) and those who reported not applying any measures to control or prevent malaria (OR 0.30, P > 0.000) were less likely to have had a history of malaria infection. Women who were more likely to have a history of malaria infection included those who had a large family (OR 6.13 P > 0.000), those whose households practiced animal farming (20.0 P > 0.000) and those whose household structure had not been sprayed (16.67 P > 0.006). However, participants residing in household structures whose walls were predominantly made of traditional material were less likely to have a history of malaria infection compared to those who resided in modern structures (0.56 P > 0.003). Table 4 shows the association between potential risk factors and a history of previous malaria infection measured using adjusted ORs by pooled analysis and multivariate analysis.

4. Discussion

This study indicates that individuals with a low income were more likely to have a history of malaria infection. This association has been reported in a number of studies, most of them linking this pattern to lack of resources to enable the implementation of control and prevention measures at the individual and household levels (Ayele et al., 2012). The claim that "malaria is a disease of the poor" is substantiated by the global distribution of the disease, i.e. it is indeed more concentrated in poor communities and countries (Snow et al., 2004; Abegunde and Stanciole, 2006). However, an increased malaria risk has not only been associated with poverty, but seen as the primary cause of poverty (Sachs and Malaney, 2002; Gallup and Sachs, 2001). A more comprehensive understanding of the interaction between malaria and individual socio-economic factors is thus important in guiding the design and implementation of effective and more coherent measures at individual and household level to fight the disease.

Contrary to other studies, our results show that individuals living in household structures whose walls are predominantly constructed using traditional materials (one of the proxies of poverty and low income) were less likely to have a history of malaria infection. This contrasting results are reported in studies conducted in Botswana (Chirebvu et al., 2014) and in India (Sharma et al., 2003). This result could be a preliminary indication of a starting development of mosquito resistance to pyrethroid, as was the case in the province between the years 1996 and 2000 (Maharaj et al., 2005). If so, then individuals residing in modern structures are at a higher risk of malaria than others, since the KwaZulu-Natal Provincial MCP is currently using DDT to spray traditional structures and pyrethroid to spray modernized structures (Moonasar et al., 2013). There is thus need for entomological studies to investigate the susceptibility of mosquitoes to pyrethroid in various sites in the Jozini Local Municipality.

Other factors that were found to be significantly associated with having a history of malaria infection were illiteracy, cross-border movement, having a large family, practicing animal husbandry and living in areas close to a health facility. Literacy levels have been shown not only to act as a marker for individual and household socio-economic variations, but also to directly and indirectly influence malaria knowledge, attitude, practices and health-seeking behaviour (Masangwi et al., 2010; Coldren et al., 2006). These are in turn directly related to the magnitude of malaria risk, as indicated in studies on the association between malaria risk and illiteracy (Chirebvu et al., 2014; Coldren et al., 2006). Similar to studies conducted in Kenya (Ernst et al., 2006) and Vietnam (Abe et al., 2009), our study shows that increased household population is a malaria risk factor, explained by the fact that increased con-

Table 4
Associations between malaria risk factors and cases of history of malaria episodes among women in Mgedula Village in 2014.

	History of malaria infection					
Potential risk factor	Exposed cases	Pooled age- adjusted OR[1]	95% CI	Multivariate adjusted OR	95% CI	p > |z|
Low income	5	1.61	0.28–9.22	1.65	1.13–2.41	0.009
Trad. household structure	1	0.31	0.04–2.70	0.56	0.38–0.82	0.003
Illiteracy	3	3.74	0.57–24.6	9.1	2.70–3.3	0.000
Large household size	5	0.41	0.07–2.39	6.13	3.61–10.39	0.000
Farming	1	4.59	0.39–53.84	20.0	8.33–50.0	0.000
Cross-border movement	1	2.05	0.19–21.57	14.29	7.14–33.3	0.000
Distant health facility	3	0.70	0.15–3.30	1.07	0.74–1.55	0.708
Poor malaria knowledge	2	0.65	0.12–3.70	0.58	0.40–0.85	0.006
Negative malaria attitude	1	0.60	0.07–5.21	0.29	0.19–0.46	0.003
Poor malaria practices	2	1.36	0.24–7.57	0.30	0.19–0.46	0.000
Structure not sprayed	1	0.89	0.09–8.40	16.67	2.27–100	0.006

*OR denotes Odds Ratio, CI denotes confidence interval and P > |z| denotes the *P*–value of the level of significance.

1 According to Mantel-Haenszel.

centration of humans increases the human odour, which attracts *Anopheles* mosquitoes (Takken and Knols, 1999).

This study further indicates that a history of previous malaria infections is associated with cross-border movements. South Africa's fight against malaria has continuously been frustrated by poor control and management of cases imported from neighbouring countries with higher endemicity and less effective malaria [control programmes (Maharaj et al., 2012). Although noteworthy progress towards malaria elimination has been recorded in the neighboring countries, it seems safe to say that the targets set at country and regional levels are rather ambitious and may not be achieved by the designated dates, given the progress made this far. Mukonka (Mukonka et al., 2014) reports that the main challenges hampering the achievement of the set targets in Zambia were significant cross-border movement of (often asymptomatic) infected people; failure to eliminate asymptomatic reservoir infections; low uptake of control interventions among various community members; and insufficient funding of control program activities. This supports the findings of Chirebvu (Chirebvu et al., 2014) and Sande (Sande et al., 2016) who conducted similar studies in Botswana and Zimbabwe, respectively. Furthermore, Sharp (Sharp et al., 2007) reported that some of the major challenges experienced in Mozambique consist of ineffective surveillance systems, untimely reporting and poor management of new cases, which may be because of the poor transport system and lack of medical resources in rural communities. Regardless of the efforts made in the South African MCP to mitigate this trend through formation of regional control programmes with endemic neighbouring nations, cross-border movement is still the major malaria risk factor, most especially in areas bordering countries like Mozambique, Swaziland, Botswana and Zimbabwe (Maharaj et al., 2012; South African National Department of Health, 2012). An example of the regional control programmes is the Lubombo Spatial Development Initiative (LSDI) that was in operation in the period 1998–2011 between South Africa, Mozambique and Swaziland.

Practicing animal husbandry in a close proximity to the household structure in which humans sleep increase malaria risk after adjustment to other potential confounders like the economic level and literacy level. Animal hoof prints may act as mosquito breeding sites whenever stagnant water is retained after rain (Abe et al., 2009). Also important to note is that *Anopheles funestus, A. gambiae* and *A. arabiensis* have been reported to be not predominantly anthropophagic. However, these mosquito species are also attracted by the animal odour (Muriu et al., 2008; Mahande et al., 2007), hence increasing the risk for individuals who live in close proximity to livestock. The odds for malaria infection were found to be high among individuals that had low literacy rate, crossed the national border, resided in houses that had not yet been sprayed and practiced proper animal husbandry, compared to other associated risk factors, thus rendering these factors more critical.

No significant association was established between malaria risk and distance from health facilities. This differs from findings of some studies which associated risk with living far from health facilities, mainly due to the reduced levels of malaria-related knowledge among such individuals (Gallup and Sachs, 2001; Masangwi et al., 2010). However, since MCP community health workers were operating in the study area at the same time as our study was carried out, disseminating malaria-related information to individuals at the household level, could not have resulted in a distinct difference in the levels of knowledge between individuals who live close to health facilities compared to those living further away, and thus no difference in malaria risk.

Inadequate or lack of basic knowledge on malaria has been associated with negative attitudes, practices and poor health seeking behaviour (Stokols, 1996; Laar et al., 2013). Our study showed that the inadequate or lack of basic knowledge was associated with not having had a history of malaria thus implying that previous exposure to malaria modified the behaviour of people. This may be explained by the fact that households with a history of malaria would have been visited by the malaria and prevention team who not only provided treatment services, but also provided basic education on malaria.

South Africa's malaria elimination strategy has been focused on IRS as one of the principal measures to attain elimination target of 2018 (South African National Department of Health, 2012). The notable stride in the fight against malaria has been, to a greater extent, attributed to IRS (Urbach, 2011). Observed association between history of malaria infection and non-sprayed household structures is evidence of the positive effects of spraying with respect to the malaria risk. This is consistent with findings of a meta-analysis done by Kim and colleagues (Kim et al., 2012).

5. Conclusion

Without negating the substantial contribution of the currently implemented elimination strategies (especially IRS and the use of community health workers), this newly developed knowledge should be fully exploited by the MCP in guiding the modification of these approaches, in order to target households and individuals at a higher risk. This would in turn positively influence the attainment of elimination by the target year of 2018.

Study limitations

Due to the fact that a narrower approach was taken in collecting data from women, these results can only be generalized to women in uMkhanyakude District and those dwelling in settings similar to the study area, as opposed to the entire population. A number of factors could be responsible for the apparent association of a history of malaria and individual and household risk factors, and these trends need to be further investigated by more rigorous studies with higher levels of evidence.

Ethical clearance

Prior to conducting the study, ethical clearance was sought and obtained (Reference number: BE 269/14) from the University of KwaZulu-Natal Biomedical Research Ethics Committee. Signed consent was also obtained from each potential study participant before being enrolled in the study.

Acknowledgments

Appreciation is extended to Dr Stephen Knight and the entire Malaria and Bilharzia in Southern Africa (MABISA) project team for the support and guidance rendered during the study. The author further appreciate Mr Tawanda Manyangadze for his Geographic Information System (GIS) technical assistance, especially in mapping the study area. The study received financial support from the UNICEF/UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR), the Canadian International Development Research Centre (IDRC) and the University of KwaZulu-Natal, College of Health Sciences.

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