The Korean Journal of Parasitology
Vol. 36, No. 4, 241-248, December 1998

Current status of vivax malaria among civilians in Korea

Jong-Soo LEE[1]*, Weon-Gyu KHO[2], Hyeong-Woo LEE[1], Min SEO[1] and Won-Ja LEE[1]

Division of Medical Zoology[1], National Institute of Health, Seoul, 122-701, and Department of Parasitology[2], Inje University College of Medicine, Pusan 614-735, Korea

Abstract: A result of national malaria surveillance in Korean civilians was described. Since a case of indigenous vivax malaria was detected in 1993, a total of 2,198 cases was confirmed by blood smear up to 1997. Of them, 1,548 cases were soldiers serving in the demilitarized zone (DMZ), while 650 cases were civilians. Number of civilian cases was 3 in 1994, 19 in 1995, 71 in 1996, and 557 in 1997. Of them, 239 were ex-soldiers who discharged after military service in the prevalent areas such as Paju, Yonchon, Kimpo, Kangwha, Tongduchon in Kyonggi-do and Chorwon in Kangwon-do while 308 patients were civilian residents in the prevalent areas. Seventy-two patients, living nationwide, had a history of visiting the prevalent areas during transmission season. Only 32 civilian patients denied any relation with the prevalent areas. As a whole, a half of the civilian cases was diagnosed when living in non-prevalent areas. Male patients in their twenties was the highest in number. Annual parasite index is steadily elevated in residents living in the prevalent areas. Monthly incidence showed an unimodal distribution, forming a peak in August. Ex-soldiers exhibited a delayed incubation ranging from 153 to 452 days (279 ± 41 days). The time required for diagnosis was shortened from 23.6 days in 1995 to 13.7 days in 1997. Although the current epidemic of vivax malaria started as a border malaria, it seems highly probable that vivax malaria is established in the local areas and responsible for at least a part of transmission.

Key words: vivax malaria, civilians, annual parasite index, delayed incubation period, Korea, epidemiology

INTRODUCTION

Among many tropical diseases, malaria is prevalent worldwide and remains a major health problem. According to the World Health Organization (WHO) (1994), one third of the world population are living in malaria endemic regions. Vivax malaria has been prevalent throughout the Republic of Korea (ROK) for a long time. However, as a result of a national malaria eradication program with a help from WHO, the incidence of vivax malaria rapidly decreased (National Malaria Eradication Service, 1966; Paik *et al.*, 1988). Vivax malaria was believed to be eradicated in ROK since the late 1970s, although two sporadic cases were detected in the 1980s (Soh *et al.*, 1985), which were relapsed after long incubation.

In 1993, a vivax malaria case was diagnosed among ROK army soldiers serving in the northern Kyonggi-do (Chai *et al.*, 1994). Subsequently, Cho *et al.* (1994) reported two civilian patients infected with vivax malaria. Thereafter, a total of 2,198 patients (soldiers 1,548, civilians 650) was detected from 1994 to 1997 near the demilitarized zone (DMZ) centering around Paju-shi, Yonchon-gun, Chorwon-gun, Kimpo-shi, Kangwha-gun,

• Received 6 May 1998, accepted after revision 16 November 1998.

* Corresponding author (e-mail: ent-par@hanmail.net)

Koyang-shi, and Tongduchon-shi. Hence, the possibility of re-establishment and geographical expansion of malaria is highly concerned.

The Department of Medical Zoology, National Institute of Health (Korea) is the responsible body-organ for undertaking national malaria surveillance. In order to make basic epidemiologic data on the reemerging malaria in ROK, we describe the malaria occurrence and its geographical distribution in civilian cases.

MATERIALS AND METHODS

History taking of patients

According to the "Prevention Law of Communicable Disease", in which malaria is one of reportable diseases of the second class, physicians are responsible to report its occurrence. Therefore, physicians all over the country, who diagnosed and treated malaria patients, reported the case to our Department by telephone or by document. Compliance rate was extremely high because anti-malarials, especially primaquine is very difficult to get in Korean market without the report.

All the patients in this report were diagnosed as vivax malaria by blood smear. Once reported, every case was investigated individually for the following epidemiologic items by direct or telephone interview to attending physicians: age, sex, residence, occupation, onset of symptom, date of diagnosis, past hisory of traveling abroad and within Korea, especially the experience of visiting the northern Kyonggi-do. In cases of young men, they were asked about their service areas and episodes of fever in the event they were discharged from military service. All the cases who have traveled abroad within three years were excluded from this data.

Determination of prevalent area

The prevalent area was determined by investigating the activities of patients during the malaria transmission season (May through October) and onset of symptoms. In this article, based on the above criteria, the prevalent area of malaria was determined as the northern part of Kyonggi-do and a part of Kangwon-do along the DMZ, including Paju-shi, Yonchon-gun, Chorwon-gun, Kimpo-shi, Kangwha-gun, Koyang-shi, and Tongduchon-shi.

Calculation of annual parasite index and delayed incubation period

The annual parasite index (API) was calculated as the incidence of malaria per 1,000 inhabitants. The patients of delayed incubation period (DIP) was determined as follows: patients demonstrating symptoms during the period when adult mosquitoes are inactive and after military service of soldiers in prevalent areas during the transmission period.

RESULTS

All the detected cases were vivax malaria without exception. The number of civilian cases were 3 in 1994, 19 in 1995, 71 in 1996, and 557 in 1997. Among the total civilian cases (650), 411 cases (63.2%) were civilians who had no relation with military service in the past two years, while the remaining 239 were personnel discharged from military service within two years, suggesting a correlation between malaria infection and military service.

During 1994, malaria was reported from persons of 20 years or older. In the subsequent years, the malaria incidence rate among 20-29 year-old group rapidly increased, possibly as a result of military service. The age groups 30-39, 40-49, 50-59 and over 60 years old increased similarly. Malaria rates among persons more than 20 years old was infrequent (Table 1).

Most of the civilian patients resided in the northern part of Kyonggi-do, but the distribution of malaria for discharged soldiers demonstrated a nationwide pattern. The number of patients was the highest in Paju-shi (138) and Yonchon-gun (85), in the second place. Fewer cases were observed in Chorwon-gun (9), Kimpo-shi (17), Kanghwa-gun (17), Koyang-gun (41), Tongduchon-shi (10), and other areas (333). Civilian patients were not reported from Chorwon-gun and Kangwha-gun until 1996 (Table 2).

The relationship between civilian cases and

Table 1. Age and sex of civilian malaria cases reported in 1994-1997

Age	No. of cases by year														
	1994			1995			1996			1997			Total		
	M[a]	F[b]	T[c]	M	F	T	M	F	T	M	F	T	M	F	T
0-4	0	0	0	0	0	0	0	0	0	5	0	5	5	0	5
5-9	0	0	0	0	0	0	0	0	0	3	3	6	3	3	6
10-14	0	0	0	0	0	0	0	2	2	6	5	11	6	7	13
15-19	0	0	0	0	2	2	1	0	1	19	5	24	20	7	27
20-29	1	0	1	13	0	13	28	1	29	224	12	236	266	13	279
30-39	0	0	0	0	0	0	10	1	11	64	28	92	74	29	103
40-49	0	0	0	2	1	3	8	2	10	62	18	80	72	21	93
50-59	0	1	1	1	0	1	6	1	7	27	24	51	34	26	60
60 <	1	0	1	0	0	0	8	3	11	24	28	52	33	31	64
Total	2	1	3	16	3	19	61	10	71	434	123	557	513	137	650

[a]male; [b]female; [c]total.

Table 2. Administrative districts where the civilian cases of vivax malaria were diagnosed as shown by year

City or Province/County		1994	1995	1996	1997	Total
Kyonggi-do	Paju	2	1	18	117	138
	Yonchon	0	2	15	68	85
	Kimpo	0	1	1	15	17
	Kanghwa	0	0	0	17	17
	Koyang	0	0	3	38	41
	Tongduchon	0	1	2	7	10
	all others	0	3	11	61	75
	subtotal	2	8	50	323	383
Kangwon-do	Chorwon	0	0	0	9	9
	all others	0	1	1	1	3
	subtotal	0	1	1	10	12
Chungchongbuk-do		0	1	0	3	4
Chungchongnam-do		0	0	1	13	14
Chollabuk-do		0	0	0	8	8
Chollanam-do		0	0	2	13	15
Kyongsangbuk-do		0	0	3	9	12
Kyongsangnam-do		0	1	2	20	23
Cheju-do		0	0	0	2	2
Seoul		1	5	7	90	103
Pusan		0	1	1	14	16
Taegu		0	1	1	13	15
Inchon		0	1	2	26	29
Kwangju		0	0	1	6	7
Taejon		0	0	0	7	7
Total		3	19	71	557	650

Table 3. Number of civilian cases of vivax malaria in relation to the prevalent areas in northern Kyonggi-do and Kangwon-do

Group	No. of cases (%)
Residents in the area	317 (48.8)
Ex-soldiers served in the area	226 (34.8)
History of travel in transmission season	75 (11.6)
Denial of the relevance	32 (4.9)
Total	650 (100)

Table 4. Annual parasite index (API) of civilian vivax malaria cases in the prevalent areas, 1994-1997

Area	No. of population	1994		1995		1996		1997	
		No	API	No	API	No	API	No	API
Paju	172,037	2	0.012	1	0.005	18	0.105	117	0.680
Yonchon	55,225	0	0.000	2	0.036	15	0.272	68	1.232
Kimpo	124,510	0	0.000	1	0.008	1	0.008	15	0.121
Kanghwa	70,242	0	0.000	0	0.000	0	0.000	17	0.236
Koyang	674,203	0	0.000	0	0.000	3	0.004	38	0.056
Tongduchon	73,684	0	0.000	1	0.014	2	0.027	7	0.095
Chorwon	54,366	0	0.000	0	0.000	0	0.000	9	0.167
Total	1,224,267	2	0.002	5	0.004	39	0.032	271	0.221

prevalent areas were analyzed; the residents of the prevalent area occupied nearly half of the total civilian cases, ex-soldiers discharged from the prevalent areas for the second, and some had the history of traveling there. Few cases denied the relevance to the prevalent area (Table 3).

The distribution patterns were analyzed with a village as a unit. Patients from Paju-shi and Yonchon-gun were concentrated within 10 km from the DMZ in 1996, but the boundary was expanded to 20 km from DMZ in 1997. The Chorwon area reported civilian cases near the civilian control line (CCL) for the first time in 1997. Patients from Kimpo-shi and Kanghwa-gun mainly resided along the Imjingang (River) or near the river basin. Among the prevalent areas, the API of 1997 was the highest in Yonchon-gun, 1.232, and lowest in Koyang-shi, 0.056 (Table 4).

Monthly incidence of the civilian cases were shown in Table 5. The cases were diagnosed from March through December each year. But more than a hundred cases were diagnosed in July, August and September, showing an unimodal curve.

The geographical distribution pattern of 650 malaria patients was shown in Fig. 1. The malaria infection was focused to Paju-gun and Yonchon-gun, 233 and 218, respectively. Then, tens of malaria cases were infected in Kimpo-gun, Kangwha-gun, and Chorwon-gun. In addition, there were a few infections in Uijongbu-shi, Inchon-shi, Seoul-shi, Kapyong-gun, *etc.*

After resurgence of malaria was recognized in 1994, mean of the days from onset of symptoms to diagnosis was 23.6 days in 1995, and shortened to 13.7 in 1997. In some cases, the diagnosis was delayed up to 65-77 days after the onset of fever. However, the maximum number of days for individual patients (65-77) was not significantly different among the years 1995 through 1997.

The prolonged incubation period was calculated based on the malaria transmission season and the time of diagnosis, in 107 cases who had discharged from military service. The average of delayed incubation period was calculated as 279 ± 41 days (153 to 452 days)

Table 5. Monthly incidence of vivax malaria cases in 1994-1997

Area/year		No. of cases by month													
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	U[a]	Total
Paju	1994	0	0	0	0	0	1	0	1	0	0	0	0	0	2
	1995	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	1996	0	0	0	0	0	0	1	9	6	1	1	0	0	18
	1997	0	0	0	1	2	10	19	39	35	8	3	0	0	117
Yonchon	1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	1	0	1	0	0	0	0	0	2
	1996	0	0	0	0	0	1	6	4	3	1	0	0	0	15
	1997	0	0	1	0	0	2	11	18	32	5	0	0	0	69
Kimpo	1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	0	0	0	1	0	0	0	0	1
	1996	0	0	0	0	0	0	1	0	0	0	0	0	0	1
	1997	0	0	0	0	0	1	2	7	2	1	1	0	0	14
Kanghwa	1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1997	0	0	0	0	0	1	2	5	5	1	0	0	3	17
Koyang	1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1996	0	0	0	0	0	0	0	1	2	0	0	0	0	3
	1997	0	0	0	0	0	4	8	14	11	1	0	0	0	38
Tongduchon	1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	1996	0	0	0	0	0	0	1	0	1	0	0	0	0	2
	1997	0	0	0	0	0	0	1	2	2	2	0	0	0	7
Chorwon	1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1997	0	0	0	0	0	0	0	1	5	0	3	0	0	9
All others	1994	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	1995	0	0	0	1	0	3	2	7	1	0	0	0	0	14
	1996	0	0	0	0	1	3	8	9	7	3	1	0	0	32
	1997	0	0	1	2	2	25	59	89	73	28	5	1	1	286
Total		0	0	2	4	5	52	121	209	186	52	14	1	4	650

[a]unknown

in those cases.

DISCUSSION

From these results, the northern Kyonggi-do and a part of Kangwon-do were confirmed to be the prevalent area of vivax malaria. The establishment of malaria along the north eastern boundary are results of ecological and socioecological conditions. Since the report of malaria patients who had never been abroad in 1993 (Chai *et al.*, 1994), the number of patients has been annually increasing at the northern part of Kyonggi-do (Cho *et al.* 1994; Yim *et al.* 1996; Lee *et al.* 1997). This article describes all the civilian patients from 1994 to 1997, including the cases reported by other authors.

The proportion of cases diagnosed from active duty soldiers was 70.4%, and increased to 81.3% when discharged soldiers are included. Yim *et al.* (1996) indicated that there was a correlation between malaria cases and guard duty at night along the DMZ since

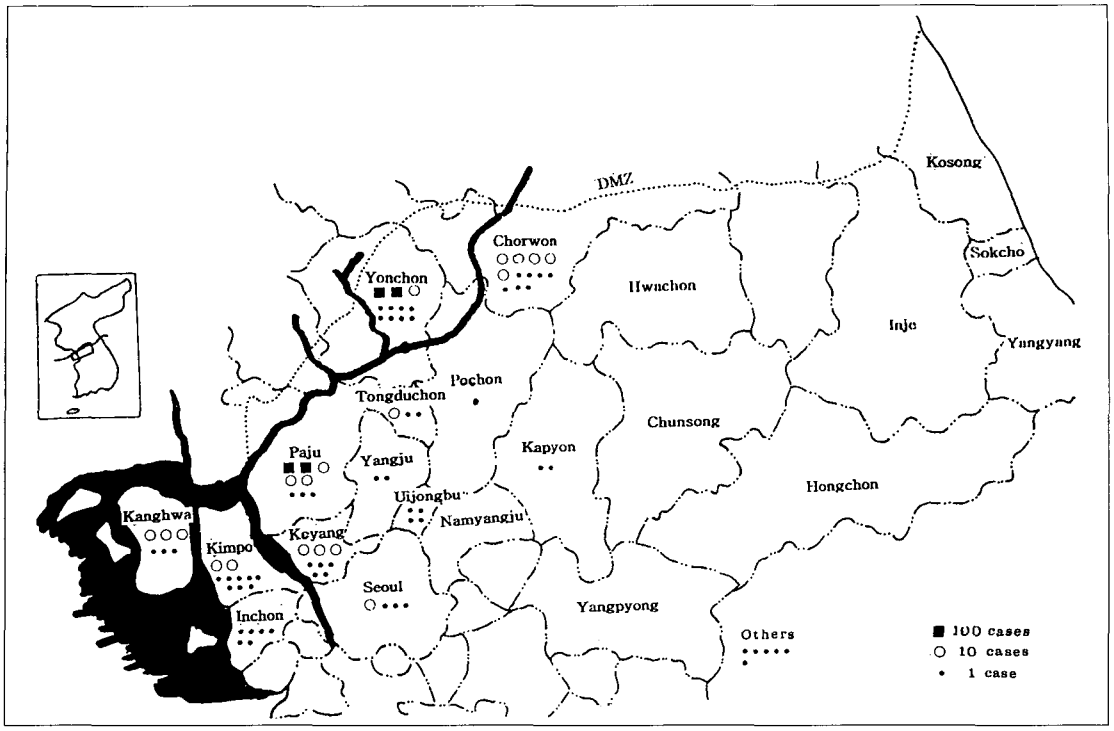

Fig. 1. Geographical distribution of 650 civilian malaria cases by area, where the infection was presumably contracted.

soldiers are exposed to mosquito bites. Malaria cases during the early period of malaria reemergence were suspected to be bitten by sporozoite positive mosquitoes which flew from North Korea. In addition, we proved that the mosquitoes collected from two areas of Paju-gun, *i.e.*, Jangpa-ri and Tongil village, had the sporozoites of *Plasmodium vivax* by PCR method. Based on the patients occurrence and discovery of sporozoite positive mosquitoes, the northern Kyonggi-do and a part of Kangwon-do were confirmed to be the prevalent area of vivax malaria, and malaria is established and does not require more introduction from North Korea.

Area of the greatest transmission had been damaged by floods during 1995 and 1996. The flood of July 1996 submerged farmland and houses in the northern part of Kyonggi-do and a part of Kangwon-do. About the time of environmental disasters, there was an 3.7 fold increase of malaria cases in 1996, and 7.8 fold increase in 1997. This suggests that the floods may have played a role in increased transmission of malaria by spreading mosquito population, and thereby increasing human exposure to mosquito bites.

The API for malaria ranged from 109.2 to 2.5 in 1960s when the vivax malaria had been prevalent (Kim *et al.* 1982; Lee *et al.* 1994). Currently, the API ranges from 0.056 to 1.232 in 1997, much lower than that in the early 1960s. However, because of the increasing trend and the reestablishment of malaria at Kyonggi-do, early detection and early treatment is required to interrupt the transmission cycle of malaria.

Shim *et al.* (1997) concluded that *Anopheles* mosquitoes from North Korea migrated to the south for blood-sucking to cows or pigs due to the absence of blood sources in North Korea. In addition, the environment was suitable for the mosquito survival, and the amount of insecticide used along the DMZ was less than for other areas. *Anopheles sinensis* is zoophilic, but readily bites human and is attracted to light, resulting in the mosquitoes' entering into houses. Due to the scarcity of

large animals along the DMZ, unprotected soldiers may be the primary source of blood.

The distribution pattern by residence indicates that malaria occurs nationwidely, but these data merely reflect the return of the discharged soldiers to their residences in non-prevalent areas. However, the distribution of malaria is increasing as malaria had not been reported in Chorwon and Kangwha until 1997. The malaria distribution pattern reported by a village showed that the malaria outbreak of Paju-gun and Yonchon-gun was confirmed within 10 km of the DMZ in 1996, but the estimated prevalent area extended further south in 1997. Asymptomatic reservoirs among the civilian population might act as an infection source, increasing the distribution of malaria to areas beyond the DMZ. Hence, malaria surveillance must include an area wider than the estimated prevalent area.

By investigating the history of infected soldiers, Lim *et al.* (1997) recognized that 4.0% had been blood donors within a month of confirmed diagnosis, and based on delayed diagnosis, may have been positive for asexual parasites. In fact, a 67-year old woman was infected with *P. vivax* through blood transfusion during an operation, and the donor was proven to be a soldier during leave. Subsequently, blood examination revealed malaria parasites from the asymptomatic soldier. In Korea, the blood donation has been executed without any precaution about malaria except for conventional history report. Hence, the careful control of blood donation is required for residents of prevalent areas or persons with history of visiting prevalent areas.

In 1913, Hasegawa showed that the delayed incubation period was characteristic of Korean malaria parasite strains (Lee *et al.*, 1994). Of 650 civilian patients, at least 239 demonstrated delayed onset of symptoms when considering the area and duration of military service. In Korea, the mosquito activity is confined to the period from May through October. Patients developing symptoms from December to May might have the delayed incubation period. Therefore, the early detection and early treatment of these carriers might prevent the additional occurrences during the onset of the malaria season.

With the reintroduction of malaria, there was insufficient knowledge and education for malaria resulting in delayed diagnosis. As health officials become more aware of malaria, the period of onset of symptoms to diagnosis decreased. However, diagnosis and radical treatment was delayed because some patients went first to the drugstore for self-treatment.

The military service began to execute the chemoprophylaxis or radical chemotherapy for soldiers conducting guard duty near the DMZ. The effect of administering chemoprevention on soldiers will be evaluated for integrating potential malaria control programs among the civilian population.

REFERENCES

Chai IH, Lim GI, Yoon SN, Oh WI, Kim SJ, Chai JY (1994) Occurrence of tertian malaria in a male patient who has never been abroad. *Korean J Parasitol* **32**(3): 195-200.

Cho SY, Kong Y, Park SM, *et al.* (1994) Two vivax malaria cases detected in Korea. *Korean J Parasitol* **32**(4): 281-284.

Kim DC (1982) Status of malaria infection in the Republic of Korea. *Yonsei Rep Trop Med* **13:** 59-62.

Lee JM, Kim MY, Kim YR, *et al.* (1997) A small epidemiological survey for vivax malaria in Kimpo-gun, Kyonggi-do, Korea undertaken after detecting two consecutive cases. *Korean J Parasitol* **35**(4): 291-293.

Lee TU, Cho YJ, Paik YH (1994) An epidemio-historical study on malaria in Korea. *Kyung Hee Univ Med J* **19**(2): 205-220.

Lim CS, Kim YK, Lee KN, *et al.* (1997) Risk of malaria transmission by blood donation from army soldiers in Korea. *Korean J Inf Dis* **29**(2): 113-117.

National Malaria Eradication Service, Ministry of Health and Social Affairs, ROK (1966) Malaria pre-eradication programme in Korea. Progress report 1961-1965 (with English resume) pp44-70.

Paik YH, Rhee HI, Shim JC (1988) Malaria in Korea. *Jpn J Exp Med* **58:** 55-66.

Shim JC, Shin EH, Yang DS, Lee WK (1997) Seasonal prevalence and feeding time of mosquitoes (Diptera: Culicidae) at out-break regions of domestic malaria (*P. vivax*) in Korea. *Korean J Entmol* **27**(4): 265-277.

Soh CT, Lee KT, Im KI, *et al.* (1985) Current

status of malaria in Korea. *Yonsei Rep Trop Med* **16**(1): 11-18.
Yim HW, Suh GY, Ahn YS, *et al.* (1996) Epidemiologic and clinical analysis of 87 indigenous malaria in Korean soldiers in 1995. *Korean J Inf Dis* **28**(3): 219-224.

=초록=

한국에서의 민간인 삼일열말라리아 발생현황

이종수[1], 고원규[2], 이형우[1], 서 민[1], 이원자[1]

국립보건원 의동물과[1] 및 인제대학교 의과대학 기생충학교실[2]

1993년 외국여행 경험이 없는 말라리아 환자가 발견된 이래 1997년까지 총 2,198명의 환자가 발생하였다. 대부분은 휴전선 근처에서 복무한 군인이었으며, 민간인 환자는 총 650명으로 1994년 3례, 1995년 19례, 1996년 71례, 1997년 557례였다. 그 중 239명은 경기도의 파주, 연천, 김포, 강화, 동두천 및 강원도 철원에서 복무한 경험이 있는 제대군인이었으며, 308명은 유행지역에 거주하는 주민이었다. 72명은 모기 활동기에 유행지역을 방문한 적이 있었으며, 32명은 유행지역에 간 적이 없는 사람이었다. 전체적으로 보아 20대 남자가 가장 많았다. 연중 말라리아 발생지수는 높지 않았지만 1993년 이후 유행지역에서 꾸준히 증가하였다. 한국에서 말라리아는 일년 내내 발생하였으며, 8월에 가장 많았다. 제대군인들의 경우 153일에서 452일에 달하는 지연형 잠복기를 나타냈다. 발병에서 진단에 이르는 시간은 1995년 23.6일에서 1997년 13.7일로 단축되었다. 삼일열말라리아의 발생이 휴전선 부근에서 시작되어 일부 지역에서는 이미 정착되었을 가능성이 높다.

〔기생충학잡지 36(4): 241-248, 1998년 12월〕