Risk of Malaria in Visitors to the Kruger National Park, South Africa

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Background: The risk of malaria to visitors to South Africa’s nature reserves is unknown. Current recommendations for travelers are based on malaria incidence rates in local communities. These rates may well overestimate travelers’ malaria risk and lead to unnecessary use of antimalarial prophylaxis with associated drug-related adverse events. This study investigated the incidence of malaria in visitors to South Africa’s Kruger National Park (KNP).

Methods: Postal questionnaires were sent to the cohort of visitors staying in the KNP during April 1996, 6 to 8 weeks after they returned to their homes. Nonrespondents received duplicate questionnaires 8 weeks later. Responses from 3267 groups, representing 11,107 visitors (56.8%) allowed determination of the malaria attack rate in this group of travelers and assessment of associations between malaria risk and a number of factors, including type of accommodation used during the visit; duration of stay; use of chemoprophylaxis; and use of personal protection measures. All travelers indicating that they had suffered an episode of malaria following their visit were telephonically contacted and their health providers traced to determine the basis of diagnosis and clinical outcome.

Results: One clinically suspected and four confirmed cases of Plasmodium falciparum malaria among the visitors suggest a low attack rate of 4.5 cases per 10,000 visitors during April, the highest risk month for malaria in South Africa. No association was found between malaria risk and accommodation type, duration of stay, use and type of chemoprophylaxis, and use and number of personal protection measures.

Conclusions: These findings confirm the importance of careful assessment of local malaria risk before individualized advice is provided to travelers.

The risk of malaria in travelers to South Africa’s nature reserves is unknown, although the majority of these reserves are situated within the area designated as high risk for malaria by the South African Department of Health. The Kruger National Park (KNP), at over 1.949 million hectares, is the largest and most frequented wildlife haven, by both local and international visitors. Situated in the northeastern corner of South Africa (Fig. 1), the KNP is in the heart of the seasonal high-risk malaria zone.

Currently the number of reported malaria cases among local inhabitants in Mpumalanga Province during the previous decade is used as an indicator of risk to travelers. It also forms the basis for defining chemoprophylaxis recommendations. The validity of this inference must be questioned as there are profound dissimilarities in exposure to malaria vectors between visitors and local inhabitants. Factors contributing to this disparate risk include length of stay in the malarious area, location of dwelling in relation to vector breeding sites, exorbitant cost to local residents of most commercially available personal protection measures, and type of accommodation. Air conditioning, window and door screens, and indoor spraying with residual insecticides all contribute to reduced exposure among visitors compared to locals.

In the past, increases in malaria cases among local residents have led to media furore and cancellation of planned visits by prospective travelers. As this predominantly rural area is dependent on ecotourism for socioeconomic development, it was considered important to quantify the risk of malaria to visitors to the KNP. This study investigated the incidence of malaria in visitors to the KNP during April 1996, and the use of chemoprophylaxis.

Methods

The database of addresses of all persons making a reservation to stay in the Kruger National Park (KNP) during April 1996 was provided by the National Parks
The month of April was chosen as this is historically the month with the greatest number of malaria cases in South Africa. A 10-year review revealed that during April there was a relative increase in reported malaria cases of 89.6% over the monthly average.4

A questionnaire was designed to determine whether any visitor to the KNP during this period developed malaria, and to investigate the use of personal protection measures and chemoprophylaxis among visitors. The questionnaire was posted to the person responsible for any individual or group booking of less than seven persons. This cut-off was chosen because a contact address was available only for the person making the reservations, and distribution of copies of the questionnaire to other members of the group depended upon this individual's cooperation and goodwill.

The questionnaire was accompanied by a short letter explaining that the survey was being conducted to ensure the health and safety of future visitors. This letter, on the National Park's letterhead and signed by the Chief Warden of the KNP, urged travelers to complete the questionnaire. The questionnaire was first posted 6 to 8 weeks after the visitors' departure to their homes. Those travelers who did not respond within 8 weeks received a duplicate questionnaire with a second letter from the Chief Warden, politely requesting their assistance.

Questionnaires were mailed to 5938 groups representing 20,521 visitors. One hundred and eighty-two envelopes were returned unopened because of postal delivery failures. The person responsible for making the booking for 5756 groups (representing 19,931 visitors) thus received a questionnaire. Responses were received from 3267 groups (56.8%), representing 11,107 visitors, and 7397 individuals (66.6%) from these groups responded.

All cases of malaria indicated on returned questionnaires were personally traced and telephonically interviewed by the principal investigator. Medical staff responsible for treating these respondents were then also interviewed to determine the basis for diagnosis and to discuss the clinical presentation and treatment of cases.

Data was captured into a customized Access for Windows Version 7 database, and statistical analysis was performed using the SSPS for Windows 95 software package. Malaria attack rates were calculated to determine the incidence of Plasmodium falciparum infections per 10,000 visits during the month of April. Fisher's exact test was used for comparing proportions between groups, and two-tail significance testing was used throughout. The small number of cases precluded investigation of interactions between covariates by logistic regression methods.

Results

Four laboratory-confirmed (Giemsa-stained blood films) cases of malaria due to Plasmodium falciparum were diagnosed, and an additional case was diagnosed and treated on the basis of clinical suspicion alone. The latter case had negative results both by Giemsa stained films and Quantitative Buffy Coat (QBC) testing. The risk of P. falciparum malaria per 10,000 visitors during the month of April was thus 3.6 (95% CI 1.0–9.2). If the unconfirmed case was included, the risk increased fractionally to 4.5 (95% CI 1.5–10.5) malaria cases per 10,000 visitors during the month of April. Some details of the cases are reflected in Table 1.

The malaria attack rate was not influenced by the duration of stay. Four of 6110 visitors staying for less than a week (0.07%) and one of 1201 visitors staying for a week or more (0.08%) contracted malaria (p = .592).

Of 7074 visitors for which information on the type of accommodation used was available, the majority, or 4926 visitors (69.6%), stayed in bungalows, while 1896 (26.8%) stayed in camping sites, and 252 (3.5%) stayed in both forms of accommodation at different camps during their stay. Development of malaria was not asso-
associated with the type of accommodation used. Three confirmed cases had stayed exclusively in bungalows, compared to two cases (one proven and one clinically suspected) that had stayed in a camp site during their visit ($p = .643$).

The majority of visitors who responded to the question on use of chemoprophylaxis (591917310 [81.0%]) indicated they had made use of chemoprophylaxis during their stay in the KNP. Three of the malaria cases (including the case diagnosed on clinical grounds) had used chemoprophylaxis during their visit, while two cases had not. Although the malaria attack rate varied between the two groups, at 0.05% and 0.14%, respectively; this difference was not statistically significant ($p = .243$).

Closer scrutiny of the three “breakthrough” cases which used chemoprophylaxis revealed that there were two cases of proven malaria in the 2605 visitors using chloroquine and proguanil, with an attack rate of 7.7 per 10,000 visitors during the month of April (95% CI 0.9–27.7). The unconfirmed case (clinically suspected by a medical officer), one of the 1347 travelers using mefloquine, gives an attack rate of 7.4 (95% CI = 0.2–41.3); there were no cases in the smaller groups of travelers employing chloroquine alone (n=1150), proguanil alone (n=253), doxycycline (n=67) or any other drug (n=497).

There was also no important difference in the incidence of malaria in those who reported taking every dose of chemoprophylaxis as prescribed (2/4850) and those that reported imperfect adherence with the dosing schedule (1/1003) ($p = .431$). The majority of visitors made use of personal protection methods: 6122 of the 7034 visitors (87%) with valid responses. The malaria attack rate was not associated with use of personal protection measures. There were four cases in 6122 people (0.07%) reporting use of at least one personal protection measure compared to one case of malaria in 912 people (0.11%) not employing any personal protection measures ($p = .501$).

The number of protection methods used was investigated. Where information was provided it was found that 912/7034 visitors (13.0%) had used no personal protection, while 1907 (27.1%), 1565 (22.2%), 1441 (20.5%), 819 (11.6%) and 390 travelers (5.5%) had used one, two, three, four, and five or more measures, respectively.

When the incidence of malaria was investigated by the number of measures employed, it was found that the number of methods used did not substantially influence the attack rate. The attack rate, for example, among those visitors reporting the use of less than three measures was 0.07% during the month of April (3/4384) which was similar to the attack rate in those using three or more measures of 0.08% (2/2650) ($p = 1.000$).

Adverse events were frequently reported by users of all chemoprophylaxis regimens, with an overall cumulative incidence of 23.8% (n = 1355) in 5704 visitors responding to the question “Did you experience any symptoms while on the antimalarial medication?”

### Table 1: Details of Malaria Cases among Kruger National Park (KNP) Visitors, April 1996

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Age [years]</th>
<th>Gender</th>
<th>Duration of Stay [days]</th>
<th>Accommodation</th>
<th>Prophylaxis</th>
<th>Compliance</th>
<th>Other Exposure*</th>
<th>Basis of Diagnosis</th>
<th>Therapy</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47</td>
<td>F</td>
<td>6</td>
<td>Campsite</td>
<td>Chloroquine &amp; proguanil</td>
<td>Yes</td>
<td>GBF (Pf)</td>
<td>Quinine &amp; doxycycline</td>
<td>Complete</td>
<td>Complete</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>M</td>
<td>3</td>
<td>Bungalow</td>
<td>None</td>
<td></td>
<td>Mozambique for 8 d after leaving KNP</td>
<td>GBF(Pf)</td>
<td>Quinine</td>
<td>Complete</td>
</tr>
<tr>
<td>3*</td>
<td>41</td>
<td>F</td>
<td>1</td>
<td>Bungalow</td>
<td>None</td>
<td>Mefloquine</td>
<td>Comoros for 1 wk before KNP visit</td>
<td>GBF(Pf)</td>
<td>Quinine</td>
<td>Complete</td>
</tr>
<tr>
<td>4</td>
<td>28</td>
<td>F</td>
<td>4</td>
<td>Bungalow</td>
<td>None</td>
<td></td>
<td></td>
<td>GBF(Pf)</td>
<td>Comoros Halofantrine (clinical diagnosis)</td>
<td>Complete</td>
</tr>
<tr>
<td>5</td>
<td>65</td>
<td>M</td>
<td>10</td>
<td>Campsite</td>
<td>Chloroquine &amp; proguanil</td>
<td>Irregular use of drugs</td>
<td>GBF(Pf)</td>
<td>Quinine</td>
<td>Complete</td>
<td></td>
</tr>
</tbody>
</table>

*Exposure in another high-risk malaria area epidemiologically compatible with incubation period; † GBF (Pf) = Plasmodium falciparum parasites diagnosed by Giemsa blood film.

†Recalls walking into swamp area after dark and suffering multiple mosquito bites.
Conclusions

The choice of prophylaxis for visitors to malarious areas is becoming increasingly more complex due to drug resistance in Plasmodium falciparum parasites. In chloroquine-resistant areas, the use of alternative regimens has resulted in an increase in the frequency of adverse events. Although few people suffer adverse events of a magnitude necessitating hospitalization, many visitors experience an impaired sense of well-being.4

Attempts to provide general recommendations for travelers are made difficult by the frequency of contraindications. For example, in one study 9% of travelers had contraindications to the use of mefloquine for malaria prophylaxis.5 There are presently also inconsistencies in specific recommendations for visitors to South Africa.6-8 These considerations have served to complicate the provision of sound advice to travelers, and may partly explain the present finding that nearly 20% of respondents were not using chemoprophylaxis despite national and international recommendations for travelers to this area.

The low attack rate of 4.5 cases of P.falciparum malaria per 10,000 visitors during the highest risk month of April may actually represent an underestimate of the usual risk to travelers as the survey was conducted during the most extensive malaria epidemic in the area in more than 10 years. There were 10,195 malaria cases notified for 1996 in Mpumalanga Province, compared to 2797 cases in 1995 and 3198 in 1994, indicating that the intensity of transmission exceeded the norm.9 During April 1996 alone, there were 1745 cases of malaria reported to the Malaria Control Programme in Mpumalanga. Further, previous experience has indicated that those who have experienced disease are more likely to respond to a postal survey. Careful consideration of case details also revealed that two of the malaria cases had visited other malaria endemic areas shortly before the onset of symptoms. The visitor to Mozambique, in particular, was more likely to have contracted his malaria outside the KNP.

The risk of malaria was not associated with either the type of accommodation used during the visit; duration of stay; use of chemoprophylaxis and the specific chemoprophylactic agent utilized; and use of personal protection measures and number of measures employed. This intriguing finding deserves further study in this and other similar areas that are affected by seasonal malaria and frequented by travelers.

There can be little doubt that the use of prophylactic agents has been effective in reducing the risk of contracting malaria in nonimmune travelers to endemic areas with a high force of infection. However, in areas of low transmission, the risk of adverse events attributed to chemoprophylaxis may exceed the benefit of avoided infections.10,11 In addition, the use of chemoprophylaxis without appropriate education may lead to a false sense of security and irresponsible behavior.

The “beginning of effective malaria prevention is the traveler’s awareness of the risk of malaria,”7 and health workers, the media, and travel agents have an important role to play in disseminating accurate advice. It is important to document the actual risks for specific areas so that advice is factual and sensible.12-14 The present findings emphasize the importance of educating travelers to South African nature reserves about malaria, with emphasis placed on avoidance of mosquito bites and prompt investigation of fever.15,16

Risk is not static, and climate, weather and other ill-defined factors profoundly affect the dynamics of mosquito-borne infections. There will therefore be a need to regularly monitor the local situation and provide updated information on risk.17

Health care workers should not feel “helpless in the face of a population of patients who have an overwhelming need to alter chemically their experiences of the world in which they live”18 but must strike a balance between the risk of infection, the severity of disease, the availability of experienced medical care, the protection offered by preventive measures, and the potential risks associated with such measures, before tailoring advice on chemoprophylaxis for individual travelers.

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References


Taylor Valley (one of the “dry valleys” in Transantarctic Mountains). Submitted by Paul Prociv, MB BS, PhD.