

Prevalence of Placental Infection with *Plasmodium Falciparum* Detected by Polymerase Chain Reaction and Associated Risk Factors in Women After Delivered Ouagadougou (Burkina Faso)

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Research

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Abstract

Background: Malaria is known to have a negative impact on pregnant women and their foetuses. This infection during pregnancy represents a major public health problem in tropical and subtropical regions. The aim of this study was to determine the prevalence and risk factor of *Plasmodium falciparum* in pregnant women the city of Ouagadougou (Burkina Faso).

Methods: A cross-sectional study was conducted from April 2019 to March 2020 in four health districts within Ouagadougou, capital city. Samples were collected from the placenta from 531 women after delivered *Plasmodium falciparum* then by PCR.

Results: The prevalence placental malaria with of *Plasmodium falciparum* was estimated at 7.53%. The status of unemployment and/ or the status of residence around the city of Ouagadougou represent risk of malaria infection.

Conclusion: Malaria in pregnancy is responsible for several complications so emphasis should be placed on communication about malaria control in pregnancy and, the behavior of pregnant women and health workers as well.

Background

Malaria is a life-threatening parasite disease transmitted an of infected Anopheles female mosquitoes. According to the World Health Organization (WHO), more than half of world's population was at risk of malaria in 2019 [1]. Unfortunately, the vast majority of malaria cases and deaths occur in are from sub-Saharan Africa, where about 30 million pregnant women are highly exposed to the disease each year [2].

Malaria infection during pregnancy is a major public health, and poses substantial risks to the mother, her fetus and the new-born [3]. Indeed, it may cause a variety of adverse consequences including maternal anaemia and death, placental accumulation of parasites, low-birth-weight neonates from intrauterine growth retardation, congenital infections and infant mortality with higher rates of miscarriage, intrauterine demises, premature delivery and neonatal death [4].

Burkina Faso is among the ten countries with the highest number of malaria cases and deaths with 3% of the global cases and deaths and is also among the 20 countries where the prevalence of exposure to malaria infection during pregnancy was more than 30% while maternal anaemia was over 40% in 2018 [5].

For the prevention of malarial disease during pregnancy the World Health Organization has recommended since 2004 relevant strategies, such as the administration of intermittent preventive treatment IPT with Sulfadoxine/Pyrimethamine during pregnancy, the use of insecticide-treated bed nets (ITN) by pregnancy women and the effective management of clinical cases to reduce the burden of malaria and improve pregnancy outcome. In Burkina Faso, Intermittent preventive treatment with

Sulfadoxine/Pyrimethamine (IPTp-SP) was adopted in 2005, with the objective of giving at least three doses of sulfadoxine-pyrimethamine to women during their pregnancy [6].

Despite the implementation of WHO strategies, the recent studies have shown that an important proportion of pregnant women were infected and had sequestered parasites in their placenta.

[7, 8, 9] This situation could be explained par many risks factors such as pregnant women behaviour towards disease prevention. Lack of formal education, attitude health workers, access measures prejudices and resistance of *Plasmodium falciparum* to antimalarial agents constitute important other factors contributing to the persistence of malaria with its adverse effects [10]. This cross-sectional study was performed with the aims to determine by using a PCR detection method the prevalence and risk factors of placental malaria infection in pregnancy women living in Ouagadougou the capital city of Burkina Faso. The study results will help to update on the placental malaria infection in Burkina Faso

Methods

Study sites

A cross-sectional study was conducted in the hospital of four health districts of the city of Ouagadougou named, the Boulmiougou district hospital, the Paul VI hospital, the Schiphra hospital and the Noongr-Massom district hospital.

Ouagadougou is the capital of Burkina Faso (lat. 12°22'N and long. 1°31'W). Its population is estimated at around 2 684 052 inhabitants in 2020. This city is subjected to tropical savanna climate with a rainy season between June and October, a cold and dry season between November and January, and a hot and dry season between February and May. There are three artificial lakes located within the city intended to supply water to the population. Malaria transmission is considered to be high in Ouagadougou.

we sectioned 4 sites that correspond to the major hospitals of the city which are the Boulmiougou district hospital located in the district of BOULMIUGOU, the Paul VI hospital in the district of SIG-NONGHIN, the Schiphra hospital and the Noongr-Massom district hospital in the district on NONGRE-MASSOM, which correspond to the major hospitals in the city of Ouagadougou (Fig. 1).

Study population

The study enrolled all of pregnant women who accepted to participate to the study and signed the written the information consent form. HIV positive pregnant women were excluded. A total of 531 women were enrolled. The study was carried out during on year from April 2019 to march 2020.

Ethical considerations

Approval for this study was granted by the National Ethics Committee for Health Research of Burkina Faso (deliberation N° 2019-4-056). The study received administrative approval from the district medical officer, the mayor, and the head of each local health centre where the study took place. Pregnant women

were approached when reporting delivery. Only pregnant women volunteer who signed an inform consent form for their participation were enrolled.

Demographic and clinical data capturing :

A structured questionnaire was used to capture demographic and clinical data from the pregnant women participating to the study. Data collected included age, marital status, educational level, occupation, current and previous pregnancies, environmental and living conditions. Information about the use of Intermittent Preventing Treatment (IPT) and Insecticide Treated Nets (ITNs) bare also recorded.

Blood sample collection

To determine the infection of the placenta by *Plasmodium falciparum*, blood from the maternal face of placenta, thick and thin films preparation according to WHO protocol [11] and blood spotting on filter paper (Whatman N° 3) for PCR detection (Fig. 2).

Malaria diagnosis by microscopic method

Microscopy, which is the WHO reference method for diagnosing malaria was used.

Thick and thin films prepared from blood of the maternal face of placenta of each woman were examined by two laboratory microscopists.

First, the dried slides were stained with May Grunwald Giemsa for 15 minutes. They are then rinsed with water and left to dry. The slides were read using the oil immersion objective lens of an optimal microscope at 100X magnification. *Plasmodium falciparum* parasites were counted parallelly with leukocytes. The counting was stopped when the number of leucocytes reached 200 and the following formula was used to determine the parasite density per microlitre of blood:

$$PD = \frac{\text{number of counted parasites} \times 8000}{40}$$

PD is the parasites density per microlitre of blood

8000 is the average number of leucocytes per microliter of blood.

At least 100 high power fields were examined before a thick smear was declared negative

Detection of Plasmodium falciparum by Polymerase Chain reaction

Plasmodium falciparum DNA was extracted from dried blood spots using QIAamp® DNA Mini Kit (250) according to the manufacture's recommendation. Eluted DNA was immediately used in amplification reactions or stored at - 20 °C until processing. The DNA amplification method was described elsewhere by nested polymerase chain. The primers sequences for first (nested) amplification were: rPLU5 5-CCT GTT GTT GCC TTA AAC TTC-3 (forward) rPLU6 5-TTA AAA TTG TTG CAG TTA AAA CG-3 (reverse). For

the second (nested) amplification were used rFAL1 5-TTA ACC TGG TTT GGG AAA ACC AAA TAT ATT-3 (forward) rFAL2 5-ACA CAA TGA ACT CAA TCA TGA CTA CCC GTC-3 (reverse).

PCR amplification of *Plasmodium falciparum*

Amplification was performed on an Applied Biosystem 2720 Thermal cycler. It was in 20µl volume containing 1µl of genomic DNA, 2µl of polymerase chain reaction (PCR) buffer 10X, 0,5µl of 10µM of each primer, 1,25µl of mM of dNTP, 0,8µl of 50mM of MgCl₂ and 0,1 of 5UI Taq polymerase. The system was programmed to 5 min for initial denaturation at 95°C, to 1min of denaturation at 94°C and this was followed by 24 cycles, each consisting of 1 min of denaturation at 94°C, 2 min of annealing at 58°C, 2 min of extension at 72°C. At the final cycle, an additional 5 min of incubation at 72°C was performed to complete the extension. For second amplification the cycle condition outer PCR 30 cycles. The amplified PCR products were either stored at + 4°C or analysed immediately by electrophoresis on a agarose gel (Fig. 3).

Data interpretation

Data DNA fragments from the second amplification electrophoresis were assessed and data interpreted as *Plasmodium falciparum* positive when the size the DNA is about 205 bp.

Statistical analysis

The data were analysed using R software. The proportions comparison was made by Chi squared and normally distributed continuous data by the Student's test and ANOVA.

Results

Characteristics of the study population

A total 531 blood spots samples were obtained. The mean age of the study participants from the four sites was estimated at 26,9 years. About 30,80% patients were primigravidae, 54,04% patients lived in Ouagadougou city and 45,63% were unemployed, of which 53,04% were married.

Prevalence of placental malaria

In our study, we obtained a prevalence of placental malaria of 7,53%. This prevalence was only for *Plasmodium falciparum*.

Factors associated with placental malaria infection

It represents the different risk factors associated placental malaria infection (Table 1)

Table 1
Identified risk factors associated with placental malaria infection

Risk factors							
Place residence	Ouaga			Around Ouaga		Other	
	228			330		3	
Age (years)	< 18		[18–25[[25–32[[32–39[≥ 39
	21		375	24		103	7
Profession	No occupation	Salaried agent	Shopping	Agriculture	Breeding	Worker	Student
	242	106	102	1	1	19	59
Secondary effects	No	General tired	Nausea	fear of heights		Vomitting	
	412	53	15	4		27	
Parity	Primigravidae			Paucigravidae		Multigravidae	
	182			257		59	
Gesture	Primigests			Paucigests		Multigests	
	163			260		112	
ANC place	CSPS		Private clinic	CMA		CHR	Other
	316		108	100		5	2
Agent ANC	Gynecologist			Midwife		Other	
	57			472		2	
LLIN	Yes			No			
	478			53			
Start TPI	1 ^{er} trimester			2nd trimester		3eme trimester	
	70			430		18	
Supervised TPI	Yes			No			
	54			475			

Influence of risk factors of placental malaria prevalence's

The Table 2 representee age, residence place, occupation, gestures, and parity prevalence's. It reveals more positive case in the 18 to 25 years, among parturient living around Ouagadougou city's, those who were without a profession, paucigestures and pauciparous. The difference was statistically significant at the level of place and occupation with p value of ($P= 0,0046$, and $P= 0,0186$) respectively (Table 2).

Table 2
the influence of age, place of residence, occupation, number of pregnancies and parity on placental malaria infection

	PCR	
	Négatif	Positif <i>p value</i>
< 18 years	20	1
[18–25[343	32
[25–32 [24	0 <i>p = 0,6298</i>
[32–39[96	7
≥ 39 years	8x	0
Place of residence	Around ouaga 201	27
	Ouaga 287	13 <i>P = 0.0046</i>
	Autre 3	0
Profession	No occupation 221 salaried agent 103	21
	Schopping 95	3
	Agriculture 0	7
	Breeding 1	1
	Worker 16	0 <i>P= 0.0186</i>
	Student 54	3
	Other 1	5
		0
Number of gestures	Primigeste 151	12
	Paucigeste 238	22 <i>P = 0.6266</i>
	Multigeste 106	6
Number of parity	Primipare 170	13
	Paucipare 234	23 <i>P = 0.5424</i>
	Multipare 87	4

The Table 3 reveals more positive cases in the 18 to 25 years, among parturients living around the city of Ouagadougou, those whose were without a profession, paucigestes and pauciparus. The difference was statistically significant at the level of place of residence and occupation ($P = 0,0046$ and $P = 0,0186$).

Table 3
Influence of the location of the Prenatal Consultation (ANC), the qualification of the ANC agent on placental malaria infection

	PCR	
	Négatif	Positif <i>p</i>
Place of prenatal consultation	SPHC 290	26
	CMA 103	5
	Clinical 91	9 <i>p = 0.6617</i>
	RHC 50	0
	Other 2	0
Prenatal consultation agent	Gynecologist 56	1
	Midwife 434	38 <i>p = 0.0174</i>
	Other 1	1

The table below represents the influence of the location antenatal consultation (ANC) the qualification of the ANC agent on the placental malaria infection (Table 3)

There were more positive cases among women who underwent their antenatal consultation (ANC) in the SPHC and by midwives. The difference was statistically significant among women who have had their antenatal consultation with a midwife ($P = 0,0174$)

There was no statistically significant association between placental malaria infection of TPI supervised, using long-acting insecticide-treated mosquito net, start IPT and secondary effects (Table 4)

Table 4
Influence of the use of long-acting insecticide-treated mosquito net, side effects, supervised IPT, on placental malaria infection

	PCR	
	Négatif	Positif <i>p value</i>
LLIN	Yes 441	37
	No 50	3 <i>p = 0.5862</i>
Start TPI	Trimester 1 67	3
	Trimester 2 396	34 <i>p = 0.2305</i>
	Trimester 3 15	3
TPI supervised	Yes 52	2
	No 437	38 <i>p = 0.4847</i>
Secondary effects	No 377	35
	general fatigue 52	1
	Nausea 15	0 <i>p = 0.2198</i>
	fear of heights 4	0
	Vomiting 27	1

Discussion

The present study was designed to determine the prevalence of placental malaria infection and risk factor among delivering women at the main hospitals in Ouagadougou, Burkina Faso. The prevalence observed in our study 7,53% was lower compared to the prevalence previously reported elsewhere ,19, 40% and 19,50% in Angola [12] and Burkina Faso [13] respectively. The factors responsible for such variations in the placental malaria prevalence were reported to be acquired immunity related to the malaria transmission in the various setting [14]. This difference may be explained by the fact that parturients in our study received intermittent preventive treatment with Sulfadoxine/Pyrimethamine. Moreover, this prevalence is higher than the previous recorded in a study in Ghana [15] which value was.

The risk of the malaria infection was higher in pregnant women aged between 18 and 25 years. This is confirmed by Bianor [12] who found that the age was also identified as a risk factor for placental infection,

In addition, women unemployed and who lived around the city of Ouagadougou, performing their prenatal consultation in a health and social promotion centre and by midwife. Therefore, the young age,

precarious living condition and lack of financial support would be constituting a risk factors increasing malaria infection.

The prevalence of placental malarial was found higher in paucigestates, and who started their intermittent preventive treatment in the second trimester of their pregnancy. Probably due to the late start of the intermittent preventive treatment with Sulfadoxine/ Pyriméthamine different from World Health Organization's recommendation of the start of the intermittent preventive treatment (IPT) at the end of the 28 weeks of pregnancy.

Indeed, malaria prevalence is higher in the first and second trimesters of pregnancy and decreases in third trimester to reach the rate before childbirth. This would explain the high placental malaria infection prevalence in pregnant women starting their intermittent preventive treatment in the second trimester. Essiben *et al.* reported the same results in Cameroun.

Sulfadoxine/Pyrimethamine administration was not supervised and more than 50% of the women slept regularly under untreated mosquito net [16].

Placenta malaria prevalence was higher in pregnant women who were not taking intermittent preventive treatment unattended by a health professional and those who had no side effects after taking intermittent preventive treatment. The difference was not statically significant ($P = 0,2198$). Mosquito net impregnated with repellents reduces nocturnal mosquito bites, thus limiting Plasmodium infestation. According to WHO, women should be encouraged to use insecticide-treatment mosquito nets throughout their pregnancy because Sulfadoxine/Pyrimethamine intermittent preventive treatment would not replace LLINs.

The management strategies adopted for malaria preventive in pregnancy are the use of the Impregnated Long-Action Mosquito Net (LLIN), Sulfadoxine/Pyrimethamine intermittent preventive treatment (IPTp-SP) and adequate cases management thanks to rapid malaria treatment in pregnant women. The value of this work lies in the identification of factors that may have an influence on placental malaria infection.

Conclusion

The observed prevalence of placental parasitaemia at delivery suggest that malaria remains one of the main concerns during pregnancy. As malaria in pregnancy is responsible for several complications so emphasis should focus on communication for change of behaviour of pregnant women and also of health professionals. Our study allowed us to determine placental malaria prevention and risks factors associated with placental malaria infection.

Abbreviations

WHO

World Health Organization, PCR:Polymerase Chain Reaction, ANC:Antenatal Clinic, IPTp-SP:Intermittent preventive treatment with Sulfadoxine-pyrimethamine, ADN:Desoxyribonucleic acid, HIV:Human immunodeficiency virus, LLIN:Impregnated Long-Action Mosquito Net, SPHC:Social promotion health centre.

Declarations

Author's contribution:

SH, ZA, and ZC conceived of designed the field study. SH conducted the field study , SH, SI and conceived and designed the molecular analysis, SH analysed the data and wrote the manuscript, ZA, ZC, SI, SPM, DT,SI, OTR, SL, DRT critically revised the manuscript. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Consent for publication

This part is not applicable because the manuscript contains no individual person's data in any form (including individual details, images or videos).

Availability of data and materials

Not applicable

Ethics approval and consent to participate

The study protocol was approved by the National Ethics Committee for Health Research of Burkina Faso. Written informed consent was obtained from all study participants.

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References

1. -**World Health Organization (WHO)**. **Malaria**. Who fact sheets.2021 Available from: <https://www.who.int/news-room/fact-sheets/detail/malaria> [accessed 10/04/2021].
2. -**Tegegne B**, Getie S, Pillai DR. Performance of loop-mediated isothermal amplification (LAMP) for the diagnosis of malaria among malaria suspected pregnant women in Northwest Ethiopia. *Malar J*. 2017;16:34.
3. -**Kanbanywanyi AM**, MacArthur JR, Stolk WA, Habbema DFJ, Mshinda H, Bloland PB, Abdulla S, **Kachur PS**. Malaria in pregnant women in an area with sustained high coverage of insecticide-treated bed nets. *Malar J*. 2008; 7: 133.
4. -**Feleke DG**, Adamu A, Gebreweld A, Tesfaye M, Demissis W, Genet Molla G. Asymptomatic malaria infection among pregnant women attending antenatal care in malaria endemic areas of North-Shoa, Ethiopia: a cross-sectional study. *Malaria Journal*.2020; 19: 67.
5. -**World Health Organisation (WHO)**. World malaria report. Geneva: World Health Organization; 2019. Licence: CC BY-NC-SA 3.0 IGO. Available from: <https://www.who.int/publications/i/item/9789241565721> [accessed 12/03/2021].
6. -**Cissé M**, Soulama AGA, Tinto A **A.**, **Hayette MP**, **Guiguemdé RT**. Recent uptake of intermittent preventive treatment during pregnancy with sulfadoxine-pyrimethamine is associated with increased prevalence of Pfdhfr mutation in Bobo-Dioulasso, Burkina Faso. *Malar J*. 2017, 16: 38.
7. -**Cisse M**, Lougue SI **G.**,**Bamba S.**, **Bayane D.**, **Guiguemde RT**. Prevalence and risk factors for *Plasmodium falciparum* malaria in pregnant women attending antenatal clinic in Bobo-Dioulasso (Burkina Faso). *BMC Infect Dis*.2014, 14: 631.
8. -**Tiono AB**, Ouedraogo A, Bougouma EC, Diarra A, Konaté AT, Nébié I, Sirima SB. Placental malaria and low birth weight in pregnant women living in a rural area of Burkina Faso following the use of three preventive treatment regimens. *Malar J*. 2009, 8: 224-10.1186/1475-2875-8-224.
9. -**Elime FA**, Nkenyi NR, Ako-Egbe L, Njunda A, Nsagha D. Malaria in pregnancy: prevalence and risk factors in the Mamfe health district, Cameroon. *Journal of Advances in Medicine Medical Research*. 2019; 30:1–11. doi:10.9734/jammr/2019/v30i130161.
10. -**Ouedraogo CMR**, Nebié G, Sawadogo L, Ouedraogo A, Lankouandé J. Study of factors favouring the occurrence of *Plasmodium falciparum* in pregnant women in the health district of Bogodogo. *J Gynecol Obstet Biol Reprod (Paris)* 2011; 40:529–34. doi:10.1016/j.jgyn.2011.03.005.
11. -**Organisation Mondiale de la santé**. Diagnostique microscopique du paludisme: manuel d'assurance qualité-Ver 2 World Health Organisation, 2020 [cited 2020 Aug 24], <http://www.who.int/malaria/publication/atoz/97892415493994/fr/>.
12. -**Valente B**, Compos PA, **Rosario VE do**, **Varandqs** Silveira L **H**. Prevalence and risk factors of *Plasmodium falciparum* infections in pregnant women of Luanda, Angola. *Tropical Medicine and International Health*. 2011. 16;1206–1214.
13. -**Ouédraogo A**,Tiono AB, Diarra A, Bougouma ECC, Nébié I, Konaté AT, Sirima SB. Transplacental Transmission of *Plasmodium falciparum* in a Highly Malaria Endemic Area of Burkina Faso. *Journal of Tropical Medicine*. 2012. 84;3 386–9.

14. -**Omer** SA, Idress H, Adam I, Abdelrahim M, Noureldein AN, Abdelrazig AM, Elhassan MO, Sulaiman SM. Placental malaria and its effect on pregnancy outcomes in Sudanese women from Blue Nile State. *Malaria Journal*. 2017.16: 374.
15. -**Stephens** KJ, Ofori FM, Quakyi AI, **Mark** Lee Wilson LM, Akanmori DB. Prevalence of peripheral blood parasitaemia, anaemia and low birthweight among pregnant women in a suburban area in coastal Ghana. *Pan African Medical Journal*. 2014.17; 1: 3.
16. -**Essiben** F, Foumane P, Tsafack de Nguetack MA, Eko Eko F, Njotang PN, Enow RM, Mboudou ET. Facteurs prédictifs de l'échec du Traitement Préventif Intermittent du paludisme à la sulfadoxine – pyriméthamine (TPIp-SP) dans une population de femmes enceintes à Yaoundé. *Pan Afr Med J* 2016 23:152. doi:10.11604/pamj.2016.23.152.7936.
17. -**Crompton** PD, Pierce SK, Miller LH, 2010. Advances and challenges in malaria vaccine development. *The Journal of Clinical Investigation*. 2010.120;12: 24–39.
18. -**Organisation Mondiale de la Santé**: traitement préventif intermittent (TPI) pour les femmes enceintes. OMS 2013.
19. -**Nagalo** K, Dao F, Minodier P, Sawadogo O, Sanon H, Tall FH, **Diarra Yé**. 2014: Congénital malaria *Plasmodium falciparum* disease: épidémiologic, clinic, biological, thérapeutic and pronostic in Ouagadougou, Burkina Faso. *The Pan African Medical Journal – ISSN*. 2014; 1937–8688.
20. -**Maubert** B, Fievet N, **Tami G, Boudin C et Deloron P**. Cytoadherence of *Plasmodium falciparum* - infected erythrocytes in the human placenta. *Parasite Immunol*. 2000. 22;4:191–9.
21. -**Organisation Mondiale de la Santé**. World malaria report 2015. Genève: WHO.
22. -**Roll Back Malaria et Programme des Nations Unies pour le Développement (PNUD)** (2013). multisectoral action framework for the fight against malaria. Genève: RBM et PNUD. 2013.
23. -**Ministère de la Santé**: National guideline for management of malaria in health facilities in Burkina Faso. 2014. 31 pages.
24. -**Ministère de la Santé**: strategic plan to fight against malaria 2011–2015. Ouagadougou, Burkina Faso. National malaria control program. 2011.
25. -*Kurtis JD, Higashi A, Wu HW, Gundogan F, McDonald EA, Sharma S, PondTor S, Jarilla B, Sagliba MJ, Gonzal 548 A, Olveda R, Acosta L, Friedman JF. Maternal Schistosomiasis japonica is associated with maternal, 549 placental, and fetal inflammation. Infection and immunity. 2011. 79:1254–1261*

Figures

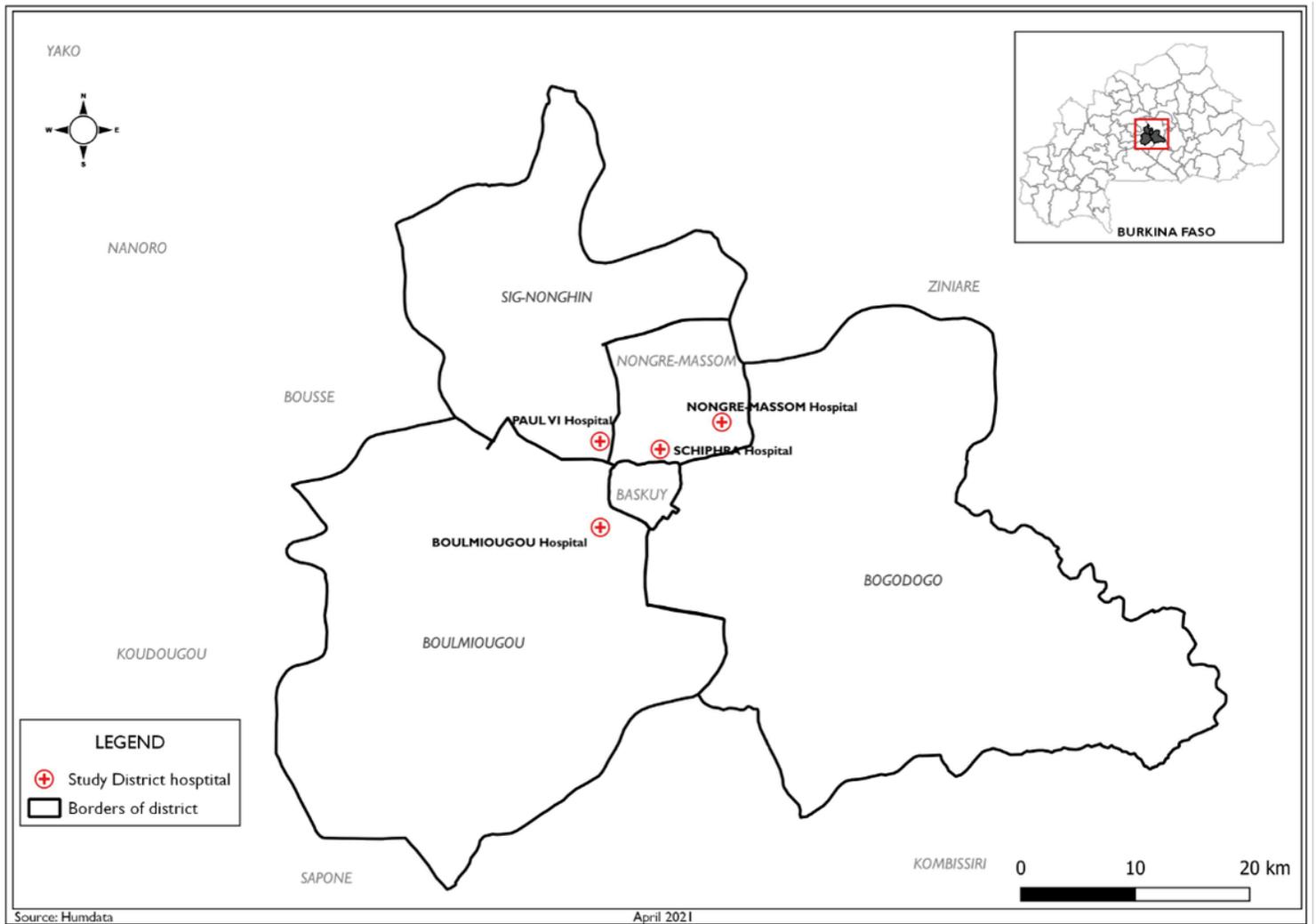


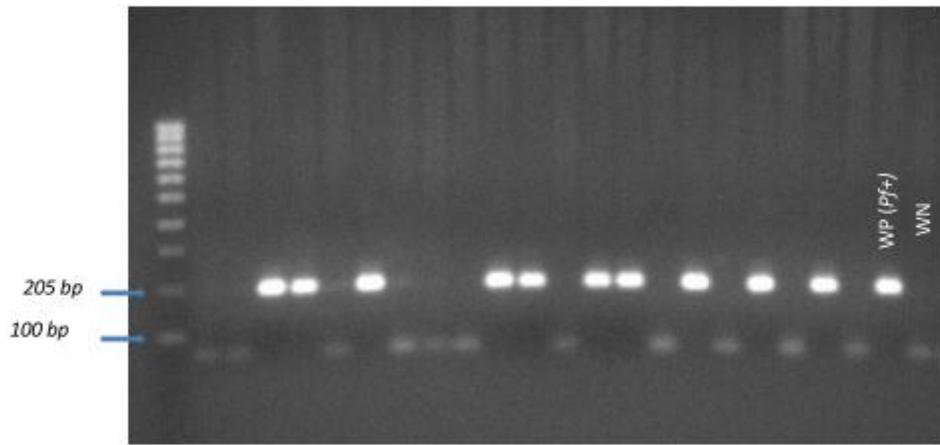
Figure 1

Map of the study areas and selected sites Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.



Figure 2

Blood confetti for molecular analyses



WP : positive witness (*Pf*+) of *Plasmodium falciparum*
WN : negative witness
100 bp : standard molecular weight marker
205 bp : *P. falciparum* diagnostic strip:

Figure 3

Image of bands revealed after gel migration read with UV rays