INTRODUCTION

According to report of International Organization for Migration and World Health Organization, malaria is still the disease which has the leading burden and significant impacts on public health and is the reason of death ranking in the fifth position over the world. In Africa, malaria is the reason of death ranking in the second position for changing emigrant population [27], [129], [130].

The diversified development of economy and powerful development of information lead to the population exchanging and movement between areas increasing more and more [35], [49]. The health of emigrant group is impacted. Bringing germs from malaria area to other areas, especially they can bring the malaria parasite with drug-resistant gene pfk13-propeller [83] which causes difficulties for preventing and eliminating malaria [31], [123], [127].

For recent years, the situation of malaria in Vietnam decreases significantly [6]. Currently, the National malaria prevention program is implementing formally the malaria prevention methods. However, in many resident areas, especially in Bu Gia Map District, Binh Phuoc Province and Krong Pa District, Gia Lai Province, the ratio of people infected by malaria is highest in the country, occupying 50% malaria patients over the whole country. On the other hand, in Bu Gia Map District, Binh Phuoc Province and Krong Pa District, Gia Lai Province, the situation of emigration has many changes because of economic reasons. Therefore, the selection of major districts of two provinces which use the methods for intervening and strengthening the malaria prevention is contributing into reducing the ratios of malaria patients and death in the whole country [34], [113]. Thanks to urgency of this title, we conduct the study on several epidemiological characteristics of malaria and prevention methods strengthened in the malaria area with changing emigration in Binh Phuoc and Gia Lai (2016 – 2017), for the following goals:

1. Describing the current situation of malaria and related factors in malaria area with changing emigration in Binh Phuoc and Gia Lai in 2016.

2. Identifying the artemisinin – resistant K13 genetic mutation on patients infected by P. falciparum.

3. Evaluating the efficiency of several methods for strengthening the malaria prevention in areas with changing emigration.

STRUCTURE OF THESIS

The thesis covers 114 pages, including: Introduction with 2 pages; Overview with 30 pages; Researching object and methods with 21 pages; Researching findings with 33 pages; Discussion with 26 pages; Conclusion with 2 pages; Petition with 1 page. The thesis has 16 figures, 48 tables. There are 135 references, in which 60/135 documents have been published for 5 recent years.

Chapter 1: OVERVIEW

Malaria is a dangerous infectious disease caused by Plasmodium which is the malaria parasite transmitted from patients to healthy people by Anophenles mosquitoes sucking human blood. Currently the malaria is still the big health issue in the World and also in Vietnam. According to report of International Organization for Migration in 2013, the malaria is still the leading disease burden. In Africa, the malaria is the reason of death ranking in the second position for changing emigrant community [49], [132], [133]. The report of WHO in 2016 shows that *P. Falciparum* causes about 99% malaria cases in Africa. Meanwhile, in other areas, *P. Vivax* has the high ratio of causing disease, such as in South America, it occupies 64%, in South East Asia, it is > 30% and it occupies about 40% in East-Med area, *P. Malariae* [33].

In Vietnam, Binh Phuong and Gia Lai are two provinces which have the most serious situation of malaria in the country, occupying 50% clinical malaria cases and also malaria cases caused by parasite. On the other hand, in two provinces, the situation of artemisinin-resistant malaria parasite *Plasmodium falciparum* is increasing higher and higher. According to report of National Institute of Malariology – Parasitology and Entomology in 2015, Binh Phuoc had 1.352 malaria parasites, occupying 18.51% of total parasites in the whole country. In Binh Duong Province, the number of malaria patients concentrates in Bu Gia Map District, occupying > 50% of malaria cases, in Gia Lai the number of malaria patients concentrates mainly in KrongPa District, occupying > 50% number of malaria cases in the province [57].

An. minimus, *An. dirus*, *An. Epiroticus* are three major transmission vectors of malaria in Vietnam [8], [13], [52]. *An. Minimus* live in forests, edges of forests; mosquito larvae lives along the banks of streams with slow flowing water; mosquitoes live in forests and mountains over the country.

Until now, there are symptoms of "resistant" in several provinces in South and Central Highlands of Vietnam in the context of "drug-resistant" and artemisinin sensitiveness relief and ACTs in the borders of Cambodia, Thailand, Myanmar [29], [30], [128]. In Vietnam, especially in the area of

Central Vietnam – Central Highlands, and provinces with heavy malaria condition, there are many studies applying the communicty intervention methods and having very satisfactory results, such as: Study of Nguyen Xuan Xa (2015), Phung Thi Kim Hue (2015). The application of community intervention methods such as: women's association, medical collaborator groups in hamlets, mountain villages also reduces the ratio of malaria patients and improves the knowledge and understandings of inhabitents in malaria prevention [23]; Che Ngoc Thach (2014), has used the intervention methods into groups with high malaria infecting risks as people going to forests and sleeping in forests, going to mountain fields and spleeping in mountain fields, consequently reduced significantly the retio of malaria patients [38], and etc.

Chapter 2: RESEARCHING METHODS

2.1. Researching method of target 1: *Describing the current situation of malaria and related factors in malaria area with changing emigration in Bu Gia Map District, Binh Phuoc Province and KrongPa District, Gia Lai Province in 2016.*

2.1.1. Researching objects, places and time

- The objects are: inhabitants living in the malaria area with changing emigration, including all ages, sexes and ethnic groups in Bu Gia Map District, Binh Phuoc Province and KrongPa District, Gia Lai Province; the malaria parasites collated in people in the researching places; Mosquitoes transmitting malaria are collected in the researching places.

- Field researching places are Bu Gia Map Commune, Dak O Commune, Bu Gia Map District, Binh Phuoc Province. Chu R'Cam Commune and La HDreh Commune, Krong Pa District, Gia Lai Province.

- The study has been conducted since April 2016.

2.1.2. Researching methods

2.1.2.1. Study designing

The topic is designed by researching method of descriptive epidemiology with analysis [3].

- *Size of researching sample:* After applying the sample size calculation formula, we have a ratio of malaria patients:

n=$Z^2_{1-\alpha/2}$ $\dfrac{(1-p)}{p\varepsilon^2}$ [3]. In which: n: Minimal sample size; p: Ratio of malaria patients, selecting p = 0,10 [12] (according to Nguyen Xuan Xa) [59]; $Z_{1-\alpha/2}$: Reliability coefficient corresponding with reliability coefficient 95%, and then $Z_{1-\alpha/2}$ = 1,96; ε: Desired relative error, selecting ε = 0,27. With selected values, the calculation sample size is 469/1 commune. In fact, the topic has been done in Bu Gia Map Commune for 516 people, in Duc O Commune

for 511 people, in Chu R'Cam for 500 people, in Ia Hdred Commune for 481 people. Total number of people is 2008 people.

+ *Individual selection method into researching sample:* Selecting total individuals of households and total 6 hamlets of Bu Gia Map Commune and Dak O Commune, Binh Phuoc Province and 6 hanlets of Chu R'cam Commune and Ia Dreh Commune, Gia Lai Province to participate voluntarily into research. Excluding: People who do not agree to particupate into research, people with mental diseses.

+ *KAP survey form for interviewing householders:* The thesis has researched 605 households.

All households in 6 hamlets of Bu Gia Map Commune, Dak O Commune, Binh Phuoc Province and 6 hamlets of Chu R'cam and Ia Dreh Commune, Gia Lai Province. In fact, 605 qualified households have selected into the researching group. The householders and members in familt participate voluntarily into research. The householders are able to reply the interviews made by researching officials. Excluding: Households/ people who do not agree to participate into research. Householders who have metal diseases.

+ *Method of researching place selection:* Firstly: For recent years, the situation of malaria is complicated, the number of malaria patients is high, there are many changes on emigration. Secondly, Selecting communes and hamlets with high number of malaria patients who frequently go to forests, sleep in forests, and pass borders.

With standards stated above, the thesis selects KrongPa District and Bu Gia Map District. In Bu Gia Map District, Duc O Commune and Bu Gia Map Commune are selected; In KrongPa District, Ia Hdreh Commune and Chu R'Cam Commune are selected.

+ Researching conents: surveying individuals; examining clinically all members in families; Taking blood as blood smear with thick drop and dyeing and using microscope in order to identify the malaria patients who have fever or not when examining clinically and testing blood smear with thick drop and finding out malaria parasite by microscope.

2.2. Researching method of target 2: *Identifying artemisinin-resistant K13 genetic mutation on patients infected by P. falciparum.*

2.2.1. Researching object, place and time

- ***Researching object:*** the Watman paper samples absorbing blood of researching object are collected through cross-section survey in researching places belonging to Bu Gia Map District, Binh Phuoc Province and KrongPa District, Gia Lai Province.

- ***Researching place:*** In laboratory, Department of Molecular Biology, National Institute of Malariology – Parasitology and Entomology.

- Researching time: From April 2016 to December 2016

2.2.2. Researching method

- Research designing: Experimental research design in babo.

- Researching sample size: Selecting 26 blood samples of patients infected by *P. falciparum* from samples, *P. falciparum* is confirmed to identify the artemisinin-resistant genetic mutation and conductor of K13 gene.

- Researching content: Separating and extracting ADN; Semi - Nested multiplex PCR for identifying blood samples infected by *P. falciparum*.

- Researching materials: Materials: Whatman blotting paper 3MM; Eppendorf 1.5ml; ADN separator set; Tube PCR 0,2ml; tip head 1ml, 200µl, 20µl và 10µl ; Primer pairs; (dATP, dCTP, dGTP, dTTP); Hotstart Taq DNA- polymerase; 10 X PCR buffers, $MgCl_2$ 25 mM; BigDye Terminor V3.1 (Life Technology); POP -7 Polymerase 3500 (Life Technology); Chemicals: AND separator set; PCR product cleaning set; primer pairs: dNTPs; Hosttart Taq DNA-polymerase; Buffer 10X PCR; Buffer solution Anode (ABC) 350 series; Buffer solution Cathode (CBA) series; Standard buffer for machine; well for machine; Positive control: Standard sensitive mono clone P. falciparum 3D7; Electrophoresis buffer solution TBE (1X, 10X) – Invitrogen – US. Machines and devices: micropipets; High-speed centrifugal machine; PCR machine; Image photographing and analyzing system.

- Techniques used in research: Technique of taking blood into Whatman blotting paper 3MM: According to standard procedure of National Institute of Malariology – Parasitology and Entomology [54]; Technique of separating and extracting AND from parasites of medical samples: According to guidelines of manufacturer. Technique of multi-primer semi-cage poluymerase chain reaction for identifying samples identified by Plasmodium through 2 PCR reactions; The primer pái are used, such as: UNR: GAG GGT ATG TGA TCG TCG TC; PLF: AGT TCC CCT AGA ATA GTT ACA. PCR technique through 2 reactions: PCR reaction for the first time, PCR reactions for the second time. PCR products are tested by electrophoresis technique on gel agarose 2% and dyeing Resafe. Photographing electrophoresis photos and reading *P. Falciparum* results with electrophoresis bands with dimension 395 bp.

- AND sequencing technique for discovering K13 genetic mutation: the PCR cage technique multiplies K13 genetic segment according to methods of Ariey and CS 2013.

- Researching variables and indexes: The number of samples (+) by PCR technique. Ratio of each mutation kind on K13 gene/ total *P.falciparum* samples.

2.3. Researching method of target 3: *Evaluating the efficiency of several methods for strengthening the malaria prevention in the area with changing emigration.*

2.3.1. Researching objects, places and time

 - Researching objects: The inhabitants who live in malaria area with changing emigration are in all ages, sexes and the ethnic minorities in 12 hamlets belonging to 4 communes of Bu Gia Map District, Binh Phuoc Province and KrongPa, Gia Lai Province; The malaria parasites are collected on people in the researching places; Mosquitoes transmitting malaria are collected in the researching places.

 - Researching places: In 12 hamlets belonging to 4 communes of 2 districts: Bu Gia Map Commune and Dak O Commune, Bu Gia Map District, Binh Phuoc Province. Chu R'Cam Commune and Ia HDred Commune, Krong Pa District, Gia Lai Province.

 - Researching time: From April 2016 to April 2017

2.3.2. Researching method

 - Researching designing: The thesis is designed by the community intervention researching method with comparison and no control group.

 - Sample size and researching sample selecting method

 + Sample size of household survey: All households in 6 hamlets of Bu Gia Map Commune and Dak O Commune, Binh Phuoc Province and 6 hamlets of Chu R'cam and Ia Dreh Commune, Gia Lai Province. In fact, 605 standard households were selected into the researching group.

 + Sample selecting standard: The households had the permanent residence in 6 hamlets of Bu Gia Map Commune, Dak O Commune, Binh Phuoc Province and 6 hamets of Chu R'cam Commune and Ia DReh Commune, Gia Lai Province. The householders and members in familities voluntarily participated into research. The householders were able to reply interviews made by researching officials. Excluding the householders who had metal diseases.

 - Sample size for surveying and evaluating the efficiency of strengthened community intervention methods: All members and householders in 605 households were interviewed in 4 communes of Bu Gia Map District and KrongPa District: Bu Gia Map Commune for 516 people, Duc O Commune for 511 people, Chu R'Cam Commune for 500 people, Ia Hdred Commune for 481 people. In fact, 1851 people were examined and taken blood samples for testing.

 - Researching content: Strengthening the intervention methods for malaria prevention, including: Interviewing householders about knowledge, behavior and practice of malaria prevention. In all, 605 householders were interviewed; Taking the blood samples for tesing thick drop and thin drop

in order to find out the malaria parasites for all members who were present in family. In all, there were 1851 people. Communicating and educating the health for malaria prevention for community. Applying the intervention methods for strenthening the malaria prevention, researching the community intervention methods for strenthening the malaria prevention in researching places KrongPa – Gia Lai and Bu Gia Map – Binh Phuoc, such as: Providing cream driving mosquitos away Soffell of PT. Herlina Inda. JI Rawa Sumur It Blok DD.N016. JaKata Timur 1390. Indonesia, with capacity of 60 ml. Guiding the using ways for members of families who frequently went to and slept in forests.

- Providing the medical service packages for malaria prevention: The malaria prevention service package was a package equipping the malaria prevention means for individuals, including the malaria drugs and normal antifebriles for treating malaria. It aimed at reducing the risks of malaria transmisison and preventing from dealth caused by malaria. The objects of malaria prevention service package included: People who went to and slept in forests; people who worked and slept in mountain fields and in forests.

- Communicating and educating the health for malaria prevention: Objects communicated were 605 householders and members in families selected to participate into research. Communicating affairs aimed at improving knowledge, behavior and practice of malaria prevention for inhabitants by ready-designed questionaires of medical officials who implemented the communication affairs. The communicators were: medical officials of hamlets, mountain villages, officials of medical stations and officials of National Institute of Malariology – Parasitology and Entomology.

- Techniques used in research on strengthening the malaria prevention for comunity: Community interviewing technique; clinical examining technique for discovering the people with clinical malaria; Taking blood technique as blood smear with thick drop and thin drop; technique of catching mosquitos by human primer; Technique of communicating and educating the comunity health:

- Evaluation indexes: Ratio of clinical malaria for 12 months after intervention, ratio of infection with malaria parasite for 12 months after intervention; Ratio of understanding about malaria prevention methods when goring to forests and mountain fields or passing borders for working and trading; Ratio of people understanding when they had fever, they had to visit medical units for testing and treating malaria. Ratio of practicing methods for individual protection when they went to forests, mountain

fields and passed borders for trading and visiting relatives and etc. Evaluating the efficiency of post and pre intervention:

$$\text{Intervention efficiency (\%)} = \frac{|\text{Pre-intervention ratio of malaria patients} - \text{Post-intervention ratio of malaria patients}|}{\text{Previous ratio}} \times 100$$

2.4. Errors and error eliminating methods

Complying with researching object selecting principles. Training the investigators, deploying the trial researches before researching officially. Cooperating with local officials who were proficient in ethnic minority language to interview and interpret. Implementing according to procedures of techniques NIMPE. HD 03 PP 01, NIMPE HD 03 PP.06 [54], [55]. Controlling the sample quality, quality of ADN separation and PCR analyzing results.

2.5. Method of data counting and analyzing

Entering data by Excel and EpiData software and analyzing by Stata 12.0. Comparing the ADN sequence by 3D7 genetic sequence refered in NBCI genetic bank with code >XM_001350122.1 *Plasmodium falciparum* 3D7 kelch protein K13 (PF3D7_1343700), analyzing and comparing the genetic sequence by software [56]. Using the biomedical statistical test for analyzing data, such as: Test t, x^2..

2.6. Ethics in researching

- The researching draft of thesis has been approved by ethics council in biomedical study of National Institute of Malariology – Parasitology and Entomology.

- Approved advance by researching object. Describing carefully the rights and responsibilities of research participants and responsibilities of researchers.

Chapter 3: RESEARCHING RESULTS

3.1. Current situation of malaria and related factors in malaria area with changing emigration in Binh Phuoc and Gia Lai, in 2016.

3.1.1. Several information on researching object

Total number of people who were tested and discovered the malaria parasites was 2008, male 46.66%, female 53.34%. In all, there were 4 communes with 2008 people, in which: there were 346 people who emigrated from other communes in province and from other provinces, occupying 17.23%. The ratio of emigrants from other places to Dak O Commune was the highest ratio 31.64%. The ratio of households working in mountain fields was 91.24%.

3.1.2. Current situation of malaria patients in malaria area with changing emigration in binh Phuoc and Gia Lai, in 2016

- Ratio of patients infected by malaria parasite in blood smear test

Table 3.6. Ratio of tested patients with malaria parasites (n = 2008)

Name of district, province	Test number	Malaria parasite	
		Quantity	Ratio (%)
Bu Gia Map District – Binh Phuoc	1027	32	3,12
Krong Pa District, Gia Lai Province	981	09	0,92
Total	2008	41	2,04
Value χ^2, p	$\chi^2 = 12{,}03$, p $= 0{,}0001$		

Remarks:

The results in Table 3,6 shows that: The ratio of malaria patients in Bu Gia Map District, binh Phuoc Province and Krong Pa District, Gia Lai Province is 2.04%. The difference has statistical meaning between ratio of patients with malaria parasite between Bu Gia Map District, Binh Phuoc and Krong Pa District, Gia Lai Province has the ratio 3.12% compared with 0.92% with $\chi^2 = 12{,}03$, p $< 0{,}01$.

- Ratio of malaria patients who frequently pass borders

Table 3.8. Ratio of malaria patients who pass borders (n =605)

Passing borders	Test number	Number of patients with malaria parasites	Ratio (%)
Frequently passing borders	23	04	17,40
Do not pass borders	1985	37	1,86
Total	2008	41	2,04
Value χ^2, p	$\chi^2 = 9{,}5$, p $= 0{,}045$		

Remarks:

Thanks to results of Table 3.8, we can see that: the difference has statistical meaning on ratio of malaria patients who frequently pass borders and patients who do not pass borders with values 17.40% compared with 1.86%, with $\chi^2 = 9{,}5$, p $< 0{,}05$.

- Ratio and composition of parasite species by blood smear test
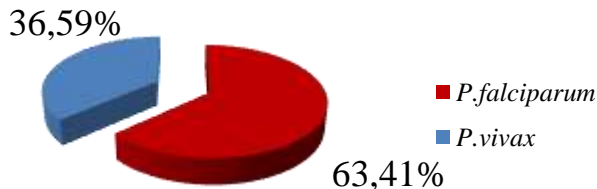

Figure 3.1. Ratio, composition of malaria parasite species in researching place (n = 41)

Remarks:

In the researching place, 2 malaria parasite species are discovered *P.falciparum* and *P. vivax,* in which patients infected by *P. falciparum* occupy 63,41%(26/41).

3.1.3. Knowledge, behavior and practice of people in malaria prevention

- Knowledge of people about malaria

Exploited through interviewing householders, the results are as follows:

Table 3.14. Ratio of people who know reasons of malaria (n = 605)

Researching places	Do not know (1)		Due to fly (2)		Due to dirty living (3)		Due to mosquito (4)	
	Number	Ratio (%)	Number	Ratio (%)	Number	Ratio (%)	Number	Ratio (%)
Bu Gia Map	31	20,53	7	4,64	3	1,99	113	74,83
Dak O	2	1,33	4	2,67	0	0,00	134	89,33
Chu R'Cam	31	20,53	5	3,31	10	6,62	104	68,87
Iah Dreh	90	58,82	18	11,76	1	0,65	59	38,56
Total	154	25,45	34	5,62	14	2,31	410	67,77
Value χ^2, p	p = 0,0001							

Remarks: Results in Table 3.14: Ratio of people knowing that mosquito is reason of malaria is 67.77%. The difference has the statistical meaning between people knowing that mosquito is the reason of malaria and people who do not know or people knowing reasons of flu, dirty living , with values 66.77% compared with 25.45%; 5.62% compared with 2.31%, with p<0.01.

- Practicing to sleep in mosquito net for malaria prevention

Table 3.19. Ratio of households who frequently sleep in mosquito net (n = 605)

Researching place	Frequently		Not frequently		Do not sleep		Total household
	SL	TL (%)	SL	TL (%)	SL	TL (%)	
Bu Gia Map	97	64,24	51	33,77	3	1,99	151
Dak O	98	65,33	11	7,33	41	27,33	150
Chu R'Cam	109	72,19	34	22,52	8	5,30	151
Ia Hdreh	95	62,09	51	33,33	7	4,58	153
Total	399	65,95	147	24,30	59	9,75	605
Value χ^2, p	p = 0,0001						

Remarks:

The results in Table 3.19 show that: Difference has the statistical meaning between ratio of families who frequently sleep in mosquito net in

comparison with families who do not sleep frequently in mosquito net and do not sleep in mosquito net (65.95% compared with 24.30% and 9.75%, p < 0.01).

3.1.4. Current situation of composition and density of Anopheles species

The composition and density of vectors in researching places are as follows:

- ***In Ia Hdred Commune and Chu R'Cam Commune, KrongPa District:*** In 2 communes of KrongPa District, the main malaria transmission vector has not found, we only find out 06 auxiliary vectors: *An.aconitus; An.sinensis; An.vagus; An.maculatus; An.philippinesis; An.tessellatus.* In which, the highest density of *An.sinensis* is 14.5 mosquitos/ person/ night, next *An.vagus* 4.06 mosquitos/ person/ night.

- ***In Dac O Commune and Bu Gia Map Commune, Bu Gia Map District:*** By indoor human primer, *An. Dirus* has the density of 0.08 mosquitoes/ person/ night; *An.minimus* has the density of 0.06 mosquitoes/ person/ night. In Dak O Commune, by indoor human primer, *An.dirus* has the density of 0.127 mosquitoes/ person/ night; *An.minimus* has the density of 0.08 mosquitoes / person/ night.

3.1.5. Seversal fasctors related to malaria patients

- *Relation of passing borders and malaria:*

Table 3.25. Relation of passing borders with malaria (n = 2008)

Passing or not passing border	Situation of malaria patients		Total
	Catch malaria	Not catch malaria	
Yes	4	32	36
No	37	1935	1972
Total	41	1967	2008
OR = 6,54, CI95%(2,19-19,51), p = 0,0000..			

Remarks: The results in Table show that: there is the relation between passing borders and malaria OR = 6,54, CI95%(2,19-19,51), p < 0,01.

- *Relation between working in forest and malaria:*

Table 3.26. Relation between working in mountain field and in forest with malaria (n = 2008)

Working in mountain field, farm or in forest	Situation of malaria patients		Total
	Catch malaria	Not catch malaria	
Yes	36	1378	1414
No	5	589	594
Total	41	1967	2008
OR = 3,08, CI95%(2,1 – 7,4), p = 0,000…			

Remarks: Table 3.26 shows that: there is a relation between malaria and working in mountain field or in forest OR = 3,08, CI95%(2,1-7,4), p < 0,01.

3.2. Identifying several molecular biological characteristics: *artemisinin – resistant K13 genetic mutation on patients infected by P. falciparum*

3.2.1. Identifying and selecting samples infected by *P. falciparum*

- *K13 genetic sequencing result of subdivision P. falciparum*: We implemented successfully the reaction PCR for amplifying ADN segment on gene K13 for sequencing with primer pairs designed according to Areiy and cs 2013. All 26/26 samples have the electrophoresis bands with dimension 849 bp (Figure 3.3).
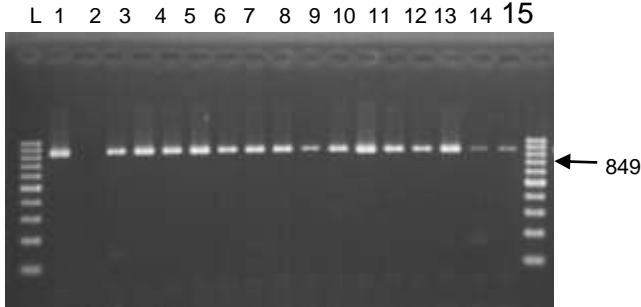

L 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

← 849

Figure 3.3. Photo of PCR electrophoresis multiplying K13 genetic segment of *P. falciparum (L: Scale 100 bp; Well 1: sensitive species PCR in laboratory; Well 2: Bank control group; Wells 3 – 7: PCR product multiplies AND of patients using genetic sequencing)*

- ***Results of analyzing samples collected in Binh Phuoc:***

Table 3.29. Results of investigating the frequency of genetic type of *P. falciparum* **genetic subdivision for gene K13 in the specific artemisinin-resistant places (n=20)**

No.	Mutation	Appearing frequency of genetic types			
		Wild genetic type		Mutated genetic type	
		Number	Ratio (%)	Number	Ratio (%)
1	F446I	20	100	0	0
2	N458Y	20	100	0	0
3	M476I	20	100	0	0
4	Y493H	20	100	0	0
5	R539T	20	100	0	0
6	I543T	20	100	0	0
7	P553L	20	100	0	0
8	R561H	20	100	0	0
9	C580Y	1	5	19	95
	Total	1	5	19	95

Remarks: 100% subdivisions *P. falciparum* in Binh Phuoc bringing the wild genetic type in 8 amino acid positions. There are 95% *P. falciparum* subdivisions having the artemisinin-resistant mutated genetic type in position C580Y mutated from Cystein to Tyrosin, 5% subdivisions having the wild genetic type in this position.

   - Result of analyzing samples collected in Gia Lai :
   Table 3.30. Results of discovering K13 genetic mutation of *P. falciparum* samples collected in Gia Lai (n=6)

No.	Investigating place	Appearing frequency of genetic types			
		Wild genetic type		Mutated genetic type	
		Number	Ratio (%)	Number	Ratio (%)
1	P446I	6	100	0	0
2	N458Y	6	100	0	0
3	M476I	6	100	0	0
4	Y493H	6	100	0	0
5	R539T	6	100	0	0
6	I543T	6	100	0	0
7	P553L	5	83,33	1	16,17
8	R561H	6	100	0	0
9	C580Y	2	33,33	4	66,67
	Total	1	16,17	5	83,33

Remarks: The results in Table 3.30 with *P. falciparum* samples in Gia Lai for discovering two mutations of points C580Y and P553L with ratio 66.67% and 16.17%. The general mutation ratio is 83.33%.

3.3. Efficiency of several intervention methods for strengthening the malaria prevention in malaria area with changing emigration

   3.3.1. Ratio of malaria patients after 12 intervention months

   Ratio of patients infected by malaria parasites after intervention is as follows:

Table 3.31. Ratio of patients infected by malaria parasites after 12 intervention months

Investigating time	Test number	Patients with malaria parasites in blood	Ratio (%)	Intervention efficiency
Before intervention	2008	41	2,04	94,6%
12 months after intervention	1851	2	0,11	
Value χ^2, p	$\chi^2 = 63,46$, p = 0,0000..			

Remarks: The results of Table 3.31 shows the statistical meaning with ratio of patients infected by malaria parasites for 12 months after

intervention with value 2.04% in comparison with 0.11% with $\chi^2 = 63,46$, p < 0,01. The intervention efficiency is 94.6%.

- Ratio of general malaria patients in Bu Gia Map and Krong Pa after 12 intervention months

After 12 months applying the strengthened interventions, the result is as follows:

Table 3.33. Ratio of patients infected by malaria parasites in Bu Gia Map

Investigating time	Test number	Patients with malaria parasites in blood	Ratio (%)	Intervention efficiency
Before intervention	1027	32	3,12	96,47
12 months after intervention	922	1	0,11	
Value χ^2, p	$\chi^2 = 31,88$, p = 0,0000..			

Remarks: Table 3.33 shows the statistical difference about ratio of patients infected parasites before and 12 months after intervention in Bu Gia Map 3.12% compared with 0.11%, with $\chi^2 = 31,88$, p < 0,01. The intervention efficiency is 96.47%.

- Ratio of inhabitants infected by malaria parasites in Krong Pa

Table 3.34. Ratio of inhabitants infected by malaria parasite in Krong Pa after 12 intervening months

Investigating time	Test number	Patients with malaria parasites in blood	Ratio (%)	Intervention efficiency
Before intervention	981	09	0,92	82,00%
12 months after intervention	929	01	0,10	
Value χ^2, p	$\chi^2 = 6,07$, p = 0,0142			

Remarks: Table 3.34 shows the statistical meaning about ratio of patients infected by malaria parasites before and 12 months after intervention in KrongPa with value 0.92% compared with 0.10% with p < 0.05, $\chi^2 = 6,07$. The intervention efficiency is 82.00%.

3.3.2. Knowledge, practice of malaria prevention after 12 intervening months

- Knowledge of inhabitants about malaria prevention after 12 months

Table 3.35. Knowledge of inhabitants about malaria prevention after 12 intervening months (n = 605)

Interview content	Before intervention			After 12 intervening months			Intervening efficiency (%)
	Interview number	Number of exact answer	Ratio (5)	Interview number	Number of exact answer	Ratio (5)	
Knowing reason SR	605	408	67,48	605	589	97,35	24,7
Knowing method PCSR	605	461	71,02	605	536	88,60	24,7
Value χ^2, p	$\chi^2 = 32,05$, p = 0,0000..						

Remarks: The result in Table 3.38 shows that statistical meaning about ratio of people who know reasons of malaria before and after intervention 67.48% to 97.35%, with $\chi^2 = 32,05$, p < 0,01, the efficiency is 24.7%; the statistical meaning about ratio of people who know about malaria prevention methods before and after intervention 71.02% compared with 88.60%, with $\chi^2 = 32,05$, p < 0.01, efficiency 24.7%.

- Practice of inhabitants about malaria prevention

Table 3.43. Frequently sleeping in mosquito net for malaria prevention

District	Intervention time	Number of people sleeping frequently in mosquito net	Ratio (%)	Value χ^2, p	Intervention efficiency (%)
Bu Gia Map	Before intervention	285/325	87,69	$\chi^2=21,21$	10,88
	After intervention	316/325	97,23	p=0,00..	
KrongPa	Before intervention	296/400	74,00	$\chi^2 =16,38$	11,48
	After intervention	342/400	85,50	p= 0,00..,	
Total	Before intervention	581/725	80,14	$\chi^2 =32,88$	13,25
	After intervention	658/725	90,76	p= 0,00..	

Remarks: The result in Table 3.40 shows that: there is the difference between ratio of people sleeping in mosquito net before and after 12 intervening months in Bu Gia Map District and KrongPa District, with ratios 80.14% compared with 90.76%,with $\chi^2 =32,88$, p < 0,01, efficiency 13.25%.

Chapter 4: DISCUSSION

4.1. Current situation of malaria and several related factors in malaria area with changing emigration in Binh Phuoc and Gia Lai, in 2016.

  - **Ratio of people infected by malaria parasites**

The researching results in Table 3.6, Table 3.7, Table 3.9 show that the ratio of patients infected by malaria parasite of researching group is 2.04%. The ratio of patients infected by malaria parasite in Bu Gia Map, Binh Phuoc Province is higher than ratio in KrongPa, Gia Lai Province. This difference has the statistical meaning (3.12% compared with 0.92%, p < 0,01, χ^2 = 12,03).

The results in Table 3.8 show the difference about ratio of patients infected by malaria parasites for people passing borders and people who do not pass borders, with values 17.40% compared with 1.86%, p < 0,05, χ^2 = 9,5. These results confirm that the malaria has the close relation with passing borders and working in forests, suitable to recommendations of International Organization for Migration and UNDP [49], [129], [130].

The ratio of people infected by malaria parasites in the researching group is 2.04%, in group of people who go to forest or sleep in mountain fields, the ratio of people infected by malaria parasite is higher than people who do not sleep in mountain field (2.34% compared with 1.06%, p> 0.05).

The results in Table 3.9,Table 3.13 show that the ratio of patients infected by malaria parasite in Dac O Commune is 5.09% higher than in other communes, the lowest ratio is 0.62% in Ia Hdreh Commune. This difference has the statistical meaning when compared with ratio of patients in Dak O Commune with other commune with χ^2 = 32,08, p < 0,01. The results of thesis are suitable to several studies in Tay Nguyen area, such as:

The study of Nguyen Quy Anh in 2016 shows the ratio of malaria patients in group of people going to forest is 3.8 times as high as group of people who do not go to forest [1]. The study of author Vu Duc Chinh in Dak Nhau Commune shows the risk of malaria for people going to forest and sleeping in mountain fields is 128.64 times as high as; In Dak O, the risk of catching malaria for people who go to forest and sleep in mountain fields in this study is significantly higher[9].

The study of author Dong Le Thanh and et al. in Dak O Commune shows that the group of emigrants in Dak O Commune has the average living time in mountain fields 98 days in year [12]. The results in our study show that the ratio of people infected by malaria parasites in group of people who go to forest and sleep in mountain fields is higher than group of people who go to forest and do not sleep in forest and mountain fields (2.55% compared with 0.84%) and especially group of people passing

borders and sleeping in forest has the ratio of catching malaria many times as high as group of people passing borders but do not sleep in forest (11.11% compared 1.88%, p<0.05). This difference has no statistical meaning, thus any person goes to forest for long or short time has the risk of catching malaria. This result confirms that "Sleeping in forest" and "forest" is the pocket of malaria germs. It should have many deeper studies to confirm this issue.

The researching results in Table 3.12 in our survey show that the ratio of patients infected by malaria parasites in King ethnic group is 0.92%, in Stieng ethnic group 3.50%, Jrai ethnic group and other ethnic groups 1.11%, the difference about ratio of malaria patients has the statistical meaning, with p < 0.01, χ^2 = 14,113. It is absolutely suitable to reality that the malaria parasites can cause diseases in all objects, including inhabitants of malaria area, people who are frequently infected by malaria parasite in nature, because the immune in people infected by malaria parasites is not sustainable and specific. On the other hand, currently, in localities in Tay Nguyen generally and in two researching districts, King people buy land of Jrai, Stieng ethnic minority people, thus they live alternately, thus the impact boundaries of malaria risk factors are similar.

- Ratio and composition of malaria parasite species in researching places through blood smear testing

The researching results in Figure 3.1 and Table 3.13 show that: Among 41 disease cases, we find out the malaria parasites by blood smear dyeing technique and microscope and 63.41% (26/41) parasites are malaria parasites caused by *falciparum,* only 36.59% (15/41) parasites are malaria parasites caused by *P. Vivax*. The rate *falciparum/P. vivax* = 2/1. This result shows that the malaria parasite *P. Falciparum* is the majority and is main disease causing agent for inhabitants in the locality.

This results is also absolutely suitable to previous researching results in Tay Nguyen and the eastern area of South Vietnam such as the study of Huynh Hong Quang, Le Thanh Dong, Bui Quang Phuc and etc. and many other authors. However, in reports, currently the ratio of patients infected by *P. Falciparum* has the tendency of decreasing gradually and the ratio of patients infected by *P. Vivax* has the tendency of increasing highly. Consequently, managers must have methods for treating long-lasting malaria caused by *P. Vivax* and the drug-resistant situation of *P. falciparum* [82], [113].

- Current situation of knowledge, practice of malaria prevention

According to malaria epidemic zone in 2014, KrongPa District and Bu Gia Map District belonging to heavy malaria area [16], especially in researching provinces, the number of patients infected by malaria

parasites is frequently higher than in other provinces in the region [58], [59].

Although the malaria prevention affairs here have been invested by projects and programs, the number of malaria patients still reduces very slowly. Annually, the health and malaria prevention educating and communicating affairs are done in mass media, such as loudspeakers, images, leaflets. Through interviewing knowledge of householders in Table 3.14, the ratio of people knowing malaria caused by mosquito is 67.77%, the highest ratio is in Dak O Commune 89.33%, the lowest ratio is in Ia Hdreh Commune 38.56%. The number of people with exact answer of malaria caused by mosquito occupies the highest ratio in comparison with other reasons, but when comparing with other studies, this ratio is lower. This ratio is equivalent to study of author.

In Table 3.17, the ratio of people who know preventing from malaria by sleeping in mosquito net is 67.93%. Among 605 people asked about malaria prevention and prevention methods, they are questions with many selections of methods, the number of people sleeping mosquito net occupies high ratio 67.93%. The researching result shows that 70.58% households have enough mosquito nets (Table 3.18), the ratio of households using mosquito net in Chu R'Cam Commune (82.781%), the lowest ratio is in Ia Hdred (62.09%). Therefore, although living in heavy malaria area, many householders do not have enough mosquito nets to use. Thus, in comparison with previous study made by Vu Duc Chinh, according to study in Dak O Commune in 2016 [9], [10], the ratio of households who have enough mosquito nets in this study is significantly lower, the reason may be the old and damaged mosquito nets, increase of population and in 2017, inhabitants did not provide additionally any mosquito net.

The ratio of households who have enough mosquito nets and frequently sleep in mosquito nets reaches 65.95%, the households who do not sleep in mosquito net or sometimes sleep in mosquito net occupy high ratio: 9.75%; the highest ratio is in Dak O Commune: 9.75%. The ratio of people who do not sleep in mosquito net in this study is higher than in study made by Nguyen Quy Anh in Dak Nong in 2015, in which the ratio of people who do not sleep in mosquito net is 0.92% [1]. However, in this study, when interviewing more deeply, the majority of inhabitants with wrong answers about: Malaria can be prevented and spraying chemicals aims at malaria prevention.

- Current situation of malaria transmission vector in researching places

+ In IaHdreh và ChuR'Cam of KrongPa District: The results in Table 3.23, Table 3.24 and Table 3.25 show that the composition and density of

malaria vectors in IaHdreh Commune and ChuR'Cam Commune, KrongPa District are as follows: 5 Anopheles species have been identified in IaHdreh Commune, KrongPa District by indoor human primer, outdoor human primer, in-forest human primer, lighting cattle coops, indoor and in-forest lamp trap methods, 100% is auxiliary vectors as: *An. aconitus, An. sinenesis*..., the presence of main vectors as *An. minimus, An. dirus*.... has not been confirmed. In Chu R'Cam Commune, KrongPa District, it is similar as in Ia Hdred Commune, we have collected 6 auxiliary vector species by indoor human primer, outdoor human primer, in-forest human primer, lighting cattle coops, indoor and in-forest lamp trap methods as: *An. aconitus, An. sinenesis*..., the presence of main vectors as *An. minimus, An. dirus*.... has not been confirmed. Therefore, in KrongPa District, the main malaria transmisison vector has not been collected, in Bu Gia Map District, the main malaria transmisison vectors have been collected.

+ In Dak O Commune and Bu Gia Map Commune, Bu Gia Map District

By malaria vector surveying techniques similar as in KrongPa, the result is: In Dak O Commune, by indoor human primer, outdoor human primer techniques and etc, the presence of two main vector species *An. Minimus* and *An dirus* have been collected with density: *An. Minimus* 0.06 mosquitos/ person/night by indoor human primer; *An. Dirus* with density of 0.08 mosquitoes/ person/ night by indoor human primer. In Bu Gia Map Commune of Bu Gia Map District by indoor human primer, outdoor human primer, in-forest human primer, lighting cattle coops, indoor and in-forest lamp trap techniques, the presence of two main vector species *An. minimus* and *An dirus* has been collected with density: *An. Minimus* 0.08 mosquito/ person/ night by indoor human primer; *An. Dirus* with density of 0.17 mosquitoes/ person/ night by indoor human primer. Therefore, in Bu Gia Map, the presence of main malaria transmission vectors has been confirmed.

- Factors related to changing emigration

+ Passing borders and sleeping in forest

The researching result in Table 3.26 shows that the risk of catching malaria for people passing borders frequently is 6.54 times as high as people who do not pass borders with value OR = 6,54, CI95%(2,19-19,51), p < 0,01. This result is absolutely suitable to reality in researching places. Catherin Smith has introduced 3 main related factors between changing emigrants and malaria: the development of economy, changing used land and group of changing emigrants infected by exotic malaria parasites, especially in border area [67]. The report in 2013 of International Organization for Migration shows that 75% cases of *P. falciparum* malaria

patients in Yunnan, China are caused by catching disease in Laos [49]. In countries in Pacific West area, the situation of malaria in the beginning years of century 21 decreased significantly in comparison with years at the end of century 20, but this situation was still heavy in several countries as Papua New Guinea, Cambodia and etc., the reasons have close relation with exchanging through borders and changing emigration.

+ *Going to forest, working in mountain fields and sleeping in mountain fields*

The result in Table 3.27 shows that the relation between working in mountain field and malaria has value OR = 3,08, CI95%(1,4 - 4,2), p < 0,01. When analyzing more deeply about time when going to forest and sleeping in forest, there is a relation between time when going to forest and sleeping in forest ≥ 14 days and value OR = 2,01, CI95%(1,4 - 4,2), p < 0,05. Thanks to this result, we can think that the malaria has a relation with time when living in forest and sleeping in forest.

4.2. Artemisinin-resistant K13 genetic mutation on patient infected by *P. falciparum*

The researching result on 20 samples of malaria patients caused by *P. Falciparum* in Binh Phuoc in 2016, the ratio of K13 genetic mutation was very high, occupying 95%, in which only C580Y mutation was discovered, the other mutation places were not found in this study. The researching result is suitable to several authors, such as Ngo Viet Thanh and et al. in 2017. By analysis of K13 gene on patients monitored in vivo in Binh Phuoc in the period 2012 – 2015, 4 mutation positions I543T, C580Y, P553L, Y493H were discovered, in which the mutation C580Y developed and increased diachronically, the other mutation positions followed the tendency of decreasing gradually. The result of analyzing patient blood samples in 2015 shows that only mutation C580Y was discovered with mutation rate 72.73%. Several other studies of Nguyen Thuy Nhien and et al. in 2017, the result of analyzing mutation K13 for samples *P. Falciparum* from 2009 – 2016 in Binh Phuoc and Gia Lai shows that in Binh Phuoc there was the significant increase of mutation C580Y from 1.7% in period 2009 – 2010 to 79.1% in period 2015 – 2016, and the sensitive species and other species with mutation as I543T decreased fast from 10.2% in period 2010 – 2011 to 2.1% in period 2013 – 2014. This mutation was not discovered in period 2015 – 2016. The ratio of mutation C580Y in Gia Lai increased from 24.6% in period 2014 – 2015 to 63% in period 2015 – 2016 [30], [33], [39].

The researching result in Gia Lai with 06 samples positive with *P. Lasmodium,* the ratio of point mutation related to chemical resistance is very high, the general ratio is 83.33% (5/6) samples in which 4 samples has

point mutation in C580Y (66.67%) and 1 sample with point mutation P553L(16,67%). This result is similar to study of Nguyen Thuy Nhien and et al. in period 2014 – 2015, 3 genetic mutation points C580Y (22,4%), P553L(15,8%), and 5,4% and 5.4% other mutations types as A539T, V568G, P574L. were discovered. The ratio of mutation in Gia Lai increased from 24.6% in period 2014 – 2015 to 63.0% in period 2015 – 2016 [30], [33], [39].

The analyzing result of Nguyen Thuy Nhien and et al. in 2017 in Ninh Thuan (2013 – 2016) only discovers 3 mutation positions T493H, Y543T and C580Y with low mutation ratio 6% [110]. The researching result is highly similar to population of parasite *P. Falciparum* in Cambodia in several recent studies made by Soy Ty Kheang and et al. in 2017, the anslysis on 98 patient samples in horizontal surveying study in 2014 – 2015, the result shows that only 2 mutation positions are disovered, they are the mutation C580Y with ratio 84% and Y493H with ratio 4% [79], [120].

According to evaluation of WHO, in the area of Mekong sub-region (GMS), 5 mutation points are discovered with appearing frequency, including F446I, R539T, I543T, P574L and C580Y. However, these mutations have the highland properties. From researching results of thesis and other reference studies on K13 artemisinin- resistant gene analysis, we can see that the drug-resistance selection and development processes of parasite *P. Falciparum* have changes diachronically, the species with C580Y-resistant mutation develop fast with frequency from 1.7%/ year in 2009 – 2010 to 97% in period 2017 – 2018, meanwhile the species with sensitivity or mutation in other positions decrease strongly, similar to evaluation of WHO, 2018. The results of thesis contribute into alarming the situation of developing and spreading broadly parasites with artemisinin-resistant mutation in Binh Phuoc and several provinces circulating malaria in our country.

4.3. Evaluation of efficiency of several methods for strengthening the malaria prevention in the region with changing emigration

4.3.1. Ratio of malaria patients after 12 intervening months

The researching result in Table 3.32 shows the statistical difference about malaria patient ratio and the malaria parasites are discovered in blood before and after 12 intervention months; 2.04% (41/2008) before intervention reducing to 0.11% (2/1851) after intervention, with $p < 0,01$, $\chi^2 = 63,46$. The ratio of patients with malaria parasites in blood in researching places is 94.6%. This result shows that all strengthening methods for malaria prevention done in thesis have very high efficiency.

In researching places Bu Gia Map (Table 3.33) and Krong Pa (Table 3.34), the results are similar. The ratio of malaria parasites in blood in Bu

Gia Map decreases significantly after 12 intervening months from 3.12% to 0.11%, the intervention efficiency is 96.47%; In Krong Pa, the ratio of patients infected by malaria parasites decreases from 0.92% to 0.43%, the intervention efficiency is 53.6%.

4.3.2. Intervention efficiency changes knowledge and practice of malaria prevention of inhabitant after 12 intervening months

The researching result of thesis in Table 3.35: There is a difference about ratio of interviewed people who know about malaria reasons and malaria prevention methods before and after 12 intervening months with values (67,48% compared with 97,35%, $p < 0,01$, $\chi^2 = 32,05$) and (71,02% compared with 88,60%, with $p < 0,01$, $\chi^2 = 32,05$). In districts, the ratio of people knowing the malaria reasons increases significantly with statistical meaning between before and after intervention (Table 3.36): the ratio of people knowing that malaria is caused by mosquito in Bu Gia Map increases from 86.15% to 95.70%; In KrongPa, this ratio increases from 87.50% to 98.75% and the general ratio of two district increases from 89.66% to 97.24%.

The knowledge of people knowing that malaria is caused by mosquito increase highly after 12 months in researching places: Bu Gia Map, the ratio increases from 86.15% to 95.70% with $p < 0,01$, $\chi^2 = 9,79$; In KrongPa, it increases from 87.5% to 98.75% with $p < 0,01$, $\chi^2 = 9,17$. People knowing preventing from malaria by sleeping in mosquito net occupy the highest ratio, increasing from 89.66% to 98.34% with $p < 0,01$, $\chi^2 = 48,52\%$ (Table 3.39). This result reflexes the high efficiency of strengthened intervention affairs in the researching places.

Not only knowledge, but the practice of inhabitant for malaria prevention changes clearly in the positive direction, in details:

The ratio of people who sleep frequently in mosquito net increases from 87.69% to 97.23% in Bu Gia Map and from 74.0% to 85.5% in KrongPa. The general ratio of two districts increases from 80.14% to 90.76% with $p < 0,01$, $\chi^2 = 32,88$. This result has been improved but there is a big question in Krong Pa District after 12 intervening months, there is still 14.5% people who do not frequently sleep in mosquito net. It is a gap leading to high risk of catching malaria and the malaria still persists, which relates to practice of preventing from mosquito by inhabitants.

CONCLUSION

1. Current situation of malaria and related factors in malaria area with changing emigration in Binh Phuoc and Gia Lai, in 2016

With 2008 survey samples about current situation of malaria, the results are as follows:

- The general ratio of patients with malaria parasites is 2.04%, in which the ratio in Bu Gia Map, Binh Phuoc Province is 3.13%, and the ratio in KrongPa, Gia Lai Province is 0.92%. The ratio of patients with malaria parasite in Dak O Commune is highest 5.09%, the lowest ratio is in Ia Hdreh 0.62%. The ratio of male patients infected by malaria parasite is 3.09% and ratio of female patients is 1.12%.

- The general ratio of patients infected by malaria parasites by testing blood smear for *Plasmodium falciparum* is 63.41% (26/41), for *Plasmodium vivax* it is 36.59% (15/41).

- There is a relation between malaria catching and factors: Passing borders and sleeping in forest OR = 6,54, CI95%(2,19-19,51), p < 0,01; Goring to forest and sleeping forest OR = 2,01, CI95%(1,4-4,2), p < 0,05; Working and sleeping in forest OR = 3,08, CI95%(2,1-7,4), p < 0,01.

- The presence of malaria transmission vectors has been confirmed: In Dak O Commune, they are *An. minimus* and *An dirus* with density: *An. Minimus* 0.08 mosquitoes/ person/ night by lighting animal coops; *An. Dirus* with density 0.17 mosquitoes/ person/ night by in-forest human primer. In Bu Gia Map Commune, Bu Gia Map District, there are the presence of two main vector species *An. minimus* and *An dirus* with density 0.08 mosquitoes/ person/ night by in-forest human primer. The main malaria transmission vector has not been found out in KrongPa District.

2. Artemisinin-resistant K13 genetic mutation on patients infected by *P. falciparum*

- Thanks to analysis of 26 blood samples infected by malaria parasite *Plasmodium falciparum* by PCR technique, we find out 01 point mutation C580Y with ratio 95% on samples collected in Bu Gia Map, Binh Phuoc Province. The ratio of K13 genetic mutation in KrongPa, Gia Lai Province is lower; The ratio of general point mutation is 83.33%; 2 point mutations C580Y and P553L are discovered with ratios 66.67% and 16.67%.

3. Efficiency of several methods for strengthening the malaria prevention in heavy malaria area with changing emigration.

The ratio of patients infected by malaria parasites decreases from 2.04% before intervention to 0.11% after 12 strengthened intervention months, the efficiency if 72.90%; In Bu Gia Map, the ratio of patients infected by malaria parasite decreases from 3.12% to 0.11%, the intervention efficiency is 96.7%.

The ratio of people knowing about malaria reasons increases from 67.48% to 07.35%; the ratio of people knowing about each kind of malaria reason increases from 89.66% to 97.24%; the ratio of people knowing that malaria can be prevented increases from 71.31% to 90.48%; the ratio knowing about malaria prevention methods: sleeping in mosquito net increases from 89.66% to 98.34%; soaking mosquito net increases from 41.38% to 59.45%; practicing to sleep in mosquito net increase from 80.14% to 90.76%.

SCIENTIFICNESS AND NOVELTY OF TOPIC

This is the first time when the topic is researched synchronously about situation of malaria in area with changing emigration with combination of labo researching and intensive techniques as PCR technique in samples infected by parasite *Plassmodium falciparum* for identifying artemisinin-resistant K13 genetic mutation and fluid in hot points about drug-resistant malaria in Vietnam.

On the other hand, the thesis designed by standard scientific researching methods is the descriptive study with analyzing and researching the community intervention. They are modern researching methods applied in the world and in Vietnam; the data of thesis are also analyzed and processed by specialized software with high reliability, such as: entering data by software EpiData and analyzing by Stata 12.0 software. Analyzing the sequence of AND for identifying mutation using genetic sequence of species 3D7 referred in genetic bank NBCI with code >XM_001350122.1 *Plasmodium falciparum* 3D7 kelch protein K13 (PF3D7_1343700), analyzing and comparing the sequence by software Bioedit V.7.0.5.3.

Using the biomedical statistical tests for analyzing data, such as: Test t, x^2.., thus the data for ensuring the reliability and covering highly scientific content.

MINISTRY OF EDUCATION AND TRAINING   **MINISTRY OF HEALTH**

NATIONAL INSTITUTE OF MALARIOLOGY-PARASITOLOGY AND ENTOMOLOGY

NGUYEN VAN QUAN

RESEARCHING SEVERAL EPIDEMIOLOGICAL CHARACTERISTICS OF MALARIA AND METHODS FOR PREVENTING AND STRENGTHENING IN MALARIA AREA WITH CHANGING EMIGRATION IN BINH PHUOC AND GIA LAI (2016 – 2017)

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Opponent 3: Assoc. Prof. Dr.

The thesis will be defended before the academy-level doctoral thesis quality examination council in National Institute of Malariology – Parasitology and Entomology at 8 o'clock day   month   year 2020.

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LIST OF THESIS-RELATED PUBLICATIONS OF THE AUTHOR

1   Nguyen Van Quan, Ngo Duc Thang, Tran Thanh Duong (2020),"Researching the ratio of malaria patients in the malaria area with changing emigration in Bu Gia Map District, Binh Phuoc and KrongPa, Gia Lai Province, in 2017", *Magazine of malaria and parasite diseases prevention,* Volume 4, Pages 1-8.

2   Nguyen Van Quan, Ngo Duc Thang, Tran Thanh Duong (2020),"Researching the strengthened community intervention efficiency of malaria prevention in the malaria area with changing emigration in Bu Gia Map District, Binh Phuoc Province and KrongPa, Gia Lai Province (2017 – 2018)", *Magazine of malaria and parasite diseases prevention,* Volume 4, Pages 9-16.