

# Prevalence of malaria and associated risk factors among asymptomatic migrant laborers in West Armachiho District, Northwest Ethiopia

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**Background:** Malaria is a febrile illness caused by protozoan parasites of the genus *Plasmodium*. It is prevalent in tropical and subtropical countries and becomes a challenge to a highly endemic area of Africa including Ethiopia. The West Armachiho district is a malaria-endemic lowland area where communities are experiencing hyperendemic malaria transmission.

**Objective:** The aim of this study was to determine the prevalence of malaria and the associated risk factors among asymptomatic migrant laborers in the West Armachiho district, Northwest Ethiopia.

**Materials and methods:** Community-based cross-sectional study was conducted from September to December 2016 on 385 migrant laborers selected by proportionate two-stage sampling method in Agricultural camps of the West Armachiho district. A standardized questionnaire was used to collect sociodemographic data and risk factors. Capillary blood was collected for Giemsa-stained blood film examination to detect and identify *Plasmodium* parasites. Data were coded, entered, checked for completeness, and analyzed using SPSS version-20 statistical software. Multivariate logistic regression was used to assess significantly associated risk factors. A *P*-value <0.05 was considered as statistically significant.

**Results:** The prevalence of malaria was found to be 18.4% (n=71). Education level, home area or origin of migrant laborers, number of visits, outdoor sleeping, and bed net utilization were associated with the risk of malaria (*P*<0.05).

**Conclusion:** Malaria was high in this study area and associated with outdoor sleeping, number of visits, home area, and bed net utilization.

**Keywords:** malaria, West Armachiho, migrant laborers, risk factor

## Background

Malaria is the most prevalent mosquito-borne disease throughout tropical and subtropical regions of the world with huge medical, economic, and social impact.<sup>1-3</sup> It is caused by protozoan parasites of the genus *Plasmodium*.<sup>4</sup> Among *Plasmodium* species that infect various species of vertebrates, five are known to infect humans, namely, *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae*, and *Plasmodium knowlesi*.<sup>4,5</sup> *P. falciparum* and *P. vivax* are the two most dominant malaria parasites in Ethiopia accounting for 60%–70% and 30%–40% of malaria cases, respectively. *P. falciparum* is the most dangerous species contributing high malarial deaths in Africa, including Ethiopia.<sup>6</sup> *Anopheles arabiensis*, member of the *Anopheles gambiae* complex, is the primary vector of malaria in Ethiopia.<sup>7-9</sup>

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According to the 2016 World Health Organization (WHO) report, about 3.2 billion people remain at risk of malaria, and there were 212 million malaria cases worldwide, accounting for nearly 4,29,000 deaths, of which 92% were in WHO African region, 6% were in WHO South-East Asian region, and 2% were in WHO Eastern Mediterranean region.<sup>1</sup> According to the 2015 Ethiopian malaria indicator survey report, the national prevalence of malaria is very low and estimated to be 0.5% among all age groups and 0.6% among children <5 years old (6–59 months) by blood film examination in areas below 2,000 m above sea level.<sup>10</sup> Malaria burden is higher in populations that are poor and malnourished. Migrant laborers traveling to endemic areas, children <5 years old, and pregnant women are high-risk groups that are affected by the high burden of malaria.<sup>1,2,11,12</sup>

Vast portions of fertile lowlands in Northwest Ethiopia have been developed for large-scale agricultural farming of cash crops such as sorghum, sesame, and cotton.<sup>13,14</sup> It is known that both farming and malaria transmission are linked to rainfall pattern; here, the agricultural season (June to October) overlaps with the main rainy season (July to September) and subsequent major malaria transmission (September to December).<sup>7,15,16</sup> This coincides with the major harvesting and planting seasons and has a severe impact on Ethiopia's subsistence economy by cutting down productivity capacity at a time when there is the greatest need for agricultural work.<sup>17</sup> North Gondar zone accounted for 20.9% of all confirmed malaria cases within the Amhara region (population 19.2 million), with the districts of Metema and West Armachiho reporting two of the top five highest weekly malaria incidence rates among the 166 districts of Amhara.<sup>18</sup> According to a study conducted in these two epidemiologically similar adjoining districts (Metema and West Armachiho), the prevalence of malaria was estimated to be 12%.<sup>19</sup>

The presence of large-scale mechanized agriculture in West Armachiho districts attracts about half a million migrant laborers mainly from nearby highland areas of Amhara and Tigray regions for cultivating and harvesting of cash crops that are used for commercial purposes.<sup>14</sup> Migrant laborers often work during cooler evening hours when there is high vector biting rate and they often sleep in the open fields or temporary shelters (Figure 1) where there is no vector control measure applied, exposing themselves to mosquito bite. They often get infected while working and sleeping in agricultural fields.<sup>14,19</sup> Malaria is the greatest health problem of migrant laborers where only 12% use long-lasting insecticide-treated bed net (LLITNs). Provision of prompt malaria diagnosis and

treatment is often difficult in this remote area (the study area), the area being one of the top five with the highest weekly malaria incidence rates reported. Hence, malaria-related death and illness of migrant laborers are very common.<sup>18,19</sup>

The WHO currently recommends malaria diagnosis by microscopy or rapid diagnostic test (RDT) and has started nationwide distribution of RDTs, Artemisinin combination therapy, LLITNs, and indoor residual spraying in Ethiopia since 2005.<sup>20,21</sup> However, zero malaria death in malaria-endemic areas and complete malaria elimination from hypo-endemic areas could not be achieved as a national strategic plan by 2015.<sup>7</sup> Knowledge of the baseline malaria prevalence among labor migrants is important to guide malaria control interventions. Therefore, the present study was aimed at determining the burden of malaria and the associated risk factors among asymptomatic migrant laborers in the West Armachiho district.

## Materials and methods

### Study area

The study was conducted in West Armachiho district, Northwest Ethiopia. According to 2007 national census, West Armachiho District has a total population of 31,730. The altitude of the West Armachiho District is 667 m above sea level. The minimum annual temperature ranges 22°C–28°C. The daytime temperature is very high from March to May reaching up to 43°C. Except some mountain tops falling outside, almost all of the lands in this district are in the lowlands. The West Armachiho district is an agricultural area where extensive farming is undertaken in Ethiopia. This area is malarious, and residents are experiencing hyperendemic malaria transmission (294 cases/1,000 risk population in 2013–2014; Personal communication).

### Study design and period

Community-based cross-sectional study was conducted from September to December 2016 in the West Armachiho district, Northwest Ethiopia, in asymptomatic migrant laborers.

### Sample size determination and sampling technique

The sample size was determined using a statistical formula [ $n = z^2 p (1-p) / d^2$ ] considering 95% CI and 50% prevalence. Proportionate two-stage cluster sampling was used to select study participants. First, farm sites were grouped by the name of the investor. Thirty farm sites were enrolled in the study, and among them 10 farm sites were randomly selected.



**Figure 1** Typical temporary shelters used by migrant laborers in West Armachiho district.

Three hundred eighty-five study subjects were selected from 10 farm sites proportionally.

## Data collection

### Sociodemographic and risk factor assessment

A standardized questionnaire that addresses all sociodemographic data and the risk factors around was developed in

English version. It was then translated into the local language of the area (Amharic). Required information was collected from concerned higher officials at Woreda and Zonal levels. Site visit to local farms and discussion with farm owners and managers were held first. A pretest was conducted in a nearby district on the same population 2 weeks prior to actual data collection to avoid confusing and repeated questions. Finally,

interview was conducted by trained health workers and field research assistants at selected farm sites/agricultural camps.

#### *Plasmodium* parasite detection and identification

Blood film examination was performed based on the standard and well-accepted guideline.<sup>22</sup> Blood samples were collected from migrant laborers at selected farm sites/agricultural camps by experienced laboratory professionals. Thin and thick blood films were made on a single slide; each slide was labeled, air dried, then stained with Giemsa and examined microscopically using 100 times objective.

## Operational definitions

### Malaria

A disease in an individual in which the presence of *Plasmodium* parasites in blood has been confirmed.

### Resident

Workers who had been there for more than 6 months and are normal residents of the study area (local name Salug).

### Migrant

Nonresident of the study area who had been there within the previous 6 months (local name Gofer).

## Quality control

To ensure reliable result, the quality of Giemsa stain was checked by using known negative and positive blood smears. Slides were rechecked by two experienced blinded laboratory technologists. To maintain the quality of generated data, they were checked for completeness and cleanness before starting the analysis.

## Data analysis and interpretation

Data were entered and analyzed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA, 2011) software. Then, the study findings were explained in words, tables, and graphs. Descriptive statistics (frequency and cross tabulations) were used. Chi-square tests and logistic regression were used for statistical analysis to show a significant difference between variables. A *P*-value <0.05 was considered as statistically significant.

## Ethics statement

Ethical clearance was obtained from the research and ethical review committee of School of Biomedical and Laboratory Sciences, University of Gondar. Written permission was obtained from the North Gondar Zone Health Department as

well as from West Armachiho Woreda Health Offices. Oral permission and negotiation were obtained from farm owners and farm managers. Written informed consent was obtained from study participants, and participation in this study was voluntary. The risks and benefits of participation in this study were explained to them. The ethical review committee approved that study participants under the legal age could provide written informed consent on their own behalf as their parents were not around. Blood test was carried out free of charge. All data and information were maintained confidentially by using a code rather than participants' name. Positives were treated without a fee, and health education about prevention and control of malaria was given to study participants.

## Results

### Sociodemographic characteristics

A total of 385 migrant laborers selected from 10 farm sites were included in this study. Their mean age was 26.3 (range 15–60 years) with standard deviation of 8.9. Among these, 90.4% (n=348) were male and 72.5% were in the age range of 15–29. Of them, 91.2% were from Amhara region and 1.6% were Sudanese. About 38.4% of study participants were able to read and write (Table 1).

**Table 1** Sociodemographic characteristics of tested migrant laborers in West Armachiho districts, Northwest Ethiopia, September–December 2016 (N=385)

Sociodemographic variables	Category	N (%)
Sex	Male	348 (90.4)
	Female	37 (9.6)
Age (years)	15–29	279 (72.5)
	30–44	87 (22.6)
	≥45	19 (4.9)
Religion	Orthodox	375 (97.4)
	Muslim	10 (2.6)
Marital status	Married	88 (22.9)
	Single	293 (76.1)
	Widowed	4 (1.0)
Ethnicity	Tigre	28 (7.3)
	Amhara	351 (91.2)
	Sudanese	6 (1.6)
Origin/home area	Highland	190 (49.4)
	Lowland	195 (50.6)
Educational status	Illiterate	41 (10.6)
	Read and write	148 (38.4)
	Elementary school	109 (28.3)
	High school	87 (22.6)
Residence	Resident	180 (46.8)
	Migrant	205 (53.2)
Malaria symptoms within the past 2 weeks	Present	123 (31.9)
	Absent	262 (68.1)

## Prevalence of malaria

The majority (68.1%) of the tested migrant laborers did not show symptoms of malaria within the past 2 weeks. Prevalence of *Plasmodium* infection was 18.4% overall, with two species of *Plasmodium* identified – 13% *P. falciparum*, 1.8% *P. vivax*, and 3.6% mixed. The relative *Plasmodium* species proportions of positive cases were 70.4% *P. falciparum*, 9.9% *P. vivax*, and 19.7% mixed infections (Table 2).

## Malaria risk factor analysis

Assessment of risk factor generally showed that educational status, home area or origin of migrant laborers, sleeping in the outdoor or informal house, number of visits to the study area, and bed net usage were significantly associated with the risk of malaria ( $P < 0.05$ ). The prevalence of malaria was not significantly associated with migrant laborers classified by age group and residence ( $P > 0.05$ ; Table 3).

**Table 2** Prevalence of malaria among asymptomatic migrant laborers in West Armachiho District, Northwest Ethiopia (N=385)

Species	N (%)
<i>Plasmodium falciparum</i>	50 (13)
<i>Plasmodium vivax</i>	7 (1.8)
Mixed	14 (3.6)
Total positive	71 (18.4)
Total negative	314 (81.6)

**Table 3** Bivariate and multivariable analysis of factors associated with malaria infection among asymptomatic migrant laborers in the West Armachiho district, Northwest Ethiopia (N=385)

Risk factors	Malaria		OR (95% CI)		P-value	
	Positive (%)	Negative (%)	COR	AOR		
Age group (years)	15–29	57 (20.4)	222 (79.6)	1.00	1.00	
	30–44	8 (9.2)	79 (90.8)	0.39 (0.18, .86)	0.41 (0.16, 1.06)	0.07
	≥45	6 (31.6)	13 (68.4)	1.80 (0.66, 4.94)	1.65 (0.47, 5.76)	0.43
Educational level	Illiterate	20 (48.8)	21 (51.2)	6.58 (2.73, 15.9)	8.22 (2.85, 23.75)	0.00
	Read and write	24 (16.2)	124 (83.8)	1.34 (0.62, 2.88)	2.13 (0.87, 5.23)	0.099
	Elementary school	16 (14.7)	93 (85.3)	1.19 (0.52, 2.71)	1.11 (0.44, 2.80)	0.82
	High school and above	11 (12.6)	76 (87.4)	1.00	1.00	
Residence	Resident	21 (11.7)	159 (88.3)	1.00	1.00	
	Migrant	50 (24.4)	155 (75.6)	2.44 (1.40, 4.26)	0.82 (0.39, 1.74)	0.60
Origin/home area	Highland	47 (24.7)	143 (75.3)	2.34 (1.37, 4.02)	2.34 (1.24, 4.42)	0.009
	Lowland	24 (12.3)	171 (87.7)	1.00	1.00	
Number of visits to study area	First	11 (13.8)	69 (86.2)	1.00	1.00	
	Second	10 (40)	15 (60)	4.18 (1.50, 11.62)	7.69 (2.23, 26.60)	0.001
	Third	18 (35.3)	33 (64.7)	3.42 (1.45, 8.06)	5.49 (1.98, 15.18)	0.001
	Fourth or more	32 (14)	197 (86)	1.02 (0.49, 2.13)	1.56 (0.65, 3.77)	0.32
Outdoor sleeping	Yes	62 (22.5)	214 (77.5)	3.22 (1.54, 6.74)	2.76 (1.19, 6.43)	0.018
	No	9 (8.3)	100 (91.7)	1.00	1.00	
Utilization of bed net	Yes	18 (9.7)	167 (90.3)	1.00	1.00	
	No	53 (26.5)	147 (73.5)	3.35 (1.88, 5.97)	2.57 (1.28, 5.18)	0.008

**Abbreviations:** AOR, adjusted odds ratio; COR, crude odds ratio; OR, odds ratio.

Migrant laborers coming from highland area were 2.34 times (adjusted odds ratio [AOR]=2.34, 95% CI: 1.24, 4.42) more likely to develop malaria than those coming from lowland area, and those who slept in outdoor sites were 2.76 times (AOR=2.76, 95% CI: 1.19, 6.43) more likely to develop malaria than those who sleep inside formal house. Migrant laborers who do not utilize bed net were 2.57 times (AOR=2.57 95% CI: 1.28, 5.18) more likely to develop malaria than those who use a bed net (Table 3).

## Discussion

Malaria is common despite interventions directed to mosquito vector control and treatment of symptomatic cases.<sup>23</sup> In areas where malaria is hyperendemic, such as the study area, a high percentage of the population may harbor the *Plasmodium* parasite in their blood.<sup>24</sup> A majority of the tested migrant laborers were males in the age range of 15–29 and Amhara in ethnicity. Half of them were coming from lowland areas. Eastern Sudan has a similar eco-epidemiology with study area, and Sudanese come to the study area seeking temporary employment on large-scale farms.

High prevalence of malaria (18.4%) was detected in the study area (hard to access population group). The overall *Plasmodium* species proportion was found to be 13% *P. falciparum*, 1.8% *P. vivax*, and 3.6% mixed infections. Results from this study revealed that number of visits to the study area, outdoor sleeping habit, bed net utilization, home area,

and educational status of migrant laborers were significantly associated with risk of malaria ( $P < 0.05$ ).

This finding is in line with a previous study conducted in two districts of the North Gondar zone (Metema and West Armachiho districts) with an overall malaria infection prevalence rate of 12% and the species proportion of 9.6% *P. falciparum*, 1.7% *P. vivax*, and 0.7% mixed infections.<sup>19</sup> Migrant workers coming from highland and highland fringe areas and those with low access to bed nets are affected by malaria infection.<sup>18</sup> This similarity may be due to similar geography of study areas except that the study period is different.

A study conducted in Sanja Town, a malaria-endemic area in Northwest Ethiopia among asymptomatic school children revealed that the overall malaria prevalence rate was 6.8%.<sup>25</sup> Another study conducted in the Oromia region, Ethiopia (an area with seasonal and unstable malaria transmission), demonstrated an asymptomatic malaria infection rate of 5%.<sup>26</sup> The reason for this discrepancy may be due to the difference in the epidemiology of the study area, study population, and period.

The high prevalence of malaria in this study might be due to the reason that the majority of migrant laborers who came from highland areas are highly susceptible and carry the parasite for long periods after repeated exposure without showing clinical sign and symptoms which is in turn influenced by lack of knowledge, low treatment-seeking behavior, and travel cost.<sup>12,27</sup> They become asymptomatic persistent carriers when they are exposed repeatedly after first-time exposure as they develop partial immunity after repeated exposures.<sup>28</sup> Those having the habit of not using bed net and outdoor sleeping are easily exposed to exophagic–exophilic mosquito bite and gets malaria infection easily. The reason for the difficulty of using LLITNs as a prevention tool is not merely due to wealth status of workers. It is also due to less attention given to the population. Such areas are not usually targeted for universal coverage of LLITNs. This results in lower ownership and access to it.

Timely intervention strategy is mandatory and should focus on the diagnosis and treatment of symptomatic cases and provision of preventive methods, like LLITNs. Attention should also be given in treating asymptomatic carriers to reduce the burden of these diseases. Even during rainy agricultural seasons, the Woreda Health Office should assign health professionals to diagnose and treat this population. Regular health education programs should be organized and implemented for this specific “at risk” population.

## Conclusion

High prevalence of malaria was observed among migrant laborers especially who came from highland areas. Low access to bed net, lack of formal sleeping accommodation, and absence of frequent exposure to malaria places migrant laborers at highly significant risk of developing malaria infection in this area. Prevention tools and strategies, particularly targeting migrant laborers, should be considered to achieve effective malaria prevention and control in the study area.

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## Author contributions

All authors contributed toward data analysis, drafting and revising the paper and agree to be accountable for all aspects of the work.

## Disclosure

The authors report no conflicts of interest in this work.

## References

1. World Health Organization. *World Malaria Report 2016*. Geneva, Switzerland: WHO, 2016.
2. Martens P, Hall L. Malaria on the move: human population movement and malaria transmission. *Emerg Infect Dis*. 2000;6(2):103.
3. Krogstad DJ. Malaria as a re-emerging disease. *Epidemiol Rev*. 1996;18:77–89.
4. World Health Organization. *Malaria Entomology and Vector Control (Learner's Guide)*. Geneva: WHO, 2003.
5. Roughton S, Green A. *Plasmodium knowlesi* malaria: assessing the risk to the British Armed Forces. *J R Army Med Corps*. 2012;158(4):318–321.
6. Federal Democratic Republic of Ethiopia Ministry of Health. *National Malaria Guidelines*. 3rd ed. Addis Ababa, Ethiopia: FMOH, 2012.
7. Federal Democratic Republic of Ethiopia Ministry of Health. *National Strategic Plan for Malaria Prevention, Control and Elimination in Ethiopia, 2011–2015*. Addis Ababa, Ethiopia: FMOH, 2015.
8. Jaleta KT, Hill SR, Seyoum E, et al. Agro- ecosystems impact malaria prevalence: large-scale irrigation drives vector population in western Ethiopia. *Malar J*. 2013;12(1):350.
9. Federal Democratic Republic of Ethiopia Ministry of Health. *National Five-Year Strategic Plan for Malaria Prevention and Control in Ethiopia 2006–2010*. Addis Ababa, Ethiopia: FMOH, 2006.
10. Federal Democratic Republic of Ethiopia Ministry of Health. *Ethiopia National Malaria Indicator Survey 2015*. Addis Ababa, Ethiopia: FMOH, 2016.
11. Rowe AK, Rowe SY, Snow RW, et al. The burden of malaria mortality among African children in the year 2000. *Int J Epidemiol*. 2006;35(3):691–704.
12. Gryseels C, Grietens KP, Dierickx S, et al. High mobility and low use of malaria preventive measures among the Jarai male youth along the Cambodia–Vietnam border. *Am J Trop Med Hyg*. 2015;93(4):810–818.
13. Keiser J, Singer BH, Utzinger J. Reducing the burden of malaria in different eco-epidemiological settings with environmental management. *The Lancet Infect Dis*. 2005;5(11):695–708.

14. Adhanom T, Deressa W, Witten H, Getachew A, Seboxa T. Malaria. In: Birhanie Y, Hailemariam D, Kloos H, editors. *The Epidemiology and Ecology of Health and Disease in Ethiopia*. 1st ed. Addis Ababa, Ethiopia: Shama Book; 2006;556–576.
15. Jima D, Getachew A, Bilak H, et al. Malaria indicator survey 2007, Ethiopia: coverage and use of major malaria prevention and control interventions. *Malar J*. 2010;9(1):1.
16. Graves PM, Richards FO, Ngondi J, et al. Individual, household and environmental risk factors for malaria infection in Amhara, Oromia and SNNP regions of Ethiopia. *Trans R Soc Trop Med Hyg*. 2009;103(12):1211–1220.
17. Federal Democratic Republic of Ethiopia Ministry of Health. *Malaria Diagnosis and Treatment Guidelines for Health Workers in Ethiopia*. Addis Ababa, Ethiopia: FMOH, 2004.
18. Amhara National Regional State Health Bureau. Annual Report 2012–2013. *Bahir Dar*. 2013.
19. Schicker RS, Hiruy N, Melak B, et al. A venue-based survey of malaria, anemia and mobility patterns among migrant farm workers in Amhara Region, Ethiopia. *PLoS One*. 2015;10(11):e0143829.
20. Jima D, Medhin A. Malaria prevention and control in Ethiopia: progress and prospects. *Federal Democratic Republic of Ethiopia Ministry of Health Quarterly Health Bulletin*. 2008;1:10–18.
21. World Health Organization. *World Malaria Report 2013*. Geneva, Switzerland: World Health Organization (WHO); 2013.
22. Cheesbrough M. *Parasitological Tests in District Laboratory Practice in Tropical Countries & Part 2*. Cambridge Low-price editions, Cambridge University Press, 2000.
23. Stresman GH, Kamanga A, Moono P, et al. A method of active case detection to target reservoirs of asymptomatic malaria and gametocyte carriers in a rural area in Southern Province, Zambia. *Malar J*. 2010;9(1):265.
24. Bottius E, Guanzirolli A, Trape JF, Rogier C, Konate L, Druilhe P. Malaria: even more chronic in nature than previously thought; evidence for subpatent parasitaemia detectable by the polymerase chain reaction. *Trans R Soc Trop Med Hyg*. 1996;90:15–19.
25. Worku L, Damtie D, Endris M, Getie S, Aemero M. Asymptomatic malaria and associated risk factors among school children in Sanja town, Northwest Ethiopia. *IntSch Res Notices*. 2014;2014:302369.
26. Golassa L, Baliraine FN, Enweji N, Erko B, Swedberg G, Aseffa A. Microscopic and molecular evidence of the presence of asymptomatic *Plasmodium falciparum* and *Plasmodium vivax* infections in an area with low, seasonal and unstable malaria transmission in Ethiopia. *BMC Infect Dis*. 2015;15(1):310.
27. Alemu K, Worku A, Berhane Y, Kumie A. Men traveling away from home are more likely to bring malaria into high altitude villages, Northwest Ethiopia. *PLoS One*. 2014;9(4):e95341.
28. Doolan DL, Dobano C, Baird JK. Acquired immunity to malaria. *Clin Microbiol Rev*. 2009;22(1):13–36.

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