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Assessment of the relationship between under-nutrition and malaria in preschool children at Bahir Dar special zone, Ethiopia: a comparative cross-sectional study

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Declaration

I, Hamid Yimam hereby declare that this thesis work is my original work and has not been presented anywhere earlier.

Name of the candidate: Hamid Yimam

Signature

Date

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Contents

Acknowledgements I
Contents II
List of tables IV
List of figures V
List of Abbreviations VI
ABSTRACT VII
1. INTRODUCTION 1
1.1 Background 1
1.2 Statement of problem 3
1.3 Significance of the study 5
2. LITERATURE REVIEW 6
3. OBJECTIVE 13
3.1 General objective: 13
3.2 Specific objective: 13
4. METHODS AND MATERIALS 14
4.1 Study area: 14
4.2 Study period: 15
4.3 Study design: 15
4.4 source population: 15
4.5 study population 15
4.6 Sample size: 15
4.7 Sampling procedures: 17
4.8 Inclusion and exclusion criteria: 18
4.8.1 Inclusion 18
4.8.2 Exclusion criteria: 18
4.9 Data collection procedures: 18
4.10 Data quality control 20
4.11 Operational definitions: 20
4.12 Data Analysis procedures: 21
4.13 Variables 22
4.14 Dissemination of results 22

4.15 Ethical consideration:.....23
5. RESULT.....24
5.1 socio demographic Characteristics of respondent.....24
5.2 House hold condition of the children.....26
5.3 Mothers/caretakers information on Malaria general knowledge, its prevention and treatment.....28
5.4 LLIN access and utilization.....31
5.5 Measures of Children's Nutritional Status and socio-demographic characteristics.....32
5.6 Plasmodium specious in malaria cases.....34
5.4 Nutritional and other Predictors of malaria in pre-school children.....35
6. DISCUSSION.....40
Strength of the study.....45
Limitation of the study.....45
7. CONCLUSION.....46
8. RECOMMENDATION.....47
References.....48
ANNEXES.....53
Informed consent form.....53
Questionnaire form.....54
Amharic Version Questionnaire.....60

List of tables

Table 1: *Estimated sample size based on the specific objectives*----------*16*

Table 2: *Socio-demographic characteristics of mothers/caretakers at Bahir Dar special Zone, 2014*----------*25*

Table 3*: household characteristics of study participant Bahir Dar special zone, 2014*----------*27*

Table 4: *Symptoms of malaria reported by mothers/caretakers, Bahir Dar special Zone, 2014*----------*28*

Table 5: *Causes of malaria reported by mothers/caretakers, Bahir Dar special zone, 2014*------*29*

Table 6: *Group of population reported as malaria is serious by mothers/caretakers at Bahir Dar special zone, 2014*----------*30*

Table 7: *Malaria prevention methods reported by mothers/caretakers, Bahir Dar special zone, 2014*----------*30*

Table 8: *Children Nutritional status at Bahir Dar special zone, 2014*----------*33*

Table 9: *Association between stunting and confirmed malaria after adjusted for other variables in pre-school children at Bahir Dar special zone, 2014* ----------*37*

Table 10: *Association between stunting and confirmed malaria after adjusted for other variables in pre-school children at Bahir Dar special zone, 2014* ----------*38*

Table 11: *Association between stunting and confirmed malaria after adjusted for other variables in pre-school children at Bahir Dar special zone, 2014*----------*39*

List of figures

Figure 1*: Conceptual frame work of the association between malaria and malnutrition*---------*12*

Figure 2: *Map of Bahir Dar special zone, 2014*----------*14*

Figure 3*: Sampling procedure of the study*----------*17*

Figure 4: *Percentage of LLIN ownership Status by households at Bahir Dar special zone, 2014*----------31

Figure 5*: LLIN utilization rate by children at Bahir Dar special zone, 2014*----------*31*

Figure 6: *Type of plasmodium specious*----------*34*

List of Abbreviations

AAU	Addis Ababa University
Ab	Antibody
DDT	Dichloride Diphenyl Trichloroethane
EDHS	Ethiopia Demographic and Health Survey
Ig	Immunoglobulin
IRS	Indoor Residual Spraying
ITN	Insecticide Treated Net
HAZ	Height for Age Z score
HC	Health Center
LLINs	Long lasting Insecticide-treated Nets
MIS	Malaria Indicator Survey
MUAC	Mid-Upper Arm Circumference
OR	Odds Ratio
P I	Principal Investigator
SD	Standard Deviation
WAZ	Weight for Age Z score
WHO	World Health Organization
WHZ	Weight for Height Z score

ABSTRACT

Background: Malaria and under-nutrition are the two major causes of childhood mortality in sub-Saharan Africa. More than half of child mortality related to major infectious diseases is attributed at least in part to under nutrition. In Ethiopia both under nutrition and malaria are very important public health problem. Although the relationship of malnutrition and respiratory infection, diarrheal diseases is well studied, the relation with malaria is still controversial. The information that obtained in this study will help to develop clear guideline on management of under nutrition and malaria at individual as well as at community level.

Objective: To assess the relationship between under- nutrition and malaria in preschool children at Bahir Dar special zone, Ethiopia

Methodology: A cross sectional study that compared two groups (with confirmed malaria and without confirmed malaria) was conducted to assess the relationship between malaria and under-nutrition at Bahir Dar special zone. A total of 621 Samples was calculated based on sample size calculation for comparative cross sectional study design using EpiInfo Statcalc. Anthropometric measurements and clinical data were recorded by trained clinical nurses and blood film results were taken by laboratory technician in respective health centers. Stunting, wasting, and underweight of children were determined using the International Reference Population defined by the WHO using WHO Anthro software. Data were entered using EpiInfo version 3.5.4 and transformed to SPSS version 21 for cleaning and analysis.

Result: The prevalence rates of stunting, underweight and wasting were 50.3%, 34.2% and 12.1% among cases respectively. Stunting (AOR = 1.614; 95%C.I. = 1.192–2.514), underweight (AOR = 1.690; 95%C.I. = 1.112– 2.903) and wasting (AOR = 2.44; 95%C.I. = 1.15–5.20) were significantly associated with confirmed cases of malaria. Other important predictors were place of residence (rural) (AOR = 2.35; 95%C.I. = 1.39 – 3.98), sex (male) (AOR = 1.88; 95%C.I. = 1.19 – 2.98), LLIN use (AOR = 0.20; 95%C.I. = 0.13 – 0.33), IRS (AOR = 0.26; 95%C.I. = 0.15 – 0.43) and educational status of the mother (above grade 12) (AOR = 0.30; 95%C.I. = 0.11 – 0.79).

Conclusion and Recommendation: the major contributor factors to malaria were wasting, stunting, underweight, rural residence, male sex, LLIN use, indoor residual spray and low educational status of the mother/caregiver. Therefore, governmental and non-governmental organizations need to consider integration of malaria control program with nutrition intervention.

1. INTRODUCTION

1.1 Background

Malaria is the most significant parasitic disease of human beings and remains a major cause of morbidity and mortality worldwide in general and in most developing countries in particular. Globally, an estimated 3.3 billion people were at risk of malaria in 2011, with populations living in Sub-Saharan Africa having the highest risk of acquiring malaria: approximately 80.0% of cases and 90.0% of deaths are estimated to occur in the WHO African Region, with children below the age of five and pregnant women most severely affected (1). It is estimated that 300 million clinical cases of malaria are occurring each year in malaria-endemic regions including Ethiopia and Falciparum and vivax malaria species are the common causes (1).

On the other hand hunger and malnutrition also remain among the most devastating problems facing the majority of the world's poor and needy, and continue to dominate the health of the world's poorest nations (2). Nearly 30.0% of human population that includes infants, children, adolescents, adults and older persons in the developing world are currently suffering from one or more of the multiple forms of malnutrition (2). The United Nations Food and Agriculture Organization estimates that nearly 870 million people, or one in eight people in the world, suffering from chronic undernourishment in 2010-2012. Almost all the hungry people, 852 million, live in developing countries, representing 15.0% of the population of developing counties (3). Likewise Protein-energy malnutrition (PEM) affects a large proportion of under five children in the developing countries of which about one third (32.0%) are stunted and about 9.0% are wasted with regional variations (4, 5). According to UNICEF report in Sub-Saharan Africa, 38.0% of children under five years of age suffer from chronic malnutrition or stunting, and acute malnutrition or wasting affects 9.0% of preschool children (6).

In Sub-Saharan Africa, malaria and under-nutrition are the two major causes of childhood mortality. More than half of child mortality related to major infectious diseases is attributed to under nutrition (7).

In Ethiopia both under nutrition and malaria are common public health problem. An estimated 55.7 million people (68.0% of the population) are at risk for malaria and around 80.0% of the 736 districts (woredas) in Ethiopia are considered malarious. In 2009/2010, malaria was the leading cause of outpatient visits and health facility admissions, accounting for 14.0% of outpatient visits and 9.0% of admissions (8). According to Ethiopian Malaria Indicator Survey 2011 microscopic blood-smear test results for altitudes <2,000m showed a small increase in malaria prevalence, from 0.9% to 1.3%, respectively though the case definition is varied (8). Malaria is the number one health problem in Ethiopia with an average of 5 million cases a year (9). Likewise the prevalence of stunting, underweight and wasting in Ethiopia was 44%, 29% and 10% respectively (10). Showing that both malaria and undernutrition to be a major problem in Ethiopia including the study area though the prevalence varied (8, 10).

Nevertheless, available information on the co-existence of malaria and undernutrition in the proposed study area is scanty and this study will fill the gap.

1.2 Statement of problem

Nutrition plays a major role in maintaining health, and malnutrition appears to generate vulnerability to a wide variety of diseases and general ill health (7). Infection and malnutrition have always been intricately linked. Malnutrition is considered as the primary cause of immunodeficiency worldwide which elicits dysfunctions in the immune system and promotes increased vulnerability of the host to infections. Malnutrition can make a person more susceptible to infection, and infection also contributes to malnutrition, which causes a vicious cycle (11). It is estimated that two third of deaths among under 5 children in the world are related to feeding factors (12). Malnutrition is the underlying cause of one third of the 7.6 million child deaths each year before their fifth birthday. More than half of child mortality related to major infectious diseases including malaria is attributed at least in part to under nutrition (13).

Even though the relationship between malnutrition and respiratory infection, diarrheal diseases is well studied, the relationship with malaria is still controversial. A recent study that described clinical and laboratory features of infants with pneumonia demonstrated an elevated fatality rate in severely malnourished children compared to well-nourished infants (14). There are different studies which assess the relationship between malaria and malnutrition including micronutrient deficiency and protein energy malnutrition. Some of them indicate that under nutrition increase the risk for high malarial parasitemia and morbidity. For instance, a study conducted in Kenyan preschool children indicate that stunted children had more malaria parasitemia, high-density parasitemia, clinical malaria and severe malarial anemia than non-stunted children (15). On the other hand the study conducted in Papua New Guinea showed that stunting protected children from malaria (16), while a study conducted in South West Ethiopia that assess the relationship between malaria and malnutrition found that there was no statistically significant association (27). As a result of controversy there is a difficulty in managing both malaria and malnutrition in malaria endemic area.

In Ethiopia both under nutrition and malaria are very common. But studies that assess relationship between malaria and malnutrition to develop comprehensive prevention approach and management guideline are limited.

Therefore, this study attempted to substantiate the non-conclusive findings and contribute to develop clear guideline and comprehensive approach on management of under nutrition and malaria at individual as well as at community level.

1.3 Significance of the study

In Ethiopia both malnutrition and malaria are very common. Amhara region is amongst the malarious endemic regions. So far many studies had documented that assess determinant factors of malaria and undernutrition separately. Nevertheless, there are little studies which assess the relationship between them and the available information are non-conclusive. Therefore, malaria-control programs will have limited effects if we do not recognize and consequently target the underlying causes of the disease. Therefore, assessing the relationship between undernutrition and malaria be essential to substantiate present findings and ultimately contribute to design a better intervention and control programme. In addition if there any association between them it helps to consider the risk of malaria in areas of high prevalence of malnutrition and vice versa.

2. LITERATURE REVIEW

There are different studies on the relationship between malnutrition and infection in general and malaria in particular at molecular as well as community level. There is a difference in the association according to the study design and setting.

Infection and undernutrition

Undernutrition is considered to be the underlying cause of more than 50.0% of all childhood deaths in the world. Children are the most visible victims of undernutrition. Children who are poorly nourished suffer approximately 160 days of illness each year (11). Poor nutrition plays a role in at least half of the 10.9 million child deaths each year. For many infectious diseases, such as acute lower respiratory infections, undernutrition is associated with risk of experiencing the infection in addition to the risk of dying from it (17). Regarding the relation with parasitic infection, a study conducted by Donald *et al* show that the risk of stunting was significantly higher in children with Ascaris lumbricoides and the risk of wasting was higher in children with A. lumbricoides or Trichuris trichiura, whereas the risk of kwashiorkor was high with T. trichiura but much reduced in those with A. lumbricoides. Plasmodium infection was not related to nutritional indicators (18).

Several studies have been conducted to examine the associations of malnutrition, deficiencies in cell-mediated immunity, and the incidences of gastrointestinal or respiratory infections in children under 5 years of age. Regarding the severity of malnutrition the previous study indicates that severely stunted children appeared to be less immune responders compared to their control whereas no significant difference was found in geometric means of parasite density between the two groups (19).

Findings in humans point to an impaired ability of malnourished children to mount effective immune responses when exposed to pathogens. Atrophy of lymphoid tissues like the thymus is believed to be part of the underlying pathogenesis. In children, PEM causes widespread atrophy of lymphoid tissues, particularly T-lymphocyte areas. The thymus involutes causing a reduction in the thymus-derived lymphocyte growth and maturation factors, arrest of lymphocyte development, reduced numbers of circulating mature CD4 helper cells, and impairment of antibody production to T-dependent antigens.

Imbalance in Th1-Th2 activation occurs depending on nature of stimuli and altered regulatory pathways, including responses mediated by the nuclear factor-kB (NFkB), a major transcription factor involved in the development of innate and adaptive immunity. Hence the patient's ability to ward off infections and show recovery is compromised (20). On the other way a study conducted by Cunningham-Rundles S and etal show that malnutrition down-regulates immune functioning, resulting in higher risk of infection (21). In addition the previous study indicate that the prevalence of immune responders was significantly lower in mildly stunted children than in their controls whereas no significant difference in the geometric mean of parasite density was observed between the two groups (19).

Malnutrition and malaria

In relation with malaria, there are different studies from molecular to community level. A study conducted by Florie *et al* indicate that prevalence of anti-malarial immune responders was significantly lower in malnourished children than in controls (P = 0.001) whereas no significant difference in the geometric mean of parasite density was observed between the two groups and 45.0% decrease in the IgG Ab level was observed in malnourished children compared to control children (P = 0.008) (19). There are also studies at community level on the association between malnutrition and malaria with different study design and setting. Some of them show that undernutrition is a risk for malaria while the others as protective effect or no association. There are also differences in the direction and magnitude of the association as the type of malnutrition varies.

Stunting and malaria

There are different views regarding the association between stunting (the major indicator of chronic malnutrition) and malaria. A longitudinal study in Gambia indicate that stunting at the start of a transmission season was associated with increased incidence of malaria (22). Another cross sectional study conducted by *Jennifer F. et al* in Kenyan preschool children indicate that stunted children had more malaria parasitemia (odds ratio [OR] 1.98, P< 0.0001), high-density parasitemia (OR 1.84; P< 0.0001), clinical malaria (OR 1.77; P< 0.06), and severe malarial anemia (OR 2.65; P< 0.0001) than non-stunted children (23).

This is supported by immunological study conducted by Fillol and *et al* found that the prevalence of anti-malarial immune responders was significantly lower in stunted children than in non-stunted children (P = 0.001).

While an observational follow-up study that was conducted in a cohort of 2–59-month-old children living in a rural area of Senegal where malaria transmission was highly seasonal indicated that there is no association in subsequent malaria attack between stunted and non-stunted children (24). likewise the study conducted in Ghana also described, stunting and fast breathing were not associated with whether or not a child was positive for asymptomatic malaria (25). Similarly Verhoef and others also found that, presence of stunting was not related to increased prevalence of malaria infection even if it was associated with increased severity of anemia among children who were infected (26). A study conducted in Western Ethiopia show that stunting is not significantly associated with malaria morbidity while other factors were associated with stunting. As the age of children increased, the prevalence of stunting increased. Compared to boys, girls were less likely to be stunted (OR = 0.8, 95% CI = 0.7–0.9). The other independent variables like presence of malaria parasite, family income and birth order were not correlated with stunting (27).

Underweight and malaria

Children who are underweight are thought to have increased susceptibility to malaria for a variety of reasons, most notably through a reduction in the function of the immune system. When a child is undernourished, he or she may be unable to mount an appropriate immune response to the malaria parasite due to reduction in T lymphocytes, impairment of antibody formation, decreased complement formation, and atrophy of thymus and other lymphoid tissues, among others (28). Several studies assessed the association between underweight and malaria in different methodology and study setting with different results. For instance, a follow up study conducted in Gambia, anthropometry and blood samples were assessed in a group of children (n=317) who were followed throughout the rainy season and the result showed that children with higher weight-for-age were at a slightly higher risk of developing parasitemia, but this was not statistically significant (29). When considered within the spectrum of underweight severities, there appears to be a risk gradient. The most underweight children have the highest risk of malaria mortality and risk decreases with improved underweight status as identified by z-scores (30).

Similarly, in a previous study in Tamale, have shown that underweight increased the risk of fatal outcome of severe malaria three fold which indicates underweight not only increases the risk of clinical malaria by 70.0% but also it is a risk factor for fever and anemia (31).

Similarly a study conducted in Port Harcourt; the capital of Rivers State, Nigeria showed that Children who are underweight were found to be at a higher risk of acquiring malaria infection than the well-nourished children (RR = 1.02, $\chi 2$= 0.320, P < 0.02) (32). In addition, the World Health Organization's Comparative Risk Assessment project found that children who were moderately to severely underweight had an increased, but not statistically significant risk of a clinical malaria attack, as compared with those who were better nourished (7). This result is supported by a study conducted by Scrimshaw N. *et al.* Indicate that Children who are underweight are thought to have increased susceptibility to malaria for a variety of reasons, most notably through a reduction in the function of the immune system. When a child is undernourished, he or she may be unable to mount an appropriate immune response to the malaria parasite due to reduction in T lymphocytes, impairment of antibody formation, decreased complement formation, and atrophy of thymus and other lymphoid tissues, among others (28).

On the other hand, a study conducted in Burkina Faso showed no association between the occurrence of clinical malaria and PEM; however, PEM was associated with a higher mortality risk (30). A prospective study conducted in Kenya also found no relationship between baseline nutritional status and subsequent incidence of malaria (33). Another study in West Africa showed that there was no association between PEM and malaria morbidity, but malnourished children had a more than two-fold higher risk of dying than non-malnourished children (34). Considering clinical malaria a study conducted in Gambia Children who developed a clinical attack of malaria accompanied by a high level of parasitaemia tended to have a higher mean weight-for-age at the beginning of the rainy season than did children who had a clinical attack accompanied by a low level of parasitaemia, but the difference between groups was not significant (35). The study conducted in western Ethiopia showed that no significant association between malaria parasite and under-weight, [OR = 0.9, (95%CI: 0.7, 1.2)]. After controlling for the effect of potential confounding variables, children above one years of age were more likely to become under-weight as compared to infants. Sex, birth order and family income did not have significant association with under-weight.

Wasting and malaria

Wasting (measure of acute malnutrition) is also associated with malaria incidence, morbidity and death in either of direction. A study conducted in Vanuatu where there is both Plasmodium falciparum and P. vivax, followed a much larger group of children (n=1,511) found that P. Vivax malaria during the six-month period before assessment was strongly associated with acute malnutrition (36). On the other hand, study conducted in Kenya have shown protective effects against malaria for other forms of under-nutrition (33). While the presence of wasting increased the risk for only severe malarial anemia (23). While an observational follow-up study that was conducted in a cohort of 2–59-month-old children living in a rural area of Senegal where malaria transmission was highly seasonal indicated that wasted children were at lower risk of experiencing at least one subsequent clinical malaria attack, whereas no association was observed in stunted children (24). Similar with this children with wasting in Papua New Guinea, humoral responses to malarial antigens have been found to be low, suggesting that wasting is a risk factor for malaria (16). Similar with this a study conducted by Ehrhardt S. *et al* also show that Protein energy malnutrition predispose children to malaria infection through reduction of malaria specific antibodies (IgG) (37). While a previous study conducted in Western Ethiopia show that even though Children in the age group of 12–23 months were 2.2 times more likely to develop wasting than infants, [OR = 2.2, (95%CI: 1,1, 4.4)], there was no statistically significant association between malaria, sex, income and birth order of the children with wasting (27).

With regard to nutritional oedema, a study conducted in Congo show that malaria was more frequent in those children who had, at the time of hospitalization, nutritional oedema, a WHZ < -2 and a MUAC <115 mm. In multivariate analysis, malaria remained significantly higher in children with nutritional oedema and in those with a MUAC <115 mm, during hospitalization (38). Similarly a study conducted at Lwiro, in the province of South Kivu, DRC, children without nutritional oedema at the time of hospitalization had a higher risk of malaria infection (39). Regarding malaria's contribution to under-nutrition, randomized controlled insecticide-treated bed net (ITN) trials that is conducted in Kenya suggest that malaria has a detrimental effect on nutritional status in children under 5 years (40).

Regarding association with death a study conducted in West Africa revealed that After adjustment for possible confounding variables, malnourished children had a more than two-fold higher risk of dying than non-malnourished children, with a RR of 2.4 [CI 1.0–5.7, P¼0.05] for stunted children, 2.7 (CI 1.0–7.3, P¼0.05) for underweight children, and 2.8 (CI 1.1–6.7, P¼0.02) for wasted children (34).

Socio-demographic factors

Different socio demographic factors affect the incidence of malaria. A study conducted in Senegal shows that the geometric mean of parasitemia varied by sex in which girls had a lower mean than boys; P= 0.008) (19). While a study in Nigeria showed that there is no significant difference in malaria parasitaemia by sex (41). Regarding age of the children another study in Nigeria showed that younger children are at higher odds of having malaria parasitaemia than older children ($\chi 2$ = 10.36, $p < 0.006$) (32). Similarly a study by Jennifer and *et al* showed that older children have higher likelihood of having malaria attack than younger children. (23)

Malaria related factors

Concerning the association of LLIN with malaria incidence a community based comparative interventional study conducted in Abuja under-five children showed a 93.0% reduction in prevalence of malaria (P= 00000) using a thin blood film was recorded in the intervention group (42). Similarly a study conducted in Kenya showed that Malaria prevalence in the rainy season was about 30.0% lower in ITN users than in non-ITN users (OR 0.72, 95% CI = 0.51-1.00, P <0.05) (43) In addition Cochrane review concluded that, ITNs reduce clinical episodes of malaria caused by Plasmodium falciparum and P.vivax infections by 50.0% on average (range 39.0–62.0%) (44). With respect to the association of malaria and indoor residual spray a secondary data analysis in East Shoa, Ethiopia showed that the incidence of malaria in 2011 and 2002 among the sprayed villages was lower than the respective preceding years for both the Plasmodium species [incidence rate ratio (IRR) 0.60; CI 0.35 to 0.95; pB0.0001] (45).

In summary, despite the previous studies the association of malaria and undernutrition is non-conclusive and it is appropriate to do a research like this with comparison groups to substantiate the findings to consider a better prevention and control approach.

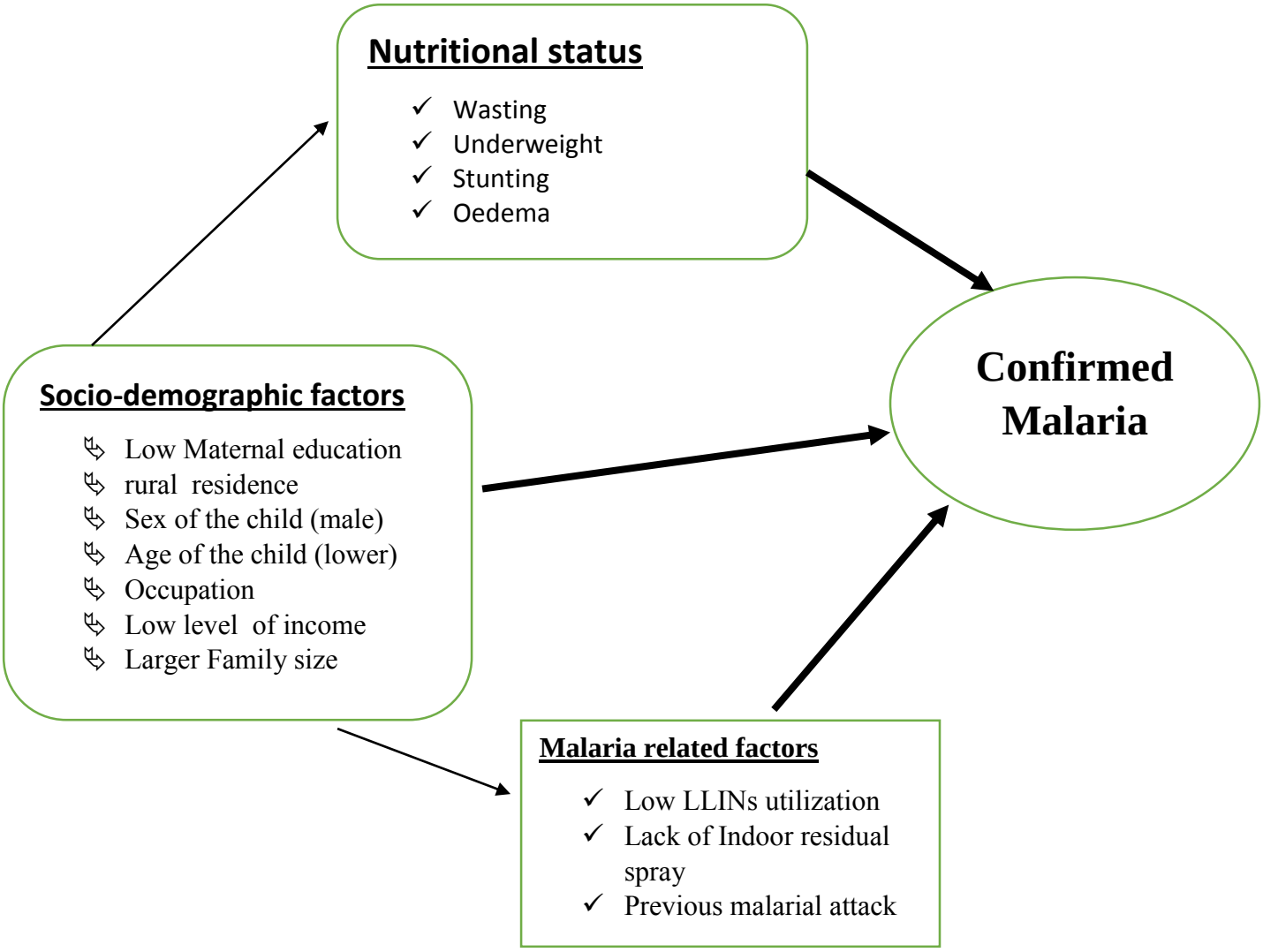

Figure 1*: Conceptual frame work of the association between malaria and malnutrition*

3. OBJECTIVE

3.1 General objective:

- To assess the relationship between under nutrition and malaria in preschool children at Bahir Dar special zone, Ethiopia:

3.2 Specific objective:

- To assess the relationship between stunting and malaria
- To identify the relationship between underweight and malaria
- To discuss the relationship between wasting and malaria
- To identify other related factors

4. METHODS AND MATERIALS

4.1 Study area:

The study was done in Bahir Dar special zone which is the capital of Amhara region North-western, Ethiopia, situated on the southern shore of Lake Tana. The city is located approximately 564 Km North-west of Addis Ababa, having a latitude and longitude of 11°36′N 37°23′E Coordinates: 11°36′N 37°23′E and an elevation of 1,840 meters above sea level.

Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia, Bahir Dar Special Zone has a total population of 221,991, of whom 108,456 were men and 113,535 were women; 180,174 or 81.16% were urban inhabitants, the rest of population are living in the out skirt of Bahir Dar. The special zone is subdivided into 9 urban, 9 rural and 3 special kebeles. This zone have 1 hospital, 10 public Health Centers (7 urban and 3 rural), 10 private clinics, 19 pharmacy, 55 drug vender and 4 laboratory diagnostics.

Bahir Dar special zone is one of malaria endemic zones in Amhara regional state. According to Zonal health office report malaria is a major health problem in the zone. The transmission of malaria in the zone is seasonal and major transmission occurs from September to December; after the summer rainfall and May to July.

Figure 2: *Map of Bahir Dar special zone, 2014 (source Google map, 2013)*

4.2 Study period:

The study was conducted from February 2014 to June 20. 2014

4.3 Study design:

Institution based cross-sectional study design which compares the nutritional status of children with malaria (cases) and children without malaria (controls) was used.

4.4 source population:

The source population for this study were all preschool children in Bahir Dar special zone.

4.5 study population

All children who sought health care in health centers in Bahir Dar special zone during the study period.

4.6 Sample size:

Sample size was calculated based on sample size calculation for comparative cross sectional study design using EpiInfo Statcalc taking 95% confidence interval, power of 80%, odds ratio of 2.2 and ratio of with malaria and without malaria of 1:3. Which assumes the following formula;

$$n_1 = \frac{\left[Z_{\frac{\alpha}{2}} \sqrt{\left(1+\frac{1}{r}\right) P(1-P)} + Z_{\beta} \sqrt{P_1(1-P_1) + \frac{P_2(1-P_2)}{r}} \right]^2}{(P_1 - P_2)^2}$$

Where;

Where P= (P1+r P2)/1+r

n1 = required minimum sample size for group 1

P1 = Prevalence of (wasting, underweight or underweight among malarious children

P2= Prevalence of underweight among general population

Z α/2 = 1.96 at 95% level of confidence, Zβ = 0.84 for 80% power of the test r = 3, Proportion of cases to controls (children with malaria and without malaria) is taken as equal 1:3

The prevalence of underweight, stunting and wasting was taken from EDHS 2011 for Amhara region and computed the sample size as shown in table 1 below.

Table 1: *Estimated sample size based on the specific objectives*

Specific Objective	Factors	Percentage	CI	Power	OR	Sample size	Adding 5% NRR (the final sample size)
1	Stunting	52%	95%	80%	2.2	303	318 (80 cases and 238 controls)
2	Underweight	33.4%	95%	80%	2.2	322	338 (85 cases and 253 controls)
3	Wasting	9.9%	95%	80%	2.2	591	**621 (155 cases and 466 controls)**

Since 621 accommodate the required sample size for all specific objectives, **155 those with malaria and 466 without malaria** was the final sample size.

4.7 Sampling procedures:

Of 10 health centers (3 rural and 7 urban) 2 rural and 4 urban health center was selected proportionally based on the distribution of urban to rural population. Accordingly ***Tis Abay, Meshenti, Shinbit, Abaymado, Bahir Dar,*** and ***Han*** Health centers were selected purposively based on flow of clients. The sample size was allocated for 6 health centers proportionally based on their average monthly patient flow in under-five OPD. The estimate was taken from monthly reports of March, April and May in the previous year. The average monthly report of three months was taken. All children who had laboratory confirmed malaria was included in the sample until the required sample size for the respective health centers fulfilled. When one confirmed malaria case was found three controls were interviewed based on their order of visiting that health center where they fulfilled the inclusion criteria of the study. The sampling procedure showed in figure 3 below.

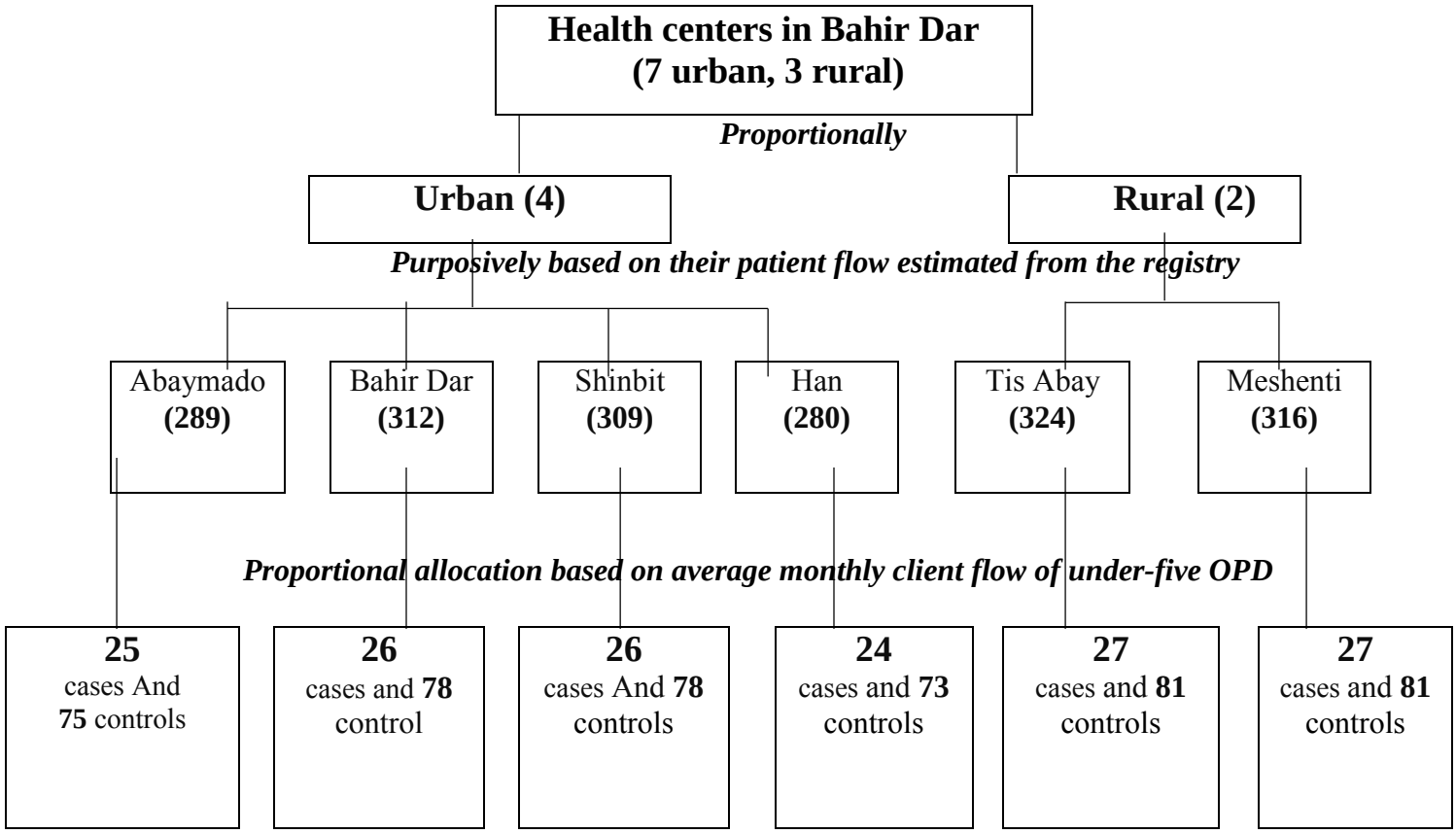

Figure 3*: sampling procedure of the study*

4.8 Inclusion and exclusion criteria:

4.8.1 Inclusion

All laboratory confirmed malaria cases were included as cases and children with minor upper respiratory tract infection, ear infection, eye infection, minor injury, minor dermal cases were included as controls.

4.8.2 Exclusion criteria:

Children with acute lower respiratory tract infection, diarrhea, and measles, severely ill and chronically ill (such as TB, HIV and AIDS etc.) were excluded from the study. Suspected malaria cases were also excluded from the study.

4.9 Data collection procedures:

Personnel:

A total of 12 data collectors (two clinical nurses from each health centers) and two supervisors (public health officers) were recruited and trained for two days by the principal investigator. The content of the training was; about the questionnaire, the method, the objective of the study, how to select study participants (confirmed cases and controls), how to take anthropometric measurements and do clinical evaluation of the children theoretically as well as practically.

Data collection instruments:

A structured questionnaire was used for face to face interview of Mothers/caretakers with preschool children in the local Language (Amharic). The questionnaire was adapted from EDHS, MIS Ethiopia and other relevant literatures. The questionnaire have 3 components namely; Socio-demographic characteristics of the respondents, Malaria general knowledge, its prevention and treatment and Anthropometric and nutritional information of the child.

Socio demographic and household characteristics:

Indicators of socioeconomic status (SES) and educational status of the caretaker and head of household, marital status of the caretaker, house condition of the parents, size of the household, distance of health care center, presence or absence of parents were some of the characteristics assessed in this part.

Anthropometric measurements was recorded with the help of trained clinical nurses in the under-five OPD of selected health centers. Recumbent length measurements was taken for children under 2 years of age, while standing height was measured for children above 2 years using height/length board. Measurements was precise to the nearest 100mm. Weight measurements was taken using electronic weighing scale, precise to the nearest 10g. The nutritional status of children was determined using the International Reference Population defined by the WHO.

Mid upper arm circumference (MUAC) was measured using standard MUAC tape at the midpoint of the child's left upper arm by locating the tip of the child's shoulder with finger tips.

Oedema was checked by grasping both feet with thumbs on the top of the feet. Pressing thumbs gently for 3 sec or count 101, 102, 103 if there was no stop watch. If pit (dent) remains in both feet when lifting the hand the child considered as having oedema. If oedema is on one side of the feet it was not considered as oedema of malnutrition.

The ages of the children was transcribed from verbal report from the caregiver or the respondent. The year and month of birth was determined for all children. For those children with an unknown day of birth, the 15th day of the month was used.

Clinical Data: The clinical condition of the child was assessed by trained under-five OPD staffs of the selected health centers. History of illnesses in the preceding 2 weeks was recorded. In addition whether the presence or absence of chronic diseases in the children were assessed. They were also asked if their child received treatment for any of these illnesses, and if so, from where. Axillary Temperature was measured using Digital thermometer two times and the average of them was taken.

Laboratory procedures:

For confirmation of malaria parasite, thick and thin films were prepared in the field and stained with Giemsa in the respective health centers. Each slide was read by laboratory technicians of health center. Absence of malaria parasite in 200 high power ocular fields of the thick film was considered as negative.

4.10 Data quality control

To control the data quality all data collectors were trained for two days by the principal investigator. Supervisors also monitored data collection process daily and the principal investigator visited frequently. The questionnaire was first prepared in English language and translated to Amharic and again re-translated in to English by another person to check for consistency. 10% of the questionnaire was pretested at Tana health center (health center which was not included in the sample) then reliability and validity was checked using appropriate statistical package. Internal consistency was checked using SPSS version 21 until the acceptable level was reached. Completeness and consistency of the collected data were checked during data collection by the supervisors and the principal investigator. Anthropometric equipment were calibrated frequently for every five measurements to control fallacy. Both intra-observer and inter-observer variation were checked using SPSS version21 during training of anthropometric measurement and the training was continued until acceptable level of variation was reached.

4.11 Operational definitions:

Fever: a child with axillary temperature of above 37.5 ^{0}centigrade.

Confirmed malaria: positive laboratory result using microscopy

Stunting was defined as HAZ< minus two Z-score based on WHO reference group.

Severe stunting was defined as HAZ< minus three Z-score

Moderate stunting was defined as minus three <= HAZ < minus two

Under-weight was defined as WAZ < minus two Z-score, based on WHO reference group.

Severe underweight was defined as WAZ < minus three Z-score.

Moderate underweight was defined as minus three <= WAZ < minus two

Wasting was defined as WHZ < minus two Z-score based on WHO reference group.

Severe wasting: was defined as WHZ < minus three Z-score while Z-score.

Moderate wasting was defined as minus three <= WHZ < minus two

ITN utilization by children: Sleeping under ITN a night before the interview.

4.12 Data Analysis procedures:

Data collected in the health centers were checked for completeness, coded, and entered using EpiInfo version 3.5.4 then exported to SPSS version 21 for cleaning and analysis. For the analysis of nutritional indices the data were exported to WHO Anthro statistical package. Nutritional indices HAZ, WAZ, WHZ and MUACZ were calculated based on International Reference Population defined by the WHO. Children were classified as stunted, wasted, and under-weight when the HAZ, WHZ, and WAZ were below minus two Z-score. Severe stunting, underweight and wasting were considered when HAZ, WAZ and WHZ were below minus three Z - score respectively. Under-nutrition was defined as the presence of either of the three indices below minus two Z-score.

Overall descriptive statistics was reported based on frequency and appropriate measure of central tendency and dispersion. Bivariate analysis was done to see the association between socio-demographic variables and under-nutrition with malaria and to identify variables for consideration in multivariate models. Those variables with P value <=0.2 and some important variables were considered in multivariate analysis. Finally multivariate analysis was performed using multiple logistic regression to control the effect of confounding variables and to identify nutritional and other predictors for malaria status of preschool children. Multicollinearity was checked for anthropometric variables WHZ, WAZ and HAZ with the help of SPSS version 21.0 using Variance Inflation Factor (VIF). Therefore, three different multivariate models were applied for stunting, underweight and wasting independently to identify possible confounding variables. Finally, predictors with a P-value <0.05 was considered statistically significant and OR with confidence interval used to describe association.

4.13 Variables

4.13.1 Main Dependent variable

- Malaria status

4.13.2 Main Independent variable

- height for age
- weight for age
- weight for height
- MUAC
- oedema

4.13.3 Other Independent variable

- family size
- maternal education
- income
- LLIN use
- Indoor residual spray
- gender
- age
- drinking water source for the child
- place of residence
- preceding illness in the past 2 weeks

4.14 Dissemination of results

Results will be disseminated to all Addis Ababa university community through presentation and possibly it will be presented in the EPHA annual conference, 14th world conference of public health. In addition it will be presented to Amhara regional health bureau and Bahir Dar health office through presentation and hard copy. An attempt will be made to publish the information in reputable journal.

4.15 Ethical consideration:

The study get ethical clearance from the school of public health, ethics committee. Permission of Amhara regional research center and Zonal Health office and the head of the health center were guaranteed. The purpose of the study was explained to the care givers of study participants and oral consent was taken from mothers/caretakers of children. Treatment was provided for children with confirmed malaria according to the national guideline in respective health centers while under-nourished children were referred to nutritional rehabilitation center in respective study area.

5. RESULT

Of the total study subject 621 (155 cases and 466 children controls), 607 caretakers of the child were interviewed (with response rate of 96.2% for cases and 98.3% for controls)

5.1 socio demographic Characteristics of respondent

The socio demographic characteristics of respondents are shown in Table 2. The mean age of the mothers/care takers were 31.6 years for cases and 30.6 years for controls. Almost all of the respondents were female in both cases (96.8%) and controls (97.2%) and were dominantly mothers of study children in both cases (95.3%) and controls (96.9%). More than half of the respondents in cases (58.4%) and Majority of mothers/caretakers in controls (85.6%) were urban in residence. Majority of the respondents in both cases (86.6%) and controls (90.4%) were married. Only 1 (0.7%) of respondents of cases and 4 (0.9%) respondents of controls were single. Almost half (49.0%) of respondent of cases and more than one third (37.1%) of controls cannot read and write. Twenty five (16.8%) of respondents of cases and 56 (12.2%) of controls achieved primary education (grade 1-8). Below a quarter (13.4%) of respondents of cases and almost quarter (23.4%) respondents of controls achieved secondary education (grade 9-12) while 12 (8.0%) of cases and 72 (15.7%) of controls were above grade 12. Almost half (48.3%) of cases and controls (48.7%) were housewives. While 43(28.9%) of cases and 161 (35.2%) of controls, 18 (12.1%) of cases and 23 (5.0%) of controls, 8(5.4%) of cases and 45 (9.8%) of controls, 7 (4.7%) of cases and 6 (1.3%) of controls were farmer, daily laborer, employer and merchant, respectively. Majority (87.2%) of cases and most of (93.7%) controls children have both parents alive. While 19 (12.8%) of children in cases and 29 (6.3%) of controls one of the parents were not alive.

Table 2: *Socio-demographic characteristics of mothers/caretakers by study group at Bahir Dar special zone, 2014*

Socio-demographic characteristic	**Cases N (%)**	**Controls N (%)**
Sex		
Male	20(13.4%)	74(16.2%)
Female	129(86.6%)	384(83.8%)
Age		
10-19	3 (2.0%)	39 (8.5%)
20-29	43 (28.9%)	200 (43.7%)
30-39	75 (50.3%)	163 (35.6%)
40- 49	25 (16.8%)	52 (11.4%)
≥ 50	3 (2.0%)	4 (0.9%)
Residence		
Urban	87 (58.4%)	392 (85.6%)
Rural	62 (41.6%)	66 (14.4%)
Marital status		
Married	129 (86.6%)	414 (90.4%)
Single	1 (0.7%)	4 (0.9%)
Divorced	11 (7.4%)	28 (6.1%)
Widowed	1 (0.7%)	12 (2.6%)
Separated	7 (4.7)	0 (0.0)
Educational status		
No read and write	73 (49.0%)	170 (37.1%)
Read and write	19 (12.8%)	53 (11.6%)
Primary (grade 1-8)	25 (16.8%)	56 (12.2%)
Secondary (grade 9-12)	20 (13.4%)	107 (23.4%)
12 and above	12 (8.0%)	72 (15.7%)
Occupation		
Housewife	72 (48.3%)	223 (48.7%)
Farmer	43 (28.9%)	161 (35.2%)
Daily laborer	18 (12.1%)	23 (5.0%)
Employer	8 (5.4%)	45 (9.8%)
Merchant	7 (4.7%)	6 (1.3%)
Other	1 (0.7%)	0 (0%)
Parent of the child		
alive	130 (87.2%)	429 (93.7%)
died	19 (12.8%)	29 (6.3%)
Total	**149 (100.0%)**	**458 (100.0%)**

5.2 House hold condition of the children

The household condition of the study participants summarized in Table 3. The average No. of household members were 4.7 and 5.4 for cases and controls respectively. The total number of under-five children in the study household was 1 in almost two-third (64.4%) of household of cases and more than two-fifth (42.6%) of household of controls. While one-third (33.6%) of household of cases and almost half (45.6%) households of controls had 2 living under-five children. Only 3 (2%) of household of cases and 54 (11.8%) of controls have three or more living under five children.

More than three-fourth (77.2%) of houses of cases and more than two-third (71.4%) of controls is made of Corrugated iron roof. While one-fifth (20.1%) of cases and more than quarter (28.2%) of controls were made of Thatch. Similarly most (89.3%) of cases and 90.2% of controls had houses made of mud and wood wall.

A quarter (26.2%) of households in cases and 79 (17.2%) of controls earns average monthly income of less than 500ETB. Almost quarter (24.2%) of cases and almost two-fifth (39.5%) of controls earns above 500 and below 1000ETB per month. More than one-third (35.6%) of cases and 133 (29.0%) of controls earns approximately above 1000ETB and below 2000ETB per month. While 21 (14.1%) of cases and 65 (14.2%) of controls earns 2000ETB and above per month.

More than half (51.7%) of respondents in cases and most (93.4%) of controls were less than 30 minute walk far from the health care center. While only 10 (6.7%) of cases and 7 (1.5%) of controls were more than 3 hour walk far from the health care center.

Table 3*: household characteristics of mothers/caretakers by study group Bahir Dar special zone, 2014*

House hold condition	**Cases N (%)**	**Controls N (%)**
Total number of household members		
<=2	5 (3.4%)	19 (4.1%)
3 – 4	75 (50.3%)	158 (34.5%)
>=5	69 (46.3)	281 (61.4%)
Mean (SD)	**4.7 (1.80)**	**5.4 (2.15)**
Total number of under-five		
1	96 (64.4%)	195(42.6%)
2	50 (33.6%)	209 (45.6%)
3	3 (2.0%)	54 (11.8%)
Mean	**1.69 (0.67)**	**1.38 (0.53)**
Roof of the house		
Thatched	30 (20.1%)	129 (28.2%)
Corrugated iron	115 (77.2%)	327 (71.4%)
Other	4 (2.7%)	2 (0.4%)
Wall of the house		
Concrete	9 (6.0%)	28 (6.2%)
Mud and wood	133 (89.3%)	404 (90.2%)
Other	7 (4.7%)	16 (3.6%)
Monthly family income(ETH)		
<500	39 (26.2%)	79 (17.2%)
500-999	36 (24.2%)	181 (39.5%)
1000-1999	53 (35.6%)	133 (29.0%)
>=2000	21 (14.1%)	65 (14.2%)
Mean (SD)	**1106.3 (820.1)**	**1026.9 (778.5)**
Distance from the health care		
<=30 minutes' walk	77 (51.7%)	428 (93.4%)
30min to 1hr	19 (12.8%)	5 (1.1%)
1hr to 2hr	34 (22.8%)	11 (2.4%)
2hr to 3hr	9 (6.0%)	4 (0.9%)
>=3hr	10 (6.7%)	7 (1.5%)
Don't know	0 (0.0%)	3 (0.7%)
Total	**149 (100%)**	**448 (100%)**

5.3 Mothers/caretakers information on Malaria general knowledge, its prevention and treatment

Almost all (99.3%) of the respondents of cases and controls (98.3%) considered malaria as a major public health problem of their community.

Awareness on symptoms of malaria:

As shown in table 4; majority (86.6%) of mothers/caretakers in cases and more than three-fourth (78.6%) of controls report fever as symptom of malaria while more than two-third (68.5%) of cases and three-fourth (74.7%) of controls considers feeling cold as one symptom of malaria. Chills, headache, sweating, nausea, vomiting, tiredness, bodyache and thirsty were also reported by considerable percentage of respondents as symptoms of malaria in both cases and controls.

Table 4: *Symptoms of malaria reported by mothers/caretakers, by study group at Bahir Dar special zone, 2014*

Reported as symptoms of malaria	Cases N (%)	Controls N (%)
Fever	129 (86.6%)	360 (78.6%)
Feeling cold	102 (68.5%)	342 (74.7%)
Chills	105 (70.5%)	385 (84.1%)
Headache	93 (62.4%)	325 (71.0%)
Sweating	80 (53.7%)	220 (48.0%)
Nausea	86 (57.7%)	184 (40.2%)
Vomiting	70 (47.0%)	198 (43.2%)
Tiredness	50 (33.6%)	194 (42.4%)
body ache	40 (26.8%)	179 (39.1%)
Thirsty	28 (18.8%)	142 (31.0%)
Diarrhea	18 (12.1%)	79 (17.2%)

Awareness on the causes of malaria and perception on seriousness

About 9 in every ten of respondents of both cases (92.6%) and controls (88.9%) reported mosquito bite as a cause of malaria. Significant number of respondents reported that exposure to cold, hunger, eating sugarcane and maize stalk, exposure of dirty swampy water and drinking dirty water as a cause of malaria. Summary of awareness on cause of malaria is shown in table 5 below.

Table 5: *Causes of malaria reported by mothers/caretakers, by study group at Bahir Dar special zone, 2014*

Reported as a cause of malaria	**Cases N (%)**	**Controls N (%)**
Mosquito bite	138(92.6%)	407(88.9%)
Eating sugarcane stalk	19(12.8%)	75(16.4%)
Eating maize stalk	15(10.1%)	52(11.4%)
Hunger	28(18.8%)	70(15.3%)
Changing weather	6(4.0%)	24(5.2%)
Witchcraft	0(0.0%)	4 (0.9%)
Exposure to dirty swampy area	42(28.2%)	38(8.3%)
Drinking dirty water	14(9.4%)	40(8.7%)

Regarding perception on group of population in which malaria is more serious most of respondents (85.2%) of cases and almost all (95.2%) of controls believed that malaria is more serious problem in under-five children than other age group of population. More than two-third (69.8%) of mothers/caretakers in cases and more than four-fifth (82.8%) of controls believed that malaria is more serious in pregnant women. Perception on which group of the population malaria is more serious is summarized in table 6 below.

Table 6: *Group of population reported as malaria is serious by mothers/caretakers by study group at Bahir Dar 2014.*

Group of population in which reported as malaria is more serious	**Cases N (%)**	**Controls N (%)**
Under-five children	127 (85.2%)	436 (95.2%)
Pregnant women	104 (69.8%)	379 (82.8%)
Above five children	15 (10.1%)	9 (2.0%)
Adults	15 (10.1%)	11 (2.4%)
Elderly	11 (7.4%)	83 (18.1%)

Awareness on the prevention and treatment of malaria

Almost all of respondents (98.7%) of both cases and controls (99.1%) believed that malaria is both preventable and treatable. Majority (82.6%) of respondents of cases and majority (84.5%) of controls reported that sleeping under LLIN prevents from malaria. Two - third (67.8%) of respondents of cases and more than two-third (71.8%) of controls believed that IRS spraying protects from malaria. Almost two-third (65.1%) of cases and more than half (58.3%) of controls believed that Drainage of mosquito breeding site as malaria prevention method. Prevention methods reported by mothers/caretakers is summarized in table 7 below.

Table 7: *Malaria prevention methods reported by mothers/caretakers, by study group Bahir Dar special zone, 2014*

Reported as a method of prevention for malaria	**Cases (N)**	**Controls (N)**
Sleeping under LLIN	123 (82.6%)	387 (86.4%)
To spray on the wall of the house	101 (67.8%)	329 (71.8%)
Smoking	40 (26.8%)	49 (10.7%)
Drainage of mosquito breeding site	97 (65.1%)	267 (58.3%)
Window screening	32 (21.5%)	61 (13.3%)
Eat garlic	11 (7.4%)	37 (8.1%)
Drink alcohol	1 (0.007%)	3 (0.02%)

5.4 LLIN access and utilization

More than two-third (71.1%) of households of cases and majority (81.7%) of controls reported that there was at least one LLIN in their home of which almost half (47.2%) of households in cases and 43.8% of group two owns 2 and above LLINs.

Regarding utilization of LLIN quarter (24.8%) of children in cases and near to two-third (60.3%) of children in controls sleep all nights under LLIN. More than a quarter (28.9%) of children in cases and two third (66.2%) of children in controls sleep a day before interview under LLIN.

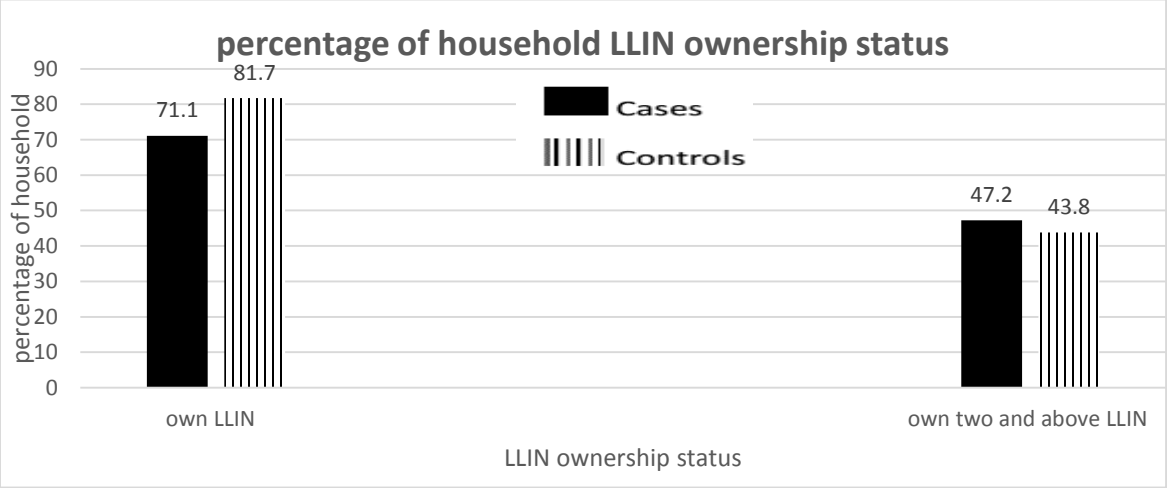

Figure 4: *Percentage of LLIN ownership Status by households at Bahir Dar special zone, 2014*

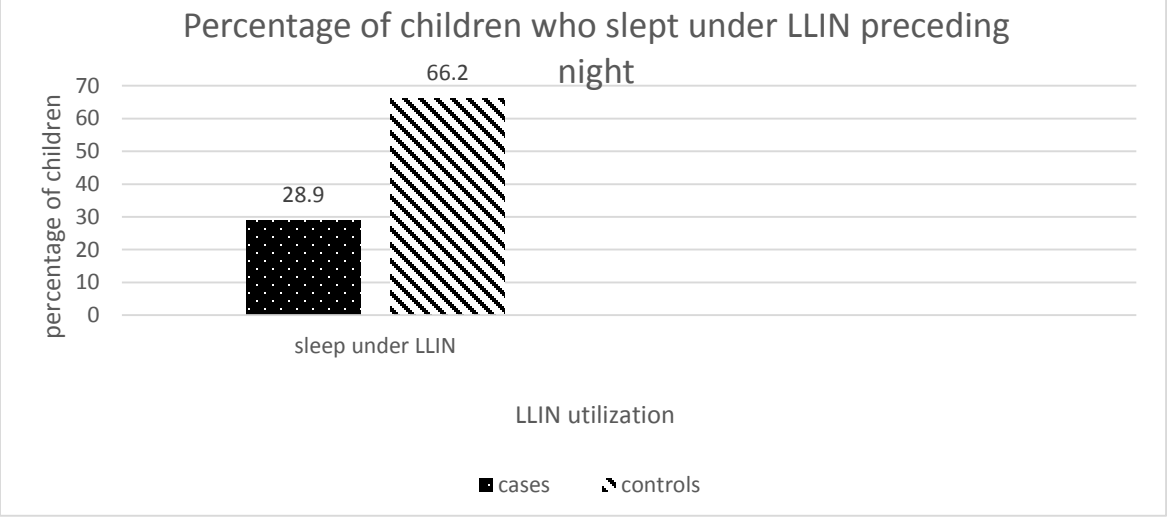

Figure 5*: LLIN utilization rate by children at Bahir Dar special zone, 2014*

5.5 Measures of Children's Nutritional Status and socio-demographic characteristics

Clinical characteristics and nutritional status of the study children presented in table 8 below. As shown, from a total 607 under five children included in the study, more than half (58.4%) of cases and half (51.5%) of controls were males. The mean ages of children were 27.5 (SD of 12.9) and 32.2 (SD of 16.3) months for cases and controls respectively.

Stunting

Over all more than two -fifth (42.7%) of children were stunted of which 87(14.3%) were severely stunted. Half (50.3%) of under-five children in cases and two-fifth (40.2%) of controls were stunted of which 24 (16.1%) of cases and 63 (13.8%) of controls were severely stunted.

Underweight

Overall about quarter (25.2%) of under-five children were underweight and 45 (7.4%) were severely underweight. The percentage of underweight were 34.2% in cases and 22.3% in controls. Of which 14 (9.4%) of cases and 31 (6.8%) of controls were severely underweight.

Wasting

Overall 44 (7.2%) of under-five children were wasted and 17 (2.8%) were severely wasted. Percentage of wasted children were 12.1% in cases and 5.7% in controls. Of which 7 (4.7%) of cases and 10 (2.2%) of controls were severely wasted based on WHZ. In addition MUAC < minus two Z-score, another indicator for acute malnutrition, was in 20 (13.4%) in cases in 29 (6.3%) controls.

Fever

The mean and SD temperature (in degree Celsius) of cases and controls were 37.8 ($\pm$0.8) and 36.4 ($\pm$0.7) respectively. Majority (83.2%) of children from cases and 26 (5.7%) from controls had axillary temperature of 37.5 and above.

Table 8: *Nutritional and clinical characteristics of preschool children by study group at Bahir Dar special zone June, 2014*

Variable	**Cases N (%)**	**Controls N (%)**
Child age (in months)		
6-24	70 (47.0%)	173 (37.8%)
24-59	79 (53.0%)	285 (62.2%)
Mean age (SD)	**27.5 (12.9)**	**32.2 (16.3)**
Sex		
Male	87 (58.4%)	236 (51.5%)
Female	62 (41.6%)	222 (48.5%)
Mean Temperature (SD)	37.8 (0.8)	36.4 (0.7)
Stunting		
Severe stunting	24 (16.1%)	63 (13.8%)
Moderate stunting	51 (34.2%)	121 (26.4%)
Normal	74 (49.7%)	274 (59.8%)
Underweight		
Severe underweight	14 (9.4%)	31 (6.8%)
Moderate underweight	37 (24.8%)	71 (15.5%)
Normal	98 (65.8%)	356 (77.7%)
Wasting		
Severe wasting	7 (4.7%)	10 (2.2%)
Moderate wasting	11 (7.4%)	16 (3.5%)
Normal	131 (87.9%)	432 (94.3%)
MUACZ		
Severe wasting	7 (4.7%)	11 (2.4%)
Moderate wasting	13 (8.7%)	18 (3.9%)
Normal	129 (86.6%)	429 (93.7%)
Total	**149 (100%)**	**458 (100%)**

5.6 Plasmodium specious in malaria cases

Figure 4 shows types of plasmodium species in Bahir Dar special zone. Malaria diagnosis and plasmodium specious differentiation was done by using Microscope in both group. P.falciparum was the major species responsible for more than two-fifth (43%) of malaria cases while P.vivax was responsible for almost two-fifth (39.6%) of malaria cases. The rest 26 (17.4%) of malaria cases were mixed infection.

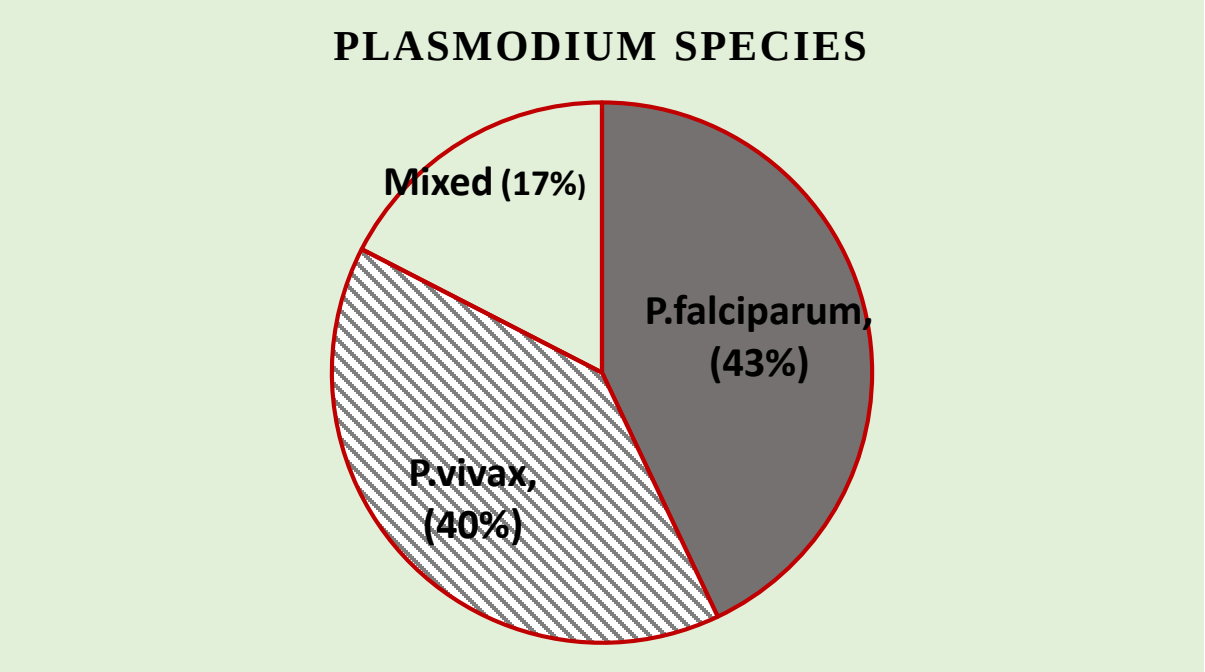

Figure 6: *Type of plasmodium specious in Bahir Dar special zone, 2014*

5.4 Nutritional and other Predictors of malaria in pre-school children

Predictors of malaria in pre-school children are presented in table 9, 10 and 11 below. Those variables with P-value < =0.2 on bivariate analysis and some important variables were entered to the multivariate Analysis. Since anthropometric variables were composite variable there was issue of multi-collinearity and that was checked using multi-collinearity diagnostic using SPSS version 21. Therefore, three different models were applied for stunting, underweight and wasting by controlling other associated variables.

As shown in table 9, multivariate logistic regression was done to identify the relationship between stunting and confirmed malaria after adjusted for socio-demographic and malaria related variables. Therefore, stunting was significantly associated with confirmed malaria which showed that stunted children were 1.6 times more likely to have confirmed malaria than non-stunted children (AOR=1.614; 95% CI= 1.192 - 2.514). But there is no significant difference between the effect severe stunting and moderate stunting on malaria status of children. Place of residence, LLIN utilization and Indoor residual spray were also significantly associated in this model after controlling of other variables.

As shown in table 10, another multivariate analysis was done to assess the association between underweight and confirmed malaria by controlling for socio-demographic and malaria related variables. It indicated that underweight children were 1.7 times more likely to have confirmed malaria than those who were not underweight (AOR = 1.690; 95%CI= 1.112 - 2.903). There is also a difference in status of malaria according to severity of underweight; those severely underweight children were 1.8 times more likely to have confirmed malaria than those who are not underweight. While there was no statistically significant difference between moderately underweight and those not underweight. Place of residence, sex of the child, LLIN utilization, and indoor residual spray were also significantly associated with malaria after controlling of other variables included in this model.

As shown in table 11, another multivariate model was applied to discuss the association between wasting and confirmed malaria including socio-demographic and malaria related variables. Wasted children were 2.4 times more likely to have confirmed malaria than those children not wasted (AOR=2.440; 95% CI= 1.146 - 5.197) when other variables being controlled.

Place of residence, sex of the child, LLIN utilization, Indoor residual spray, educational level and occupation of the mother were also significantly associated with malaria after controlling of other variables included in the model.

Regarding LLIN utilization those children who slept the night preceding the interview under LLIN were 79.6% less likely to have malaria than those children not slept under LLIN (AOR=0.20, 95% CI= 0.13 - 0.33) as summarized in table 11 below.

Similarly those children from the house that was sprayed in the last 12 months were 74.3% less likely to have confirmed malaria than those from the house not sprayed (AOR=0.26; 95% CI: 0.15 - 0.43).

Sex of the child was not significant during bivariate analysis but it became significant during multivariate analysis in model three. Males were 1.9 times more likely to have confirmed malaria than females in which other confounders remain constant (AOR=1.88; 95% CI= 1.19 - 2.98).

Children from rural area were also 2.3 times more likely to have confirmed malaria than those from urban when wasting and other factors being controlled (AOR=2.35; 95% CI: 1.39 - 3.98).

Children of merchant and daily laborer mothers were 2.8 times at higher odds of having confirmed malaria than those children from housewives (AOR=2.82; 95% CI 1.308 - 6.083).

While children of mother/caretaker who are grade 12 and above were 70% less likely to have confirmed malaria than children from illiterate mothers (AOR=0.30; 95% CI= 0.114 - 0.785).

Table 9: *Association between stunting and confirmed malaria after adjusted for other variables in pre-school children at Bahir Dar special zone, 2014*

Variable	Cases	Controls	Crude OR (95% CI)	Adjusted OR (95% CI)
Stunting				
Yes	75 (50.3%)	184 (40.2%)	1.509 (1.041, 2.188)	**1.614 (1.192, 2.514*)**
No	74 (49.7%)	274 (59.8%)	1	
Residence				
Rural	62 (41.6%)	66 (14.4%)	4.233 (2.789, 6.424)	**1.546 (1.007, 3.179*)**
Urban	87 (58.4%)	392 (85.6%)	1	**1**
Sex				
Male	87 (58.4%)	236 (51.5%)	1.320 (0.908, 1.918)	1.416 (0.931, 1.980)
Female	62 (41.6)	222 (48.5%)	1	1
Child age				
6-24	70 (47.0%)	173 (37.8%)	0.685 (0.472, 0.995)	1.128 (0.649, 1.676)
24-59	79 (53.0%)	285 (62.2%)	1	1
Sleep under LLIN last night				
Yes	43 (28.9%)	303 (66.2%)	0.208 (0.139, 0.311)	**0.314 (0.148, 0.360*)**
No	106 (71.1%)	155 (33.8%)	1	1
Indoor residual spray within last 12 month				
Yes	63 (42.3%)	338 (73.8)	0.260 (0.177, 0.383)	**0.337 (0.204, 0.530*)**
No	86 (57.7%)	120 (26.2)	1	1
School level of respondent				
Cannot read & write	73 (49.0%)	170 (37.1%)	1	1
read & write	19 (12.8%)	53 (11.6%)	0.835 (0.462,1.508)	0.811 (0. 401, 1.716)
grade 1-12	45 (30.2%)	163 (35.6%)	0.643 (0.419, 0.987)	0.778 (0. 510, 1.311)
above 12	12 (8.1%)	72 (15.7%)	0.388 (0.199, 0.758)	0.618 (0.414, 1.286)
Occupation of respondent				
House wife	72 (48.3%)	223 (48.7%)	1	1
Farmer	43 (28.9%)	161 (35.2%)	0.827 (0.539, 1.270)	0.880 (0.487, 1.884)
Merchant &other	26 (17.4%)	29 (6.3%)	2.777 (1.536, 5.021)	1.621 (0.988, 7.164)
Employer	8 (5.4%)	45 (9.8%)	0.551 (0.248, 1.222)	0.994 (0.553, 2.046)

Predictors with '*' were significantly associated factors controlled for other variables in the table. ($P < 0.05$)

Table 10: *Association between underweight and confirmed malaria after adjusted for other variables in pre-school children at Bahir Dar special zone, 2014*

Variable	Cases	Controls	Crude OR (95% CI)	Adjusted OR (95% CI)
Underweight				
Yes	51 (34.2%)	102 (22.3%)	1.816 (1.213, 2.720)	**1.690 (1.112, 2.903*)**
No	98 (65.8%)	356 (77.7%)	1	
Residence				
Rural	62 (41.6%)	66 (14.4%)	4.233 (2.789, 6.424)	**2.009 (1.108, 3.662*)**
Urban	87 (58.4%)	392 (85.6%)	1	1
Sex				
Male	87 (58.4%)	236 (51.5%)	1.320 (0.908, 1.918)	**1.681 (1.021, 2.690*)**
Female	62 (41.6)	222 (48.5%)	1	1
Child age				
6-24	70 (47.0%)	173 (37.8%)	0.685 (0.472, 0.995)	1.328 (0.980, 1.714)
24-59	79 (53.0%)	285 (62.2%)	1	1
Sleep under LLIN last night				
Yes	43 (28.9%)	303 (66.2%)	0.208 (0.139, 0.311)	**0.372 (0.168, 0.495*)**
No	106 (71.1%)	155 (33.8%)	1	1
Indoor residual spray within last 12 month				
Yes	63 (42.3%)	338 (73.8)	0.260 (0.177, 0.383)	**0.457 (0.304, 0.610*)**
No	86 (57.7%)	120 (26.2)	1	1
School level of respondent				
Cannot read & write	73 (49.0%)	170 (37.1%)	1	1
read & write	19 (12.8%)	53 (11.6%)	0.835 (0.462,1.508)	0.804 (0.601, 1.916)
grade 1-12	45 (30.2%)	163 (35.6%)	0.643 (0.419, 0.987)	0.708 (0.506, 1.260)
above 12	12 (8.1%)	72 (15.7%)	0.388 (0.199, 0.758)	0.608 (0.414, 1.085)
Occupation of respondent				
House wife	72 (48.3%)	223 (48.7%)	1	1
Farmer	43 (28.9%)	161 (35.2%)	0.827 (0.539, 1.270)	0.852 (0.420, 1.481)
Merchant &other	26 (17.4%)	29 (6.3%)	2.777 (1.536, 5.021)	1.820 (0.918, 5.460)
Employer	8 (5.4%)	45 (9.8%)	0.551 (0.248, 1.222)	0.602 (0.355, 1.737)

Predictors with '*' were significantly associated factors controlled for other variables in the table. ($P < 0.05$)

Table 11: *Association between wasting and confirmed malaria after adjusted for other variables in pre-school children at Bahir Dar special zone, 2014*

Variable	Cases	Controls	Crude OR (95% CI)	Adjusted OR (95% CI)
Wasting				
Yes	18 (12.1%)	26 (5.7%)	2.283 (1.214, 4.295)	**2.440 (1.146, 5.197*)**
No	131 (87.9%)	432 (94.3%)	1	1
Residence				
Rural	62 (41.6%)	66 (14.4%)	4.233 (2.789, 6.424)	**2.349 (1.387, 3.979*)**
Urban	87 (58.4%)	392 (85.6%)	1	1
Sex				
Male	87 (58.4%)	236 (51.5%)	1.320 (0.908, 1.918)	**1.884 (1.191, 2.980*)**
Female	62 (41.6)	222 (48.5%)	1	1
Child age				
6-24	70 (47.0%)	173 (37.8%)	0.685 (0.472, 0.995)	0.928 (0.587, 1.466)
24-59	79 (53.0%)	285 (62.2%)	1	1
Sleep under LLIN a night preceding				
Yes	43 (28.9%)	303 (66.2%)	0.208 (0.139, 0.311)	**0.204 (0.128, 0.325*)**
No	106 (71.1%)	155 (33.8%)	1	1
Indoor residual spray within last 12 month				
Yes	63 (42.3%)	338 (73.8)	0.260 (0.177, 0.383)	**0.257 (0.154, 0.430*)**
No	86 (57.7%)	120 (26.2)	1	1
School level of respondent				
Cannot read & write	73 (49.0%)	170 (37.1%)	1	1
read & write	19 (12.8%)	53 (11.6%)	0.835 (0.462,1.508)	0.974 (0. 501, 1.896)
grade 1-12	45 (30.2%)	163 (35.6%)	0.643 (0.419, 0.987)	0.687 (0. 406, 1.161)
above 12	12 (8.1%)	72 (15.7%)	0.388 (0.199, 0.758)	**0.300 (0.114, 0.785*)**
Occupation of respondent				
House wife	72 (48.3%)	223 (48.7%)	1	1
Farmer	43 (28.9%)	161 (35.2%)	0.827 (0.539, 1.270)	0.950 (0.569, 1.585)
Merchant &other	26 (17.4%)	29 (6.3%)	2.777 (1.536, 5.021)	**2.820 (1.308, 6.083*)**
Employer	8 (5.4%)	45 (9.8%)	0.551 (0.248, 1.222)	0.492 (0.152, 1.596)

Predictors with '*' were significantly associated factors controlled for other variables in the table.

($P < 0.05$)

6. DISCUSSION

This institution based cross sectional study revealed that under-nutrition is highly prevalent in the area. The overall prevalence of stunting was 42.7% in both groups which is lower than the regional percentage of stunting i.e. 52% according to EDHS 2011. However, based on WHO estimate if the prevalence of stunting is above 40% the magnitude is considered as very high which indicates in our study it is very high magnitude. It is also higher than the school based study conducted in Gondar town where stunting is reported to be 23% (47). The prevalence of underweight 25.2% was also high based on WHO cutoff point although it is below the regional percentage that is 34%. It is higher than the previous study which is conducted in Gondar that is 21% of children were underweight (47). Regarding acute malnutrition in our study 7.2% of under-five children were wasted using weight for height Z-score which is lower than the previous study in Gondar in which 11% of children were wasted but it is WHO classification of high magnitude. All nutritional indices were lower than the regional average which can be explained by majority of the study participant were from urban while regional percentage was from majority of rural population.

Regarding the association of undernutrition and other factors with malaria; stunting, underweight, Wasting, LLIN use, indoor residual spray, place of residence, sex of the child, maternal education and occupation of the mother were significantly associated with occurrence of malaria after controlling for other variables.

As presented in table 9, stunted children were 1.6 times more likely to have confirmed malaria than non-stunted children after adjusted for possible confounders. This result is consistent with a longitudinal study in Gambia, cross-sectional study conducted in Kenya; a prospective study in Uganda; in which stunted children were at higher risk of malaria parasitaemia, clinical malaria (22, 23, 26). Even though there was a difference in study setting and design the result was consistent. Again this result is supported by cellular level nested case control study conducted by Florie F. *et al* which indicated the prevalence of anti-malarial immune responders was significantly lower in stunted children than in non-stunted children after adjustment for parasite density without considering intensity of infection (OR = 0.4, P = 0.01) (19).

On the other hand, an observational follow-up study that was conducted in a cohort of 2–59-month-old children living in a rural area of Senegal indicated that no association was found in subsequent malaria attack between stunted and non-stunted children (24). But the study focused on subsequent malarial attack which can be due to development of post exposure immunity unlike our study that considers all type of malarial attack whether it is new or subsequent attack. A study conducted in Ghana also describe these, stunting was not associated with a child's status of asymptomatic malaria ($p = 0.519$) (25). The discrepancy could be due to the difference in case definition in which this study compares asymptomatic malaria which is different from confirmed malaria in our study. In addition the study done in Ghana was with small sample size and control only for age and sex unlike in our study it controls for possible confounders with higher sample size. The only study conducted in Western Ethiopia also show that stunting was not significantly associated with malaria morbidity (OR= 0.9; 95% CI= 0.7–1.2) (27). But the prevalence of malaria was low (9.4%) as compared to non-malaria that makes the analysis non-significant. The comparative nature of our study alleviate the problem of low prevalence of malaria to compare the association.

Regarding underweight, table 10 showed that underweight children were 1.7 times more likely to have confirmed malaria than normal weight children after adjusted for socio-demographic and other confounding variables. This result is in line with a prospective study conducted in Port Harcourt; Nigeria that showed underweight children were found to be at a higher risk of acquiring malaria infection than the well-nourished children ($RR = 1.02$, $P < 0.02$) (32). Similarly, World Health Organization's Comparative Risk Assessment project found that children who were moderately to severely underweight had an increased, but not statistically significant risk of a clinical malaria attack, as compared with those who were better nourished (7). The reason for non-significance could be low prevalence of clinical malaria as described by the study as a limitation.

On the other hand, a prospective study conducted in Kenya found no relationship between baseline nutritional status and subsequent incidence of malaria (15). Similarly studies conducted in West Africa, Gambia also show no significant association in clinical malaria and nutritional status considering weight for age as nutritional status measurement (34, 35). But the study setting and design were different as compared to the previous studies.

The higher odds of confirmed malaria in underweight children could be explained by a molecular study conducted by Scrimshaw *et al* who indicated that Children who are underweight are thought to have increased susceptibility to malaria for a variety of reasons, most notably through a reduction in the function of the immune system. When a child is undernourished, he/she would be unable to mount an appropriate immune response to the malaria parasite due to reduction in T lymphocytes, impairment of antibody formation, decreased complement formation, and atrophy of thymus and other lymphoid tissues, etc. (28). Similar explanation was given in studies with large sample size comprising of 4000 children done in northern Guinea (48). In contrary, study done in Uganda revealed that no significant difference in the incidence of malaria with underweight and normal children (49). The difference in character of malaria transmission i.e. the transmission in Tororo Uganda is holo-endemic and occurring perennially, unlike the seasonal type of malaria transmission in Ethiopia specifically in our study area could be the possible reason for the difference.

According to table 11, the odds of having confirmed malaria among wasted children was 2.4 times higher than non-wasted children. This is coherent with a study conducted in Vanuatu where there is both Plasmodium falciparum and P. vivax, followed a much larger group of children (n=1,511) than the previous study and found that P. Vivax malaria during the six-month period before assessment was strongly associated with acute malnutrition (36). Similarly a study conducted in LAO PDR found that wasted children have higher odds of malaria specifically to P.falciparum (37). On the other hand, An observational follow-up study conducted by Fillol *et al* in a cohort of 2–59-month-old children living in a rural area of Senegal where malaria transmission was highly seasonal indicated that wasted children were at lower risk of experiencing at least one subsequent clinical malaria attack (OR= 0.33; 95%CI= 0.13–0.81) (24). But the study had lower prevalence of wasting (3.1%) which is difficult for comparison as mentioned as a limitation of the study and focus on subsequent clinical malaria attack acquired immunity could be developed.

The higher odds of malaria among wasted children is supported by an immunologic study in Papua New Guinea reported that in children with wasting humoral responses to malarial antigens have been found to be low, suggesting that wasting is a risk factor for malaria (16). Similarly a study conducted by Ehrhardt *et al* also showed that Protein energy malnutrition predispose children to malaria infection through reduction of malaria specific antibodies (IgG) (37).

While a previous study conducted in Western Ethiopia show that there was no statistically significant association between malaria and sex of the children with wasting (27).

The reason for wasted children to be at higher risk for clinical malaria can be explained by a lower anti-malarial immunoglobulin among wasted children such as a study conducted by Florie *etal* indicate that prevalence of anti-malarial immune responders was significantly lower in wasted children than in controls (P = 0.001) (19).

More than two-third (71.1%) of the house hold in cases and majority (81.7%) of controls own at least one LLIN while 38.1% of households in cases and 34.6% of households in controls have more than one net which is higher than the regional LLIN coverage according to Ethiopian Malaria Indicator Survey of 2011 i.e. 73.7% and 23.9% respectively (8). But the study population is different which is in case of MIS 85% of the population surveyed were from rural residents while in our study 78.9% of the study population was from urban. Both in our study and MIS 2011 LLIN coverage is higher in urban than rural. Average number of nets per person was 2.3 for cases and 2.6 for controls which is below the required standard. National policy aims to provide one LLIN for every sleeping space (approximately one net per 1.8 persons in malaria-endemic areas<2,000m). Even though our study area was below the altitude <2000m the net per person ratio is below the required standard which indicates lower coverage of LLIN.

In this study, percentage of children under age 5 years who slept under LLIN a night preceding the interview was 28.9% for cases and 66.2% for group two on average 57% which is a little bit higher than the regional estimate of 51.2% according to Ethiopian MIS 2011 (8). This result is higher than a study conducted by Zewdei A. and Mola G. in Amhara regional state which reported 26% (50). While a study conducted by Abebe *et al* showed that the mean utilization rate of nets based on history of sleeping under nets in the previous night was 81.6%. The difference noted could be due to the type of study subjects assessed; in this study under-five children were enrolled whereas the previous study both adults and children were enrolled (51).

Use of LLIN for children during sleeping was strongly associated with clinical malaria. As shown in table 11 those children who slept under LLIN were 79.6% less likely to have confirmed malaria as compared to those who didn't sleep under LLIN. It is concordant with a Community based comparative interventional study conducted in Nigeria which showed 93% decrease in malaria prevalence for those who slept under LLIN than those who did not (52). Another study conducted in Cameroon also showed that utilization of LLIN is significantly associated with prevalence and incidence of malaria (53).

Those children from the house that sprayed with IRS in the last 12 months were 74.3% less likely to have confirmed malaria than their counterparts when other confounders controlled. This result is in line with the study conducted in south central Ethiopia which showed that the use of LLIN and/or insecticide spraying had reduced the indoor resting mosquito vectors which ultimately decreased the transmission of malaria (54). Similarly a study conducted in East Shoa zone, Ethiopia indicated that the incidence of malaria among the sprayed villages was significantly lower than those not sprayed for both Plasmodium species (55).

Males have 1.9 times more likely to have confirmed malaria than females and the difference was statistically significant as shown in table 11 (AOR: 1.884; 95%CI: 1.191, 2.980). This result is in line with a study conducted by Fillol *et al* showed that the geometric mean of parasitemia to be 300 parasites/μL and varied by sex in which girls had a significantly lower mean than boys (P= 0.008) (24).

Place of residence was also one of the factors that affect the malaria status of children. In this study those children form rural were 2.3 times more likely to have confirmed malaria than children from urban residence. This could be explained by the high irrigation and drainage in rural than the urban which is favorable for mosquito breeding and malaria transmission.

Strength of the study

- ✓ The comparative nature of the study was helpful to compare groups with appropriate sample size for both groups
- ✓ Using of laboratory confirmation for malaria diagnosis decreased the subjectivity of diagnosis that decreases health workers bias
- ✓ The anthropometric measurements decrease information bias for the primary independent variable i.e. nutritional status of the child

Limitation of the study

- ✓ Even though there is a relationship between macro-nutrient and micro-nutrient deficiency, this study didn't assess level of micronutrients which might have impact on malaria morbidity.
- ✓ This study didn't assess the status of anaemia, the level of parasitaemia and clinical manifestation of under-nutrition which could have association with malaria.
- ✓ The study didn't clearly identify the temporal relationship of malaria with acute undernutrition.

7. CONCLUSION

- ✓ This study revealed that there is high prevalence of malnutrition among under-five children in Bahir Dar special zone.
- ✓ Almost all of the mothers/caretakers of the children consider malaria as the major problem of their community.
- ✓ Most of the mothers/caretakers of the children know more than three method of prevention of malaria.
- ✓ There was low utilization of LLIN for preschool children among cases than controls.
- ✓ Weight for age and height for age were significantly associated with confirmed malaria using bivariate analysis.
- ✓ There was statistically significant association between stunting, underweight, wasting, place of residence, LLIN use, indoor residual spray, sex of the children, educational level and occupation of the mother/care taker and malaria status of children independent one another factors.

8. RECOMMENDATION

- ✓ For health centers and health office of the Zone in malaria endemic area, there should be distribution of LLIN for households and creating awareness on the importance and other preventive measures especially children with undernutrition.

- ✓ For governmental and non-governmental organization working on malaria and undernutrition, integration of malaria – undernutrition intervention should be considered.

- ✓ For researchers, further research needed on the relationship between malaria and malnutrition that include the effect of micronutrients.

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ANNEXES

Informed consent form

This study is to explore the relationship between undernutrition and malaria in children at Bahir Dar. If you are willing of your child to participate in the study we will ask some questions and examine the children. If your child have problem of undernutrition we will refer to the appropriate nutritional care center depending on the severity of the problem. Your name will not be mentioned in the questionnaire and the information you have given us will be kept in confidence. We would like to thank you in advance for participating in our study.

CODE OF THE QUETIONNAIRE_____

Name of the interviewer_____

Signature_____

Questionnaire form

Section 1: Socio-demographic characteristics of the respondents

No.	Questions	Responses	Skip to
1	Sex of the respondent:	1. Male 2. Female	
2	Age of the respondent in full years	years [_____]	
3	What is your place of residence (rural / urban)?	1. Rural 2. Urban	
4	What is your current marital status?	1. Married 2. Never married (single) 3. Divorced 4. Widowed 5. Separated	
5	Can you read and write?	1. Yes 2. No ……..	→7
6	If "**Yes**" to **Q7**, what is the highest level of school or grade you attended or completed?	1. Can only read and write 2. Elementary school (1-8) 3. secondary school (9-12) 4. above 12 5. other (specify)	
7	What is your relationship to the sick child?	1. Mother 2. Father 3. Brother 4. Sister 5. Others (specify)_____	
8.	What is your current main work/occupation? • ***Circle only one main answer***	1. Housewife 2. Farmer 3. Daily labourer 4. Government/NGO employee 5. Trader	

		6. Other (specify)_____	
9.	Are both parents of the child alive? If No, which of the parents Died?	1. Yes 2. NO (specify) _____	
10	How many people currently live in the household, including you and under-five children?	Total number of household members [____]	
11	How many children under-five currently live in the household?	Total number of under-five [____]	
12	What is the main material of the roof of house of the household?	1. Thatched 2. Corrugated iron 3. Other (Specify)_____	
13	What is the main material of the wall of house of the household?	1. Concrete 2. Mud and wood 3. Other (specify)_____	
14	What is your household average monthly income?	[____] Birr	
15	How far is this health care from your home?	1. Less than 30 minutes' walk 2. 30 minutes –1 hour walk 3. 1 hour to under 2 hours walk 4. 2 hours to under 3 hours walk 5. 3 or more hours 6. Don't know	

Section 2: Malaria general knowledge, its prevention and treatment

No.	Questions	Responses			Skip to
16	Do you consider malaria a major health problem in your community?	1. Yes 2. No			
17	What are the main symptoms of malaria? • ***Multiple responses possible and circle all responses that apply*** • ***Probe for possible answers (Anything else?)***		yes	**No**	
		Fever	1	**2**	
		Feeling cold	1	2	
		Chills or shivering	1	2	
		Sweating	1	2	
		Headache	1	2	
		Nausea	1	2	
		Vomiting	1	2	
		Loss of appetite	1	2	
		Bitterness in the mouth	1	2	
		Body weakness/tiredness	1	2	
		Body ache/joint pain	1	2	
		Thirsty	1	2	
		Diarrhea	1	2	
		Don't know	1	2	
		Other (specify)_____ __88			
18	In your opinion, what causes malaria? • ***Multiple responses possible and circle all responses that apply*** • ***Probe for possible answers (Anything else?)***	1. Mosquito bite 2. Eating immature sugarcane 3. Eating maize stalk 4. Hunger (empty stomach) 5. Exposure to cold or changing weather 6. Drinking dirty water 7. Witchcraft 8. Exposure to dirty swampy areas			

		9. Don't know 10. Other (specify) _____	
19	For which group of the population do you think malaria is more serious? • ***Multiple responses possible and circle all responses that apply*** • ***Probe for possible answers (Anything else?)***	1. Adults 2. Children under five years of age 3. Children over five years of age 4. Pregnant women 5. Elderly 6. Equally serious for all 7. Don't know 98	
20	Is malaria treatable disease?	1. Yes 2. No	
21	Is malaria preventable disease?	1. Yes 2. No _____	**23**
22	How can someone protect themselves against malaria? • ***Multiple responses possible and circle all responses that apply*** • ***Probe for possible answers (Anything else?)***	1. To sleep under mosquito net/LLINs 2. To spray house with insecticide (IRS) 3. Smoking (burn leaves/cow dung) nearby the house 4. Drain mosquito breeding sites around the house 5. Window screening 6. Eat garlic 7. Drink alcohol 8. Other (specify)_____ 9. Don't know	
23	Does your household currently have any LLIN that can be used while sleeping?	1. Yes 2. No ……..	→28
24	How many LLIN do you currently have [both used and unused]?	[_____]	

25	How many of the LLIN the household has are **currently used** by household members while sleeping?	[_____]	
26	How frequently did the Sick CHILD sleep under mosquito net/LLINs within the last 15 days?	1. All nights 2. Almost all nights 3. Sometimes 4. Only few nights 5. None of the nights	
27	Did the Sick CHILD sleep under mosquito net/LLINs last Night?	1. Yes 2. No	
28	Did the child experiences fever in the last 48 hours?	1. Yes 2. No	
29	When was the last time the child experienced fever?(other than current fever, if any)	[_____]	
30	Did the child get malaria illness in the past 12 month?	1. Yes 2. No …….	→ 33
31	How many times the child suffered from malaria in the past 12 month?	[_____]	
32	Did the child get any anti malaria treatment in the past 12 months?	1. Yes 2. No	
33	At any time in the past 12 months, has anyone sprayed the interior walls of your dwelling against mosquitoes?	1. Yes 2. No …… 3. Don't know	→section 3
34	How many months ago was the house sprayed against mosquitoes? IF LESS THAN ONE MONTH, RECORD 00 MONTHS AGO.	[_____]MONTHS AGO	

Section 3: Anthropometric and breast feeding information of the child

No	Question	Response categories	skip
35	What is the age of the child?	Birth date___ ___ ____ (DD/MM/yyyy) OR Age: __Years ___ months and ____days	
36	What is the sex of the child?	1. Male 2. Female	
37	What is the source of the water your child drinks?	1. Packed water 2. Pipe water 3. Well 4. Spring 5. Other (specify)_____	
38	Weight	_____ kg	
39	Height/length (in cm)	_____cm	
40	MUAC	_____cm	
41	Presence of pitting Oedema	1. Yes 2. No	
42	Axillary Temperature	_____degree Celsius	
43	Blood film for plasmodium	1. Positive 2. Negative	
44	Type of species	1. P. falciparum 2. P. vivax 3. Mixed	

Amharic Version Questionnaire

የፈቃደኝነት ማረጋገጫ ፎርም

የዚህ ጥናት ዋና አላማ በወባ እና ያልተመጣጠነ አመጋገብ መካከል በህፃናት ላይ ያላቸውን ተዛማጅነት ለማብራራት ነው፡፡ በዚህ ጥናት ልጅዎት እንድትሳተፍ ፈቃደኛ ከሆኑ የተወሰኑ ጥያቄዎችን እጠይቀዎታለሁ፡፡ በተጨማሪም ለልጅዎት ትንሽ ምርመራ እናደርጋለን፡፡ ልጅዎት የምግብ እጥረት ችግር ካለበት ወደ አስፈላጊው የአመጋገብ እርዳታ መስጫ ማእከል እንልካለን፡፡ ስምና ሌሎች መረጃዎች መጠይቁ ላይ አይጠቀሱም፡፡ ልጅዎት እንድትሳተፍ ፈቃደኛ ስለሆኑ በቅድሚያ እናመሰግናለን፡፡

የመጠይቁ የመለያ ኮድ፡ _____

የጠያቂው ስም፡_____

ፊርማ፡_____

ቀን፡_____

የመጠይቅ ቅፅ

ክፍል አንድ - ማህበራዊና ኢኮኖሚያዊ መረጃዎች

ተ.ቁ	ጥያቄ	መልስ	ማለፍ ወደ
1	የመላሹ ፆታ	1. ወንድ 2. ሴት	
2	የመላሹ እድሜ በአመት	አመት [_____]	
3	የመኖሪያ ቦታ	1. ከተማ 2. ገጠር	
4	የትዳር ሁኔታ	1. ያገባ/ች 2. ያላገባ/ች 3. የፈታ/ች 4. የሞተችበት/የሞተባት 5. የተለያዩ	
5	ማንበብና መጻፍ ትችላለህ/ትችያለሽ?	1. አዎ 2. አይደለም	 →7
6	ለ ጥያቄ 7 መልሱ አዎ ከሆነ፣ የተማርከው/ሽው ወይም ያጠናቀከው/ሽው ከፍተኛ የትምህርት ደረጃ	1. ማንበብና መፃፍ 2. ከ 1-8 ክፍል 3. ከ 9-12 ክፍል 4. ከ 12 በላይ 5. (ሌላ ካለ ይገለጽ)_____	
7	ታመመው/ች ልጅ ጋር ያላችሁ ዝምድና ምንድ ው?	1. እናት 2. አባት 3. ወንድም 4. እህት 5. ሌሎች _____	
8	በአሁኑ ሰዓት የአንተ (ያንቺ)ዋና ስራ ምንድን ነው? • አንድ መልስ ብቻ ይመለስ	1. የቤት እመቤት 2. ገበሬ 3. የቀን ሰራተኛ 4. የመንግስት ሰራተኛ 5. ነጋዴ 6. ሌሎች ይገለፅ _____	

9	የልጁ/ቷ ሁለቱም ወላጆች በህይወት አሉ?	1. አዎ 2. የለም	
10	በአሁኑ ሰዓት ቤታችሁ ውስጥ ስንት ሰው ይኖራል? አንተን/ቺን እና ህፃናን ጨምሮ ?	የቤተሰቡ አባላት ቁጥር_____	
11	ቤታችሁ ውስጥ ስንት ከ አምስት አመት በታች ህፃናት?	ከአምስት አመት በታች ህጻናት ቁጥር [_____]	
12	የመኖሪያ ቤታቹሁ ጣራ የተሰራበት መሳሪያ ምንድን ነው?	1. ሳር 2. ቆርቆሮ 3. ሌሎች (ይገለፅ).....	
13	የመኖሪያ ቤታቹሁ ግድግዳ የተሰራበት መሳሪያ ምንድን ነው?	1. ሲሚንቶ 2. ጭቃ እና እንጨት 3. ሌሎች (ይገለፅ).....	
14	ወርሃዊ የቤተሰብ ገቢ ስንት ነው(በብር)?	[_____]ብር	
15	ከመኖሪያ ቤታቹሁ እስከ ጤና ተቁም ምን ያክል ይርቃል?	1. ከ 30 ደቂቃ በታች 2. ከ 30 ደቂቃ እስከ ፣ ሰዐት 3. ከ ፣ ሰዐት እስከ 2 ሰዐት 4. ከ 2 ሰዐት እስከ 3 ሰዐት 5. ከ 3 ሰዐት በላይ 6. አይታወቅም	

ክፍል 2፡ ስለ ወባ መከላከልና ህክምና ያለው እውቀት መመዘኛ

ተ.ቁ	ጥያቄ	መልስ	ማለፍ ወደ
16	ወባ በ እናንተ ማህበረሰብ ዋነኛ የጤና ችግር ነው ብለህ/ብለሽ ታስባለህ/ታስቢያለሽ?	1. አዎ 2. አይደለም	
17	የወባ ዋና ዋና ምልክቶች (What are the main signs and symptoms of malaria?) (ከአንድ በላይ መልስ ይቻላል) • ***Probe for possible answers (Anything else?)***		Yes No
		ትኩሳት /Fever	1
		ብርድ ብርድ ማለት /Feeling cold	1
		ማንቀጥቀጥ /Chills or shivering	1
		ማላብ /Sweating	1
		ራስ ምታት /Headache	1
		ማቅለሽለሽ /Nausea	1
		ማስታወክ /Vomiting	1
		የምግብ ፍላጎት ማጣት /Loss of appetite	1
		የ አፍ መምረር /Bitterness in the mouth	1
		ድካም መሰማት /Body weakness/tiredness	1
		የመገጣጠሚያ ህመም /Body ache/joint pain	1
		ዉሃ መጥማት /Thirsty	1
		ተቅማጥ /Diarrhea	1
		አላቅም /Don't know	1
		ሌላ ካለ ይገለጽ)_____	**2**
18	በአንተ አስተያየት የወባ ምክኒያት ምን ይመስልሃል? (ከአንድ በላይ መልስ ይቻላል) • ***Probe for possible answers (Anything else?)***	1. የትንኝ ንክሻ 2. ለጋ ሽንኮራ አገዳ መብላት 3. የማሽላ አገዳ መብላት 4. ርሃብ 5. ለብርድ ተቲጋላጭ መሆን 6. ቆሻሻ ውሃ መጠጣት 7. ሰይጣን 8. ለቆሻሻ እና ጨቀጨቅ ቦታዎች ተጋላጭ መሆን	

		9. አላውቅም 10. ሌላ ካለ ይገለፅ _____	
19	ወባ ለየትኞቹ የማህበረሰብ ክፍሎች ችግሩ የባሰ ነው ብለህ/ሽ ታስባለህ/ሽ? (ከአንድ በላይ መልስ ይቻላል) • ***Probe for possible answers (Anything else?)***	1. አዋቂዎች 2. ከአምስት አመት በታች ያሉ ህፃናት 3. ከአምስት አመት በላይ ያሉ ህፃናት 4. ነፍሰ ጡር ሴቶች 5. አዛውንቶች 6. ለሁሉም እኩል ነው 7. አላውቅም	
20	የወባ በሽታን ማከም ይቻላለልን?	1. አዎ 2. አይደለም	
21	የወባ በሽታን መከላከል ይቻላለልን?	1. አዎ 2. አይደለም _____	**23**
22	አንድ ሰው ራሱን እንዴት ከወባ መጠበቅ ይችላል? (ከአንድ በላይ መልስ ይቻላል) • ***Probe for possible answers (Anything else?)***	1. በኬሚካል የተነከረ የአልጋ አጎበር ስር መተኛት 2. ቤታችን በ ኬሚካል መርጨት (ዲዲት) 3. ቤታችን ዙሪያ ማጨስ (ቅጠል ማቃጠል/የከብቶችን ፍግ) 4. የወባ መራቢያ ቦታዎችን ማፋሰስ 5. መስኮት መጋረድ 6. ነጭ ሽንኩርት 7. አልኮል መጠጣት 8. ልላ ካለ ይገለፅ _____ 9. አላውቅም	
23	በአሁኑ ሰዐት ቤታችሁ ውስጥ ጥቅም ላይ የሚውል የአልጋ አጎበር አለን?	1. አዎ 2. የለም ……..	→28
24	ለጥያቄ 28 መልሱ አዎ ከሆነ በአሁኑ ሰዐት ስንት አጎበር አለ (ጥቅም ላይ የዋለም ያልዋለም)?	[_____]	
25	ከላችሁ የአልጋ አጎበር ምን ያህሉን ስትተኙ ትጠቀሙታላችሁ?	[_____]	

26	ባለፉት 15 ቀናት ውስጥ የታመመው ልጅ በምን ያክል መጠን አነበር ውስጥ ተኝቱአል?	1. ሁሉንም ሌሊቶች 2. አብዛኛዎችን ሌሊቶች 3. አልፎ አልፎ 4. ጥቂት ሌሊቶች ብቻ 5. ምንም	
27	ትናንት ሌሊት የታመመው ልጅ በአነበር ውስጥ ተኝቱአል?	1. አዎ 2. አይደለም	
28	ባለፉት 48 ሰዐታት ህፃኑ/ኑአ ትኩሳት ነበረው/ራት?	1. አዎ 2. አይደለም	
29	ህፃኑ/ነአ ለመጨረሻ ጊዜ ትኩሳት የነበረው/ራት መች ነበር (ከአሁኑ ውጭ ካለ)?	[_____]	
30	ህፃኑ/ነአ ባለፉት 12 ወራት ወባ ታሞ/ማ ያውቃል/ታውቃለች?	1. አዎ 2. አይደለም	→ 33
31	ህፃኑ/ነአ ባለፉት 12 ወራት ምን ያክል ጊዜ ወባ ታሞ/ማ ያውቃል/ታውቃለች?	[_____]	
32	ህፃኑ/ነአ ባለፉት 12 ወራት የወባ ህክምና ወስዱአል/ለች?	1. አዎ 2. አይደለም	
33	ባለፉት 12 ወራት የመኖሪያ ቤታችሁ ግድግዳ ፀረ ትንኝ ኬሚካል ተረጭቶ ያውቃልን?	1. አዎ 2. አይደለም ..... 3. አይታወቅም	→ ክፍል 3
34	ለጥያቄ 38 መልሱ አዎ ከሆነ ከምን ያክል ወር በፊት? (ከ 1 ወር በታች ከሆነ 00 ተብሎ ይሞላ)	[_____]ወር በፊት	

ክፍል 3፡ ከአመጋገብ ጋር የተያያዘ መረጃ

ተ.ቁ	ጥያቄ	መልስ	ማለፍ ወደ
35	የልጁ/ቱ እድሜ ስንት ነው?	የትውልድ ቀን___ ___ _____ (ቀን/ወር/ዐ.ል) OR እድሜ: __አመት ___ ወር እና _____ቀን	
36	የልጁ/ቱ ፆታ?	1. ወንድ 2. ሴት	
37	ለልጅዎት የመጠጥ ውሃ የሚያገኙት ከየት ነው?	6. የታሸገ ውሃ 7. የባንባ ውሃ 8. የገድጋድ ውሀ 9. የምንጭ ውሃ 10. ሌላ ካለ ይገለፅ_____	
38	ክብደት (Weight)	…… ኪ.ግ	
39	ቁመት/ርዝመት (በሴ.ሜ)	……ሴ.ሜ	
40	MUAC	……ሴ.ሜ	
41	Presence of pitting Oedema	1. Yes 2. No	
42	Temperature	_____	
43	Blood film for plasmodium	3. Positive 4. Negative	
44	Type of species	1. P. falciparum 2. P. vivax 3. Mixed	

ለትብብርዎ በጣም እናመሰግናለን!!!

Addis Ababa University

School of Graduate Studies

This is to certify that the thesis prepared by Hamid Yimam, entitled: ***Assessment of the relationship between under nutrition and malaria in preschool children at Bahir Dar, Ethiopia***: and submitted in partial fulfillment of the requirements for the master of public Health in Epidemiology complies with the regulation of the university and meets the accepted standards with respect to originality and quality.

Signed by the examining committee:

Examiner_____signature_____date_____

Examiner_____signature_____date_____

Advisor_____signature_____date_____