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SORT IT: MALARIA ELIMINATION SUPPLEMENT

Moving towards malaria elimination: trends and attributes of cases in Kavango region, Namibia, 2010–2014

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Setting: Kavango, a 'moderate' transmission risk region located in north-eastern Namibia, borders Angola, a country with higher malaria transmission levels.

Objective: To determine 1) the trends in malaria incidence between 2010 and 2014 in Kavango, 2) the socio-demographic and clinical characteristics of confirmed cases in 2014, and 3) associated risk factors of cases classified as imported.

Design: This was a retrospective study of malaria case investigation forms conducted in all 52 public health facilities in 2014. Incidence was derived from aggregate routine surveillance data from the Health Information System (HIS).

Results: During the 5-year study, incidence fell from 53.6 to 3.6 cases per 1000 population, then increased again to 47.3/1000. Fifty-five per cent of cases were males, and 49% were aged between 5 and 17 years. Of the 2014 cases, 23% were imported, and were associated with higher odds of severe malaria (adjusted odds ratio [aOR] 1.8; 95%CI 1.01–3.29), not having long-lasting insecticide treated nets (aOR 2.1, 95%CI, 1.3–3.4) and not receiving insecticide residual spraying (aOR 3.2, 95%CI, 2.1–5.1).

Conclusion: Sporadic outbreaks in the 5-year period posed a threat to malaria elimination. Better targeting of vector control interventions, strong cross-border collaboration and robust health promotion will be key to achieving malaria elimination.

Malaria remains a major global public health concern. In 2014, an estimated 214 million malaria cases and 438000 deaths were reported worldwide.[1] Over the years, there has been a significant decrease in malaria-related morbidity and mortality in several countries,[1] with the World Health Organization (WHO) reporting a 37% reduction in malaria cases and a 60% decrease in mortality between 2000 and 2014.[2]

Several countries in the southern Africa region have successfully scaled up malaria control interventions and are gradually reorienting their programmes to target elimination.[2]

Namibia is a low-transmission setting, with varying transmission risk zones. Within Namibia, transmission varies geographically from 'moderate' to 'risk free'. There has been a significant reduction in malaria cases since the scale-up of control intervention activities in 2005, and the country is now aiming towards malaria elimination by 2020.[2,3] As Namibia moves toward malaria elimination, the risk of importing malaria via cross-border population movement from neighbouring countries with a higher transmission risk, such as Angola, remains a major challenge.[4]

During the 2014 malaria transmission season, between January and May, Namibia reported a 70% increase in malaria cases and deaths compared to the 2013 malaria season.[5] Eighty per cent of these cases were from the Kavango region, which borders Angola, a country with significantly higher transmission gradients.[3] The Kavango region is mostly rural, and its population of 274089 represents 11% of the country's population. This region accounts for 22% of the population most at risk for malaria, and falls within the country's 'moderate' transmission risk zone stratification.[6]

Namibia is stratified into three malaria transmission zones: zone 1 is classified as 'moderate transmission', zone 2 is 'low transmission risk' and zone 3 is 'risk free'. Figure 1 shows Namibia's malaria stratification by transmission risk zone, with Kavango region marked.

The Namibian National Vector-borne Diseases Control Programme (NVDCP) has been actively working toward improving its malaria surveillance system. Surveillance activities and epidemic response vary by zones within the country. Zone 1 areas are only mandated to carry out passive surveillance, while zones 2 and 3 must carry out both passive and active surveillance. For passive surveillance, upon confirmation of a malaria case at health facility level, a case investigation form is completed for each individual case. This investigation form captures patients' personal details, diagnosis and treatment, travel history and vector control interventions. This form is then transferred from the health facility to the districts for active surveillance to be carried out. For reactive case detection, the index case is followed up to the household level, and all occupants and immediate neighbours within a 100 m radius are tested. If an individual tests positive, he/she is treated immediately. In addition, an entomological investigation is conducted in the area of the index case. Supplementary vector control interventions are also deployed in response to cases identified at community level.

In order to guide and refine malaria control interventions in the Kavango region, it is crucial to clearly understand where the reported cases are coming from, including their sociodemographic and clinical characteristics. A clear understanding of population movement dynamics, both domestic and international,

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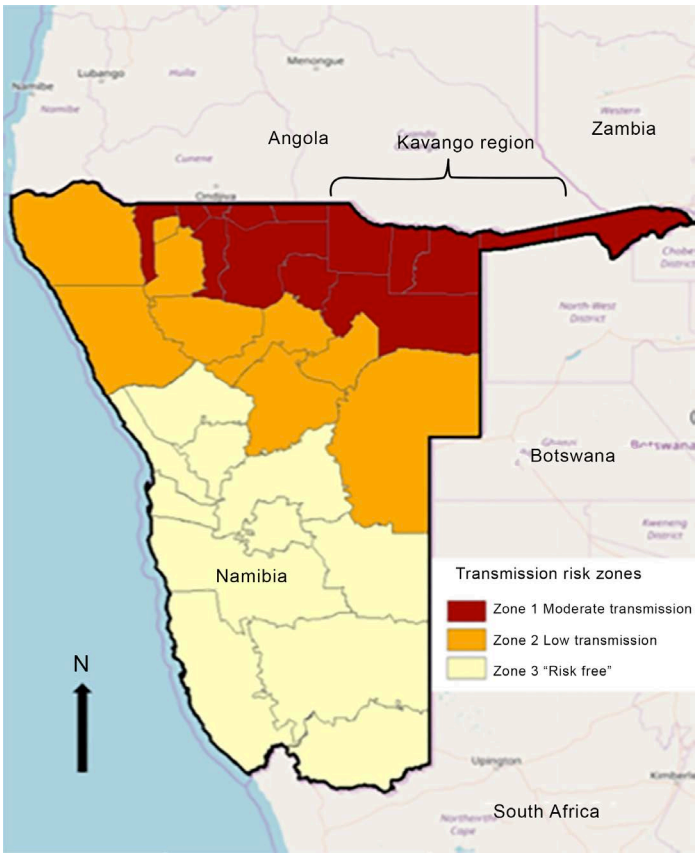

FIGURE 1 Map of stratification by malaria transmission zone in Namibia, indicating Kavango region.

along with cross-border malaria transmission, is vital for the development of appropriate surveillance strategies and response systems.[7]

As surveillance improves, more information is captured about malaria cases and their sociodemographic characteristics. However, these data are not always fully analysed, and there are no previous studies describing the epidemiology of malaria in the Kavango region. The aim of this study was to therefore describe the sociodemographic profiles and clinical characteristics of malaria cases reported during the 2014 season in the Kavango region, with completed case investigation forms included in the study. The specific objectives were 1) to determine the trend in malaria incidence between 2010 and 2014; 2) among cases in the year 2014, to determine sociodemographic and clinical characteristics; and 3) to identify associated risk factors of imported cases.

STUDY POPULATION, DESIGN AND METHODS

This was a descriptive, analytical cross-sectional study using routine surveillance patient records.

Study population

The study population included all confirmed malaria cases reported between 2010 and 2014, to investigate trends, and all confirmed malaria cases with a completed case investigation form in 2014, to investigate sociodemographic characteristics. The study included all 52 public health facilities in the Kavango region of Namibia in 2014.

Data collection methods

Aggregate data on the total number of malaria cases in the Kavango region from 2010 to 2014 were obtained from Namibia's Health Information System (HIS), which houses country data on all diseases at district level.

Among the confirmed cases, the following data variables were extracted from the case investigation forms: age, residence, sex, pregnancy status, occupation, ownership and usage of long-lasting insecticide-treated nets (LLINs), whether the household had been sprayed and whether the cases were classified as local or imported. A local case was defined as any individual who, based on his/her reported 2-week travel history, was found to have contracted malaria within the borders of Namibia. An imported case was defined as any individual who, based on his/her reported 2-week travel history, was found to have contracted malaria outside the borders of Namibia. In cases of frequent travel, where the origin of infection was difficult to determine, cases were classified as local by default.

Analysis and statistics

Study data were entered into an Excel spreadsheet (Microsoft Corp, Redmond, WA, USA), and analyses were

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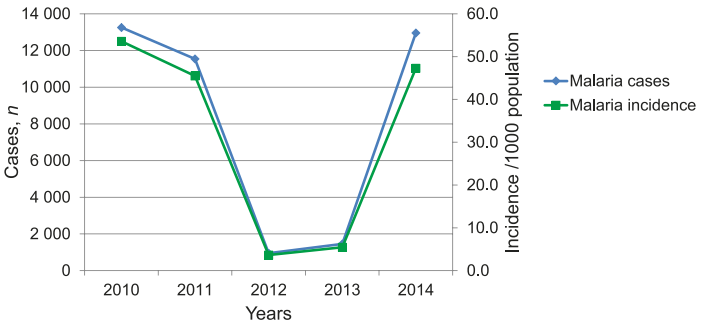

FIGURE 2 Trends in number and incidence of confirmed malaria cases per 1000 population, Kavango region, Namibia, 2010–2014.

performed using EpiData (v. 2.2.2.182, EpiData Assoc, Odense, Denmark).[8] Medians and interquartile ranges (IQR) were calculated for skewed continuous variables, while numbers and proportions were reported for categorical variables. Logistic regression was used to estimate the unadjusted and adjusted odds ratios (OR) and their 95% confidence intervals (CIs) for factors associated with being an imported malaria case. Those factors associated with the outcome and with a *P* value <0.25 in the univariate analysis were included in the multiple logistic regression model. The level of significance was set at 5%.

Ethical considerations

Permission to conduct the study was obtained from the NVDCP (Ministry of Health, Windhoek, Namibia); ethics approval was obtained from the Namibian Biomedical Research Ethics Committee (Windhoek, Namibia) and the Ethics Advisory Group of the International Union Against Tuberculosis and Lung Disease (Paris, France).

RESULTS

Between 2010 and 2014, 40165 patients in the Kavango region were confirmed as having malaria. Confirmed malaria cases decreased in 2012 and 2013, only to increase by more than 89% in 2014. Incidence was highest, at 53.6 per 1000 population, in 2010, and declined to 3.6/1000 in 2012, before increasing again to 47.3/1000 in 2014 (Figure 2).

Of the 12959 confirmed malaria cases in 2014, only 1716 (18%) were reported through routine surveillance as having had a case investigation form completed; 811/1716 (47%) records were found. Overall, 6% of reported cases in 2014 were found to have a completed case investigation form (Figure 3).

Sociodemographic and clinical profiles of confirmed malaria cases in 2014

Table 1 shows the profile of confirmed malaria cases in 2014 who had completed case investigation forms. The majority of these cases were male (55%) and were aged between 5 and 17 years (49%), with a median age of 10 years. Children aged <5 years accounted for 23% of cases with a completed investigation form, while non-pregnant women made up 93% of all females with completed forms. Overall, 23% of reported malaria cases were imported.

Preventive measures for malaria cases in Kavango region, 2014

Table 2 shows that 65% of confirmed cases with completed investigation forms reported not owning LLINs, while 50% reported

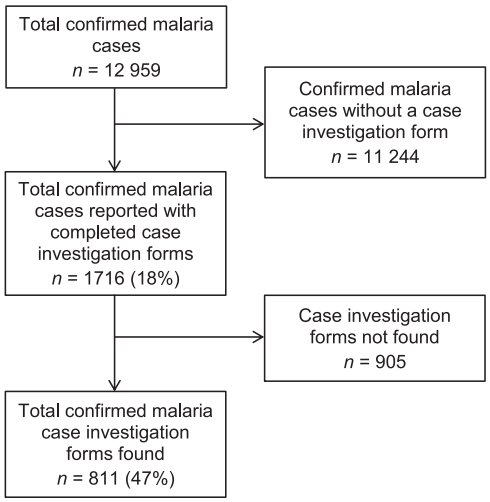

FIGURE 3 Flow chart of confirmed malaria cases with completed case investigation forms, Kavango region, Namibia, 2014.

TABLE 1 Sociodemographic and clinical profile of malaria cases with completed case investigation forms, Kavango region, Namibia, 2014

Characteristics	Respondents with characteristic/total respondents *n/N* (%)*
Total case investigation forms, *N*	811
Age, years	
<5	156/673 (23)
5–17	327/673 (49)
⩾18	190/673 (28)
Not recorded	138/811 (–)
Sex	
Male	434/793 (55)
Female	359/793 (45)
Not recorded	18/811 (–)
Pregnancy status	
Pregnant	23/325 (7)
Not pregnant	302/325 (93)
Not recorded	34/359 (–)
Diagnosis	
Uncomplicated malaria	716/802 (89)
Severe malaria	80/802 (10)
Unknown type	6/802 (1)
Not recorded	9/811 (–)
Occupation	
Unemployed	203/754 (27)
Employed	45/754 (4)
Minor/student	506/754 (67)
Case classification	
Local	592/766 (77)
Imported	174/766 (23)
Not recorded	45/811 (–)

*Some percentages do not add up to 100% due to rounding.

TABLE 2 Preventive measures among malaria cases with completed case investigation forms, Kavango region, Namibia, 2014

Characteristics	Respondents with characteristic/total respondents *n/N* (%)*
Total case investigation forms, *N*	811
Ownership of LLINs	
Yes	231/659 (35)
No	428/659 (65)
Missing	152/811 (–)
Household structures sprayed	
Yes	318/703 (45)
No	355/703 (50)
Do not know	30/703 (4)
Not recorded	108/811 (–)

*Some percentages do not add up to 100% due to rounding.
LLINs = long-lasting insecticide treated nets.

not having had their houses sprayed. Further analysis showed that 39% of these confirmed cases neither owned an LLIN nor had they previously had their households sprayed.

Sociodemographic and clinical profile associated with imported malaria cases in Kavango region, 2014

Table 3 shows factors associated with being an imported malaria case. Patients with severe malaria were more likely to be classified as imported cases than patients with uncomplicated malaria (adjusted OR [aOR] 1.9, 95%CI 1.1–3.5), while those owning LLINs (aOR 0.5, 95%CI 0.3–0.9) and those whose household structures had been sprayed (aOR 0.3, 95%CI 0.2–0.5) were less likely to be imported cases.

DISCUSSION

This study shows the parasite incidence of confirmed malaria cases was constantly higher than 5/1000, with the exception of 2012, comparing well with the WHO expected parasite incidence of <100 cases/1000 for a country moving towards malaria elimination with very low transmission.[8]

Despite the large number of reported cases, less than one tenth had a completed case investigation form, the majority of whom were older children and adolescents. Close to a quarter of all cases with a completed case investigation form were imported; imported cases were also less likely to have used vector control measures than local cases.

A strength of this study is that it was undertaken in a region that accounted for more than 80% of Namibia's malaria cases, and therefore provides a solid representation of the at-risk population in the country. Routine case-based programme data were used, in line with the WHO's malaria elimination surveillance guidelines, which emphasise the importance of a case-based surveillance system.[8] The study was limited, however, by the large numbers of missing and partially filled out case investigation forms, as the study group therefore might not be representative of the entire population of confirmed cases.

The low number of case investigation forms completed during the study period could be due to the fact that the region is in a moderate-risk transmission zone, which would result in an extremely high workload for the subsequent investigation visits (within 48 h) to the households in the vicinity of the index cases. In 2014 there were no standard malaria surveillance guidelines to highlight the importance of using case-based investigation forms. Case investigations can only be undertaken if the necessary information about the index cases is collected and documented in a case investigation form that is later transmitted to the district.

TABLE 3 Factors associated with being an imported malaria case with completed case investigation form, Kavango region, Namibia, 2014

Characteristics	*n* (%)	aOR (95%CI)
Age, years		
<5	45 (32.9)	Reference
5–17	61 (21.3)	0.7 (0.4–1.1)
⩾18	35 (23.2)	0.8 (0.5–1.5)
Not recorded	15 (14.3)	—
Diagnosis		
Uncomplicated malaria	128 (21.2)	Reference
Severe malaria	28 (41.8)	1.9 (1.1–3.5)
Undiagnosed	0 (0)	—
LLINs ownership		
No	113 (28.7)	Reference
Yes	29 (14.2)	0.5 (0.3–0.9)
Not recorded	11 (22.5)	—
Household sprayed		
No	117 (34.1)	Reference
Yes	34 (11.1)	0.3 (0.2–0.5)
Do not know	5 (17.2)	0.4 (0.1–1.2)

aOR = adjusted odds ratio; CI = confidence interval; LLINs = long-lasting insecticide treated nets.

The Kavango region borders Angola, a country with high malaria transmission, and the study shows that a quarter of all cases reported in the region were imported. Imported cases were more likely to present with severe malaria, and were less likely to own an LLIN or to have had their households sprayed. This could be explained by the mobile nature of these cases and potentially poor access to treatment, leading to late presentation at a facility for treatment. Inter-country differences in vector control intervention activities between Namibia and Angola could explain the poor distribution of nets and insecticide residual spraying (IRS) not being performed in the southern part of Angola, due to efforts being focused on reducing the number of cases and deaths in the central and northern parts of the country, where the malaria burden is much higher. Furthermore, access to health facilities and malaria preventive measures are thought to be poor at most health facilities in Angola.[9] This underscores the need for neighbouring countries to work together to implement malaria control activities.

Our findings show that vulnerability to malaria has shifted from children aged <5 years and pregnant women to children aged ⩾5 years, adolescents and men,[10] and that those most at risk were children and adolescents aged between 5 and 17 years.

The results of this study have a number of implications. First, the incidence of malaria in the Kavango region is high, given that the country is reorienting its programme towards malaria elimination, and the inability to control malaria in the Kavango region could derail the progress made so far. This is evident in the sudden increase in malaria incidence in 2014 after a decline in 2012 and 2013, and could be attributed to outbreaks from human reservoirs. Second, nearly half of the confirmed malaria cases neither owned a LLIN, nor had they previously had their households sprayed. This highlights a need to effectively target vector control interventions and to increase advocacy on the importance of ma-

laria prevention measures. Social mobilisation and health promotion are also necessary to encourage communities to present early after experiencing malaria-related symptoms to prevent progression to severe malaria, which is associated with mortality.

Third, the high proportion of imported cases who were less likely to have adopted the two common vector control interventions, LLINs and IRS, demonstrates the need for inter-country malaria control programmes for neighbouring high malaria transmission countries if Namibia is to achieve malaria elimination. This has proven effective in the inter-country Lubombo Spatial Development Initiative, where vector control using IRS over a 5-year period in southern Mozambique resulted in significant declines in *Plasmodium falciparum* prevalence in the region, as well as notable declines in notified malaria cases in the low-transmission countries of Swaziland and South Africa.[11] Finally, full adoption of surveillance activities can greatly assist in fully investigating 100% of confirmed cases and foci within 48 h, thus further curbing the spread of malaria and subsequently lowering the number of malaria cases notified in the following malaria seasons. Although this would require greater human and financial resources, it would be worthwhile in assisting Namibia reach zero local malaria transmission by 2020.

As Namibia moves toward malaria elimination, increased knowledge about the changing epidemiology of the disease will require the roll-out of case-based surveillance to profile these cases, in addition to appropriate targeting of malaria interventions. Sporadic malaria outbreaks in low-transmission zones in areas bordering high-transmission countries will continue to pose a threat to malaria transmission and elimination, including frequent travellers with unknown travel history. For Namibia to manage the changing epidemiology of malaria, vector control interventions must be accurately targeted to the most at-risk regions, such as Kavango. As long as high rates of malaria transmission remain in the cross-border regions of Angola, Kavango and similar regions in Namibia will continue to experience importation and be prone to outbreaks. Cross-border collaboration with neighbouring countries should be strengthened by promoting joint vector control interventions such as LLIN distribution, increased IRS coverage, educating communities in the importance of preventive measures and encouraging early health-seeking behaviour at the onset of signs and symptoms of malaria on either side of the border. Namibia should continue to engage in sustainable interventions and cross-border collaboration to reduce the receptivity of areas prone to malaria importation.

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Contexte : Kavango, une région à risque « modéré » de transmission du paludisme, située dans le nord-est de la Namibie, est limitrophe de l'Angola, un pays à niveau de transmission plus élevé.

Objectif : Déterminer 1) les tendances de l'incidence du paludisme entre 2010 et 2014 à Kavango, 2) les caractéristiques sociodémographiques et cliniques des cas confirmés en 2014, et 3) les facteurs de risque associés aux cas classés comme importés.

Schéma : Une étude rétrospective des formulaires d'investigation des cas de paludisme a été réalisée dans les 52 structures de santé publique en 2014. L'incidence a été dérivée des données agrégées de surveillance de routine du Système de Surveillance de Santé (HIS).

Résultat : L'incidence a chuté de 53,6 pour 1000 population à 3,6/1000 et est remontée à 47,3/1000 au cours des 5 années de l'étude. Cinquante-cinq pour cent des cas ont été masculins et 49% étaient âgés entre 5 et 17 ans. Vingt-trois pour cent des cas de 2014 étaient importés et associés à un risque plus élevé de paludisme grave (odds ratio ajusté [ORa] 1,8 ; intervalle de confiance [IC] 95% 1,01–3,29), au fait de ne pas avoir de moustiquaires imprégnées d'insecticide rémanent (ORa 2,1; IC95% 1,3–3,4) et de ne pas bénéficier de la pulvérisation d'insecticide à effet rémanent (ORa 3,2 ; IC95% 2,1–5,1).

Conclusion : Les flambées sporadiques de paludisme pendant la période de 5 ans constituent une menace à l'élimination du paludisme. Un meilleur ciblage des interventions de lutte antivectorielle, une solide collaboration transfrontalière et une bonne promotion de la santé seront cruciaux pour atteindre cette étape.

Marco de referencia: Kavango es una región con un riesgo 'moderado' de transmisión del paludismo, localizada en el noreste de Namibia en la frontera con Angola; en Angola existe un nivel más alto de transmisión de la enfermedad.
Objetivo: Determinar los siguientes datos: 1) la evolución de la incidencia de paludismo del 2010 al 2014 en Kavango, 2) las características sociodemográficas de los casos confirmados en el 2014, y 3) los factores de riesgo asociados con los casos clasificados como importados.
Método: Se realizó un estudio retrospectivo de los formularios de investigación de casos de paludismo en 52 establecimientos públicos de salud en el 2014. La incidencia se derivó de los datos agregados de la vigilancia corriente del Sistema de Información Sanitaria.
Resultados: La incidencia osciló entre 53,6 y 3,6 por 1000 habitantes y aumentó a 47,3 por 1000 en los 5 años del estudio. El 55% de los casos consistió en casos de sexo masculino, y el 49% era de 5 años a 17 años de edad. Los casos importados en el 2014 correspondieron al 23% del total y se asociaron con una mayor posibilidad de paludismo grave (cociente de posibilidades ajustado [aOR, por *odds ratio*] 1,8; intervalo de confianza [IC] del 95% de 1,01 a 3,29), con una carencia de mosquiteros impregnados de insecticida de larga duración (aOR 2,1; IC95% 1,3–3,4) y con la falta de fumigación domiciliaria con insecticidas de efecto residual (aOR 3,2; IC95% 2,1–5,1).
Conclusión: La aparición de brotes epidémicos esporádicos durante el periodo de 5 años representa una amenaza a la meta de eliminación del paludismo. Las medidas como una mejor adaptación del control dirigido de los vectores, la colaboración transfronteriza y una sólida promoción de la salud serán primordiales con el fin de alcanzar esta importante meta.

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