

Background

During the late 1970s, a combination of improved housing and socioeconomic conditions, water management, vector-control efforts, and case management was successful at interrupting malaria transmission in Tunisia. [4] The country became malaria free since 1979 and the majority of notified malaria cases in Tunisia acquired the infection in malaria endemic countries. However, the re-emergence risk of local foci is not considered impossible because *Anopheles labranchiae* and *Anopheles sergenti*, the former vectors of malaria in Tunisia, are still present and are increasing following the building of dams and manmade lakes. [6] Notification of malaria cases is obligatory but national authorities considered that data underestimate the true situation and that underreporting is considerable.

The objective of this study was to describe malaria surveillance data and to estimate the total number of malaria cases and the completeness of malaria notification in Tunisia between 2002 and 2007 using record-linkage and capture-recapture methodology.

Methods

We conducted a retrospective epidemiological survey using a standardized questionnaire, in which sociodemographic (sex, age, country of birth, place of residence, reporting center, hospitalization, country of travel), diagnostic (species, technique), chemoprophylaxis and treatment variables were collected, as well as the dates of onset of symptoms, diagnosis, and hospital admission. Information about completion of the chemoprophylaxis treatment was also noted.

Imported malaria is defined as an infection acquired in an endemic area by an individual (either Tunisian or other nationalities) and diagnosed in Tunisia.

The completion of notification was assessed by searching for cases which were also reported to the public healthcare system (PHCS) and diagnosed in parasitological laboratory using two-source-capture-recapture method (CRM). Completion refers to the proportion of cases detected by the notification system.

On the basis of previous literature, the estimated number of cases (N) is:

$$N = \frac{(a + b + 1) \times (a + c + 1)}{(a + 1)} - 1$$

b and c are the number in only one of the sources.

$$C = \frac{(a + b)}{N} \times 100$$

b is the number of malaria cases only known to PHCS
"a+b" are the number of cases known to PHCS.

To calculate the completion of notification relative to the estimated number of cases (C) is:

Results

After record-linkage and cross-validation 317 cases of malaria were identified, of whom 231 were notified, resulting in an observed under-notification of 17%. The estimated number of malaria cases using capture-recapture analysis was 366 (95%CI [336-397]) for the period of study with a completeness of 63.1% which increased from 44.8% for 2002 to 78.7% for 2007. 162 patients (51.1%) had been born in sub-Saharan Africa, 113 (35.6%) in Tunisia, 35 (11.0%) in North Africa and 7 (2.2%) in Europe with predominance of men (87.1% of all cases). The median age was 25.0 years (21-30) for sub-Saharan Africans, 38.0 years (23.5-45.5) for North Africans, 38.5 years (30.75-38.5) for Tunisian and 39.0 (26-43) for European ($p < 10^{-3}$). The most predominant malaria species was *P. falciparum* with 216 cases (72.5%), and the most frequent area of acquisition was sub-Saharan Africa. In our study, information on compliance with malaria prophylaxis was only sporadically available and 34% of Tunisian infected individuals had not used any chemoprophylaxis.

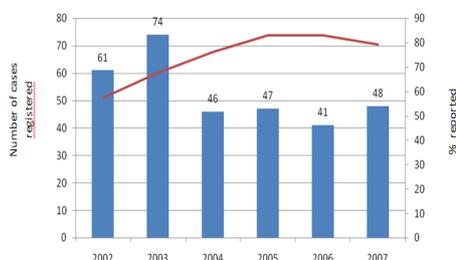


Figure 1: Trend of registered malaria and the proportion of cases reported to PHCS per

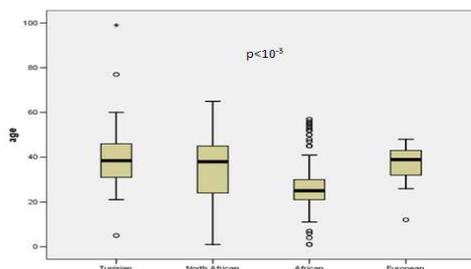


Figure 2: Age comparison of malaria patients by nationalities

Table 1: Results of capture-recapture method of malaria cases in Tunisia and completeness of declaration by year

Year of diagnosis	Two sources of notification (a)	Public Health Care system declaration (b)	Laboratory confirmation and notification (c)	Total number of cases by capture-recapture (N)	95% CI (N)	Completeness (%)
2002	19	16	24	78.2	[63.1-93.3]	44.8
2003	27	23	20	86.4	[72.2-100.6]	57.9
2004	20	15	7	47.0	[39.7-54.3]	74.5
2005	17	22	8	56.8	[43.5-70.0]	68.7
2006	18	16	6	45.1	[37.1-53.0]	75.5
2007	18	20	5	48.3	[39.3-57.3]	78.7
Total	119	112	70	366.3	[335.8-396.8]	63.1

Table 2: Comparison of epidemiological characteristics of Tunisian patients with others nationalities

Characteristics	Tunisian N (%)	Other nationalities N (%)	p value
Age (md, IR) years	98 (38.5, 15)	145 (26.0, 16)	$< 10^{-3}$
Sex (M/F)	104(92.0)/9(8.0)	153(84.1)/29(15.9)	NS
Purpose of travel			
Missionary work	62(95.4)	13(13.1)	
Tourism	-	1(1)	
Study	-	74(74.4)	
Sport manifestation	2(1.8)	5(5.1)	
Others	1(0.9)	6(6.1)	
Hospital admission(yes/total)	81/99(81.8)	87/130 (66.9)	0.012
Hospitalization duration (md, IR) days	47(5.0, 4)	30(3.5, 2)	$< 10^{-3}$
Delay before care (md, IR) days	54(5.0, 6)	39(5.0, 3)	NS
Delay before diagnosis (md, IR) days	55(14.0, 15)	52 (12.5, 20)	NS
Chemoprophylaxis Received	42(66.7%)	NA	

Discussion and conclusion

Our study shows delayed identification of malaria that indicates a deficit in medical awareness and expertise in the management of this infection. Lack of homogeneity in the collected data has been the major obstacle to quantifying the problem of malaria in Tunisia and to estimate incidence. An active survey with a standardized form to collect key data variables on malaria cases could be introduced. Cooperation with the travel industry should lead to the development of preventive strategies to increase malaria awareness of travelers. In addition, the medical profession must be conditioned to consider malaria in the differential diagnosis of any explained fever. More studies are needed in order to better characterize the population at high risk of imported malaria and to improve awareness of the disease and the information provided to Tunisian travelers to malaria endemic areas. Improvement in surveillance and reporting would therefore help to quantify incidences, identify risk groups and provide an indication of the prophylactic efficacy. [20] A standardized form of data on malaria cases could be introduced with the creation of a one page short form with key data variables, including demographic information (age, sex, nationality, occupation) reason for travel, area of acquisition of infection, chemoprophylaxis used, date of diagnosis, species identification, and outcome.