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Malaria and travel : where does it come from?

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- How common are cases like this?
- Could we get an outbreak in the UK

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Malaria in UK

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- 16th to 19th century cases in England
 - ‘Ague’, ‘marsh fever’, intermittent fever
- Term ‘malaria’ first used on 19th cent
 - Meaning: ‘bad air’
- Last major outbreak
 - Isle of Sheppey during First World War.
 - Servicemen returning from Macedonia carrying malaria parasites in their blood were billeted on the edge of town.
 - local mosquitoes bit convalescing soldiers.
 - These mosquitoes then went on to infect 32 local people over a period of several years

Source: Wellcome Trust

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UK malaria

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- British malaria infection from an aircraft was in July 1983 when two people were infected in a village several miles from Gatwick Airport. A pub landlord and a motorcyclist passing through the village both contracted the disease.
- “Women seemed to die most frequently, so men from East Anglia used to go to Essex to get new wives”
 - Increased mortality during pregnancy?

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Malaria Plasmodium species



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<p><i>Plasmodium falciparum</i></p> <p>Africa SE Asia Latin America</p> <p>(original image provided by Steve Almy)</p>	<p><i>Plasmodium malariae</i></p> <p>Africa SE Asia Latin America</p>
<p><i>Plasmodium vivax</i></p> <p>Middle East Asia Western Pacific Latin America Africa</p> <p>(original image by Mark Lontis)</p>	<p><i>Plasmodium ovale</i></p> <p>Tropical Africa West Pacific</p>

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Vectors

- The malaria parasite is transmitted by *Anopheles* mosquitoes
- Many different species – in total approx 70 out of 420 species are able to transmit the parasite

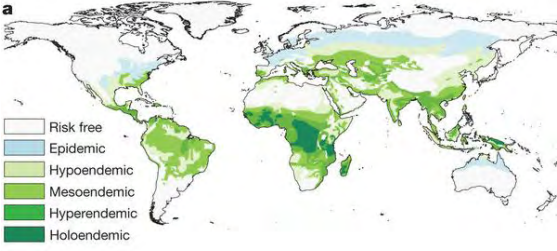



Anopheles

• Anopheles	• Anopheles	• Anopheles	• Anopheles	• Anopheles
• Anopheles	• Anopheles	• Anopheles	• Anopheles	• Anopheles
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Historical malaria prevalence



a

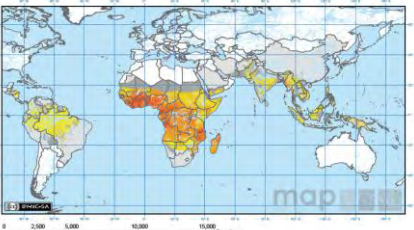
- Risk free
- Epidemic
- Hypoendemic
- Mesoendemic
- Hyperendemic
- Holoendemic

Getthing et al Nature 2010

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Prevalence of *P. falciparum* in 2007

The spatial distribution of *Plasmodium falciparum* malaria endemicity in the World



Source: www.map.ox.ac.uk

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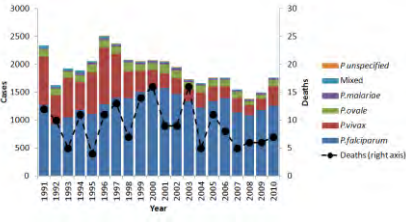
Imported cases

- Travellers from the UK who visit malaria endemic areas may contract malaria
 - Treated abroad
 - Report symptoms when arrive back in the UK
- Visitors to the UK may be infected with malaria
 - May be more likely to have some immunity
 - Delays in reporting
- Reporting is of symptoms only, so case numbers are believed to be underrepresentative

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UK cases

- Vast majority of travellers to affected areas are not affected.
- ~2,000 cases reported per year
- Majority *P. falciparum* – most likely to be symptomatic
- ~5-10 deaths per year



Data source: Health Protection Agency

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Advice to travellers

The ABCD of Malaria Treatment

A: be Aware of the risk of malaria if you are travelling to a foreign country.

B: avoid mosquito bites by taking appropriate measures. Reducing the number of bites reduces the chances of getting malaria.

C: Comply with the appropriate prophylactic drug regimen for the area you are visiting. This is vitally important since failure to comply places you at great risk. Studies have shown that there is a reduced risk of contracting malaria even if you take the wrong regimen.

D: Awareness of the residual risk, and prompt Diagnosis and treatment of clinical malaria

- Many online sources of information
- Many suppliers of prophylactic drugs
- Variable adherence

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- Choices depend on resistance profile
- Can be very expensive
- Require pre- and post- exposure adherence
- <http://www.cdc.gov/malaria/travelers/drugs.html>

You searched for city named Bangkok, in the province of Bangkok Metropolis, in the country of Thailand
 NOTE: Malaria information generally available only for the province and country in which the city is located
 Malaria in Province:

Province Name	Malaria in Province	Prophylaxis for this State/Province/District
Bangkok Metropolis	None	Not applicable

Malaria in Country:

Country Name	Malaria in Country	Drug Resistance	Malaria Type	Prophylaxis for Areas with Malaria
Thailand	Rural, forested areas that border Cambodia, Laos, Burma (Myanmar) Rural, forested areas in districts of Phang Nga and Phuket. None in cities of Bangkok, Chang Mai, Chang Rai, Pattaya, Koh Samui, Koh Phangan, Phang Nga, and Phuket.	Chloroquine Mefloquine	P. falciparum 50% (up to 75% some areas), P. vivax 50% (up to 60% some areas), P. ovale remainder	Atovaquone/proguanil or doxycycline.

Imperial College London **Severe disease** MRC Medical Research Council

- *P. falciparum* associated with hospitalisation and fatalities
- Study of admissions in UK showed protective effect of previous exposure and

Table 2. Multivariate analysis of factors associated with the risk of severe falciparum malaria, according to the World Health Organization definition of severity.

Variable	OR (95% CI)	p
Ethnic group		<.001
Black	1.00 (reference)	
Asian	8.05 (2.93–22.1)	
White	8.20 (2.94–22.9)	
Previous malaria		.01
No	1.00 (reference)	
Yes	0.35 (0.15–0.80)	
Parasitemia		<.001
<2%	1.00 (reference)	
≥2%	4.93 (2.22–11.0)	
Hemoglobin level	0.75 (0.63–0.90)	.002
WBC count	1.39 (1.15–1.68)	.001
Platelet count*	0.47 (0.31–0.72)	<.001
Creatinine level [†]	13.1 (2.73–63.1)	.001

NOTE. The final regression model was based on 408 patients with available data (of a total of 462 patients).
 * OR is given for a 50-U change in the explanatory variable.
 † Variable was analysed on a log scale.

Source: Phillips *et al* Clinical Infectious Diseases 2009, 48

Imperial College London **Relation to travel patterns** MRC Medical Research Council

- Increasing travel to malaria endemic countries
- No large changes in number of cases
- Suggest good adherence to protective measures by most groups

Fig 11 Reported cases of malaria, 1987 to 2006

Source: Smith *et al* BMJ 2008

Imperial College London **UK Cases** MRC Medical Research Council

- Majority of cases are from West Africa, particularly Nigeria

Source: Pinsent *et al* submitted.

Imperial College London **Number of visitors from UK** MRC Medical Research Council

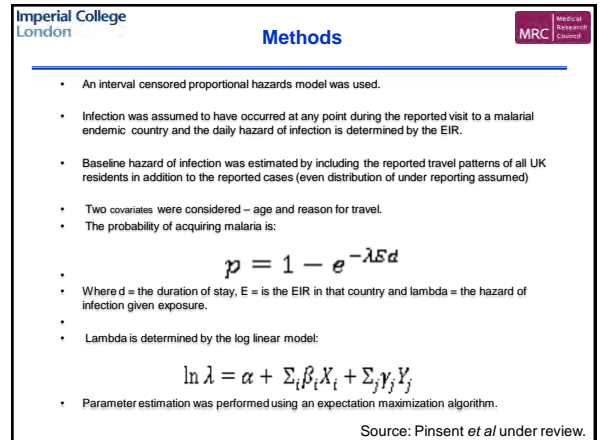
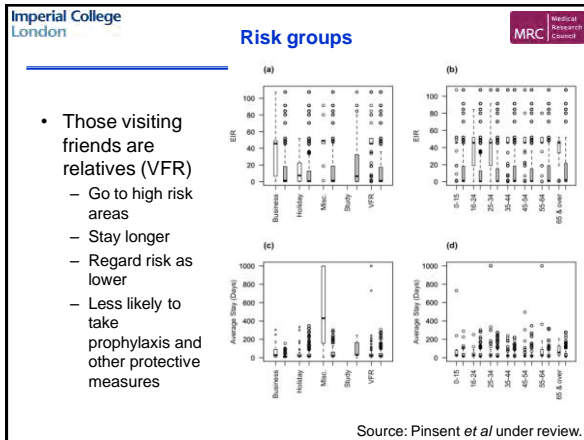
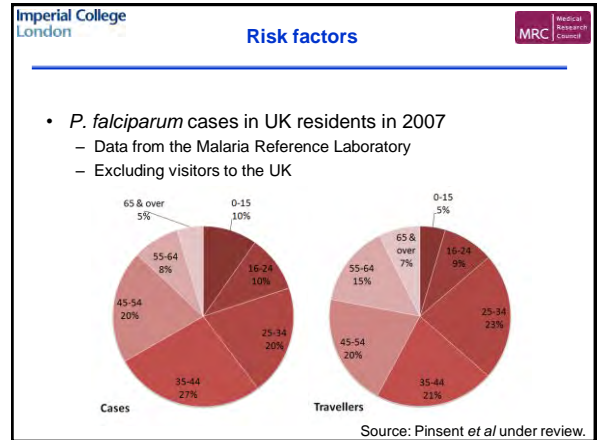
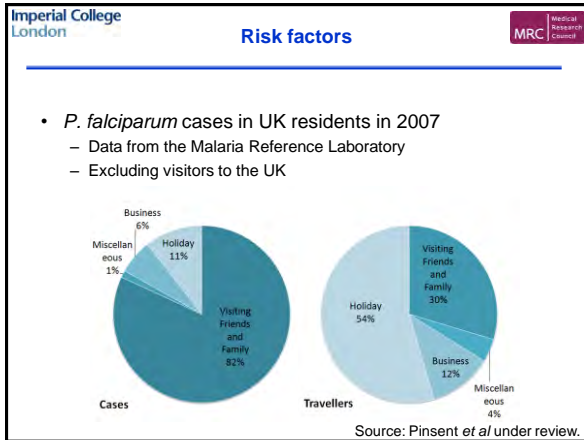
- Highly variable depending on country visited

Source: Pinsent *et al* submitted.

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- Entomological Inoculation Rate (EIR) – number of infectious bites per person per year

Source: Pinsent *et al* under review.



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	Hazard Ratio (95% confidence interval)	p	Adjusted hazard ratio (95% confidence interval)	p
Purpose		<0.0001*	<0.0001*	
VFR	6.1 (5.9-7.2)	<0.0001	6.2 (6.4-16.8)	<0.0001
Miscellaneous	0.47 (0.45-0.53)	<0.0001	0.47 (0.29-0.57)	<0.0001
Business	2.4 (1.9-3.2)	<0.0001	3.6 (2.7-4.9)	<0.0001
Holiday	1		1	
Age (years)		<0.0001*		<0.0001*
0-15	1		1	
16-24	0.21 (0.14-0.24)	0.002	0.28 (0.21-0.37)	<0.0001
25-34	0.15 (0.13-0.18)	<0.0001	0.19 (0.15-0.25)	<0.0001
35-44	0.13 (0.10-0.17)	<0.0001	0.12 (0.08-0.15)	<0.0001
45-54	0.30 (0.28-0.34)	<0.0001	0.44 (0.32-0.59)	<0.0001
55-64	0.33 (0.23-0.59)	<0.0001	0.52 (0.38-0.68)	<0.0001
65 & over	0.47 (0.35-0.62)	<0.0001	0.41 (0.32-0.54)	<0.0001

Source: Pinsent *et al* under review.

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Table 1 Key determinants of incubation period for *P. falciparum*. The acceleration factor indicates the proportional increase (>1) or decrease (<1) in the median time from infection to onset of symptoms.

Factor	Estimate	Acceleration Factor (95% confidence interval)	p-value
Self reported previous malaria			
No	1.00	Reference	
Yes	99	(2.7-3560)	0.012
Ethnic Origin			
African	1.00	Reference	
Asian	0.15	(0.0022-9.8)	0.37
Caucasian	0.40	(0.0037-4.2)	0.70
Use of antimalarials			
No	1.00	Reference	
Yes	13	(0.56-320)	0.11

Source: Hollingsworth *et al* in prep.

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An outbreak in the UK?

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THE INDEPENDENT ON SUNDAY UK

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Malaria kills BA steward and leaves two se

The death of a cabin crew member raises concerns that a change in drug staff at risk

By Jane Herrick, Political Editor

Sunday, 1 February 2009

Britain's largest union demanded an urgent investigation yesterday after a British Airways cabin crew member died from malaria and two others were left seriously ill from the disease.

A BA air steward caught the most deadly strain of malaria after working on a flight from Heathrow to Ghana. Two more became ill after flying to other destinations. Officials from Unite, which represents cabin crew, raised

ABC NEWS WORLD EDITION

You are in: UK: England

Wednesday, 23 August, 2002, 10:26 GMT 19:26 UK

Inquiry into Heathrow malaria case

The disease could have come through Heathrow Airport

A man who works near Heathrow airport has been struck down with malaria.

It is thought the patient, who has not been named, may have contracted the disease from a bite by a mosquito transported to Britain via the airport.

The man has now recovered, but had not been named to any country affected by malaria.

A report on the case in New Scientist magazine says officials from the Public Health

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Vectors

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- Britain has five native species of mosquito that can carry a strain of the disease called vivax malaria, which was rife from the 16th to 18th centuries.

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Environment and transmission

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- Environment affects dynamics of
 - Vector growth
 - Parasite development

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Climate suitability for transmission

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- Using climate models and data from 1917-1918 presence of malaria
- Mapped current climate suitability for malaria
- Correspond to presence of vectors and historic cases

Figure 2 Malaria risk across Great Britain for the 1961-1990. Shading represents the number of months where the climate could support vivax malaria if it were introduced. Red circles show cases of vivax malaria (some of which will have been malaria cases) in the 19th Century [1].

Source: Lindsay et al Malaria Journal 2009

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Future climate suitability?

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- Future climate in the UK is favourable for the transmission of vivax malaria,
- Risk of locally transmitted malaria is considered **low** because of
 - low vector biting rates
 - low probability of vectors feeding on a malaria-infected person.

Figure 3 Malaria risk across Great Britain for 2015 (a) and 2030 (b). Shading represents the number of months where the climate could support vivax malaria if it were introduced.

Source: Lindsay et al Malaria Journal 2009

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Summary

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- These data indicate that malaria, an almost completely preventable disease but one which can be fatal, remains a significant issue for UK travellers.
- Failure to take prophylaxis is associated with the majority of cases in UK residents travelling to malarial areas.
- There is continuing evidence that those of African or Asian ethnicity going to visit friends and relatives are at increased risk, and those providing advice should engage with these travellers wherever possible.

HPA Epidemiology of malaria