The Prevalence of Malaria and the Associated Risk Factors in Jiga area, Northwest Ethiopia

By

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ABSTRACT

Malaria remains among leading causes of morbidity and mortality globally. In Ethiopia the public health and socio-economic impact of malaria is huge. It contributes highly to the country's poverty and underdevelopment. This study aimed at assessing the current situation of the disease in relation to relevant socio-demographic and environmental factors in Jiga area, northwest Ethiopia. Descriptive cross-sectional household (HH) survey was carried out in November-December 2013. Out of 2,574 HHs (11,815 people), 392 were randomly selected from three purposely selected clusters/*Kebeles,* the smallest administrative units in government structure. Heads of the selected HHs or any member of age ≥18 years, when the former was not at home during the visit, were interviewed using a pre-tested structured questionnaire to capture relevant data on socio-demographic/environmental variables and malaria control interventions. Further, randomly selected afebrile 392 inhabitants of the selected HHs within selected clusters were tested for malaria by malaria rapid diagnostic test (mRDT) using finger-prick blood samples. Eleven participants (2.8%) were found to be mRDT positive. Out of the screened inhabitants 95.9% had long-lasting insecticidal nets (LLINs) and 76.1% self-reported to sleep under net the previous night. Insecticide residual spray (IRS) coverage was similarly reported to be 85.5%. Binary logistic regression analyses revealed that low-income inhabitants were significantly positively associated with malaria infection (odds ratio (OR) = 1.165, 95% confidence interval (CI): 0.2100-6.4671, p=0.047). The association between proximity to mosquito breeding site and malaria incidence was also significant (p=0.025). In multivariate analysis while HH income level and number of LLINs/HH were positively associated with significantly reduced malaria prevalence with p-values 0.049 (OR=4.5, 95% CI: 1.004-20.163) and 0.004 (OR=0 .508, 95% CI: 0.074-3.46), respectively, HH distance from mosquito breeding site significantly increased the risk of malaria ((OR=0.077, 95% CI: 0.010-0.587), p=0.013). Ownership and use of LLINs in the previous night, IRS coverage, and other socio-demographics were not significantly associated with malaria cases. The recorded malaria prevalence estimate is unexpectedly higher, relative to the most recent nationwide report, given the extensively undergoing control interventions, survey population and period, limitations of mRDT implicating the sustained risk of malaria in Jiga area with the involvement of multiple locality-specific factors. Therefore further work has to be done in scaling-up the implementation of proven malaria control tools in addition to the employment of other complimentary strategies.

Keywords: Indoor residual spraying, long-lasting insecticidal net, mRDT, malaria, prevalence, Jabi-Tehnan, Jiga

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TABLE OF CONTENTS

Content	Page
List of Tables	vi
List of Acronyms	vii
1. INTRODUCTION	1
2. Objectives of the Study	4
2.1. General Objective	4
2.2. Specific Objectives	4
3. MATERIALS AND METHODS	5
3.1 Study area description	5
3.2. Study design, population and sampling procedure	6
3.3 Data collection	7
3.3.1 Malaria-risk-factor assessment	7
3.3.2 Malaria survey	7
3.4 Data quality control, entry and analysis	8
3.5 Ethical considerations	8
4. RESULTS	9
4.1 Socio-demographic characteristics	9
4.2 LLIN and IRS coverage	10
4.3 Malaria prevalence by sex, age and locality	13
4.4 Univariate analysis of malaria-risk-factors	14
4.5 Multivariate analysis of malaria-risk-factors	17
5. Discussion	18
6. CONCLUSIONS	21
7. RECOMMENDATIONS	21
8. REFERENCES	22
9. ANNEXES	27

LIST OF TABLES

Table Page

Table 1: ITN Distribution and IRS in Amhara Region, Ethiopia (2011) 3
Table 2: Demographic characteristics of inhabitants diagnosed for malaria 10
Table 3: Socio-demographics/economics of inhabitants interviewed for malaria-risk-factor assessment 12
Table 4: LLIN and IRS coverage 13
Table 5: Malaria prevalence by age, sex and locality among study participants 14
Table 6: Binary logistic regression analysis of malaria incidence and socio- demographic /environmental factors in respondents 16
Table 7: Multivariate logistic regression analysis of the relationship between socio-demographic or environmental factors and malaria prevalence 18

LIST OF ACRONYMS

AAU	Addis Ababa University
ACT	Artemisinin Combined Therapy
AOR	Adjusted Odds Ratio
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
CSA	Central Statistical Agency
DHS	Demographic and Health Survey
FMoH	Federal Ministry of Health
HH	Household
IPTp	Intermittent Preventive Treatment in pregnancy
IRS	Indoor Residual Spraying
ITNs	Insecticide Treated Mosquito Nets
JWARDO	Jabithenan Woreda Agriculture and Rural Development Office
LLIN	Long-Lasting Insecticidal Net
M	Meter
MOP	Malaria Operational Plan
MRDT	Malaria Rapid Diagnostic Test
OR	Odds Ratio
PMI	Presidential Malaria Initiative
RDT	Rapid Diagnostic Test
SD	Standard Diagnostics
SNNPR	Southern Nations, Nationalities and Peoples Region
SPSS	Statistical package for social sciences
SSA	Sub-Saharan Africa
UNICEF	United Nations Children's Fund
USA	United States of America
USAID	United States Agency for International Development
WHO	World Health Organization
µL	Micro Liter

1. INTRODUCTION

Malaria parasites and vectors

Malaria is caused by protozoan parasites of the genus *Plasmodium* and transmitted by female *Anopheles* mosquitoe. *Plasmodium falciparum*, *P. vivax, P. ovale*, and *P. malariae* cause human malaria, among which *P. falciparum* is responsible for the majority of malaria related deaths and severe sickness (CDC 2012). *P. knowlesi* that causes malaria in macaque monkeys has been recently reported to infect humans in Southeast Asia (Collins 2012). About 30-40 species of *Anopheles* mosquitoes carry malaria among which *Anopheles gambiae*, *An. funestus*, and *An. arabiensis* are the most notable vectors in Africa (Tonnang et al. 2010).

Malaria burden and control

Globally about 219 million malaria episodes and 660,000 deaths occurred in 2010 with the vast majority of cases (81%) being in Africa followed by South-East Asia and the Eastern Mediterranean Region (WHO 2012). According to this same World Health Organization (WHO) report, though malaria is endemic in most tropical and subtropical regions, over 90% of malaria deaths currently occur in sub-Saharan Africa (SSA). The disease is responsible for approximately 15% of all deaths among children younger than five years of age in SSA (Liu et al. 2012). Several efforts have been underway to protect individuals and communities against malaria. Long-lasting insecticidal treated nets (LLINs), Indoor residual spraying (IRS) and prompt diagnosis and treatment of cases are the current global strategies to control the disease (UN 2002).

Use of bed net is a sensible physical barrier precaution against malaria-transmitting mosquitoes since the major malaria vectors bite during the night (Pates and Curtis 2005). Widespread community use of ITNs reduces the proportion of mosquitoes surviving long enough to transmit malaria; each attempt at a blood meal from an ITN-protected human results in a potentially lethal insecticide exposure for the mosquito (Curtis et al. 2006). ITNs have been shown to avert around 50% of malaria cases, making protective efficacy significantly higher than that of untreated nets, which under ideal conditions (such as those found in research settings) usually provide about half the protection of nets treated with an effective insecticide (Clarke et al. 2001). There are two categories of ITNs conventionally treated nets and long-lasting insecticidal nets (LLINs). A conventionally treated net is a mosquito net that is treated by dipping in a

WHO-recommended insecticide. To ensure its continued insecticidal effect, the net should be re-treated after three washes, or at least once a year. A LLIN is a factory-treated mosquito net made with netting material that has insecticide incorporated within or bound around the fibers. The net must retain its effective biological activity without re-treatment for at least 20 WHO standard washes under laboratory conditions and three years of recommended use under field conditions (WHO 2007). IRS involves spraying insecticide on indoor residential walls and ceilings; depending on the insecticide and surface, the effect can last for extended periods (WHO 2000).

Malaria in Ethiopia

About 75% of the country's landmass is malarious putting 68% of the total population at risk of malaria (Ghebreyesus et al. 2006). The Ethiopian Federal Ministry of Health (FMoH) estimated that 5-10 million clinical malaria cases occur each year, half of which is caused by *P. falciparum*; approximately 70,000 people die of malaria each year (FMoH 2012). About half of the total population living between altitudes of 1,500 and 2,500 meters above sea level is at risk of epidemic malaria in Ethiopia (Negash et al. 2005). Transmission of the disease depends on altitude and rainfall with a lag time varying from a few weeks before the beginning of the rainy season to more than a month after the end of the rainy season. Peak malaria transmission occurs at the end of the rainy season, generally lasting from mid-September to mid-November (Ghebreyesus et al. 2006). This coincides with the major growing season and harvest time and so malaria diminishes agricultural productivity. This has serious consequences for Ethiopia's subsistence economy. Major epidemics occur every five to eight years with focal epidemics as the commonest form.

Cross-sectional studies in different eco-geographic regions of the country documented malaria prevalence rate ranging from 0-36.7% on the average (Collins et al. 1971, Nigatu et al. 1992, Wezam 1994, Abose et al. 1998, Adish et al. 1999, Ghebreyesus et al. 2000, Newman et al. 2003, Yohannes et al. 2005, Tilaye and Deressa 2007). Most of these studies were done in peak transmission season, or shortly after, and blood smears were examined. A malaria survey including mosquito net coverage in Oromia and Southern Nations, Nationalities and Peoples Region (SNNPR) regions of Ethiopia revealed malaria prevalence of 2.4% (Shargie et al. 2008). A more recent and extensive population-based study conducted in three large regions of Ethiopia, following the scale-up of preventive interventions in the country, found malaria slide positivity of 4.1% (Graves et al. 2009). A more recent malaria impact evaluation done by the US Presidential Malaria Initiative (PMI) in collaboration with the FMoH [http://ethiopia.usembassy.gov/pr_15/14.html] revealed that deaths among all-age-groups were considerably declined as compared to the baseline malaria status prior to 2005 in Ethiopia. This same US embassy source reported that at least 70% reduction is seen in malaria deaths among under-five children

and malaria epidemics in the country is largely suppressed. This is due to massive deployment of the major control tools including prompt treatment of confirmed and presumptive cases, and the strengthening of healthcare education and awareness systems. Encouraged by its success Ethiopia has further scaled-up its malaria control efforts with a goal to achieve elimination in some historically low endemic foci by 2015 (http://www.pmi.gov/docs/default-source/default-document-library/malaria-operational-plans).

In Ethiopia, as in any other malarious country, malaria control interventions are being scaled-up in recent times. In areas where laboratory facilities are lacking clinical diagnosis and rapid diagnostic test (RDT) are widely used to facilitate malaria control attempts (FMoH 2004). Although microscopy performed on peripheral blood smears remains the most widely used diagnostic test and the standard against which other tests are measured, it is not easily adapted to rural settings. Since most malaria patients reside in remote rural areas where basic healthcare and laboratory infrastructure often is unavailable malaria RDTs (mRDT) are recommended by the global malaria control programs to be used under field conditions. Apart from rapid diagnosis and early treatment of clinical cases proven vector control tools are extensively implemented in the country. According to FMoH, in 2011 in Amhara Region alone 1,234,440 and 463,653 households (HHs) had access to LLINs and IRS, respectively (Table 1). This indicates that 60% of the malarious areas of the Region were covered by ITNs and 27.6% by IRS. Despite such a huge control effort malaria incidence shows little decline in healthcare systems in the Region.

Table 1: ITN Distribution and IRS in Amhara Region, Ethiopia (2011)

Region	Amhara (n %)
Total clinical and confirmed malaria cases	674,698 (40.2%)
Total No of HHs in malarious area of the Region	1,678,003 (37.5%)
No of ITN distribution during the year	1,234,440 (60%)
No of HH spray during the year	463,653 (27.6%)
Total death	18 (0.003%)

Source: Health and Health Related Indicators, Ethiopia (2011)

Jiga, located in northwest Ethiopia, is among top malaria affected areas in Amhara Region, Jabi-tehnan district and presents a case in point. Out of 194,818 patients examined for malaria between September 2009 and August 2013 in Jiga health center, 24,103(25.4%) had microscopically confirmed malaria (Jiga Health Center Record). On average, more than 50,000 malaria suspected cases visited these public health facilities between 2009 and 2013. A study some 5 years back (Animut et al. 2009) also revealed high malaria prevalence among the inhabitants of Jiga. This verifies that there could be several reasons that contribute to the continued high malaria transmission level in the area. These may include deficiencies in

the health systems in implementing control programs, low compliance in utilizing malaria intervention tools, low level community awareness and participation or any other factors. Thus it is very imperative that operational research is conducted to identify the gaps. It is essential to address some special local risk-factors that may influence the continuous high transmission of malaria in Jiga area. This study, therefore, was undertaken to assess the prevalence of malaria and associated risk factors in Jiga area. Ownership and appropriate utilization of LLINs and coverage of IRS; and socio-economic, physical, environmental and demographic factors that are associated with malaria elsewhere were analyzed. The study examined the effects of socio-demographic and environmental variables and the malaria control intervention tools in use on mRDT positivity in a multivariate logistic regression model. The baseline information which provides important information on age- and sex-specific malaria infection rates coupled with an estimate of current (late 2013) intervention coverage can be utilized by concerned health professionals and policy- makers for future malaria control and possible pre-elimination plans in the area.

2. Objectives of the Study

2.1. General Objective

The general objective of the study was to determine malaria prevalence and associated risk factors in Jiga area, northwest Ethiopia.

2.2. Specific Objectives

The study had the following specific objectives.

- Determining the prevalence of malaria in the study area,
- Assessing the impact of ongoing control interventions on malaria transmission, and
- Assessing risk factors that may contribute to malaria transmission in the area.

3. MATERIALS AND METHODS

3.1 Study area description

The study was conducted in Jiga area, Amhara Region, northwest Ethiopia. Jiga is a small town, located 372 km away from Addis Ababa, the center (Figure 1). The town is located between 10°42′N latitude and 37°16′E longitude with an area of 1169.54 km². Jiga was selected purposively for the aforementioned reason. Most parts of the area lie at 1812 meters above sea level. It is bordered by *Bure* in the west, *Degadamot* in the east, *Sekela* in the north and *Dembecha* in the south. Based on the 2007 housing and population census conducted by the Ethiopian Central Statistics Agency (CSA), Jabi-tehnan district had a total population of 194,818 of whom 95,804 were males and 99,014 females and of these 25,093 were under 5. Of this total population, 6% were urban dwellers. An estimated population density of the district is about 237.396 people per km² (JWARDO 2012).The number of HHs was 45,306. Administratively the district has 41 *Kebeles,* the lowest administrative unit in government structure. All of the *Kebeles* are malarious (district health office information). Except the two all the *Kebeles* are rural.

According to the above same Jabi-tehnan Woreda Agriculture and Rural Development Office (JWARDO) document, 88% of the district is a midland (*Weynadega*) and the rest lowland (*Kolla*). The mean annual temperature is about 23ºC, with a maximum temperature slightly above 32ºC, down to a minimum of 14ºC. The mean annual rainfall is 1250 mm. The topography of the district is generally characterized by flat gentle slope (65%), mountainous (15%), undulating terrain (15%) and valley (5%). Agriculture is the principal source of livelihood for the rural population. Cereal crops such as teff, maize, wheat and barley are the most commonly cultivated crops and thus are the staple food crops in the district. Pepper, sugarcane and coffee are the dominant cash crops in some sites including the study villages.

Jabi-tehnan district is one of the hotspot areas within the region. Jiga area is known to be a malaria endemic area with transmission being seasonal. Peak transmission is usually reached between September and November, and April to May shortly after the big and small rainy seasons respectively. Jabi-tehnan district has 109 health workers, 47 health facilities, one of these being a hospital (*Finoteselam*) others are health centers (7) and health posts (39). From 23 private health facilities in the district 15 are medium clinics, 7 drug stores, and 1 pharmacy. IRS is practiced twice per annum and ITN distribution takes every four years. All the nets owned by the study participants were LLINs. One LLIN is donated to a family size of 1-4, two to 5-7 and three to a family size of ≥8. The sources of the LLINs are the United States Agency for International Development (USAID) from American people and the United Nations Children's Fund (UNICEF). The type of IRS was bendocarb.

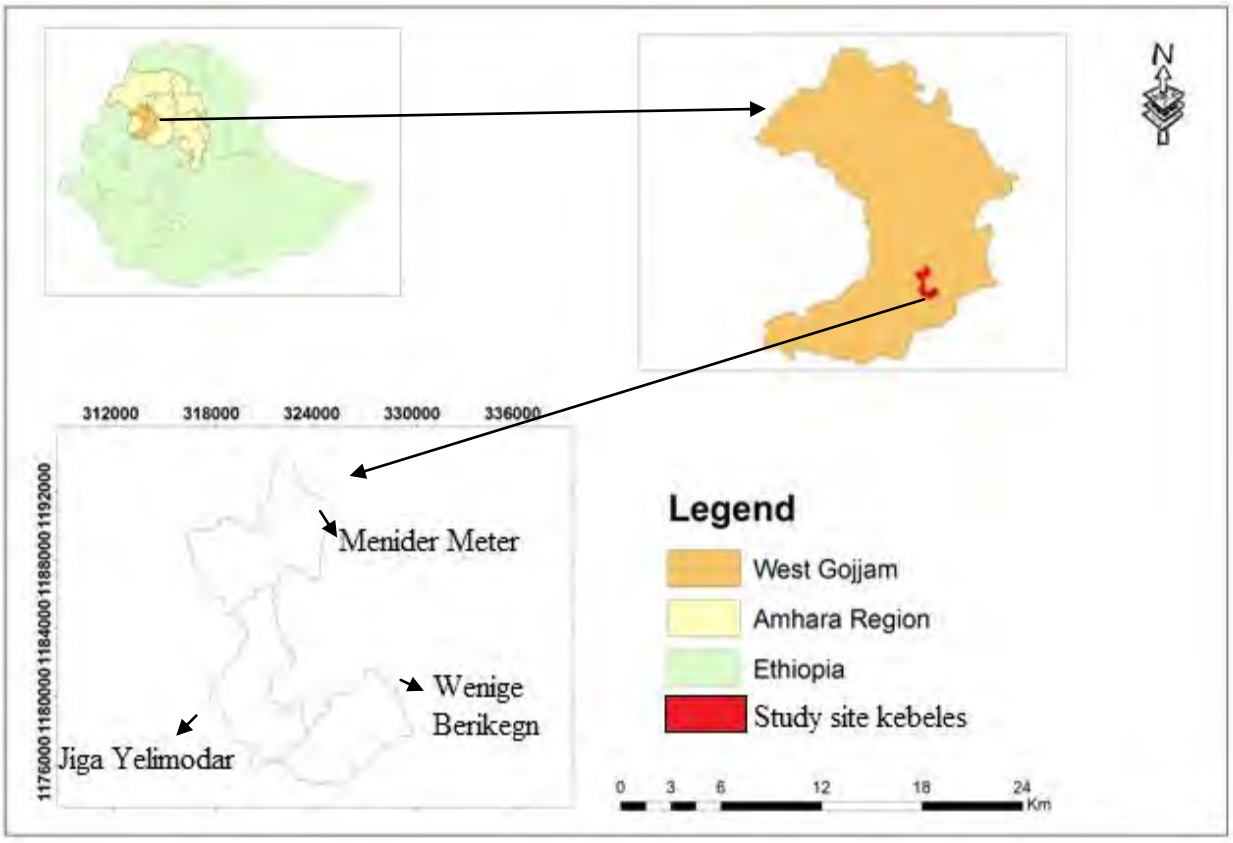

Figure 1: Map of Ethiopia and the surveyed households in Jiga area, northwest Ethiopia (source:Jiga health center) Scale = 1:50,000

3.2. Study design, population and sampling procedure

The study population was divided into two groups: (1) respondents who were checked for malaria parasites using the Malaria Rapid Diagnostic Test (mRDT) (2) HH heads or ≥18 years old HH members, when the former was not around at the time of HH visit, were interviewed for HH characteristics. The study design was a community-based descriptive quantitative cross-sectional HH survey. The study period was November and December 2013. The minimum number of study participants was estimated by using minimum sample size determination formula $n = z^2p\ (1\text{-}p)/d^2$ (Daniel, 2004); where n = the sample size, z=1.96 at 95% confidence interval (CI), d= margin of error, p = expected malaria prevalence rate in the locality which was assumed to be 50% with 95% CI and margin of error (d) at 5% (standard value of 0.05). Then n is 384. With a non-response rate of 2% the total sample size of 392 HHs, giving a total of 784 individual members. Among these, 392 (50%) were diagnosed for malaria while the remaining 392 (50%) were interviewed in order to assess malaria-risk-factors in the area.

Out of 2,574 HHs (11,815 people), 392 were randomly selected from three purposely selected clusters/*Kebeles*. To arrive at sampling HHs, first a list of forty-one *Kebeles* (villages) was obtained from the Jabi- tehnan district three *Kebeles* namely; *Wonige berikegn*, *Jiga yelimodar* and *Menider meter* were selected purposely. All the three *Kebeles* have almost similar topography. In each *Kebele*, 92-169 HHs were randomly selected to give an overall sample size of 392 study HHs. Based on the HH size, the estimated sample size was proportionally distributed to the selected three *Kebeles*. Each HH was selected using simple random sampling technique. Based on the master list of inhabitants all ≥1 year old members from the selected *Kebeles* were invited to participate in the study.

3.3 Data collection

3.3.1 Malaria-risk-factor assessment

A structured and pre-tested questionnaire was developed as a modification of the Malaria Indicator Survey Household Questionnaire (WHO 2005). It was administered to gather information on markers of socioeconomic status, demographic, and geographic variables that included sex, age, family size, income, state of pregnancy, marital status, level of education, main source of drinking water, house distance from nearby mosquito breeding site, main material of room's roof, wall and floor, presence of eaves and opening on the wall, presence of latrines, incidence of anti-malarial spraying in the past 12 months, possession and use, number and type of ITNs. Every head of the selected HHs either female or male present at home during the house-to-house visit was interviewed in Amharic which is the local language.

3.3.2 Malaria survey

One laboratory technician having more than two years of work experience and each selected *Kebele* healthcare providers were given two-days training on the study protocol as well as data recording formats. The lottery selection approach was used to collect blood samples from any of the family members of the selected HHs for malaria screening. A drop of finger-prick blood sample was taken once from any of the selected HH inhabitants using sterilized lancet by a trained healthcare provider for RDT test (SD FK80 P.f/P.v malaria antigen rapid test, standard diagnostics, Korea) as per the manufacturer's instruction. Briefly, a drop of blood specimen was applied to the sample pad on the test card along with a buffer. After 15 minutes, the presence of specific bands in the test card window indicated the presence of infection and species of human malaria parasites. To ensure maximum participation, HHs with absentees were revisited a second time on the same day to recruit those missing at the first visit.

3.4 Data quality control, entry and analysis

Questionnaire data quality control was assured during and at the end of each day of data collection. During data collection in the field and at the end of each day, the questionnaires were reviewed and checked for errors, completeness, accuracy and consistency before entry into Microsoft Office Excel and corrective measures were taken. For the malaria test, the RDTs were checked for expiration date and batch before the blood screen was taking place. The availability, current use, condition and the type of ITN were checked by observation during the survey. And all the verifiable information were verified by the principal investigator.

Data were coded and entered into Microsoft Office Excel, cleaned and exported to statistical package for social sciences (SPSS) version 16.0 (SPSS Inc., Chicago, IL, USA) for analysis. The response variable or the outcome of interest in the study was mRDT result. Thus, the response variable is binary, indicating whether or not a person was positive for malaria. The independent covariates comprised the baseline information captured through the questionnaire. RDT result, age, sex, state of pregnancy and marital status, were collected at individual level. All other questionnaire data were collected at a HH level. Descriptive statistics were used to describe the characteristics of the sample. Differences between proportions of the malaria positive and negative study inhabitants were tested using the Chi–square test. Binary logistic regression and multivariate analysis were employed to examine the association between socio-demographic variables and other risk factors with malaria infection. A p-value of less than 0.05 was considered significant.

3.5 Ethical considerations

The study was conducted after obtaining ethical clearance from the College of Natural Sciences Health Research Ethics Review Board, Addis Ababa University and permission from the local administrators. Before commencement of the study, the principal investigator conducted meetings with respondents in all selected localities during which the objectives of the study including procedures to be followed were explained. A written informed consent was sought from each respondent prior to data collection. For participants less than 18 years old an assent was obtained from parents or caretakers/guardians. A healthcare provider treated all malaria positive cases, free of charge, as per the national guideline.

4. RESULTS

4.1 Socio-demographic characteristics

A total of 784 individuals belonging to the 392 randomly selected HHs in the three clusters (*Kebeles*) participated in the study. The mean HH size was 4.875 (95% CI: 4.6836-5.0664). Of these; 392 (50%) were diagnosed for malaria and the remaining half, one participant per HH, were interviewed for assessment of malaria-risk-factors. Female participants were 243 (62%) and males were 149 (38%). Forty eight (12.2%) individuals were 1-4 years old, 117 (29.8%) belonged to the age group 5-14 years, 75 (19.0%) to 15-25 years and 152 (39.0%) were ≥26 years old (Table 2). The maximum age was 80 years. The mean age was 21.9 year (95% CI: 20.3052-23.5519).

A total of 392 participants, one member from each HH of the 392 HHs, were separately recruited from the three selected *Kebeles* were interviewed. This subpopulation was composed of 157 (40.1%) males and 235 (59.9%) females. Of these, 131 (33.4%) were able only to read and write, 57 (14.6%) reported to have attained primary education, 38(9.7%) had secondary education, and 166 (42.3%) reported to have never been to school or were uneducated. Fifty (12.8%) were in the age group 18-25 years, 142 (36.2), 26-35 years, and 200 (51.0%) were in the age group ≥36 years. Three hundred five (77.8%) participants were married, 17 (4.3%) were never-married singles, 27 (6.9%) divorced and the rest 43 (11.0%) widowed. The majority (98.0%) of the participants relied on subsistence farming and the rest (2.0%) were public servants. Sixty three (16.0%) of the HHs had an estimated family income of <500 Ethiopian birr, 230 (58.7%) had monthly income between 500 and 1000 birr and 99 (25.3%) had >1000 birr. One hundred and sixty-nine (43.1%) of HHs had family size between 1 and 4, 188 (48.0%) 5-7 and 35 (8.9%) had ≥8 persons per head. Table 3 shows detailed socio-demographic/economic characteristics of the respondents in this category.

While 214 (91.1) reported not pregnant 21 (8.9 %) were self-reported pregnant women. The main source of drinking water of the inhabitants were spring water 260 (66.3%) and the rest, 132 (33.7), had tap water. Out of the 392 participants 358 (91.3%) had latrine and 34 (8.7%) had no latrine. With regard to housing, 367 (93.6%) of the inhabitants lived in houses with corrugated iron sheet roof and 25 (6.4) lived in houses with thatch roof, seventy four (18.9%) of the participants lived in houses that had opening on their eaves, and 120 (30.6%) lived in houses that had openings on their walls. Almost all of HHs had walls made from sticks and floors from earth.

4.2 LLIN and IRS coverage

Long-Lasting Insecticidal Net ownership was evidenced among most participants in the study area. Only 16 (4.1%), 7 (5.3%) participants from *Jiga yelimodar* and 9 (5.3%) from *Menider meter*, lacked the nets (Table 4). In other words, mosquito net coverage was observed to be 100% in *Wonige berikegn*, 94.6% in *Jiga yelimodar* and 94.7% in *Menider meter Kebeles*.Thirtyfour (9.0%) self-reported that their HHs owned one LLIN, 204 (54.3%) two and 138 (36.7%) owned more than three. The mean number of LLINs owned per house was 1.8 (95% CI: 1.7414-1.8913). The estimated percentage of HHs that had at least one LLIN was 95.9% (95% CI: 93.48%-97.47%). The proportion of LLIN for under-fives and self-reported pregnant women were 0.9792 (95% CI: 0.8911-0.9963) and 0.9524 (95% CI: 0.7733-0.9915) respectively. While to 348 (93.0%) of the HHs the nets were delivered in the previous two months prior to this survey, 28 (7.0%) respondents declared that they acquired the nets some three years back. The reasons for dispossession of nets during the study period were impossibility of getting substitutes for worn out one. Regarding the condition of the LLIN possessed by the participants, 373 (99.2%) were graded as in good conditions and 3 (0.8%) were not (have had holes that fit a torch battery based on WHO). Out of the screened participants, 286 (76.1%) reported that they had slept under LLINs during the previous night and 90 (23.9%) responded to the contrary. In 26 (9.0%) HHs the LLINs were used only by husbands and wives, in 62 (22.0%) mothers and children and in 198 (69.0%) HH the whole family slept under the nets. The reasons for not using the LLINs were investigated and the replies were that 33 (36.7%) HHs had no beds and 57 (63.3%) due to incompatible house structures that could not allow LLIN use.

Table 2: Demographic characteristics of inhabitants diagnosed for malaria (N=392) in Jiga area, northwest Ethiopia, 2013

		Age group				
Locality		1-4 (n, %)	5-14 (n, %)	15-25 (n, %)	≥26 (n, %)	Total (n, %)
Wonige berikegn	Male	6(54.5)	18(62.06)	4(23.5)	13(37.1)	41(44.6)
	Female	5 (45.5)	11(37.9)	13(76.4)	22(62.9)	51(55.4)
	Total	11(12.0)	29(31.5)	17(18.5)	35(38.0)	92(23.5)
Jiga yelimodar	Male	7(46.6)	19(44.2)	7(29.2)	16(32.7)	49(37.4)
	Female	8 (53.3)	24(55.8)	17(70.8)	33(67.3)	82(62.6)
	Total	15(11.4)	43(32.8)	24(18.3)	49(37.4)	131(33.4)
Menider meter	Male	12(54.5)	16(35.5)	13(38.2)	18(26.5)	59(34.9)
	Female	10(45.5)	29(64.4)	21(61.8)	50(73.5)	110(65.0)
	Total	22(13.0)	45(26.6)	34(20.1)	68(40.2)	169(43.1)
Total		48(12.2)	117 (29.8)	75 (19.0)	152 (39.0)	392(100)

n = number of study participants, % = percentage

IRS coverage and frequency were assessed during the household survey and the findings in the three localities are presented in table 4 below. The overall IRS coverage in the study locality was 85.5%. Of this, 280 (62.1%) of the HHs were sprayed in the last 6 months of the study year and 127 (37.9%) in the last 12 months. Almost all participants reported LLINs as the main malaria preventive measure. Whereas 309 (78.8%) of the interviewed were aware of the aim of IRS, 52 (13.0%) and 31 (7.9%) participants had some knowledge of environmental cleanliness and mosquito source reduction in malaria control strategy, respectively.

Table 3: Socio-demographics/economics of inhabitants interviewed for malaria-risk-factor assessment in the three selected *Kebeles* of Jiga area, northwest Ethiopia, 2013

Socio-demographics	Locality			
	Wonige berikegn (n=92) № (%)	*Jiga yelimodar* (n=131) № (%)	*Menider meter* (n=169) № (%)	Total (N=392) № (%)
Sex				
Male	35(38.1)	55(42.0)	67(39.6)	157(40.1)
Female	57(61.9)	76 (58.0)	102(60.4)	235(59.9)
Age				
18-25	11(12.0)	21(16.0)	18(10.6)	50(12.8)
26-35	31(33.7)	53(40.5)	58(34.3)	142(36.2)
≥36 years	50(54.3)	57(43.5)	93(55.1)	200(51.0)
Marital status				
Married	70 (76.1)	100(76.3)	135(80.0)	305(77.8)
Single	2(2.2)	9(6.9)	6(3.5)	17(4.3)
Divorced	6(6.5)	11(8.4)	10(5.9)	27(6.9)
Widowed	14(15.2)	11(8.4)	18(10.6)	43(11.0)
Pregnancy(self-reported)				
Present	6(10.5)	5(6.6)	10(9.8)	21(8.9)
Absent	51(89.5)	71(93.4)	92(90.2)	214(91.1)
Family size				
1-4	40(43.5)	50(38.2)	79(46.7)	169(43.1)
5-7	41(44.5)	74(56.5)	73(43.2)	188(48.0)
≥8	11(12.0)	7(5.3)	17(10.1)	35(8.9)
Education				
Illiterate	38(41.3)	46(35.1)	82(48.5)	166(42.3)
Read and write	34(36.9)	46(35.1)	51(30.2)	131(33.4)
Primary school	7(7.6)	25(19.1)	25(14.8)	57(14.6)
≥Secondary school	13(14.2)	14(10.7)	11(6.5)	38(9.7)
Livelihood				
Civil servant	7(7.6)	0(0.0)	1(0.6)	8(2.0)
Farmer (private)	85(92.4)	131(100.0)	168(99.4)	384(98.0)
Income level				
Low	14(15.2)	7(5.3)	42(24.8)	63(16.0)
Medium	51(55.4)	86(65.6)	93(55.1)	230(58.7)
High	27(29.4)	38(29.1)	34(20.1)	99(25.3)
Drinking water source				
Spring water	60(65.2)	94(71.8)	106(62.7)	260(66.3)
Tap water	32(34.8)	37(28.2)	63(37.3)	132(33.7)
Latrine				
Present	85(92.4)	120(91.6)	153(90.5)	358(91.3)
Absent	7(7.6)	11(8.4)	16(9.5)	34(8.7)
House wall opening(s)				
Present	27(29.3)	39(29.8)	54(31.9)	120(30.6)
Absent	65(70.7)	92(70.2)	115(68.1)	272(69.4)
House roof type				
Corrugated iron sheet	87(94.6)	122(93.1)	158(93.5)	367(93.6)
Thatch	5(5.4)	9(6.9)	11(6.5)	25(6.4)
House eave				
Present	18(19.6)	23(17.6)	33(19.5)	74(18.9)
Absent	74(80.4)	108(82.4)	136(80.5)	318(81.1)

4.3 Malaria prevalence by sex, age and locality

Overall 11 (2.8%) individuals were mRDT positive, 3 (2%) males and 8 (3%) females. Three cases (3.3%) were from *Wonige berikegn Kebele* (n = 92), 7 (4.2%) from *Menider meter* (n = 169) and 1 (0.8%) from *Jiga yelimodar* (n = 131). *P. falciparum* and *P. vivax* were detected in 6 (54.5%) and 5 (45.45%) individuals, respectively. Among *Wonige berikegn* participants, 1 (33.3%) person had *P. falciparum* infection and 2 (66.7%) were positive for *P. vivax* infection. In *Menider meter* 5 (71.4%) of the cases were *P. falciparum* and 2 (28.6%) were *P. vivax*. The single infected case from *Jiga yelimodar* was *P. vivax*. The distribution of malaria prevalence by locality, age and sex is indicated in table 5. Possible variation of malaria prevalence between sexes, age groups and localities were tested using the Chi-squared test. But no significant association was found between the groups in all of the tests.

Table 4: LLIN and IRS coverage in the three selected *Kebeles* of Jiga area, northwest Ethiopia, during the study period, 2013

Description	Locality			
	Wonige berikegn (n=92) № (%)	*Jiga yelimodar* (n=131) № (%)	*Menider meter* (n=169) № (%)	Total (N=392) № (%)
LLIN owned				
Yes	92(100)	124(94.7)	160(94.7)	376(95.9)
No	0(0.00)	7(5.3)	9(5.3)	16(4.1)
Last night LLINs used				
Yes	81(88.1)	81(65.4)	124(77.5)	286(76.1)
No	11(11.9)	43(34.6)	36(22.5)	90(23.9)
LLINs/HH				
One	6(6.5)	5(4.1)	23(14.4)	34(9.0)
Two	47(51.1)	68(54.8)	89(55.6)	204(54.3)
More than two	39 (42.4)	51(41.1)	48(30.0)	138(36.7)
LLIN used by				
Moth & father	5(6.2)	7(8.6)	14(11.3)	26(9.0)
Moth & children	13(16.1)	21(26.0)	28(22.6)	62(22.0)
Entire family	63(77.7)	53(65.4)	82(66.1)	198(69.0)
LLIN delivered				
2 months back	83(90.3)	115(92.7)	150(93.7)	348(93.0)
3 years back	9(9.7)	9(7.3)	10(6.3)	28(7.0)
LLIN condition				
Good	91(98.9)	122(98.4)	160(100)	373(99.2)
Not good	1(1.1)	2(1.6)	0(0.0)	3(0.80)
IRS practice				
No	28(30.5)	11(8.4)	18(10.7)	57(14.5)
Yes	64(69.5)	120(91.6)	151(89.3)	335(85.5)
Last 6 months	28(43.8)	82(68.3)	98(64.9)	208(62.1)
Last 12 months	36(56.2)	38(31.7)	53(35.1)	127(37.9)

Table 5: Malaria prevalence by age, sex and locality among study participants in the three selected *Kebeles* (N=392) of Jiga area, northwest Ethiopia, 2013

Characteristics		Malaria prevalence			
		Positive (No, %)	Negative (No, %)	Total (No, %)	*P*-value
Sex	Male	3(2.1)	146(97.9)	149(100)	0.343
	Female	8(3.3)	235(96.7)	243(100)	
	Total	11(2.8)	381(97.2)	392(100)	
Age	1-4	2(4.2)	46(95.8)	48(100)	0.844
	5-14	4(3.4)	113(96.6)	117(100)	
	15-25	2(2.7)	73(97.3)	75(100)	
	≥26	3(1.9)	149(98.1)	152(100)	
	Total	11(2.8)	381(97.2)	392(100)	
Locality	*Wonige berikegn*	3(3.3)	89(96.7)	92(100)	0.480
	Jiga yelimodar	1(0.8)	130(99.2)	131(100)	
	Menider meter	7(4.2)	162(95.8)	169(100)	
	Total	11(2.8)	381(97.2)	392(100)	

4.4 Univariate analysis of malaria-risk-factors

Possible association of malaria prevalence with a variety of questionnaire yielded and field observed environmental factors were assessed in the study locality. Table 6 shows binary logistic regression analysis results for a list of variables that were tested for their potential association with risk of malaria. Though the chances for females to get malaria was 1.675 times higher than those of males [odds ratio (OR) = 1.675, 95% CI: 0.433-6.345] the association was statistically not significant (p=0.46). The relationship between malaria and age was also found to be statistically insignificant (p=0.849). Low-income HHs had significantly higher risk of conquering malaria than high-income ones (OR = 1.165, 95% CI: 0.21-6.4671, p=0.047). As far as proximity to mosquito breeding site(s) is concerned, HHs located in a <1000 m distance were at significantly higher risk of having malaria in comparison with those that were at a greater distance (OR = 0.097, 95% CI: 0.018-0.523, p=0.025). Although the association was not significant the likelihood of getting malaria was found to decrease in respondents who had tap water compared to those who had unprotected water, spring (OR = 0.106, 95% CI: 0.013-0.840, p=0.105). Pertaining to literacy, the likelihood of getting malaria was lower for individuals who had some kind of education, compared to the unlettered, though the difference was not significant [OR = 0.479, 95% CI: 0.056-4.067, p=0.5). Furthermore, the likelihood of getting malaria was lower, though not significant, for pregnant women than the non-pregnant [OR = 0.594, 95% CI: 0.124-2.84, p=0.515). The association between the prevalence of malaria and respondents' marital status was not statistically significant. Similarly, although the association

was not significant HHs having a family size of 5-7 were at increased odds of getting malaria compared to families with 1-4 members (OR = 1.571, 95% CI: 0.159-15.555, p=0.699).

From 376(95.9%) HHs having LLIN, 286(76.1%) used LLINs the previous night, of these 78.7% were children aged <5 years and 75.0% self-reported pregnant women. The association between malaria prevalence and possession as well as use of LLIN in the previous night was not statistically significant. However, number of LLIN/HH is associated with decreasing malaria prevalence. HH with lesser number of LLINs are at greater risk than those having more with statistically significance (p=0.004). It was observed that the likelihood of getting malaria and IRS practice was not statistically significance (p=0.997).

Table 6: Binary logistic regression analysis of malaria incidence and socio demographic /environmental factors in respondents of the three selected *Kebeles* (N=392) in Jiga area, northwest Ethiopia, 2013

Variables	n	mRDT positive № (%)	mRDT negative № (%)	OR	95% CI	*P*-value
Sex						
Male	149	3(2.0)	146(98.0)			
Female	243	8(3.3)	235 (96.7)	1.675	0.433-6.345	0.46
Age						
1-4	48	2(4.2)	46(95.8)		0.076-2.896	0.849
5-14	117	4(3.4)	113(96.6)	0.469	0.129-2.674	0.415
15-25	75	2(2.7)	73(97.3)	0.587	0.122-4.557	0.491
>26	152	3(1.9)	149(98.1)	0.745	0.097-6.338	0.750
Marital status						
Widowed	43	1(2.3)	42 (97.7)			0.99
Married	305	9(3.0)	296(97.0)	0.783	0.037-10.33	0.819
Single	17	0(0.0)	17(100.0)			
Divorced	27	1(3.7)	26(96.3)	0.619	0.124-2.84	0.738
Pregnancy(self-reported)						
Present	21	0(0.0)	21(100.0)	0.594	0.124-2.84	0.515
Absent	214	2 (0.9)	212(98.1)			
Family size						
1-4	169	3(1.8)	166(98.2)	0.739	0.088-6.194	0.780
5-7	188	7(3.7)	181(96.3)	1.571	0.159-15.555	0.699
≥8	35	1(2.8)	34(97.2)			0.556
Education						
Illiterate	166	6(3.6)	160(96.4)			
Primary school	57	1(1.8)	56(98.2)	0.479	0.056-4.067	0.500
Read and write	131	4(3.1)	127(96.9)	0.563	0.061-5.17	0.610
≥Secondary school	38	0(0.0)	38(100.0)			
Mosquito breeding site						
<1000 meter	12	2(16.7)	10(83.3)			
>1000 meter	380	9(2.4)	371(97.6)	0.097	0.018-0.523	0.025*
Income level						
Low	63	5(7.9)	58(92.1)	1.165	0.21-6.467	
Medium	230	4(1.7)	226(98.3)	0.239	0.045-1.273	0.047*
High	99	2(2.0)	97(98.0)			
Drinking water						
Spring	260	10(3.8)	250(96.2)			
Tap water	132	1(0.8)	131(99.2)	0.106	0.013-0.840	0.105
House wall opening						
Yes	120	1(0.8)	119 (99.2)			
No	272	10(3.7)	262 (96.3)	0.22	0.028-1.74	0.151
House eaves						
Yes	74	0(0.00)	74 (100)			
No	318	11(3.5)	307(96.5)	0	0	0.997
Latrines						
Yes	358	11(3.1)	347(96.9)			
No	34	0(0.0)	34(100)	0	0	0.998
House roof						
Corrugated iron sheet	367	11(3.0)	356(97.0)	0	0	0.99
Thatch	25	0(0.00)	25(100)			
Last night LLINs used						
Yes	286	10(3.5)	276(96.5)		0	0.54
No	90	1(1.1)	89(98.9)	0		
LLINs/HH						
1	34	5(14.7)	29(85.3)	1.735	0.133-4.071	0.004*
2	204	4(2.0)	200(98.0)	0.085	0.016-0.461	0.725
>2	138	2(1.4)	136(98.6)			0.05
IRS in the last 1 year						
Yes	335	11(15.0)	324(85.0)	0	0	0.997
No	57	0(0.0)	57(100)			

Key: * p-value < 0.05

The above table (Table 6) further explains the likelihood of having malaria in association with physical/ housing environmental factors. It was observed that the association between mRDT positivity and houses having wall hole was not significant (OR= 0.22, 95% CI: 0.028-1.74, *p*=0.151). It was also observed that no association was found between presence of eaves and malaria positivity. It was further noted that house roof type was not significantly correlated with getting malaria (*p*=0.99). Likewise no evidence was found to substantiate the association between malaria prevalence and latrine ownership (*p*=0.998).

4.5 Multivariate analysis of malaria-risk-factors

Potential malaria risk factors that showed significant associations in univariate analysis were selected and entered for multivariate logistic regression modeling to identify the most important predictors of malaria. Table 7 below shows the adjusted, with adjusted OR (AOR), and independent effect of socio-demographic/economic, environmental malaria-risk-factors and LLIN on protection from malaria. The association between the prevalence of malaria and income level of the parents/guardians were statistically significant (*p*=0.049). Furthermore the association between distance from mosquito breeding site and the prevalence of malaria remained highly significant (*p*=0.013) whereby the likelihood of getting malaria among inhabitants who were living at a distance greater than 1000 m from mosquitoes breeding site was 0.077 lower than those living at a distance of less than 1000 m (OR= 0.077, 95% CI: 0.010-0.587). Similarly increased the number of LLIN per family was significantly associated with protection from malaria (*p*=0.004). In summary, distance from major mosquito breeding site(s), income level of the respondents and number of LLIN per HH were the only factors that were significantly associated with mRDT positivity after adjustment for possible confounders.

Table 7: Multivariate logistic regression analysis of the relationship between socio-demographic or environmental factors and malaria prevalence

Variables	N	mRDT positive № (%)	mRDT negative № (%)	AOR	95% CI	*P*-value
Income level						
Low	63	5(7.9)	58(92.1)	4.5	1.004-20.163	0.049
Medium	230	4(1.7)	226(98.3)	3.93	0.619-24.962	0.147
High	99	2(2.0)	97(98.0)			0.116
Mosquito breeding site						
<1000m	12	2(16.7)	10(83.3)			
>1000m	380	9(2.4)	371(97.6)	0.077	0.010-0.587	0.013
LLINs/HH						
1	34	5(14.7)	29(85.3)			0.004
2	204	4 (2.0)	200(98.0)	0 .508	0.074-3.46	0.489
>2	138	2(1.4)	136(98.6)	0.045	0.006-0.33	0.002

Income Level: low= ≤ 500, medium = 500 -1000 and high = ≥ 1000 Ethiopian Birr
AOR: Adjusted Odds Ratio, mRDT: malaria Rapid Diagnostic Test, CI: Confidence Interval

5. Discussion

The 2.8% prevalence rate recorded in this study is sizeable for a population-based survey conducted in the dry season in small clusters (784 people) for a country which embarked on massive control interventions though below 10% prevalence is generally considered low (WHO 2014). In fact the figure is much lower than a past health facility-based study (Animut et al. 2009) in the same locality (65.0%). It was observed that the overall malaria prevalence was higher in *Menider meter* (4.2%) compared to that in *Wonige berikegn* locality (3.3%) and in *Jiga yelimodar* (0.8%) but the differences among the localities was not significant. A study conducted in Jimma, southwest Ethiopia showed the predominance of *P. vivax* (Alemu et al. 2011). However, this study revealed that *P. falciparum* was the predominant species in the study area being in line with the general nationwide plasmodium species composition paradigm in Ethiopia where *P. falciparum* makes up about 60% and the rest *P. vivax* (FMoH 2004). The absence of significant difference in malaria prevalence by age or sex in this study is similar to a previous study (Graves et al. 2009). However, other studies indicated that malaria incidence was significantly higher in children than adults and peaked in children at age 9 (Peterson et al. 2009). Infection prevalence was significantly lower among adults compared to children under-15 years of age (Noor et al. 2008). Studies have shown that the risk of malaria infection varied by gender with some reporting males at higher risk than females (Winskill et al. 2011, Abdalla et al. 2007, Kimbi et al. 2013). As Kimbi et al (2013) clarify this could be due to the fact that males expose their bodies more often than females, especially when the weather is hot, thus, increasing their chances of being bitten by mosquitoes. It might be because of occupational differences; males stay outside during the night time working in the fields or house garden.

This study could not find association between IRS and significant reduction in the number of malaria cases. In agreement with the present finding Graves et al. (2009) have also observed a weak association between protection from malaria and IRS practice. To the contrary, in Ethiopia a study reported a significant association between protection from febrile illnesses and insecticide spraying in children (Deressa et al. 2007). A recent study in the country has produced additional support in that sprayed houses were less likely to be affected by malaria (Ayele et al. 2012). A study done in Eritrea has also shown that spraying was positively associated with protection against malaria parasitaemia (Sintasath et al. 2005). Possible insecticidal resistance could definitely reduce the effect of IRS on malaria prevalence. Mosquito behavior (Deressa et al. 2014) or the extent of re-plastering and painting over sprayed walls could also explain the findings.

As of 2006 the WHO recommended IRS in areas of stable malaria transmission by widening the scope of IRS practice which was previously limited only to areas of sporadic transmission (van den Berg 2008). Accordingly, in 2008, 44 countries employed IRS as a malaria control strategy (WHO 2009). But, IRS efficacy may vary even from house to house within a locality, since a dilute solution of particular insecticide is sprayed indoor on walls made of porous materials such as mud or wood and not plaster as in some urban homes. The results suggest that the current spraying practice needs further assessment and improvement (efficacy, cost-effectiveness). Moreover, though IRS is identified as the major malaria control intervention for its availability and affordability for community-based application unresolved issues remain pertaining to the dosage of this tool calling for re-assessment from healthcare perspective. Thus community sensitization and awareness about IRS utilization for malaria control is required. Unless all necessary steps are taken to ensure effective implementation of IRS interventions, including selecting the appropriate insecticide and its dosage, spraying time and place with sustainably high coverage level, and regulating unauthorized or un-recommended use (WHO 2006) the strategy may prove ineffective. It may even be counterproductive by inducing mosquito insecticide-resistance and human health and environmental problems. Adequate monitoring and evaluation of the control intervention is necessary to achieve high IRS efficacy level. The WHO recommends that for IRS to be effective there must be a high percentage of sprayable surfaces within each dwelling, and the targeted mosquito vectors that must feed or rest indoors must also be susceptible to the insecticide in use in addition to contextual financial and technical capabilities (WHO 2006).

Though direct comparison of the data may prove difficult for the reason that the demographic and health survey (DHS) of 2005 included non-malarious areas as well, the dramatic increase in the coverage of nets in 2007 (19.6%) (Graves et al. 2009) compared to that in 2005 (<3%) (CSA 2006) in the three largest regions - Amhara, Oromia and SNNPR is evident. These same respective sources indicated that whereas in

2005, 1.3% of children under-5 slept under ITN and 17.4% had an LLIN in 2007. In this study over 80% of the study participants had LLIN, showing a significant coverage compared to the status in both 2005 and early 2007.

Several studies demonstrated that bed nets confer high protection against malaria (Guyatt et al. 2002, Noor et al. 2008). Additional epidemiological findings confirmed and extended past reports that ITN was significantly associated with reduced risk of malaria cases (Smithuis et al. 2013). Similarly possession of a mosquito net significantly reduced the risk of febrile illness in Ethiopian children (Deressa et al. 2007). A later more comprehensive survey in the country further underscored ITN as a crucial malaria control intervention (Graves et al. 2009). However, the authors did not find an association between ITN ownership and malaria risk suggesting that the mere presence of ITNs in HHs may not protect inhabitant from malaria morbidity unless it is properly used. Moreover, the above same report ascertained that sleeping under a net or LLIN the previous night did not seem to be correlated with significant protection from malaria in apparent agreement with the present finding. The authors plausibly argued that this might be due to the timing of the survey after peak mosquito season, or because the question regarding net use the single night before the survey did not accurately capture the net use over a longer period; or may be the mere presence of an LLIN in the house gives protection in some instances. However the number of LLINs/HH was associated with decreased prevalence of malaria among the respondents. This concurred with (Loha 2013) who reported that the prevalence of malaria was lower in those districts having ≥ one LLIN for two persons compared to those districts with less than one LLIN for two persons.

Other risk factors that were identified as important determinants in malaria incidence were house materials and design (earth roof, open eaves, windows, single sleeping rooms, no separate kitchen), presence of animals in the house, and use of irrigated land (Gebreyesus et al. 2000). Similarly, Deressa et al. 2007 indicated the increased risk of having febrile illness with presence of livestock inside the house. In this study HH materials and design, availability of latrine and type of drinking water source were found to have no significant association with malaria. A significant relationship between proximity to mosquito breeding sites and risk of malaria was noted in this study corroborating support to a study in Gondar, northwest Ethiopia (Tilaye and Deressa 2007). Recent study done in southern Ethiopia had also indicated that dwelling proximity to malaria vector breeding site(s) was the strongest risk factor for malaria (Loha 2013). On the other hand, a study from Eritrea revealed that villages located at a distance of <500 m from streams were not at a greater risk than farther villages (Sintasath et al. 2005).

The risk of malaria was higher for HHs with lower socioeconomic level than for those that enjoy a higher status suggesting the ability of higher income HHs to afford to implement malaria control measures. This

concurred with other workers who reported that family employment status was associated with malaria prevalence among the under-fives (Mushashu 2012). Although the risk to acquire malaria was fairly well distributed across socioeconomic status in Sudan it was different with better-off HHs having the better capacity to prevent and deal with the disease (Onwujekwe et al. 2006). Similarly, in this study the burden of malaria was greatest among low-income HHs with statistically significant difference.

In summary, in Africa between 2000 and 2012, the scale-up of control interventions reduced malaria incidence rates by 31% and mortality by 49% (WHO 2013). In Ethiopia too latest reports testify a dramatic reduction in both malaria cases and deaths. But the situation in the present study area needs careful assessment to further scale-up control interventions in order to be able at least to plan for malaria pre-elimination programme.

6. CONCLUSIONS

The level of LLIN and IRS coverage in the study area was encouragingly high (95.9%) but additional work is required as it is not yet 100%. However, only 76.1% of the inhabitants were sleeping under LLIN during the study period. This provides a clue for improper use of the owned nets requiring further in-depth exploration and design strategies to improve on appropriate implementation of LLINs to effectively control malaria in the area. The relatively higher mRDT positivity rate was probably, among other factors, is a reflection of this lesser compliance in using the established control tool. No age- or sex-related pattern of malaria infection was evidenced in this study. Thus locality-specific malaria control interventions should be targeted to all age- and sex-groups, not restricted to under-five children or pregnant women. Except proximity to vector mosquito breeding sites, socioeconomic status and the number of LLIN per HH most socio-demographic factors were not implicated as malaria-risk factors. The findings are believed to contribute towards improving malaria control efforts in Jiga and its surroundings.

7. RECOMMENDATIONS

Enhanced and sustainable healthcare education about malaria, its transmission and prevention strategies are warranted with main focus on HHs that are nearby water bodies. A better study design with more HHs per state team may better allow assessment of IRS effect on the mosquito population. Carefully-coordinated regular surveillance and response systems must be in place to thoroughly assess the efficacy and gaps of ongoing control interventions vis-à-vis sustained low-level transmissions in isolated hotspots as well as possible outbreaks in the locality.

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9. ANNEXES

Annex 1: English informed consent/assent form

Dear sir/madam, Interviewee's House №_____

Greetings

I am Ms Seble Ayalew an MSc student at Department of Microbial, Cellular and Molecular Biology, College of Natural Sciences, Addis Ababa University (AAU). I am here to study about malaria prevalence and associated risk factors in Jiga and its surroundings for my MSc Thesis. In order to design and implement cost-effective malaria control interventions, up-to-date information on the prevalence, distribution and influencing local factors of the disease is important. The primary objective of this study is, therefore, to assess the current status of malaria in Jiga area in relation to the ongoing control activities thereby to contribute towards informed decision making in malaria control. The study will involve any of your household (HH) members including children. The HH head or any family member of age ≥18 years, in the absence of the former, will be interviewed to gather relevant data using a structured questionnaire. In case effective communication is not possible due to language barrier or any other problem of self-expression assistant translators will be employed during the interview. Randomly selected family members will be requested for rapid malaria test using a finger-prick blood sample which will be done by a health professional among us. If you or your family members have had a problem during the finger-brick, you are assured that treatment will be given free of charge. Maximum care will be taken to minimize any risk during pricking. If you or your family members have had malaria parasite anti-malarial treatment as per national guideline is freely available. Please be assured that any information pertaining to your house and family members will be confidential through codification of the data. You are free to accept or decline this invitation to participate in the study. Your participation is totally based on your own decision about yourself or your under-18 children by signing consent or an assent form. You are also free to decide to stop yourself or your family from participation in the study at any time without fear of any negative consequences including prohibition of local healthcare facility services. At any time you are free to ask me anything about this study.

Do I have your agreement to participate and/or allow your child to participate _____ (yes or no?)

Name (participant) _____Signature_____Date_____

Child Name code_____Signature (parent or guardian) _____Date_____

Name (investigator) _____Signature_____Date_____

Annex 2: Amharic consent/assent form

የስምምነት ቅፅ

እኔ ሰብስ _አያሌዉ

የወባ በሽታ በህዝቡ ጤና ላይ ያስዉን ጉዳት እና ስበሽታዉ መስፋፋት ተፅዕኖ ያሳችውን ነግሮች ስማወቅ እያጠናሁ አገኛስሁ፡፡ የዚህ ጥናት አላማ በዘህ አካባቢ ያስውን የበሽታ ስርጭት እና ተፅዕኖወች ማወቅ በሽታዉን ስመከላከል እና ስመቆጣጠር ያስዉን ስማወቅ ታስቦ ነዉ፡፡ ደህም በሽታዉ በወረዳው ዉስጥ እያደረሰ ያስዉን የጉዳት መጠን እና የሕብረተሰቡ ተሳትፎ በሽታዉን ስመከላከል እና ስመቆጣጠር ያስዉን ጠቀሜታ ስማወቅ ነዉ፡፡ በዚህም መሰረት የሚመለከተው አካል ወደፊት ስሚያወጣቸው በሽታን የመከላከል እና የመቆጣጠር ንድፈ ሀሳቦች ደህ ጥናት ጠቃሚ የሆነ መረጃን ደሰጣል፡፡ ጥናቱ ከአንድ አመት በላይ የሆናቸውን የቤተሰብ አባል ያጠቃልላል፡፡

እርሰዎ ወይም ቤተሰብዎ በዚህ ጥናት ላይ ደሳተፉ ዘንድ በአክብሮት ተጋብዘዋል በዚህ ጥናት ስመሳተፍ ከተስማሙ መስማማትዎን የሚያሳይ ቅፅ ላይ እንዲፈርሙ፣በመጠይቁ እንዲሳተፉ እና በጥያቄዉ መሰረት መልስ እንዲመልሱ እንዲሁም እርሰዎ ወይም የቤተሰብዎ አባል አንድ ጠብታ የደም ናሙና ስአንድ ጊዜ ብቻ እንዲሰጡ እንጠይቃስን፡፡የደም ናሙናዉ በጤና ባስሙያ ከእርሰዎ ወይም ከቤተሰብዎ ደሰበሰባል፡፡የደም ናሙና በሚወሰድ ጊዜ በእርሰዎ ወይም በቤተሰብዎ ላይ ጉዳት ከደረሰ አስፈላጊውን ህክምና ያገኛሉ፡፡ በእርሰዎ ወይም በቤተሰብዎ ደም ውስጥ በሽታው ቢገኝ በአካባቢው የጤና ባስሙያ አስፈላጊውን ህክምና ያገኛሉ፡፡ ትብብርዎ ሙሉ በሙሉ በፈቃደኝነት ላይ የተመሠረተና ተሳትፎዎን መቃወም፣መተዉና በማንኛውም ሰዓት ጥናቱን ማቆም ይችላሉ፡፡ተሳትፎዎን መንፈግ ማለት የጤና እንክብካቤ ማጣት ማለት አይደለም፡፡ስምዎን ከመመዝገቤ በፊት አባክዎ መረጃዎ በሚስጥር እንደሚጠብቅ ልነግረዎ አፈልጋልሁ፣ በጥናቱ ላይ ጥያቄ ካልዎት በማንኛውም ጊዜ የጥናቱን አስተባባሪ መጠየቅ ይችላሉ፡፡በቃስ መጠይቁ ጊዜ በአማረኛ መግባባት ካልተቻስ ወደ አገወኛ ይተረገምስወታል፡፡

ተስማምተዋል? የጥናቱን መግስጫ አንብብያስሁ/ ሰምቻስሁ እናም ተረድቻስሁ፡፡ መመሪያው ምን እንደሆነና በእኔ እና በቤተሰቦቼ ላይ ምንም ችግር ሲከሰት እንደማይችል ተረድቻስሁ፡፡ በጥናቱ ላይ ስመሳተፍ ተስማምቻስሁ፡፡

ስም_____ፊርማ _____ ቀን _____

የህፃኑ ስም ኮድ_____የወላጅ ወይም ህጋዊ አሳዳጊ ፊርማ_____ቀን_____

አጥኝዉ (ተወካዩ) ፊርማ _____ቀን _____

Annex 3: English questionnaire

Malaria Indicator Survey Model Household Questionnaire

Questionnaire № _____

Date _____

SECTION I: HOUSEHOLD CHARACTERISTICS

District _____ *Kebele* _____

1. House № _____ Age___ Sex___
2. Marital status A. Single B. Married C. Divorced D. Widowed
3. State of pregnancy A. Pregnant B. delivery before 6 month C. delivery 6 months back D. Other specify_____
4. Educational status of household (HH) head A. Illiterate B. Read and write C. Primary school D. Secondary school E. ≥High school

5. Occupation of the HH A. Government employee B. Farmer C. Merchant D. Other specify ____
6. HH income in a month A. <500 Birr B. 500-1000 Birr C. >1000 Birr
7. HH size_____
8. Does your HH have any of the following mass media? A. Radio B. Television C. Internet D. No E. Other specify_____
9. Have you seen or heard any education messages pertaining to malaria from any source in the past? A. Yes B. No
10. If yes, explain the source? A. health workers B. mass media C. religious institutions D. other specify__
11. What is the most important thing in your HH to prevent getting malaria? A. use a bed net B. use insecticide sprays C. take tablet D. keep the house and surrounding clean E. destroy mosquito breeding sites F. other specify_____

SECTION II: INSECTICIDE SPRAYING AND MOSQUITO NETS

12. Is there insecticide treated bed net in the HH? A. Yes B. No… skip to Qu 17
13. If yes, how many ITNs do you have in the HH? A. 1 B. 2 C. 3 D. >3
14. Are they currently being used? A. Yes B. No ….. Skip to Qu 16
15. Did you or your family use it last night? A. Yes B. NO
16. Reasons for not using the available ITNs A. Nets do not prevent malaria B. Afraid of its toxicity C. Other (specify) _____

17. Reasons for unavailability of ITNs A. Not available B. Lost/stolen C. Used for other purposes D. Old; then thrown away F. Other (specify) _____

18. Who uses the ITNs? A. Children B. Mother C. Father D. Father and Mother E. Children and Mother F. The whole family

19. How often do you or your family sleep under bed nets? A. Daily B. Occasionally C. During Malaria season D. Almost weekly E. Other specify _____

20. Type of bed net? A. Untreated Net B. Locally Treated Net (ITN) C. Long-Lasting Insecticide Treated Net (LLIN) D. Don't Know

21. Condition of the bed net? A. Good (no holes) B. Fair (no holes that fit a torch battery) C. Poor (1-holes that fit a torch battery) D. Unsafe (>5 Holes that fit a torch battery) E. Unused (still in package)

22. For how long have you used bed nets in this house? A. Months ago B. <1 month C. >3 years D. don't know E. Other specify _____

23. Was the house sprayed with insecticide in the last 12 months? A. Yes B. No

24. If yes, when was last sprayed? A >3 months B. >6 months C. Other specify_____

25. Have you or your family members ever contracted malaria? A. Yes B. No

26. If yes, where did you go for treatment? A. Health center B. Hospital

C. Traditional healers D. Nowhere (managed at home) E. Other specify_____

SECTION III: HOUSING ENVIRONMENT

27. Main material of the Room's Roof?

A. Thatch B. Corrugated Iron sheet C. Other specify _____

28. Main material of the Room's Floor?

A. Earth B. Local dung plasters C. Other specify_____

39. Main material of the Room's Wall? A. Mud blocks B. Sticks

D. Corrugated Metal E. sticks and mud F. Other specify_____

30. Is eave present? A. Yes B. No

31. Is hole present in the wall? A. Yes B. No

32. Is there any mosquito breeding habitat around the village? A. Yes B. No-- skips to Qu37

33. If yes, distance of the house from mosquito breeding habitat?

A. <1000 m B.1000m-2000 m C.>2000 m D. Other specify_____

34. What is the main source of drinking water for members of your household? A. Spring B. Dug Well C. Surface Water (River/Dam/Lake/Pond/Stream) D. Public Tap/Standpipe E. Other specify_____

35. What kind of toilet facilities does your household use? A. No facility Bush/Field B. Pit Latrine (no cement slab) C. Other specify_____

Annex 4: Amharic questionnaire

የወባ ጠቋሚ ጥናት

የቤተሰብ መረጃ መሰብሰቢያ ቅጽ ቁጥር_____

መጠይቅ ክፍል አንድ፡ የቤተሰብ ሁኔታ

መኖሪያ አካባቢ_____ቀበሌ_____

1. የቤት ቁጥር_____እድሜ_____ ጸታ___
2. የጋብቻ ሁኔታ ሀ. ያላገባ ለ.ያገባ ሐ. የፈታ/ች መ. ባለቤቷ/ቱ በህይወት የሌለ
3. የወሊድ ሁኔታ ሀ. ነፍሰጡር ለ. ከ6 ወር በፊት የወለደች
   ሐ. ባለፈው 6 ወር ውስጥ የወለደች መ. ሌላ (ይግለጹ) _____
4. የቤተሰብ ኃላፊ የትምህርት ደረጃ ሀ. ያልተማረ ለ. መጻፍና ማንበብ የሚችል
   ሐ. የመጀመሪያ ደረጃ መ. ≥ሁለተኛ ደረጃ
5. የቤተሰብ የስራ ሁኔታ ሀ. የመንግስት ሰራተኛ ለ. አርሶ አደር
   ሐ. ነጋዴ መ.ሌላ (ይግለጹ)_____
6. የቤተሰብ የወር ገቢ ሀ. ከ500 ብር ያነሰ ለ. ከ500-1000 ሐ. ከ1000 ብር የበለጠ
7. የቤተሰቡ ብዛት_____
8. በቤትዎ ውስጥ ከዚህ በታች ከተዘረዘሩት የመገናኛ ብዙሃን የትኞቹ አሉ? ሀ. ሬድዮ
   ለ. ቴሌቭዥን ሐ. ኢንተርኔት መ. የለም ሠ. ሌላ (ይግለጹ)_____
9. ከዚህ በፊት ስለወባ እና ስለሚያስከትለው ችግር ትምህርታዊ መልዕክት ሰምተው ወይም አይተው ያውቃሉ? ሀ. አዎ ለ. የለም
10. መልስዎ አዎ ከሆነ ትምህርታዊ መልዕክቱን ከየት አገኙ? ሀ. ከጤና ሰራተኞች
    ለ. ከመገናኛ ብዙሃን ሐ. ከእምነት ተቋማት መ. ሌላ (ይግለጹ)_____
11. ቤተሰባችሁ በወባ እንዳይያዙ የምትከላከሉበት ዘዴ ምንድን ነው?
    ሀ. አጎበር መጠቀም ለ. ፀረ-ነፍሳት ፍሊት መርጨት ሐ. ኪኒን መዋጥ
    መ. ቤትና አካባቢን በንጽህና መያዝ ሠ. የተጠራቀመ ውሃን መጥረግ

መጠይቅ ክፍል ሁለት፡የመድሃኒት ስርጭትና የአልጋ አጎበርን በተመለከተ

12. በቤትዎ ውስጥ አጎበር አለ? ሀ. አዎ ለ. የለም……ወደ ቁጥር17
13. መልስዎ አዎ ከሆነ ምን ያህል አጎበር አለዎት? ሀ. 1 ለ.2 ሐ. ≥3
14. በአሁኑ ሰዓት አጎበሩን ትጠቀማላችሁ? ሀ. አዎ ለ. የለም……ወደ ቁጥር 16
15. እርስዎ (ቤተሰብዎ) ትናንት ማታ የትንኝ መከላከያ አጎበር ውስጥ ተኝተው ነበር?
    ሀ. አዎ ለ.የለም

16. አጎበር ካለዎ የማይጠቀሙበትን ምክንያት ይግለጹ? ሀ. አጎበር ወባን አይከላከልም
ለ. መርዙን ስለምንፈራ ሐ. ሌላ (ይግለጹ) _____

17. የትንኝ መከላከያ አጎበር ከሌለዎት ምክንያቱ ምንድን ነው?
ሀ. አጎበር የለም ለ. ጠፍቶናል ሐ. ለሌላ ጥቅም አውለዋለው
መ. አሮጌ ስለኖነ ጥለነዋል ሠ.ሌላ (ይግለጹ) _____

18. ከቤተሰቡ አባል በአጎበር ውስጥ የሚያድር ማነው ? ሀ. ህጻናት ለ. እናት
ሐ. አባት መ. እናትና አባት ሠ. እናትና ህፃናት ረ. ሁሉም የቤተሰብ አባል

19. አርስዎ (ቤተሰብዎ) በአጎበር ውስጥ መቼ ነው የምትተኙት? ሀ. በየቀኑ ለ. አንዳንድ ግዜ ሐ. በወባ ወቅት መ. ቢበዛ በሳምንት ሠ. ሌላ (ይግለጹ)_____

20. የትንኝ መከላከያ አጎበር አይነት ሀ. ያልተነከረ ለ. አገር ውስጥ የሚነከር
ሐ. ፋብሪካ ውስጥ የሚነከር መ. አላውቀውም

21. የትንኝ መከላከያ አጎበር ሁኔታ ሀ. ጥሩ ነው (ቀዳዳ የለውም) ለ. ደህና ነው (ቀዳዳው ትንሽን የባትሪ ድንጋይ አያሳልፍም) ሐ. ጥሩ አይደለም ከ1-4 ያሉት ቀዳዳዎች ትንሽ የባትሪ ድንጋይ ያሳልፋሉ መ. አስተማማኝ አይደለም ሠ. አልተጠቀሙበትም

22. የትንኝ መከላከያ አጎበሩን መቼ አገኙት? ሀ. ከወራት በፊት
ለ. ባለፈው አንድ ወር ውስጥ ሐ. ከሦስት አመት በፊት መ. አላውቀውም
ሠ. ሌላ (ይግለጹ) _____

23. ባለፉት 12 ወራት ውስጥ ቤትዎ በፀረ- ትንኝ ፍሊት ተረጭቷል? ሀ. አዎ ለ. የለም

24. መልስዎ አዎ ከሆነ ቤትዎ በፀረ-ትንኝ የተረጨው መቼ ነው? ሀ. ከ3 ወር በፊት ለ. ከ6 ወር በፊት ሐ. ሌላ (ይግለጹ) _____

25. እርስዎ ወይም የቤተሰብዎ አባል በወባ ተይዞ ያውቃል? ሀ. አዎ ለ. የለም

26. መልስዎ አዎ ከሆነ ለህክምና ወደ የት ሄዱ? ሀ. ጤና ኬላ ለ. ሆስፒታል
ሐ. የባህል አዋቂዎች መ. አልሄድኩም ሠ. ሌላ (ይግለጹ)_____

መጠይቅ ክፍል ሦስት፥ የቤት አሰራርን በተመለከተ

27. የቤትዎ ጣሪያ በዋናነት ከምንድን ነው የተሰራው?
ሀ. ከሣር ለ. ከቆርቆሮ ሐ. ሌላ (ይግለጹ) _____

28. የቤትዎ ወለል በዋናነት ከምንድን ነው የተሰራው?
ሀ. ከአፈር ለ. በእበት የተለቀለቀ ሐ. ሌላ (ይግለጹ) _____

29. የቤትዎ ግድግዳ በዋናነት ከምንድን ነው የተሰራው? ሀ. ከጭቃ ጡብ ለ. ከእንጨት
ሐ. ከቆርቆሮ መ. ከእንጨትና ከጭቃ ሠ. ሌላ (ይግለጹ) _____

30. በቤቱ ግድግዳ እና በጣራው መካከል ክፍተት (ቀዳዳ) አለ? ሀ. አዎ ለ. የለም

31. በቤቱ ግድግዳ ላይ ቀዳዳ አለ? ሀ. አዎ ለ. የለም

32. በአካባቢያችሁ ለወባ ትንኝ መራቢያ አመች የሚሆን ቦታ አለ?

ሀ. አዎ ለ. የለም.....ወደ ቁጥር 37

33. መልሱ አዎ ከሆነ ቦታው ከቤትዎ በምን ያህል ይርቃል ? ሀ. < 1000 ሜትር

ለ. 1000-2000 ሜትር ሐ. > 2000 ሜትር መ. ሌላ (ይግለጹ)_____

34. ለቤተሰብዎ የመጠጥ ውሃ በዋናነት የሚያገኙ ከየት ነው?

ሀ. ምንጭ ለ. የጉድጓድ ውሃ ሐ. የከርሠ- ምድር ውሃ (ወንዝ፣ ኩሬ ወዘተ..)

መ. ቦኖ ውሃ ሠ. ሌላ ይግለጹ_____

35. ቤተሰብዎ የሚጠቀሙበት የመጸዳጃ ቤት አይነት?

ሀ. መጸዳጃ ቤት የለም (ጫካ/ሜዳ ላይ ነው) ለ. መፀዳጃ ጉድጓድ ሲሚንቶ የሌለው ወለል ሐ. ሌላ (ይግለጹ)

Annex 5: Laboratory results reporting format

S. №	HH №	Sex	Age	Malaria rapid diagnostic test result		*Plasmodium* species			
				Positive	Negative	P.f	P. v	Mixed	Remark

DECLERATION

I, the undersigned, declare that this Thesis is my original work and has not been presented for a degree in any other university. All sources of materials used for the Thesis are justly acknowledged.

Name: Seble Ayalew

Signature:

Date of submission December, 2014

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