

Determinants of Insecticide Treated Nets (ITNs) Utilisation among Pregnant Women in Tanzania

Nelson Ndifwa, Leguma Bakari, Leonard Amani and Samwel Godfrey

Eastern Africa Statistical Training Centre (EASTC) P.O.Box 35103, Dar es Salaam, Tanzania

Corresponding author: nelson.ndifwa@eastc.ac.tz

Ikisiri

Kutokomeza ugonjwa wa malaria na kuleta maisha bora ni masuala muhimu ambayo yameelezwa katika Ajenda ya 2030 ya Maendeleo Endelevu ya Umoja wa Mataifa. Nchini, Tanzania, masuala haya muhimu yameelezwa pia katika Dira ya Maendeleo ya 2025. Katika kipindi cha hivi karibuni, malaria ni ugonjwa ambao umeonekana kuwa tishio hasa kipindi cha ujauzito katika nchi nyingi za Afrika, kutokana na kuchangia matokeo mabaya ya uzazi na watoto wachanga. Matumizi ya vyandarua vilivyotibiwa kwa ajili ya kuzuia wadudu vimeonesha kutoa ulinzi kwa takribani asilimia themanini dhidi ya ugonjwa wa malaria na ndiyo moja ya njia ya udhibiti wa wadudu iliyopendekezwa kwa ajili ya kuzuia malaria wakati wa ujauzito; kutokana na sababu hii, utafiti huu ulichunguza mambo ambayo yanasababisha matumizi ya vyandarua vilivyotibiwa miongoni mwa wanawake wajawazito nchini Tanzania. Utafiti huu umetumia njia ya "logit" ili kujua kwa kiwango gani vigezo vilivyoanishwa vinachangia matumizi ya vyandarua vilivyotibiwa kwa ajili ya kuzuia malaria miongoni mwa wanawake wajawazito. Matokeo yalionesha kuwa upatikanaji wa vyandarua vilivyotibiwa, idadi ya mimba alizowahi kupata mwanamke, maarifa kwamba malaria inaweza kuzuiwa kwa kutumia vyandarua vilivyotibiwa, kiwango cha elimu, na utajiri wa kaya yalikuwa ni mambo muhimu katika kubashiri matumizi ya vyandarua vilivyotibiwa kwa ajili ya kuzuia wadudu miongoni mwa wajawazito. Utafiti, unapendekeza kwamba kuwe na ugawaji wa vyandarua vilivyotibiwa kwa kaya ambazo hazina vyandarua na wale walio na vyandarua visivyotibiwa. Hii inapaswa kuambatana na mabadiliko ya tabia na hatua za mawasiliano kwa wanawake wajawazito, waume zao, na jamii kwa ujumla.

Abstract

Ending the epidemics of malaria for quality livelihood is well addresses in the 2030 Agenda for Sustainable Development and in the 2025 Development Vision. Recently, Malaria in pregnancy is still drawing much attention in most African countries, due to its contribution to devastating maternal and neonatal outcomes. The use of an insecticide-treated net is identified as providing approximately eighty per cent protection against malaria attack and is one of the recommended vector control approaches for the prevention of malaria in pregnancy. It is for this reason that, the study examined the determinants of Insecticide Treated Nets utilisation among pregnant women in Tanzania. The logit model was used to uncover the determinants of ITN utilisation among pregnant women. Results showed that access to ITN, number of previous pregnancies, knowledge that malaria can be prevented using ITN, education level and household wealth were significant predictors of ITN utilisation. The study recommends that there should be the redistribution of ITN to households with no nets and those with untreated nets. This should be accompanied by behaviour change and communication interventions to pregnant women, their husbands, and the entire community in general.

Keywords: Pregnant Women, ITN, Malaria, 2025 development vision

1. Introduction

Malaria infection during pregnancy is a significant public health problem with substantial risks to the pregnant woman, her fetus, and the newborn child (WHO, 2019). The symptoms and complications of malaria in pregnancy vary according to malaria transmission intensity in the given geographical area, and the individual's level of acquired immunity (Bhatt, 2015).

Annually, approximately 125 million pregnancies occur globally in areas with *Plasmodium falciparum* and/or *Plasmodium vivax* transmission (Dellicour *et al.*, 2010). Malaria in pregnancy (MIP) contributes to devastating maternal and neonatal outcomes, including maternal anaemia, maternal death, stillbirth, spontaneous abortion, and low birth weight, with an estimated 10,000 women and 100,000 infants dying as a result of MIP. Malaria-associated maternal illness and anaemia, preterm birth, and low birth weight newborns are mostly the result of *Plasmodium falciparum* infection and occur predominantly in Africa (Fleming, 2015; Steketee *et al.*, 2013; and Guyatt & Snow, 2010).

It has been reported that each year, an estimated 25 million pregnancies are at risk of malaria in Sub-Saharan Africa, the consequences of which can be serious for both mother and fetus in terms of morbidity and mortality. In sub-Saharan Africa malaria in pregnancy contributes to an estimated 20% of all stillbirths and 11% of all newborn deaths (Eisele *et al.*, 2011).

In Tanzania, over 93% of the population lives in areas where malaria is endemic (Chamwali, 2013). Pregnant women and children under 5 years of age are at high risk for malaria infections due to changes in hormonal levels and immune systems (Taken & D'Alessandro, 2013). It is estimated that 1.7 million pregnant women in Tanzania are susceptible to malaria infection per year (USAID, 2019).

To mitigate and avert the adverse effects associated with Malaria in pregnancy from areas with moderate to high malaria transmission in response to the Sustainable Development Goal (SDG, Goal 3 Target 3.3)¹, the World Health Organisation (WHO) recommends the implementation of a combination of various malaria vector control approaches including insecticide-treated mosquito nets (ITN).

ITNs are powerful public health tools in the fight against malaria. Regular use by pregnant women can reduce their overall risk of morbidity and mortality (Gamble *et al.*, 2009). An ITN consists of an untreated net and an insecticide treatment kit. This type of net requires regular retreatment. However, the retreatment rate in Tanzania has remained low over the years. Long-Lasting Insecticidal Nets (LLINs) have been developed in response to the low re-treatment rates of conventional insecticide-treated nets. A long-lasting insecticidal net is a ready-to-use pre-treated mosquito net, which requires no further treatment during its expected life span (Gathitu, 2015).

The evidence for the efficacy of ITNs in preventing malaria infection and its consequences in pregnancy is strong, as reported in a Cochrane review in 2009 (Gamble *et al.*, 2009) and in a meta-analysis that examined malaria prevention in pregnancy datasets from different African nations. They both provided evidence that there is a strong correlation between the use of ITNs

and a reduction in stillbirths, improvements in birth weights of babies, and a reduction in the prevalence of parasitemia and anaemia in pregnant women's deaths (Eisele *et al.*, 2011).

The National Malaria Control Programme (NMCP) and Zanzibar Malaria Elimination Programme (ZAMEP) are malaria strategic plans for Tanzania mainland and Zanzibar respectively. They both aim to envisage universal coverage of the population with ITNs through routine distribution and mass campaigns to reduce the burden of malaria. The NMCP and ZAMEP priority is increasing the possession and use of ITNs and LLINs, especially among children under 5 years and pregnant women. Prevention and treatment of malaria in pregnancy is one of the core interventions of the Malaria Strategic plans with a focus to increase ITN use among pregnant women to 85% in Tanzania Mainland and 100% in Zanzibar (URT, 2020).

Despite the known health benefits, and the vast knowledge of the importance of using ITN in pregnancy, there still exists a major gap in their utilisation and this is a cause of alarm, especially in malaria-endemic areas (Pell *et al.*, 2011). The use of ITN among pregnant women in Tanzania is still fluctuating and unstable. The proportion of pregnant women who slept under an ITN the night before the survey increased substantially from 16% in the 2004-05 TDHS to 75% in the 2011-12 THMIS and then fell to 51% in the 2017 TMIS with wide variation across regions (URT, 2017).

Therefore, this calls for a major focus on ITN utilisation as a major and cost-effective prevention strategy to reduce malaria infections and mortality among pregnant women in Tanzania. Achievement of fully ITN utilisation goes directly with understanding the underlying situations and factors that influence the use of ITN.

2. Methodology

2.1 Study Area

The area of study is the United Republic of Tanzania, a country located in Eastern Africa between longitude 29° and 42° East and Latitude 1° and 12° South. The population of Tanzania according to the 2012 census was 44,928,923 whereby 21,869,990 were males and 23,058,933 were females (National Bureau of Statistics, 2013). The Tanzanian population is projected to trend around 59.15 million in 2021 and 60.80 million in 2022. This study area was chosen due to the existence of instability in ITN utilisation among pregnant women that is to find out what are the causes.

2.2 Research Design

A cross-sectional research design was used in this study to examine the determinants of ITN utilisation among pregnant women in Tanzania. The target population is all pregnant women in Tanzania in 2017. The accessible population is the pregnant women who participated in the 2017 Tanzania Malaria Indicator Survey. The study used secondary data from the Tanzania Malaria Indicator Survey (TMIS) conducted in 2017 by the National Bureau of Statistics (NBS).

2.3 Data Analysis

2.3.1 Chi-square Test

A chi-square test at 5% level of significance was used to examine the association between ITN utilization (the dependent variable) and each independent variable.

2.3.2 Logit Regression Model

A binary logistic model is a statistical model that in its basic form uses a logistic function to model a binary dependent variable. Since the response variable Y (ITN use) is a binary variable with categories yes and no, this study employed binary logistic regression to analyze determinants of ITN utilization among pregnant women.

Binary Logistic Model: $\log it(\pi) = \beta' X$

Where,

π is the probability of pregnant women using an ITN.

β' is a vector of regression coefficients.

X is a vector of explanatory variables.

2.3.3 Diagnostics for the Logistic Regression

Link test and The Hosmer-Lemeshow goodness-of-fit test were used to assess the accuracy of the binary multiple logistic regression model.

3. Results and Discussion

3.1 Results

3.1.1. Characteristics of the Respondents

Table 1 gives the profile of 942 women (9.4%) of the total female respondents who participated in TMIS who reported that they were pregnant at the time of the 2017, TMIS survey.

Results show that majority of respondents were aged below 34 years with 29.94% being aged between 20 and 24 years. A higher proportion of respondents had primary education (62.1%) while only 0.85% of respondents had higher education this might be because the majority of respondents were from rural areas. As much as 76.43% of the respondents had reported having previous pregnancies, and approximately 23.6% reported having no previous pregnancies. The majority (82.91%) of respondents knew that malaria can be prevented using ITN, this tells that there was greater ITN awareness among respondents.

Table 1: Socio-demographic characteristics of respondents

	N (942)	%
Age		
15 - 19	157	16.67
20 - 24	282	29.94
25 - 29	228	24.2
30 - 34	139	14.76
35 - 39	93	9.87
40 - 44	30	3.18
> 45	13	1.38
Level of education		
No education	190	20.17
Primary	585	62.1
Secondary	159	16.88
Higher	8	0.85
Number of previous pregnancies		
0	222	23.57
>0	720	76.43
ITN knowledge to prevent malaria		
No	161	17.09
Yes	781	82.91

3.1.2 Respondent's Household Characteristics

Table 2 shows that the majority (78.98%) of respondents' households were in rural areas and 21.02% in urban areas. Moreover, there was an unequal distribution of wealth quantiles among respondents' households whereby 21.44% of the households were in the poorest category while only 15% were in the richest category. 81.1% of households had no access to ITN (meaning that the ITNs available were not sufficient to accommodate the entire household if each net was used by two people). This signifies that most of the respondents were from households with no access to ITN.

Table 2: Household Socio-demographic characteristics of TMIS, 2017 participants included in the study

	N (942)	%
Place of residence		
Urban	198	21.02
Rural	744	78.98
Wealth index		
Poorest	202	21.44
Poorer	224	23.78
Middle	198	21.02
Richer	170	18.05
Richest	148	15.71
Access to ITN		
Has no access	764	81.1
Has access	178	18.9

3.1.3. Association between ITN Use and Other Variables

A Chi-Square test of independence was carried out to examine the association between ITN use and each independent variable (age, place of residence, level of education, access to ITN, knowledge that ITN can prevent malaria and number of previous pregnancies). The observed association between ITN use and each independent variable (age, place of residence, level of education, access to ITN, knowledge that ITN can prevent malaria and number of previous pregnancies) was statistically significant when the p-value of the Pearson chi-square test statistics was less than 5% level. Table 3 results show that place of residence, level of education, access to ITN, household wealth, the knowledge that ITN can prevent malaria and number of previous pregnancies have a statistically significant association with ITN use at 5% level.

Table 3: Associations between ITN utilization and independent factors

Variable	Respondent slept under an ITN		χ^2	P – value	Cramer's (V)
	No (431)	Yes (511)			
Age					
15 – 19	86(71.8)	71(85.2)	10.18	0.12	0.11
20 – 24	128(129)	154(153)			
25 – 29	101(104.3)	127(123.7)			
30 – 34	52(63.6)	87(75.4)			
35 – 39	46(42.6)	47(50.4)			
40 – 44	12(13.7)	18(16.3)			
45 – 49	6 (5.9)	7 (7.1)			
Place of residence					
Urban	68(90.6)	130(107.4)	13.15	0.000**	0.12
Rural	363(340.4)	381(403.6)			
Level of education					
No education	106(86.9)	84(103.1)	10.51	0.015**	0.11
Primary	258(267.7)	327(317.3)			
Secondary	64(72.7)	95(86.3)			
Higher	3(3.7)	5(4.3)			
Access to ITN					
Yes	1(81.4)	177(96.6)	942	0.000**	0.44
No	430 (349.6)	334(414.4)			
Household wealth index					
Poorest	114(92.4)	88(109.6)	15.26	0.004**	0.13
Poorer	106(102.5)	118(121.5)			
Middle	86(90.6)	112(107.4)			
Richer	67(77.8)	103(92.2)			
Richest	58(67.7)	90(80.3)			
ITN knowledge to prevent malaria					
No	94(73.7)	67(87.3)	12.48	0.000**	0.12
Yes	337(357.3)	444(423.7)			
Previous pregnancies					
0	113(101.6)	109(120.4)	3.1	0.078*	0.06
> 0	318(329.4)	402(390.6)			

**Significant at 5% level

Findings in Table 3 revealed that the age of the pregnant woman and the number of previous pregnancies were insignificantly associated with ITN use at 5% level. According to the results number of previous pregnancies had a significant association with ITN use at 10% level although the variable was insignificant at 5% level (study's level of significance). Therefore, the number of previous pregnancies should not be ignored in consideration of determinants of ITN utilization.

3.1.4 Results from the Binary Logistic Regression Analysis

Findings in Table 4 show that the overall model was significant and indicated that predictors have a significant effect on ITN utilization (Chi-square value = 276.85, and p-value is 0.0000). In addition, level of education, the knowledge that ITN can prevent malaria, access to ITN, number of previous pregnancies, and household wealth were found to be significant predictors of ITN utilisation among pregnant women; respondent's age and place of residence were not statistically significant at 5% level.

Moreover, the odds ratio for pregnant women with primary education is 1.824. This indicates that holding other variables constant pregnant women with primary education are 1.824 times more likely to use ITNs compared to pregnant women with no education. Similarly, the results show that pregnant women with secondary education are 2.047 times more likely to use an ITN as compared to those with no education. These findings on education level align with the notion that a woman who spends more years in school adapts easily to health-related interventions including the methods of how to protect herself from malaria. In addition, the result shows that the odds ratio for women with the knowledge that ITN can prevent malaria is 1.475. This indicates that holding other variables constant the odds ratio of using ITN if a pregnant woman knows that malaria can be prevented using ITN is 1.475 times higher than those with no knowledge.

Furthermore, results show that the odds ratio for variable access to ITN is 268.9. This indicates that holding other variables constant, pregnant women residing in households with access to ITN are 268.9 times more likely to utilize ITN than those residing in households with no access to ITN. Also, the odds ratio of previous pregnancies is 2.03 which indicates that holding other variables constant pregnant women who had previous pregnancies are 2.03 times more likely to sleep under ITN than those who have never had previous pregnancies. Regarding household wealth, the findings revealed that pregnant women whose household is in the poorest and middle wealth quintile are 1.587 times and 1.756 times (respectively) more likely to utilize ITNs as compared to those pregnant women from the poorest household wealth quintile.

Table 4: Estimation for Binary Logistic Regression Model

Variable	Response	B	OR	P-value	OR 95% CI	
					Lower	Upper
Age		0.014	1.014	0.240	0.991	1.038
Residence	Urban (reference)					
	Rural	-0.351	0.703	0.167	0.428	1.158
Education level	No education (reference)					
	Primary	0.601	1.824	0.009**	1.159	2.872
	Secondary	0.716	2.047	0.042**	1.025	4.084
	Higher	-0.092	0.912	0.934	0.103	8.027
Knowledge	No knowledge (reference)					
	Has knowledge	0.389	1.475	0.045**	1.052	2.194
Access to ITN	Has no access (reference)					
	Has access to ITN	5.585	268.9	0.000**	36.85	1926.1
Previous pregnancies	0 (reference)					
	> 0	0.708	2.030	0.001**	1.32	3.12
Household wealth	Poorest (reference)					
	Poorer	0.461	1.587	0.033**	1.039	2.424
	Middle	0.562	1.756	0.013**	1.129	2.731
	Richer	0.151	1.164	0.580	0.68	1.993
	Richest	0.139	1.149	0.688	0.583	2.265
Constant		-1.747	0.174	0.000	0.068	0.442
	Number of obs = 942		LR chi2(12) = 276.85			
	Log likelihood = -511.11727		Prob > chi2 = 0.0000			
	Pseudo R2 = 0.2131					

3.1.5 Diagnostics for the Logistic Regression

3.1.5.1 Model Specification Error Test

The binary multiple logistic regression model fitted was tested for specification error. A link test was used to test the model adequacy. Table 5 presents the results of the link test which indicates no misspecification errors exist since the linear predicted value squared (hatsq) is insignificant at 5% level (p-value = 0.919), and the predicted value (\hat{y}) is very significant at 5% level (p-value=0.000); hence, the model specification is correct. This means that, to the best of the researcher's knowledge, the model contains those variables that should be in the model and the variables have been entered in the correct functional form.

Table 5: Link test results

	Z-statistics	P-value
_hat	6.73	0.000
_hatsq	-0.10	0.919

3.1.5.2 Goodness of Fit Test

Hosmer-Lemeshow goodness-of-fit test was used to test if the model has effectively described the outcome variable. The large p-value signifies that there is no significant difference between the observed and the predicted values of the outcome. The value of the Hosmer-Lemeshow goodness-of-fit statistic computed from the frequencies is $\hat{C} = 5.92$ and the corresponding p-value computed from the Chi-square distribution with 8 degrees of freedom is 0.6567. Since the p-value (=0.6567) is larger (greater than 5%) therefore, the null hypothesis was rejected; this signifies that there is no significant difference between the observed and the predicted values of the outcome. This indicates that the model is a good fit.

Table 6: Contingency table for Hosmer and Lemeshow goodness-of-fit test

Groups	prob	Sleeping under an ITN		Not sleeping under ITN		Total	$\hat{C} - \chi^2$	df	p-value
		Obs	Exp	Obs	Exp				
1	0.29	24	23.8	72	72.2	96	5.92	8	0.6567
2	0.35	30	30.7	63	62.2	93			
3	0.41	36	36.5	60	59.5	96			
4	0.45	35	41.4	61	54.6	96			
5	0.49	48	41.9	42	48.1	90			
6	0.53	54	49.3	42	46.7	96			
7	0.55	49	50.2	44	42.8	93			
8	0.61	52	53.8	42	40.2	94			
9	0.99	90	89.7	4	4.3	94			
10	0.99	93	93.7	1	0.3	94			

* Obs stands for observed
* Exp stands for expected

3.2 Discussion of the Key Findings

The study revealed that controlling the effect of other predictors and access to ITN had a statistically significant effect on ITN use. Pregnant women in households with access to ITN are more likely to sleep under ITN as compared to pregnant women in households with no access to ITN. Similar findings were also observed by Muhumuza *et al.* (2016).

The findings revealed that knowledge of malaria prevention using ITN has a significant positive effect on ITN utilisation among pregnant women. The results implied that controlling for the effect of other predictors pregnant women with the knowledge that malaria can be prevented by using ITNs, are more likely to report sleeping under an ITN compared to pregnant women with no knowledge. Similar results were reported by Ankomah *et al.* (2021) and Ezire *et al.* (2015) on determinants of ITN utilisation among pregnant women which revealed that a woman's knowledge of the dangers of malaria has a positive significant effect on ITN utilisation.

Results show that a number of previous pregnancies significantly influence the use of ITNs. Pregnant women who have had previous pregnancies were more likely to sleep under an ITN as compared to those who have never had previous pregnancies. This might be because women who have had previous pregnancies have a high awareness of the dangers of malaria and having attended numerous Antenatal Care Visits (ANCs) from previous pregnancies they are likely to have access to ITNs. This is similar to a study by Muhumuza *et al.* (2016) which found that women with a higher number of previous pregnancies have increased chances of sleeping under an ITN.

Pregnant women with primary education were more likely to report sleeping under an ITN than those with no education. Similarly, pregnant women with secondary education were more likely to report sleeping under an ITN; Education generally improves awareness and compliance to therapy, it is believed that the more a person is educated, the better he/she would readily understand the surrounding environment by learning. Also, in the case of ITN utilisation, it is expected that a woman who spent more years in school could adapt easily to the methods of how to protect herself from malaria during pregnancy. This assertion is also supported by Muhumuza *et al.*(2016), Ezire *et al.*(2015), and Ankomah *et al.* (2012). This reinforces the importance of girl-child education as a means of women's empowerment. However, the findings are contrary to a study by Sangare` *et al.* (2012) which reported that educational attainment was not significantly related to ITN use among pregnant women. Opposing findings might be attributable to the fact that in the study by Sangare` *et al.* (2012) levels of education were aggregated into two categories while in the present study four categories of educational attainment were used.

The findings of the study on age and place of residence were similar to the study by Idris which reported that age, place of residence, marital status, and other socio-demographic factors do not influence the use of ITNs by pregnant women. However, this is contrary to the study by Sangare` *et al.* (2012) which reported age being a significant predictor of ITN utilisation. A study by Ezire *et al.* (2015) was also contrary to the present study as it reported that place of residence is a key predictor of increased ITN access and utilisation with 76.2% of urban pregnant women using ITNs as against 56.7% of rural women. The conflicting findings might be due to differences in areas of study since ITN utilisation is more of a behavioural act/practise and pregnant women in different areas are more likely to have different behaviours (these studies were conducted in different areas Sangare` *et al.* (2012) in Jinja, Uganda and Ezire *et al.* (2015) in Nigeria while the present study is in Tanzania.

4. Conclusion and recommendations

4.1 Conclusion

Access to ITN increases the chances of pregnant women utilizing the treated mosquito net. The findings indicate that pregnant women with the knowledge that malaria can be prevented using ITN are more likely to utilize ITN as compared to those with no knowledge. In addition, the number of previous pregnancies is a significant predictor of ITN utilisation. Moreover, the level of educational attainment of pregnant women and household wealth has a significant effect on ITN utilisation while age and place of residence have no significant effect on ITN utilisation.

4.2 Recommendations

In the light of the study findings, the study recommends the following for policy implications:

- i. The study shows that access to ITN has a greater influence on ITN utilisation. Since household access to ITN necessarily translates to pregnant women sleeping under an ITN, the distribution strategies for ITNs should focus more on the households without ITN access to increase household access to ITN and thus increase utilisation, especially among pregnant women. The focus should also be on those sleeping under untreated nets. The availability and usage of untreated nets should be curtailed through the mass redistribution of treated nets by the government and other agencies.
- ii. On the other hand, free mass distribution and routine distribution of ITNs are not enough in translating ITN ownership and access to usage. This is because ITN utilisation is more of a behavioural act/practice therefore behavioural change and communication activities and interventions should be stirred up in addressing the dangers of malaria and the importance of utilizing treated mosquito nets during pregnancy for pregnant women, and their husbands, and the general public. This can be through creating national-wide slogans, making posters, and making use of the advancement of technology by using social media, mass messaging, TV stations, and radio stations to spread awareness of ITN importance to pregnant women. Also, reaching out physically to communities and conducting regular supportive supervision and on-job training for ANC healthcare workers to emphasize the importance of preventing malaria and related complications during pregnancy might be advantageous.
- iii. Having identified a significant effect on educational attainment in ITN utilisation, the researcher recommends that girls should be provided with even more opportunities in education. This will help scaling-up ITN utilisation and reinforces the importance of girl-child education as a means of women empowerment.

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