

## SOCIOECONOMIC AND ENVIRONMENTAL FACTORS AFFECTING MALARIA INFECTION IN FAYOUM GOVERNORATE, EGYPT

By  
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### Abstract

Malaria as a disease has been identified in Egypt since ancient times. Remnant residual foci are still localized in two districts; Sinnuris and Faiyom, Faiyom Governorate. The work focused on socioeconomic and environmental factors affecting malaria infection. The results showed that malaria infection increase with the decrease of socioeconomic level of families, educational level of examined individuals and among unemployed or students. The infection increase among those lived in muddy or bad constructed house near the breeding places. The infection decreased significantly among who owned animal sheds and had large number of animals. The indoors use of 5% mala-thion did not affect the malaria infection.

**Key words:** Malaria, Egypt, Faiyum Governorate, socioeconomic and environmental factors.

### Introduction

Malaria is the global problem causing over 1 million deaths every year. About 40% of the world's population; mostly those living in poorest countries are at risk of malaria (WHO, 1991). Malaria was perpetuated thereby continuous importation in Arab Countries (El-Refaie *et al.*, 1984; Thomas, 1998).

Human malaria is caused by *Plasmodium falciparum*, *P. vivax*,

*P. ovale* and *P. Malariae* (WHO, 1986, 1995).

Morsy *et al.* (1995,a,b) in Egypt studied the bionomics and the vector competence of the adult Anopheline mosquitoes in El Faiyum Governorate, Egypt

This study aimed to clarify the socioeconomic and the environmental factors affecting the malaria in El Faiyum Governorate, in order to

pave the way to the control measurements.

### **Subjects, Material and Method**

El Faiyum Governorate is more or less an agricultural oasis. It lies 90 km south west of Cairo in a depression averaging 20m, below the sea level. It is located between latitude 29° 45' and 30° 15' and longitude 30° 30' and 31°, it occupies an area of about 1778 km<sup>2</sup>, of population around 1,600,000. Faiyoum Governorate is composed of five centers; Faiyum, Sinnuris, Ebshway, Itsa and Tamiya. It is irrigated by Baher Youssef, a branch of the River Nile which breaks up into a number of streams before its water flow into Qaroun Lake. The lake lies in a depression averaging 45m, below the sea level. It is shallow lake of a depth about 6-7m, with a length of 45 km and a width of 9 km with averaging surface area of about 214 km<sup>2</sup>.

El Faiyum Governorate contains an open irrigation system with 39,000 km of water ways. It has many green lands irrigated all year round. Alfalfa, corn, rice, wheat, sugarcane, cotton and many vegetables are seasonally cultivated in the fields. Date palms and citrus orchards are present.

The population is around 1,600,000. Faiyoum Citizens are mostly farmers, workers, government employees, students and some nomads.

Primary and preparatory schools for basic education as well as secondary schools (general and technical) are spread all over the Governorate. Nowadays, few faculties are established as a nucleus for Faiyum University.

Kafr Fazara village was selected for implementating the study work since most of the reported malaria cases either originated from the village or the surrounding areas. It is located closely to the central part of sinnuris District with its north border lying on Qaroun Lake; it occupies an area of 1437 Feddans, of which 1387 Feddans are cultivated.

Most of the houses are located in the vicinity of the water streams. They are constructed of mud bricks with thick walls and a high ceiling supported by date logs. This type of construction provides insulation from the desert heat. Most of the houses contain one or more rooms for domestic use and one or two animals' sheds which are made of mud bricks with high ceilings partially supported by palm logs and thatch, to hold animals inside during night. Other houses are modern, which are built using red bricks and concret and provided with electricity and water supply. Disposal of domestic excreta in Kafr Fazara village is through septic tank in some houses. In most cases there is no tight cover. An overflow occurs frequently leading to accumulation of sewage materials around houses which pave the way to form suita-

ble breeding places especially for mosquitoes, besides, its offensive disturbing odour. In the majority of the houses especially those located in vicinity of water channels, inhabitants pour their excreta directly into the nearest water streams.

Domestic animals including cows, buffaloes, sheep, goats, donkeys and rabbits and a variety of birds such as ducks, geese, pigeons and chickens are reared in most of the houses. The last two kinds of the birds are often kept under the beds in bedrooms. All roads in Kafr Fazara village are unpaved except the major road linking Kafr Fazara village with nearing villages. Donkeys are the main means of transportation in the villages. Transportation by microbus is frequently used on the paved road.

A preliminary census of all households in the studied village was done, covering their composition, housing characteristics, house numbering, and possession of domestic animals and availability of predomestic vector breeding sites. Sketch maps of the study village were prepared. All useful information was plotted such as location of the different villages in the district, location of the houses and their relation to agricultural lands, water streams, swamps, brick factories...etc. Kafr Fazara which is a

small village in Sinnuris District contains 5 working brick factories scattered inside the village. It contains 856 houses with a population around 7000 inhabitants, most of them are farmers.

The high level of subsoil water leads to the formation of many pools, seepage water collections and swamps around the houses. There was a big swap (Abou-Naoura) about 2 feddan located at the western end of the village. It was formed as result of intensive excavation of the agricultural land to use the clay in brick industry. In one village nearby Kafr Fazara, the bursting of the subsoil water inside the house led to the formation of a small spring.

Systemic parasitological and entomological studies were implemented during the period from January to December, 1996. Prior to this since September 1995 tracing of the recorded positive malaria cases attending Sinnuris Malaria Unite (SMU) has been initiated and continued throughout the study.

Statistical analysis: Computer analysis data was carried out by PC using the Epi Info and SPSS for windows software packages. The 0.05 cut-off value was used as a criterion for statistical significance and all statistical tests were interpreted in a two-tailed fashion.

## Results

The details of the present study are in tables (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, & 11).

Table 1: Patients and controls according to individuals' educational level.

Education level	Positive		Negative	
	No	%	No	%
Illiterate or read and write	32	71.1	234	81.3
Basic education (primary, preparatory)	11	24.4	34	11.8
High education (secondary, university)	2	4.5	20	6.9
Total	45	100.0	288	100.0

X= 5.47, P>0.05

Table 2: Patients and controls according to occupations.

Occupations	Positive		Negative	
	No	%	No	%
Farmer	2	4.4	57	19.8
Worker	5	11.1	8	2.8
Employed	0	0.0	11	3.8
Student and/or unemployed	38	84.5	212	73.6
Total	45	100	288	100

Mont Carlo P = 0.004

Table 3: Patients and controls according to crowding index.

Crowding index (person/room)	Positive		Negative	
	No	%	No	%
Low	1	2.2	53	18.4
Middle	18	40.0	137	47.6
High	26	57.8	98	34.0
Total	45	100.0	288	100.0

X= 12.66, P < 0.05

$$\text{Crowding index} = \frac{\text{No. of persons/family}}{\text{No. of rooms}}$$

Low crowding index , 1 person/room, Middle crowding index 2 persons/room, High crowding index 3 or more persons/room.

Table 4: Patients and controls according to socioeconomic levels.

Socioeconomic level	Positive		Negative	
	No	%	No	%
Low	45	100	273	94.8
Moderate	0	0	15	5.2
Total	45	100	288	100

Fisher's exact P = 0.237

Table 5: Patients and controls according to house construction.

Type of house construction	Positive		Negative	
	No	%	No	%
Red brick walls and woody ceilings	21	46.7	114	39.6
Muddy walls and woody or muddy ceilings	16	35.5	100	34.7
Painted red brick walls and cement ceilings	8	17.8	74	25.7
Total	45	100.0	288	100.0

X= 1.48, P>0.05

Table 6: Patients and controls according to animal shed in- or outdoors.

Presence of animal shed		Positive		Negative	
		No.	%	No.	%
Houses without animal shed		24	53.3	90	31.2
Houses with animal shed	Inside	13	61.9	127	64.1
	Outside	8	38.1	71	35.9
<i>Total</i>		45	100.0	288	100.0

X= 0.04, P > 0.05 (Shed inside houses versus outside)  
 X= 8.43, P < 0.05 (Houses with animal shed versus without shed)

Table 7: Patients and controls according to animal sheds' construction.

animal shed	Positive		Negative	
	No.	%	No.	%
Muddy walls and thatch ceiling	19	90.5	106	53.5
Muddy walls and ceiling	2	9.5	84	42.4
Red brick walls and cement ceilings	0	0.0	8	4.1
<i>Total</i>	21	100.0	198	100.0

X= 10.62, P<0.05

Table 8: Patients and controls according to number of animals inside sheds

No. of animal		Positive		Negative	
		No.	%	No.	%
No animals*		26	57.8	111	38.5
Animal s	1 - 4	13	28.9	123	42.7
present	5 - 8	6	13.3	44	15.3
	9+	0	0.0	10	3.5
<i>Total</i>		45	100.0	288	100.0

X= 6.98, P>0.05 (regarding the number of animals),  
 X= 5.95, P < 0.05 (no animals versus animals present)  
 \* Animals: Goat, sheep, Cows, buffaloes, Camel, donkey

Table 9: Patients and controls according to habit of rearing pigeons indoors

Rearing pigeons in doors	Positive		Negative	
	No.	%	No.	%
Yes	18	40.0	136	47.2
No	27	60.0	152	52.8
<i>Total</i>	45	100.0	288	100.0

X= 0.82, P>0.05

Table 10: Patients and controls using malathion indoors within last 3 months.

Indoor 5% malathion	Positive		Negative	
	No.	%	No.	%
No	32	71.1	205	71.2
Yes	13	28.9	83	28.8
<i>Total</i>	45	100.0	288	100.0

X= 0.00, P>0.05

Table 11: Patients and controls according to breeding places outdoors

Breeding places* Near houses	Positive		Negative	
	No.	%	No.	%
Present	45	100.0	226	78.5
Absent	0	0.0	62	21.5
<i>Total</i>	<i>45</i>	<i>100.0</i>	<i>288</i>	<i>100.0</i>

Fisher's exact P = 0.000 \* Breeding places are: • Irrigation channels  
• Agricultural drains • Seepage water • Surface water with vegetation

### Discussion

In the present study, a comparative study between subsamples of malaria infected and none infected persons (Tab. 1) according to the educational level of the examined individuals showed that the infection increased with the decrease of educational level of the examined individuals.

Among patients, 71.1% were illiterate or read and write, 24.4% were of basic education and 4.5% had high education. Among healthy group, it was 81.3%, 11.8% and 6.9% respectively. The difference between patients and healthy persons was not statistically significant ( $X=5.47$ ,  $P>0.05$ ).

In the present study, a comparative study between subsamples of malaria infected and non infected persons according to the occupation of the examined individuals (Tab. 2) showed that among the infected group, 84.5% were students and/or unemployed, 11.1% were workers, 4.4% were farmers, while none of them was employed. On the contrary, among the non infected group, 73.6% were student and/or unemployed, 19.8% were farmers, 2.8% were workers and 3.8% were

employed. The difference between infected and non infected groups was statistically significant (Mont Carlo  $P = 0.004$ ).

In the present study, a comparative study between subsamples of malaria infected and non infected persons according to crowding index of the examined individuals (Tab. 3) showed that the infection increased with the increase of crowding index. Among the infected group, the percentages of those of low, moderate and high crowding indices were 2.2%, 40.0% & 57.8% respectively.

While among the non infected group, the comparative percentages were 18.4%, 47.6% & 34.0% respectively. The difference was more or less significant ( $X=12.66$ ,  $P<0.05$ ).

In the present study, a comparative study between subsamples of malaria infected and non infected persons (Tab. 4) according to the socioeconomic level of the examined individuals showed that the infection increased with the decrease of socioeconomic level of the examined individuals. All the infected persons were of low socioeconomic level while among the non infected group, 94.8% were of

low socioeconomic level and 5.2% were of moderate socioeconomic level. No statistically significant difference was detected between the two groups (Fisher's exact  $P = 0.237$ ):

In the present study, a comparative study between subsamples of malaria infected and none infected persons (Tab. 5) according to type of house construction of the examined individuals showed that the well constructed house, the less infection occurred. Among the infected persons 35.5% lived in house made of muddy walls and woody or muddy ceilings, 46.7% lived in houses made of red brick walls and woody ceilings and 17.8% lived in modern houses made of painted red brick walls and cement ceilings. On other hand, among the non infected persons the comparative percentages were 34.7%, 39.6% and 25.7% respectively. The difference between the infected and non infected groups was not statistically significant. ( $X=1.48, P > 0.05$ ).

In the present study, a comparative study between subsamples of infected and non infected persons according to the presence or absence of (Tab. 6) animal sheds in their houses showed that the presence of animal sheds inside the houses decreased the infection. Among the infected persons, the percentages of houses without animal sheds and with animal sheds were 53.3% and 46.7% respectively. While among the non infected group, the comparative percentages

were 31.2% and 68.8% respectively. The difference between the infected and non infected groups was statistically significant. ( $X=8.43, P < 0.05$ ). The results also indicated that among the infected persons, the percentages of those their houses with animal sheds inside and outside were 61.9% and 38.1% respectively. In none infected group, the comparative percentages were 64.1% and 35.9% respectively. The difference between the infected and non infected groups was not statistically significant ( $X=0.04, P > 0.05$ ).

In the present study, a comparative study between subsamples of malaria infected and non infected persons (Tab. 7) according to construction materials of the animal sheds showed that the infection increased with bad construction of animal sheds. Among the infected group, 90.5% had sheds made of muddy walls and thatch ceilings, 9.5% had sheds made of muddy walls and ceilings and none had sheds made of red brick walls and cement ceilings. Among the non infected group, the comparative percentages were 53.5%, 42.4% and 4.1% respectively. The difference between the infected and non infected groups was statistically significant ( $X=10.62, P < 0.05$ ).

In the present study, a comparative study between subsamples of malaria infected and none infected persons (Tab.8) according to the number of animals included inside sheds, showed that the infection decreased with the presence or the

increase of number of animals. Among the infected group, the percentage of those had no animals and had animals were 57.8% and 42.2% respectively. While the comparative percentages 38.5% and 61.5% respectively among the non infected group. The difference between infected and non infected groups was statistically significant ( $X=5.95$ ,  $P < 0.05$ ). Moreover, among the infected group the percentages of those had no animals, (1-4), (5-8) and 9 animals or more were 57.8%, 28.9%, 13.3% and 0.0% respectively. While among the non infected group, the comparative percentages were 38.5%, 42.7%, 15.3% and 3.5% respectively. No statistically significant difference between infected and non infected groups was found regarding the number of animals ( $X= 6.98$ ,  $P > 0.05$ ).

In the present study, comparative study between subsamples of malaria infected and none infected persons (Tab. 9) according to their habit of rearing pigeons under beds inside their houses, showed that the infection slightly decreased with rearing pigeons inside houses. Among the infected group, 40% of them reared pigeons inside their houses and 60% didn't. While among the non infected group, the comparative percentages were 47.2% and 52.8% respectively. The difference between both studied groups was not statistically significant ( $X=0.82$ ,  $P > 0.05$ ).

A comparative study between subsamples of malaria infected and

non infected persons according to the history of the spraying houses with malathion 5% within three months before examination has been shown in table 55. The results revealed that no statistically significant difference was detected between the infected and non infected groups ( $X=0.00$ ,  $P>0.05$ ). Among the infected persons, the percentages of those didn't spray their houses and spray them were 71.1% and 28.9% respectively. While the comparative percentages among none infected group were 71.2% and 28.8% respectively.

In the present study, comparative study between subsamples of malaria infected and none infected persons (Tab. 10) according to the presence of breeding places near their houses, showed that the infection increased with the presence of breeding places near the houses (the distance between houses and breeding places was less than 5 m). All the infected persons were living near breeding places. On the other hand, among the non infected group, 78.5% lived near the breeding places and 21.5% lived far from them. A statistically significant difference between infected and none infected group was found (Fisher's exact  $P = 0.00$ ).

Regarding the locality of the patient's dwellings (table 11 & figure 1) from September 1995 to December 1996, the detected cases (69.2%) were from Kafr Fazara village where MBE was done. The rest of the cases (30.8%) were from Bi-

ahmou (9.6%), Abheit El-Hagar, Torsa and Nakalifa showed the same percentages (5.8%) and El-Tawfikia (3.8%). Those cases were either passive cases or neighborhood of positive cases.

In the comparison between the infected and a subsample of noninfected individuals according to various ecological and socioeconomic factors affecting malaria infection, it was observed that malaria infection increased apparently with the decrease of educational level of examined individuals. The educational level of individuals is considered as one of the most important factors in determining the health status of the family. Educated individuals are always aware of better mode of life. They also did their best to provide early medical care, improved housing conditions, better state of sanitation and hygiene. They should have a better income and good quality of nutrients offered.

Consequently, malaria infection is expected to be lower among the better educated individuals. Mulumba *et al.* (1990) stated that the level of education of the parents, mainly the mothers has the greatest influence on the prevalence of malaria. The obtained results also were consistent with Crame *et al.* (1994), Slutsker *et al.* (1996) and Qun *et al.* (1998) who recorded that approximately 74.1% of malaria infected persons did not achieve senior middle school education.

Concerning the occupation of the examined individuals, it was found that the infection increased among students or unemployers and workers. The increasing infection among the student and/or unemployed individuals may be due to low immunity of this group where the majority of them were children or infants. Moreover, most of the student and children worked in the brick factories during their summer holiday carrying brick red blocks and move them in open places. Also, the increasing infection among workers may be due to that the workers spent long time at night in open places (e.g. in the street for selling, driving or working in brick factories) and exposed to the bites of exophilic anopheline species. It was also found that none of the employers were infected. This might be due to the relatively high educational level and socioeconomic status of employers. Besides, all employers belonged to adults having high immunity and the nature of their work did not require spending long time at night in open places. The difference was statistically significant.

Concerning the crowding index, the results of the present study indicated that malaria infection increase with the increase of crowding index of the examined people. Over crowding enables a large number of individuals to be bitten by a limited number of mosquitoes in a limited space. Also the high crowding index may reflect the low socioeco-

conomic status of the individuals. The differences were statistically significant and consistent with Asenso-Okyere (1994).

As regards the socioeconomic level of the examined individuals, the obtained results indicated that the infection increased with the decrease of socioeconomic status of the examined individuals. The high socioeconomic level of individuals is one of the most important factors in providing good health status, improved housing conditions, better state of sanitation and hygiene, and consequently searching early medical care. Asenso-Okyere (1994), Crame *et al* (1994) and Slutsker *et al* (1996) recorded highly significant effect of socioeconomic level. On the other hand, Luckner *et al.* (1998) reported that no significant influence of socioeconomic factors could be detected on the severity of disease or the time to first reinfection. Socioeconomic factors are not major determinants of severe malaria and hyperparasitaemia in children in Gabon (Wei *et al.*, 1998).

Concerning the type of house construction, the obtained results revealed that the infection decreased apparently in houses with well construction. This may be due to the persons lived in modern houses had higher socioeconomic level than who lived in muddy houses. Also, the houses made of muddy walls and ceilings were filled with cracks suitable for mosquitoes to rest. This finding is consistent with Mani *et al* (1984) who

stated that adult mosquitoes usually rest deep in dark corners and cracks and also is consistent with Wei *et al* (1998) who found that the incidence of malaria was 5.81 times higher in individuals who lived in mud-roofed compared to tile-roofed houses, and the risk was 15 times higher in a thatched cottage.

WHO (1991) stated that the presence of cattle near the house may somewhat protect the inhabitants from mosquito bites by dilution factors. In the present work, the result indicated that the infection decreased significantly among individuals having animal sheds inside or outside their houses. Moreover, the infection decreased significantly with the increase of number of animals included inside the sheds. These observations could indicate the zoophilic feeding tendencies of the anopheline species in the studied area. The findings could also reflect the economic statuses of the people living in village where, the people have more animals are richer than those having no animals or a few. Asenso-Okyere (1994) stated that as with many other diseases, malaria is linked to poverty in a vicious cycle; people become sick because they are poor, they become poorer because they are sick, and they become even more ill as their poverty increases. Halawani and Shawarby (1957) found a weak protective effect of having cattle near the house at night. Schultz (1989) and Bouma and Rowland (1995) stated that cattle strongly attracted

mosquitoes, thereby increasing the risk for humans who lived nearby.

In the present study, it was found that the infection increased when the shed was not well constructed and made of thatch ceiling. That is may be due to that thatch ceilings are opened allowing large number of *Anopheles* to enter the shed and move to the house easily if the number of animals was not sufficient. The bad constructions of sheds also reflect the low economic status of individuals having such sheds.

In the present study, all positive cases inhabited in houses near the breeding places. WHO (1975) reported that newly emerged mosquitoes which have not left the area of the breeding places before sunrise will remain there until the next evening. The same thing happens with porous females who have laid eggs in the early morning. When vegetation is absent around the breeding sites, the mosquitoes are forced to leave the area as soon as possible, flying to the nearest favourable human habitation or natural harbourage.

The houses of infected cases were located near brick factories. Due to the excavation of the land around the factories and using the clay in brick industry led to the formation of low land and increasing exposed subsoil water which created more breeding places. Besides the overflowing water from water tanks used in brick's manufacturing creating stagnant water collection and

forming suitable breeding places for anopheline vectors.

In the present study, no significant effect of spraying houses with malathion 5% was found. The result could be explained by WHO (1975) which reported that the low residual effect of an insecticide might be due to the bad quality of spraying (operational cause) i.e. not all walls were completely sprayed or dose was not sufficient. The environmental cause could also affect the spraying action such as whether the sprayed premises have been disturbed by natural events e.g. rains washing the residual deposits... etc. or by human activity. It also may be due to resistance of the anopheline species to insecticide (Wei *et al.*, 1998). *A. sergenti* and *A. pharoensis* were resistant to DDT and/or malathion 5% (WHO, 1986, 1992). In the present study, infection decreased with rearing pigeon indoors without significant difference.

This finding may reflect the zoophilic feeding tendency of the anopheline species and preference of the three species to feed to a large extent on large domestic mammals rather than birds as reported by Beier *et al.* (1987) who recorded the low forage ratio of the birds among all the available hosts.

### Conclusion

These facts may clarify the situation of malaria in El-Faiyum Governorate. Such data may be more or

less present in other endemic areas abroad.

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