

## **Efficacy of Indoor Residual Household Spraying in Control of Malaria among Children Under Five Ndola, Zambia**

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### **Abstract**

*Study aimed at establishing efficacy of Indoor Residual Household Spraying (IRHS) program in controlling malaria among children under-five in Ndola, Zambia.*

**Methods:** A comparative study conducted at Nkwazi (intervention) and Masala (non-intervention) compound, over a period of six months from October 2017 to April 2018. Sample size; 410 caretakers and 6 key informants. Sampling: Cluster, systematic and purposive, from, 6<sup>th</sup> to 30<sup>th</sup> April 2018 and 28<sup>th</sup> May to 26<sup>th</sup> August 2019 respectively. Interview guide, Semi-structured questionnaire and checklist used. Content analysis, univariate and bivariate, SPSS version 20 Chi-square determined association of variables: Demographic, morbidity, knowledge, acceptability, compliance, and outcome efficacy of IRHS.

**Results:** Malaria incidence was 25.4% among children under five at IRHS intervention area after six months and non-intervention areas accounted 2.1%. 83.3% had positive results and most affected aged 0-1year 46.1%, and 74 were positive,  $P > 0.225$ . 96.1% and 74.1% of caretakers in Nkwazi and Masala were knowledgeable about malaria, while 43.4% in Nkwazi lacked knowledge on danger signs. IRHS coverage was average  $n=4$ . 83.8% of the caretakers said IRHS was useful  $P < 0.000$ . 70% had homes sprayed  $P < 0.000$ . 68.2% in Nkwazi slept in sprayed houses  $P < 0.000$ . Acceptability of IRHS was average 56%  $p < 0.000$ . Community sensitization influences sleeping under mosquito net  $p < 0.000$ . Program officers  $n=5$  reported spraying done at the same time yearly. Refusals accounted 90.2% and 66.3% in Nkwazi and Masala  $P < 0.000$ .

**Conclusion:** Malaria morbidity among children under-five continued to increase in the intervention area despite IRHS.

**Keywords:** Indoor Residual Household Spraying Malaria Comparative.

### **Introduction**

In Zambia malaria is still the major cause of death among children under five (Sikambale 2013) and is the major cause of mortality in children under five years in Uganda (2014). WHO 2010, reported that a total of 185 million people was protected by IRS in 2010, representing 6% of the global population at risk? In Zambia the national malaria parasite prevalence was 16.0% with more parasitaemia among children in rural areas (20.4%) compared to urban areas (5.2%) (15). While in 2012, the national malaria parasitaemia among under-fives was 14.9% and was higher among children in rural areas (20.2%) compared to urban areas (3.7%).

On average, parasitaemia prevalence peaked among children aged four years and was highest in Luapula province (32.1%) while Copperbelt province accounted 17.4% however, the Zambia National indicator survey for 2015 showed that copperbelt had the highest prevalence of malaria and the least was Southern province. The effectiveness of IRS as a malaria control intervention arises from the fact that many important malaria vectors are endophilic (American mosquito control (2012). However, studies done in Zambia in Choma and Chelenge by Chanda E et al (2011) revealed that, there was resistance to DDT and the pyrethroids especially with *gambiae species* and *Anopheles Funestus*. These are the same drugs that are used in Zambia. However, it is worth noting that both Long Lasting treated Mosquito nets (LLNs) and Indoor Residual Household Spraying (IRHS) are utilized in the prevention of malaria. In Zambia IRHS coverage has increased from 15 districts in 2005–2006 to 36 districts in 2009, to all districts during the 2011–2012 spray seasons.

Nationally, IRS coverage rates have increased from 9.5% in 2006 to 29.1% in 2012 and 28.4% in 2015. In view of this, there is need to evaluate the effectiveness of IRS of IRS in the control of malaria among children under five years.

### **Significance and purpose**

According to WHO (2013) over 91% deaths from malaria occur in Africa and Globally, malaria caused about 627,000 deaths in 2013, of these, majority were children under 5 years living in Africa. Recent study (2010 and 2011) conducted in chipulukusu and Mushili Komando in Ndola showed significant resistance against anopheles Gambiae to deltamethrin 13.5% in chipulukusu permethrin 43% and in Mushili it was 61% and DDT was 43%, while in Mushili it was 55% [4]. The objectives of IRS are to reduce, and ultimately interrupt, malaria transmission by reducing vector survivorship, density, and human–vector contact, in a manner that is safe for human health and the environment. IRS can contribute to the elimination of malaria if rigorously applied. However, the issue of resistance and community practices after IRS is a major threat to the effectiveness of IRS in the prevention of malaria; hence the investigator would like to determine the effectiveness of this intervention. At the same time, considering the many steps the ministry of health and local government are taking to reduce malaria infection, this study will make considerable contribution in public health by enhancing strategic planning and policy direction.

The purpose of this study is to evaluate the efficacy of Indoor Residual Household Spraying (IRHS) in control of malaria among children under five in IRS Intervention area in Nkwazi compound and IRS non- intervention area in Masala compound respectively, Ndola, Zambia. The impact of this study on public health would be availability of evidence on the effectiveness of IRS in control of malaria among under -fives and reduction in the morbidity and mortality rate in this age group. There has been scarcity of literature on efficacy of IRS in prevention of malaria among children under the age of five in Ndola, Zambia as a nation.

### **Research question**

1. How effective is IRS in the control of malaria in Nkwazi compound?
2. What is the coverage?
3. What are the Benefits / and or challenges associated with IRS implementation?

### **General objective**

To assess the efficacy of Indoor Residual Household Spraying (IRHS) program in control of malaria among under-fives in the Intervention area.

### **Specific objectives**

1. To determine and compare malaria in under-five between IRS intervention area and non-IRS intervention area.
2. To determine IRS coverage in intervention area
3. To determine community's perception on performance of Indoor residual Household Spraying.
4. To review and analyze existing policies with the view of making recommendation for policy direction.

### **Hypothesis**

1. Null hypothesis: IRS has no effect in the control of malaria among children under five.
2. Alternative hypothesis: IRS has effect in the control of malaria among children under five.
3. Null hypothesis: IRS coverage has no effect in the control of malaria among children under five.
4. Alternative hypothesis: IRS coverage has effect in the control of malaria among children under five.
5. Null hypothesis: community perception of IRS has no effect in efficacy and control of malaria among children under five.
6. Alternative hypothesis: community perception has an effect in the efficacy and control of malaria among children under five.

## **Literature review**

According to WHO 2014 guidelines, IRS programs should aim for 100% coverage of all eligible structures in the area to be sprayed, although actual guidelines state that coverage above 80% is sufficient to produce a community effect. After an area is selected for spraying, there are two ways to implement IRS: blanket spraying and focal spraying. Whereas blanket spraying is defined as the spraying of all houses within a targeted area like Nkwazi compound (e.g. entire provinces or regions), and focal spraying is defined as the selection of discrete geographic areas within an area targeted for IRS activities, based on eco-epidemiologic parameters (e.g. communities) like masala compound where partial spraying has been done. The study will be done in an sprayed area with IRS like Masala Compound for comparison with Nkwazi as an intervention area. In contrast to targeted spraying, political boundaries do not constrain the geographic areas to be sprayed, meaning that spray areas are defined solely based on eco-epidemiologic parameters. Focal IRS relies on precise environmental, epidemiological, and entomological information on households within an area. The goal of focal IRS is to cover epidemiological “hotspots,” which can be defined as a town, village, or geographic area that experiences regular increases in confirmed malaria cases or transmission activity in comparison to surrounding areas. This could be due to the proximity of mosquito breeding sites; variations in housing structure; particular residence behaviors.

Evidence is needed to determine the effectiveness of IRS in malaria transmission foci, including in low transmission settings (WHO 2014). Evidence is also needed from different eco-epidemiological settings outside of Ndola. A total of 185 million people was protected by IRS in 2010, representing 6% of the global population at risk. The number of people protected by IRS in the African Region increased from 10 million in 2005 to 78 million in 2010; including all countries in sub-Saharan Africa 81 million people were protected, which corresponds to protection for 11% of the population at risk (WHO 2011). Despite this reduction, mortality related to malaria is still high.

Study done in Uganda revealed that Malaria remains the leading cause of mortality in Uganda and it is responsible for 21% (including 27% of under-five) of all hospital deaths [MOH 2010] According to a study conducted by Tukei et al 2017 in Uganda, it revealed that parasitaemia prevalence among children under-five years of age was lower in the two IRS compared with the non-IRS district 37.0% and 16.7% versus 49.8%,  $p < 0.001$ .

In Zambia the national malaria indicator survey conducted in 2008 reported a prevalence rate of 10.2% for children under age five years, of these 4.3% were in rural, while 12.4% were urban. With an estimated 91% of households with at least one child under the study further showed that 92.4% (437/473) of respondents said that IRS is important because it will help to kill mosquitoes. However, most of the respondents 74.4% (352/473) reported that IRS will be beneficial while 16.1% (76/473) said IRS will not be beneficial (Ediau M 2013). On the other hand, a large proportion of respondents had a positive perception towards IRS. This was consistent with findings elsewhere that showed positive community expectations when IRS or related prevention interventions were introduced (Mungambe K 2011, Mazigo HD 2010). This study also found that despite having positive perceptions towards IRS, a large proportion still had negative perceptions towards its use.

## **Methodology**

### **Introduction**

In this chapter the methodology comprises of study design, study setting, study population, sample selection, data collection tool and technique, dissemination of results, ethical consideration and limitation of the study.

### **Study design**

A comparative study design was used to compare IRHS intervention site in Nkwazi and non-intervention site in Masala for control of malaria among children under five. This was done through comparison of the efficacy or outcome of IRS in prevention and control of malaria among children aged under-five years in intervention and non-intervention area. Efficacy was measured by evaluating the number of malaria related cases among children under-five years following IRS intervention.

## **Research setting**

The study was conducted in Copperbelt province with a total population of 2.362 million (CSO, 2015). Ndola district is situated in the Copperbelt province of Zambia with a total population of 455,194 (provincial census, 2010).

The research was conducted in Nkwazi and masala compound in Ndola urban district. In Nkwazi compound IRHS was done in the whole area while in Masala compound IRHS was not done and acted as a control group which had similar characteristic with the intervention site. The investigator chose to conduct this evaluation in these compounds because of its high burden of malaria relative to other compounds.

## **Study population**

The sample consisted of caretakers of under-fives residing in Nkwazi compound and Masala compound in Ndola urban district. The participants were selected because they are the caretakers who look after the sick children mostly affected by malaria that are not able to make decisions on health choices of this intervention and are dependent on adults' choices.

During this study, two different study participants were investigated depending on availability at time of data collection, to determine the occurrence of malaria at different intervals. The program officers were also interviewed to validate responses from the caretakers, as they are trained experts who implement IRHS programs.

## **Sample selection**

Systematic sampling methods were used for quantitative and qualitative sampling as follows; Cluster sampling was used for compound selection of Nkwazi and Masala compound and this was the first stage of sampling; then the Second stage involved a sample of respondents within the selected areas. Cluster sampling involves dividing the population into clusters of homogeneous units usually based on geographical continuity and all units in a selected cluster are studied. The pattern of cluster analysis depends on comparative size of separate clusters. A list of compounds where blanket spraying of IRS was done were listed, each bearing a unique number and probability sampling was done using lottery method to pick the intervention compound for IRS (Nkwazi compound) was selected which acted as a sampling frame. The same method was used when selecting the non-intervention compound, where a list of compounds where IRS was not done and one compound was picked (Masala compound) which acted as a sampling frame. These compounds are divided into zones which acted as clusters and in each zone systematic sampling were used and every third household was interviewed.

In each compound 205 households were selected and the caretakers / guardians of children under five were interviewed giving us a total sample of 410 and the response rate was 100%. Nkwazi compound was selected as an intervention site where IRS has been done to the whole compound, while masala compound IRS has been partially done and the focus was to the areas where IRS has not been done as a control site. Six (6) program officers were selected based on purposive expert sampling.

## **Cases**

Caretakers of children under five residing in Nkwazi with history of malaria were recruited in the study in IRS intervention area (Nkwazi compound). Cases were classified as history of fever and a positive result for RDT as uncomplicated malaria based on the modified criteria put forth by the World Health Organization (WHO 2006)].

## **Controls**

Caretakers of children under five residing in Masala with history of malaria were recruited in the study in IRS Non-intervention area (Masala compound). Controls were classified as history of fever and a positive result for RDT as uncomplicated malaria based on the modified criteria put forth by the World Health Organization (WHO 2006)].

## **Inclusion criteria**

All caretakers of children under five living within selected households residing in Nkwazi and Masala compound for one month and above were eligible to be included in the study.

## **Exclusion criteria**

All caretakers of children under five not living within selected household residing in Nkwazi and Masala compound for one month and above were not eligible to be included in the study.

## **Sample size**

The sample size was calculated using the formula

$$n = Z^2 P (100-P) / d^2$$

N=sample size, P= prevalence, Q=100-p, D=margin of error+- 5%, Z=1.96\*1.96\*40(100-40) / 5\*5  
N= 368.79.

A sample of 369 was calculated using epi-info 6. This sample was adjusted as follows to allow for non-response 369/0.90 = 410 respondents.

## **Data collection tools**

In this study, the researcher used a Semi-structured interview schedule which contained all the study variables on which data was collected were administered to the care takers (guardians). These kinds of responses were useful in interpreting responses. A structured interview schedule was administered to the program officer (experts). Health Centre checklist was used to review health Centre records using health Centre register was done to validate the findings. The health Centre data was reviewed at baseline month of October 2017, Re-assessed at third month of February 2018 and completed in the 6<sup>th</sup> month in April 2018.

## **Validity**

Extensive review of literature before tool development and Use of standardized interview schedule for all respondents in each category and triangulation method.

## **Reliability**

The tool was modified from the national malaria indicator survey questionnaire and Cronbach alpha coefficient of 0.70 was selected as a measure of reliability). If the item scores agree very closely with the universal score, then they should also be very closely related to one another as well. This way of assessing reliability is referred to as internal consistency, and is the approach presented in this study. Some questions that scored below 0.75 were dropped. In this way, reliability may be achieved.

## **Assessment parameters**

### **Community level**

1. Survey was conducted using Semi structured questionnaire among the guardians/ caretakers
  - a) Qualitative data was described according to themes in order to understand how and why children have malaria
  - b) Quantitative measurement to know proportion of children in the sample with the disease.
2. Screening was done to identify history of malaria among under-fives in both sites.
3. Clinical malaria was defined as fever or as auxiliary temperature of >37.5°C with one or more symptoms suggestive of malaria such as headache, diarrhea and vomiting. However, this parameter was not used as children were not treated according to presenting symptoms clinically.

### **Household level**

Quality of IRS in the household was assessed by

1. Assessing whether children sleep in households which were sprayed in the past 3- 6 months.
2. Assessing the household practices after IRHS in the past six months.

### **Health facility level**

1. Review of OPD records and Laboratory results using a checklist according to months of interest at the beginning of IRS and at three and six months after IRHS.
2. Then collect information on the following
  - a) Malaria diagnosis categorized by age
  - b) Rapid diagnostic test (RDT) result including total tests done and total positive results, segregated by age
  - c) Total OPD attendance categorized by age to assess the malaria prevalence in under-fives at these sites.
  - d) Age was categorized as 5 years and below.
  - e) Malaria morbidity was measured by the RDT positive result.

### **Program experts**

1. Assess coverage
2. Assess effectiveness of IRS
3. Season of spraying

### **Data collection techniques**

Data collection technique is the method that the researcher uses to collect accurate and relevant data. In this study, a semi-structured interview schedule was used involving face to face, as well as observation using a checklist to review health Centre records, while self-administered structured questionnaire was administered to program experts to validate the findings.

Hence the Validation of data collection tools was done by pre-testing the data collection tools to assess whether their gaps and tools were measurable and attainable so as to strengthen the methodology.

### **Semi structured interview schedule**

The tool was modified from 2015 National Malaria Indicator survey questionnaire as the questionnaire items were not the same.

Some questionnaire items were adapted from review of literature review such as, MOH 2015, Tukei1 et al 2017, Ediau et al 2013, Abuaku et al 2018, Mwiinga V. 2019, Munguambe et al 2011. Data was collected from 6th April to 30th 2018.

### **Health centre checklist**

This Checklist was adapted from review of literature on Malaria from different scholars such as Abuaku et al 2018, Mwiinga 2019 etc.

### **Structured interview schedule for program experts**

This tool was modified from review of IRS guidelines and interviews with experts and literature review such as, Mwiinga V. 2019.

Data was collected from 28th May to 28th August, 2018. The checklist consisted of total OPD attendances, total OPD attendance among under-fives, malaria diagnosis among under five, Total RDT done, Total RDT positive.

### **Interviewing technique**

All selected participants were interviewed using a semi-structured interview schedule.

The purpose of the study was explained to the participants and permission was sought from them to allow the researcher to conduct the interview. Privacy and confidentiality and anonymity were maintained by not writing names on interview schedule, instead numbers were allocated to all participants. Interview will last for 15 minutes. Interviews will be conducted during working hours from 08.30- 16.00 hours using face to face method. Review of records was conducted during working hours.

## **Pre-test**

Pre-testing was done in Sinia compound as it has similar characteristics with the respondents in the main study. Respondents were selected using systematic sampling and 10 participants were selected accounting 10% of the sample. Pre-test helped to determine whether the variables are realistic, measurable and attainable. It also helped to make revisions in order to strengthen methodology.

## **Study procedure**

In this study meetings were held with the Ndola urban district council officers and neighborhood health committee members in the area to explain the purpose of the study and need to answer questions. The participants in the survey were approached in their own homes and written consent was obtained before administration of the questionnaire. Semi-structured interview schedules comprised of socio-demographic and variables associated with efficacy of IRS in prevention of malaria among children under five. Six field staff were trained from 2nd April to 4th April 2018 for three days on the methodology of interview and data collection. The community leaders were sensitized about the study.

The field work commenced on 6th April and continued up to 30th April 2018 for caretakers, 28th May to 26th August 2018 for program officers and October 2017 to April 2018 for health centre data collection. After data collection all questionnaires were stored in a lockable bag for confidentiality. In this study, IRS exposure variable includes; a 6 months' period following IRS round with time expressed as months after IRS. The month before the commencement of spraying was considered as a baseline month and was assigned a zero while the months after the baseline month were assigned numbers three (3) and six (6) respectively.

Malaria variables in this study includes: Malaria diagnosis categorized by age and sex; and Rapid diagnostic test (RDT) result including total tests done and total positive results, segregated by age. In addition, the study used the total OPD attendance categorized by age to assess the malaria prevalence in under-fives at these sites. Age was categorized as 5 years and below. Malaria morbidity was measured by the RDT positive result and or clinical malaria with fever for classification of malaria was not used as treatment is only given to those whose RDT was positive and malaria morbidity was the primary outcome of the study.

## **Limitation of the study**

Lack of adequate funds limited the study to Ndola urban district, as the research was not funded and all resources were sourced by the chief investigator.

## **Ethical consideration**

Approvals was obtained from tropical disease research ethics committee and from the Zambia National Health Research Authority and the Ndola District Health office where the study was undertaken, see attached Appendix in main document. Ethical considerations were based on the Helsinki Declaration and Belmont Reports 17, 18, 19. Also informed consent was obtained from respondents, confidentiality and anonymity was maintained throughout data collection by use of serial numbers and names were not used on the questionnaire.

## **Data process and analysis**

In this study qualitative data derived from open ended questions was analyzed by content analysis, while quantitative data derived from all questionnaires for program officers, caretakers and health Centre checklist were sorted out and edited for completeness, legibility and accuracy. SPSS version 20 was used to analyze variables. Chi-square determined the association of variables. 95% confidence interval was set and statistical significance achieved at p value 0.05.

## **Variables**

### **Dependent variable**

Indoor Residual Household Spraying Efficacy (Usefulness).

### **Independent variables**

1. Knowledge Level
2. Service Delivery Of IRS
3. Availability of Logistics
4. Acceptability Of IRS
5. Compliance with IRS Guideline

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## **Chapter four-presentation of finding**

### **Introduction**

Data was presented in form of cross tabulation reflecting frequencies, to facilitate easy understanding. Chi-square was used to compare an observed frequency distribution or table with the distribution or table frequencies expected, assuming some null hypothesis is true. In this section findings will be discussed according to assessment parameter namely: Data from the parents/ caretakers; Health facility data; and Data from program officers (Experts). It is worth noting that Data for 6 program officers has been presented in narrative form and frequencies have been used instead of percentages as the sample was very small. Data entry and analysis for all surveys were validated by Analysis of validated data using SPSS version 20

### **Section A. Data from caretakers/ guardians**

#### **Demographic data**

Majority 225 (54.9%) of the caretakers reported that most of children under five were males compared to 185 (45.1%) of females. Most 25.4% of the children in Nkwazi compound had malaria compared to 2.1% in masala. Caretakers said 189(46.1%) of these children were aged between 0-1year, 2-3 years accounted 148 (36.1%). Total children under five were 410 (100%).

#### **Knowledge level**

Majority 394 (96.1%) of the caretakers said they had heard about malaria and were knowledgeable of the signs and symptoms 353 (86.1%) said symptoms included headache, fever, joint pains and diarrhoea, while 36 (8.8%) said nausea, loss of appetite and body weakness. The findings further revealed that, the message was heard from the health institutions and health worker 252 (61.5% ), family and friends 74 (18%), Bill boards and posters 11 (2.7%), while Radio, Newspapers & TV 10 (2.4) Study further revealed that 283 (93.2%) of the caretakers reported that malaria was caused by mosquito bite, while 26 (6.3) lacked knowledge and said malaria is caused by drinking dirty water, getting soaked, and changing weather, while 2 (0.5%)said they did not know.

The table 6 shows that 266 (64.9%) of the caretakers revealed that the most affected group of people with malaria were children, everyone accounted 110 (26.8%), pregnant women 22 (5.4%) and adults accounted 12 (2.9%). The findings in table 8 further revealed that 152 (74.1%) of caretakers did not know the danger s signs of malaria in masala, while 89 (43.4%) did not know the danger signs in Nkwazi. The caretakers in Masala reported that, 175(85.3%) of the people affected with malaria are children and 91(44.3%) in Nkwazi compound also said children are the most affected with malaria. p value 0.000.



## **Fever in children**

210 (51.2%) of the respondents reported that, children did not suffer from fever in the past two weeks, while 200 (48.8%) said they had fever, of those who had fever, less than half 114 (27.8%) had fever for more than five days. The study findings revealed that 225 (54.9%) of the children did not receive a finger stick to test for fever, while 164 (40%) were tested. Those who reported that malaria diagnostic test was done, 145 (84.3%) reported that the results were positive, while 27 (15.6%) said that they were negative. P value .000.

## **Indoor residual household spraying**

Majority 141 (68.7%) of the respondents in Nkwazi (intervention area) had their houses sprayed in the past 12 months, compared to 51(24.8%) respondents in Masala the non-intervention area. p value. 000. Majority 325 (79.3%) of the respondents who had mosquito net had their children sleep under a mosquito net every day, compared to 85 (20.7%) who did not have mosquito nets. p value.000. Majority 162 (79%) of Nkwazi caretakers and 139 (67.8%) caretakers of Masala compound reported that they did not replaster or paint the walls of their homes in the past 12 months, compared to 36 (17.6%) in Masala and 15(7.3%) in Nkwazi who said they had painted or re-plastered the house p value 0.000. Majority of the respondents 305(83.8%) said that IRS is useful because it prevents malaria, while 16 said they are not useful. Others said it is useful because it kills insects like mosquitoes and cockroaches 58 (15.9%). P value .000. Majority 149 (72.6%) of the respondents in masala reported that acceptability of IRS was low compared to 115 (56%) in Nkwazi who reported that acceptability was average, p value .000. Majority of the caretakers 282 (69%) reported that the community was sensitized and their children sleep under mosquito net every day, while 43 (10.4%) said they don't sleep every day. p value 0.000. More half 185 (90.2%) of Nkwazi residents reported that, residents refuse IRS compared to 136 (66.3%) of Masala compound, p value 0.000.

## **Section B. Data from health facilities**

Baseline data: Review of health centre records at Nkwazi health centre revealed that there were 1575(100%) OPD attendance in October 2017, of these 606(38.4%) were children under-five, of these 68 (11.2%) were diagnosed with malaria. The total RDTs done in October at baseline of IRS were 1211 (100%), of these only 57 (4.7%) were positive.

Three months after IRS baseline data, record reviewed showed that, there were 5350 (100%) OPD attendance in January 2018, of these 1823(34%) were children under-five, of these 310 (36.6%) were diagnosed with malaria. The total RDTs done from November 2017 to January 2018 after IRS was 5446 (100%), of these 847 (15.5%) were positive for malaria.

Sixth (6) month after IRS: review of records revealed that, that there were 4875(100%), OPD attendance from February to April 2018, of these 1889 (38.7%) were children under-five, of these 256 (10.2%) were diagnosed with malaria. The total RDTs done from February to April 2018 after IRS was 3425 (100%), of these 434 (12.7%) were positive for malaria.

A total of 11,800 patients were seen from Nkwazi health centre from October 2017 to April 2018 and children accounted 4,318 (36.5%). During this period 10,082 (100) RDTs were performed and those that were positive were 1,338 (13.3%) of these children under-five with malaria were 634 (25.4%).

Baseline data: Review of health centre records at Masala health centre revealed that there were 6,515(100%) OPD attendance in October 2017, of these 1577 (24.2%) were children under-five, of these 24 (1.5%) were diagnosed with malaria. The total RDTs done in October at baseline of IRS were 1117(100%), of these only 87 (7.7%) were positive. Children under-five accounted 24 (27.5%) from the total RDT positive results. Three months after IRS baseline data, record reviewed showed that, there were 19,208 (100%) OPD attendance in January 2018, of these 4,584(23.8%) were children under-five, of these 79 (1.7%) were diagnosed with malaria. The total RDTs done from November 2017 to January 2018 after IRS was 3861(100%), of these 1034(26.7%) were positive for malaria. Children under-five accounted 79 (7.6%) from the total RDT positive results. Sixth (6) month after IRS: review of records revealed that, there were 16,959 (100%) OPD attendance from February to April 2018, of these 3944 (23.2%) were children under-five, of these 115 (2.9%) were diagnosed with

malaria. The total RDTs done from February to April 2018 after IRS was 4522 (100%), of these 736 (16.2%) were positive for malaria. Children under-five accounted 115 (15.6 %) from the total RDT positive results. A total of 25,723 patients were seen from Masala health centre OPD from October 2017 to April 2018 and children accounted 10,105 (39.2%). During this period 9,500 RDTs were performed and those that were positive were 1,857 (19.4%) and children under-five were 218 (2.1%).

### **Section C. Service delivery of IRS by program officers**

More than half n=4 (66.7%) of the program officers they reported that they did not spray all the compounds in Ndola. 66.7% of program officers attributed failure to spray all the compound to high IRS targets and few days for spraying. Figure 6: 83.3 % of the program officers reported that the training received by spray operators was adequate. Figure 5: 100% of the program officers reported that they supervised the spray operators on daily basis while in the field. More than half n=4 (66.6%) of the program officers reported that the coverage was medium. More than half n=4 (66.6%) of the program officers reported that, they had big catchment area with few days of spraying and n=2 (33.3%) reported inadequate time.

### **Chapter five: discussion of findings**

The study findings revealed that majority of the caretakers said they had heard about malaria and were knowledgeable of the signs and more than half said symptoms included headache, fever, joint pains and diarrhea, while others said nausea, loss of appetite and body weakness. However, a study done in Uganda by Ediau et al (2013) revealed that Less than half, 48.6% of the respondents were knowledgeable about IRS. The findings further revealed that, the message about malaria was heard from the health institutions and mainly from health worker and few were from family and friends, Bill boards and posters, Radio, Newspapers & Television. This shows that health care providers are key in the dissemination of health messages to the community. Study further revealed that, majority of the caretakers said malaria was caused by mosquito bite, while few lacked knowledges and said malaria is caused by drinking dirty water, getting soaked, and changing weather, while others did not know. Majority of the caretakers in Masala and of Nkwazi were aware of malaria, while those who have never heard of malaria were 3 (1.5%) and 44 (21.4%) respectively,  $P < 0.000$ . The findings show that majority of the respondents said that IRS is useful because it prevents malaria; more than half said it is useful because it kills mosquitoes and cockroaches, while few said they are not useful. There was a significant relationship between knowledge of usefulness and reasons for importance of IRS  $P$  value 0.000. This is in line Ediau (2013) who reported that almost all respondents who had heard about IRS 92.4% knew its importance in reducing mosquitoes and malaria. In view of this, developers of information, education and communication messages need to package the benefits of IRS as a mosquito bite reduction initiative but also emphasize its role as a malaria control strategy MOH (2010). The findings revealed that knowledge of danger signs of malaria influence decision making in a compound  $p$  value 0.000. However, more than half of caretakers said they did not know the danger signs of malaria in Masala, compared to almost half in Nkwazi. The implication of not knowing the danger signs could lead to late seeking of health services which could be the contributing factor to high mortality among the under-fives. This could be associated with their level of understanding of malaria and community sensitization. However, contrary to this assumption, majority of the caretakers in both compounds reported that the community was sensitized on malaria. Despite sensitization, there is need to continue intensifying Information Education and Communication messages on malaria in the community to ensure that all are well informed using the theory of reasoned action of behavior to obtain responses from the caretakers as they were the target population who made choices on behalf of children. The study revealed that half of the caretakers said malaria can be prevented by sleeping under a mosquito net, while almost half said sleeping under a treated mosquito net, spraying the house with insecticide; use mosquito repellants and coil. This shows that they had adequate knowledge on prevention strategies; however, the attitude and practice may be different as the study revealed that almost half of Nkwazi residents refuse IRS compared to less than half of Masala compound. These findings are in line with Winch P. et al 1992 who revealed that at community level men as heads of households may not be aware of the impact of malaria on the health of young

children or pregnant women may refuse IRS as they may not see the value. The findings compliment those of Mwiinga (2019) who reported that almost all (n=7) program officers said that residents in Ndola townships refuse IRS and 51.8% of the spray operators attributed refusals to bad smell, dirtiness on walls, and itching effects, while 18.4% said lack of information. The study further revealed that majority of the caretakers revealed that the most affected group of people with malaria are children under-five. Comparison of most affected group of people with malaria by compound revealed a significant association p value 0.000, more than half of the caretakers in Masala reported that children are the most affected, while in Nkwazi compound they were less than half. This could be attributed to the fact that children depend on adults to protect them against mosquito bite to use protective measures Ediau 2013.

### **Fever in children**

The study revealed that half of the caretakers reported that, children did not suffer from fever in the past two weeks, while almost half said they had fever. This is validated by findings in the Zambia national malaria indicator (2015) which reported that almost one-fifth of children had a fever in the two weeks prior to the survey. The study further revealed that, of those who had fever, less than half had fever for more than five days and half of the caretakers reported that they sought treatment for fever. A study done in Ghana showed that odds of parasitaemia at the end of both transmission seasons were significantly higher among children who were reported to have had fever within 48 h prior to survey compared with those who had no fever (OR = 3.2, 95% CI: 2.9–3.6 for the high transmission season and OR = 4.4, 95% CI: 3.8–5.1 for the low transmission season). The Zambia national malaria Indicator survey (2015) further highlighted that Fever prevalence remains higher in rural areas but has declined markedly in both rural and urban areas.

Findings revealed that more than half of the respondents said that results were negative, while less than half said they were positive. The study showed that the most affected age group with malaria is 0-1year, of these children, 74 were positive, while 105 were negative, compared to 19 of those who were aged 5year, only 2 were positive while 15 were negative and reject the null hypothesis P value 0.225. We can deduce that age is not significantly associated with the test result. The findings further showed that those who said malaria diagnostic test was done, majority said that the results were positive, while few said that they were negative. There is a significant association therefore we reject the null hypothesis p value 0 .000. This compliment the findings in Kenya Malaria survey 2007 which found a prevalence of 17% in children under-five years in endemic areas, compared with 1.4% in areas of seasonal malaria transmission.

A study conducted in a high-transmission-intensity area of Northern Uganda by Abuaku B. (2018) that assessed the association between IRS and malaria morbidity, revealed a much greater decrease in the odds of malaria in patients less than 5 years of age following three rounds of IRS (ORs 0.34, 0.16, 0.17 respectively,  $p < 0.001$ ). The findings also compliment those of Chanda E (2013) who reported that the impact of Zambia's interventions is visible through the reduction of the annual number of malaria deaths by over 60 percent between 2000 and 2008; under five malaria deaths by 41 percent between 2006 and 2008.

The findings further showed that majority of the respondents revealed that most of affected people with malaria were children, and adults accounted 2.9%. The study findings revealed that more than half of the children did not receive a finger stick to test for fever, while more than half were tested. Findings revealed that more than half of the caretakers reported that results were negative, while 36.6% said they were positive. The study revealed that more than half of the RDT tests were done in masala compared to almost half in Nkwazi compound. Study revealed that the most affected age group with malaria is 0-1year. These findings are contrary to 2011 multiple indicator cluster survey which was done in Ghana, which suggested that older child age-groups within children less than five years bear the highest burden of malaria infection (Abuaku B 2018). The study further revealed that out of 189 children who were tested for malaria, quarter were positive for those who were aged 0-1year, compared to few of those who were aged 5year, only 2 were positive. However, there was no statistical significance between age and malaria result, p value 0.225, we therefore fail to reject the null hypothesis.

### **Indoor residual household spraying**

This study showed that, more than half of the respondents in Nkwazi (intervention area) had their houses sprayed in the past 12 months, compared to few respondents in Masala the non-intervention area. Among those whose homes were not sprayed during IRS 153 were from Masala and 64 were from Nkwazi. There is a significant association between Indoor residual household spraying and resident compound p value .000. This compliments the findings for MIS (2015) which indicated that the percentage of houses sprayed increased from 8.9% in 2006 to 25.3% in 2015. This was affirmed by the program officers who reported that IRS coverage was average. In this study majority more than half of the caretakers from Nkwazi compound reported that children were sleeping in houses which were sprayed during IRS, compared to half of the respondents in Masala compound. It is worth noting that, despite IRS in Nkwazi malaria morbidity was higher than the control compound. The findings of this study have revealed that re-plastering of walls was significantly associated with the intervention area p value 0.000. In this study majority of the caretakers of Nkwazi and Masala compound reported that they did not replaster or paint the walls of their homes in the past 12 months, compared to 17.6% in Masala and 7.3% in Nkwazi who said they had painted or re-plastered the houses. These findings compliment the findings by Mwiinga V. (2019) who reported that 28.1% of the spray operators revealed that repainting of walls was very much an operational problem. This shows that replastering and repainting of houses after IRS was still a problem and need to be addressed. This may be the contributing factor to high morbidity of malaria among under-fives as shown by health Centre data 36.6% in the intervention compound, despite IRS done three months ago compared to 1.7% at non-intervention area.

The study showed that spraying of houses was significantly associated with malaria density in the compound P value 0.000. Majority of the caretakers from Nkwazi compound reported that children were sleeping in a house that was sprayed during IRS, compared to few caretakers in Masala. This is validated with the health Centre records which showed an increase in cases of malaria among under-fives three months after IRS. This shows that morbidity among under-fives in an intervention area Nkwazi continued to rise despite the spraying on going from more than half at baseline to 36.6% after 3 months, while the control group had a slight increase from few at baseline to 1.7% after three months of IRS. This increase in incidence of malaria calls for combined effort among stakeholders and ministry of health to address this problem if malaria was to be controlled hence the theory of reasoned action of planned behavior utilization for Outcome evaluation which focused on short- and long-term program objectives. Appropriate measures demonstrate changes in health conditions of children under-five, quality of life will be improved, and behavior change will be enhanced as people will make informed choices. The study showed that there was a statistical difference between IRHS among the compounds and the time of spraying p value 0.017 and we reject the null hypothesis, majority of the caretakers from Nkwazi compound reported that, their homes were sprayed 1-3 months ago, while few were from Masala. This is associated to non-spraying of the whole compound in Masala as sporadic spraying was done according to household preference by private arrangement. This is affirmed by the results from Masala which showed that majority of the caretakers in Masala reported that their homes were sprayed more than a year ago and are in line with what was said by all n=6 program officers that they did not spray all the compounds. The study revealed that there was a significant association between having a mosquito net and sleeping under a mosquito net p value 0.000. Majority of the respondents who had mosquito net had their children sleep under a mosquito net every day, compared to few who did not have mosquito nets. The findings of this study have revealed that replastering of walls was significantly associated with the intervention area p value 0.000. Majority of caretakers from Nkwazi and Masala compound reported that they did not replaster or paint the walls of their homes in the past 12 months, compared to less than half in Masala and Nkwazi who said they had painted or re-plastered the houses. These findings compliment the findings by Mwiinga V. (2019) who reported that 28.1% of the spray operators revealed that repainting of walls was very much an operational problem. The findings further revealed that majority of the respondents said that IRS is useful because it prevents malaria, while few said they are not useful and others said it is useful because it kills insects like mosquitoes and cockroaches, P value 0.000.

The findings revealed that majority of the respondents in masala reported that acceptability of IRS was low compared to more than half of Nkwazi caretakers who reported that acceptability of IRS was average. There was significant association between acceptability of IRS and rating of IRS p value 0.000, we therefore reject the null hypothesis. This is complimented with the findings by Mwiinga V. (2019) who reported that, program officers and spray operators rated community acceptability of IRS as average n=4 and 73.3% respectively and proportions were significantly different  $p < 0.05$ .

The study findings showed that community sensitization influences children sleeping under a mosquito net every day and the relationship was found to be statistically significant p value 0.000. Majority of the caretakers reported that the community was sensitized, and their children slept under mosquito net every day, while half said they were not sensitized and few said their children did not sleep in a mosquito net every day. These findings are in line with findings by Mwiinga (2019) who reported that, program officers said community sensitization was adequate n=4. When asked about refusal the study found a significant association between refusal and the intervention area, p value 0.000, majority of Nkwazi residents reported that, residents refuse IRS compared to more than half of Masala compound.

This compliment the study done by Ediau (2000; 2013) who reported that a large proportion of people still had negative perceptions towards use of IRS. These negative perceptions and the limited knowledge were more prevalent in rural areas, which have the greatest need for effective malaria control strategies [WHO 2013; Kenya MIS 2010; Zambia National MIS 2010]. Further analysis of studies on IRS showed that there are various reasons for refusal. A study by Mangumbe k. et al (2011) in Mozambique reported that non-adherence to the intervention was mainly due to the unavailability of key householders, disagreement with the procedures, and the perception that spraying increased the burden of insect. This was also highlighted by Mwiinga 2019 who reported that more than half 75.2% of the spray operators said reasons for refusal were mainly; bad smell, dirtying walls, itching effect and recent spray/ replastering of homes, while 24.7% said it was due to lack of information, not effective and inability kill other insects.

The findings revealed that age was significantly associated with sleeping under a mosquito net P value 0.004. More than half of the children under-five aged 0-5years were reported sleeping under a mosquito net every day, compared to less than quarter who were not sleeping under a mosquito net. These findings compliment the findings from Zambia MIS (2015) which reported that 58.9% of children under age five years were reported to have slept under a mosquito net the night before the survey, and 57.7% of children under age five years were reported to have slept under an ITN. The study revealed that more than half of the caretakers in Nkwazi and Masala reported that malaria is prevented by sleeping in a mosquito net / treated mosquito net and there was a significant relationship between knowledge on prevention of malaria and sleeping in a mosquito net P value 0.000, therefore we reject the null hypothesis.

### **Data from health facilities on incidence and prevalence of malaria**

The study findings revealed that health centre records at Nkwazi Health Centre showed that, there were 1,575 OPD attendances in October 2017 at baseline before Indoor Residual Household Spraying (IRHS) and less than half of all OPD attendances were children under-five, and of these, few were diagnosed with malaria. To confirm a diagnosis of malaria RDT was done to all patients who presented with fever to rule out malaria. The total RDTs which were done in October at baseline of IRS were 1,211, of these, few were positive. This data was compared to baseline data for the control group at Masala Health Centre, which revealed that there were 6,515 total OPD attendances in October 2017, of these almost quarter were children under-five, a total of 1,117 RDTs were done in October at baseline of IRS and less than half were positive, of these positive, three quarters were children under-five.

The data collected showed that, malaria morbidity among under-fives was at 11.2% in Nkwazi while, in Masala it was at 1.5% at baseline. This showed that there was high malaria morbidity at the intervention site than the control group, which could be attributed to high burden of malaria unlike the control group. However, these findings are contrary to the findings by Abuaku B (2018) who reported that the odds of parasitaemia was significantly lower after the application of an organophosphate

compared with the pre-IRS survey (OR = 0.3, 95% CI: 0.2–0.3), and remained stable after another round of IRS with an organophosphate (OR = 0.3, 95% CI: 0.2–0.3).

It is worth noting that, three months after IRS baseline data, record reviewed at Nkwazi showed that, there were 5,350 OPD attendances from November to January 2018, and almost half were children under-five. The total RDTs done after three months from November 2017 to January 2018 after IRS was 5,446, of which less than quarter were positive for malaria, of these almost half were diagnosed with malaria. However, data from Masala showed that three months after IRS baseline data, there were 19,208 total OPD attendances in January 2018, of these almost one quarter were children under-five. The total RDTs done from November 2017 to January 2018 after IRS was 3861, of these more than a quarter were positive for malaria and Children under-five accounted less than a quarter. This showed that morbidity among under-fives in an intervention area continued to rise 36.6% despite the IRS going on, while the control group from Masala it was 1.7%. This increase in malaria morbidity could be attributed to bleeding season of malaria during rainy season and differences in geographical location among the two sites. The peak month being January 2018 for Nkwazi, while in Masala it was in December 2017.

Re-assessment of health centre data was also done in the sixth month after IRS to determine the incidence of malaria. The study further showed that, review of health centre records at Nkwazi in the Sixth (6) month after IRS showed that, there were 4,875 OPD attendances from February to April 2018, and almost half of all OPD attendances were children under-five, of these 10.2% were diagnosed with malaria. This was affirmed by most of the caretakers who reported that the most affected group with malaria was children under-five. The total RDTs done from February to April 2018 after IRS was 3,425, of these few were positive for malaria. However, review of records from Masala health Centre revealed that, there were 16,959 OPD attendances from February to April 2018, of these, quarter were children under-five. The total RDTs done during this period was 4522, of these less than quarter were positive for malaria, of which 15.6% were Children under-five. Malaria morbidity among under-fives in Nkwazi at six months after IRS was 10.2%, while in Masala it was 2.9%. These results still showed that malaria morbidity was still high in the intervention area unlike the control group in the non-intervention area.

## Summary

A total of 11,800 patients were seen in OPD from Nkwazi health Centre over a period of six months and children under-five accounted less than quarter. During this period 10,264 RDTs were performed and those that were positive were 13.3% of these 25.4% were children under-five who had positive results for malaria. A total of 25,723 patients were seen from Masala health Centre over A total of 25,723 patients were seen from Masala health Centre over a period of six months at OPD and children accounted almost half. During this period 9,500 RDTs were performed and those that were positive were 19.4%, of these children under-five with positive RDT were few 2.1%. These findings are contrary to the findings by Tukei et al. (2017) who reported that malaria was reduced in the first months following IRS. The decreasing effect of the SPR however waned 4–6 months following IRS. Further studies are needed to expound the waning effect. This shows that findings are contrary to Tukei et al findings, as malaria morbidity did not reduce within the first three months of Indoor Residual Spraying, instead it reached it peak in December and January 2-3 months after spraying respectively. This shows that there could be other causal factors, which could have contributed to this scenario which must be explored. This could be attributed to refusals as acceptability was average to low. There is need re-package IRS messages using the model of reasoned action of planned behavior.

## Conclusion

This study has shown that children under-five is most vulnerable to malaria and should be protected. The investigator sought to find out the performance of IRS in the control of malaria among under-fives in Ndola despite high coverage of IRS. This enquiry on efficacy of IRHS from a public health perspective has great potential for improving service delivery and reducing morbidity and mortality rates for malaria among children under the age of five. The study finding has highlighted program needs, provide strategic direction for future programs, may strengthen planning and

implementation of IRS. The evidence provided acts as a basis for future research as it has contributed to the scientific body of knowledge in public health. Also, the finding shows that morbidity was high at the intervention site where IRS was done despite blanket spraying. This shows that there are other causal factors which could be associated with this scenario and may need prompt attention if malaria has to be curbed in order to reduce morbidity and mortality among under-fives. At the same time, the gaps that have been seen need to be addressed through the theory of reasoned action of planned behavior into policy process to ensure that interventions that are effective are implemented.

### **Contribution to knowledge**

This study has contributed to the scientific body of knowledge as it has first-hand information based on local experiences. It has formed a basis for future research and the findings may be generalized to other settings with similar characteristics.

### **Suggestions for future research**

There is need to conduct this research on a wider scale incorporating other provinces to establish the magnitude of the problem.

Another study can be done on efficacy of chemicals currently being used to rule out resistance.

### **Recommendations by program expert**

Spraying should be done yearly and IRS should be on going. Spray days should be increased so that targets are met.

### **Expected output**

When applied properly, IRS is a powerful malaria vector control intervention, rapidly reducing vector-transmission capacity and malaria incidence. IRS provides maximum mass effect on the vector populations when it is applied at high coverage levels, thereby reducing malaria mortality.

### **Societal and scientific relevance**

Social factors, such as the willingness of a community to accept IRS services and to cooperate with a spraying program, are of critical importance when selecting areas for IRS. Sometimes households are receptive to IRS in the early stages when malaria and intense mosquito biting are perceived as problematic, but are less receptive when transmission has been reduced but not yet eliminated. IRS is also an appropriate vector-control method for the protection of camps for displaced persons or refugees, migrants, military personnel and sometimes construction workers. More information on malaria and vector control for refugee camps is available from WHO (2013). Cultural patterns in relation to housing must be considered. In some communities, outdoor sleeping is common in the hot and humid season, a time when mosquitoes are also abundant and active. Also, individual householders may re-plaster or whitewash walls, or re-thatch ceilings after spraying, thereby reducing vector exposure to the insecticide and making repeat spraying as a necessity. IRS has been scientifically proven to reduce malaria cases in Zambia as seen by Nkonkola mine when properly applied. However, in this study the efficacy of this intervention has not been proven as incidence of malaria kept on rising 1-3 months after IRS, which could be attributed to refusals, efficacy of chemicals and community practices.

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