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EFFECT OF INDOOR RESIDUAL SPRAYING ON INCIDENCE OF MALARIA IN KAOMA DISTRICT OF WESTERN PROVINCE, ZAMBIA

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DEDICATION

They that wait upon the Lord shall renew their strength they will fly on wings like an eagle; they shall run and will never grow weary. Indeed, who can say a thing and it comes to pass until the Lord God allows it. I dedicate this work to my late grandmother Ngapizya Phiri who taught me to be resilient in the face of difficulties and challenging moments. To my wife Chomba and my sons; Madaliso , Musonda and William for bearing my long absence from home.

STATEMENT

I hereby state that this dissertation is entirely the result of my own personal effort. The various sources to which I am indebted have been clearly indicated in the references and acknowledgement.

Signed: …….

Emmanuel Phiri

DECLARATION

I declare that this dissertation herein presented for the Degree of Master of Science in Public Health (Environmental Health) has not been previously submitted either wholly or in part for any other Degree at this or any other University nor is it being currently submitted for any other Degree.

Signed: …….

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Approved by:

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Prof. K. S. Baboo (supervisor).

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Dr. J. Miller (supervisor).

APPROVAL

The University of Zambia approves this dissertation of Emmanuel Phiri as fulfilling part of the requirements for the award of the Master of Science Degree in Public Health (Environmental Health).

Signatures

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ABBREVIATIONS

CDC	US Centre for Disease Control and Prevention
DDT	Dichlorodiphenyls – trichlorethane
EHO	Environmental Health Officer
SNDP	Sixth National Development Plan
GDP	Gross Domestic Product
GNDP	Gross National Development Product
HMIS	Health Management Information System
IRS	Indoor Residual Spraying
ITNs	Insecticide Treated Mosquito Nets
ITP	Intermittent Preventive Therapy
KCM	Konkola Copper Mines
KDHMT	Kaoma District Health Management
KMIS	Kaoma Malaria Information system
MACEPA	Malaria Control and Evaluation Partnership in Africa
MDGs	Millennium Development Goals
MOH	Ministry of Health
NMCC	National Malaria Control Centre
NMSP	National Malaria Strategic Plan
PPEs	Personal Protective Equipment
RBM	Roll Back Malaria
RIHS	Residual Indoor Household Spraying
WPHO	Western Province Provincial Health Office
WHO	World Health Organization

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ABSTRACT

Introduction

Indoor residual spraying is one of the methods identified by World Health Organisation in combating malaria by controlling the vector mosquito. In line with the Zambian policy in malaria control, Kaoma district in Western Province of Zambia started implementing indoor residual spraying as the method of combating malaria in 2008.

Aim

The main purpose of the study was to ascertain the effect of indoor residual spraying on incidence of malaria in Kaoma district of Western Province of Zambia. Specific objectives were to compare incidence of malaria in health centers with Indoor residual Spraying to health centers that did not implement indoor residual spraying, determine the relationship between management of indoor residual spraying programme and the outcome of malaria incidence and find out the community level of acceptance of IRS program in Kaoma district.

Methodology

The study was a retrospective cohort analysis of incidence data across a single spray season, mixed with cross sectional survey results to assess levels of interventions, community understanding and perceptions and quality of IRS efforts.

The study involved two stages. The first stage was retrospective audit of malaria incidence data across a single spray season. The second stage was cross sectional survey to assess levels of intervention, community understanding and perceptions, and quality of IRS efforts, which were compared with household sprayed. Interviews included household heads or the representative. The other party interviewed included the supervisors for the IRS program.

Multistage sampling was used to select respondents from households and probability proportional to size (PPS) was used to select clusters in which respondents were picked. To validate the findings of the study, statistical significance was set at $p < 0.05$.

Results

The study demonstrated that areas with a larger percentage of the population (greater than 60%) protected by Indoor residual spraying had lower incidence of malaria (82/1000 and 400/1000) compared to unsprayed area (398/1000 and 773/1000) both at the beginning and pick of malaria transmission season. A chi-square test shows that there was an association between spraying and reduced malaria incidence, $p < 0.05$. Factors such as length of Insecticide Treated Nets ownership and building material for the house (p-value< 0.04 and 0.03) respectively had an association with the level of IRS acceptance. Acceptance of indoor residual spraying program was good at 64% of the 100% response rate interviewed. Reasons given for those who did not have the houses sprayed among others was absence from home (79%). There was an association between Knowledge of the use for IRS and school attendance p-value < 0.001. Management of the program was poor, negatively affecting results of indoor residual spraying, starting from ill timing (wrong season) to management of commodities such as personal protective equipments, Insecticide, inadequate transport and short notice given to the households.

Conclusion

Indoor residual spraying was association with reduced malaria incidence in Kaoma district in areas where it was implemented. Poor management of the programme, however, negatively affected the results. The study clearly demonstrated that IRS activities continued during the rainy season. According to IRS policy activities of spraying should have been completed before the onset of rains. The district needs to focus on management of logistics, intensify sensitisation and improve on the starting time of IRS if it has to have the desired impact in preventing malaria. This matter should be critically looked at if Zambia has to eliminate malaria by 2015.

Contents

LIST OF TABLES

LIST OF FIGURES

Definition of Key Operational Terms

- **Indoor residual spraying :** The process of applying insecticide inside the dwelling place
- **Indoor** **:** That which takes place inside the house
- **Residual** **:** The amount of active chemical that remains on the wall
- **Insecticide** **:** The chemical used for killing the mosquitoes or any other insect
- **Spray operator** **:** An individual who does the spraying
- **Household** **:** A house or any other structure of dwelling
- **Structure** : A house or dwelling place
- **Catchment area** : The jurisdiction of the rural health centre
- **Malaria Incidence** : Number of new malaria cases per 1000 population
- **IRS protected population** : Number of people in the houses that have been sprayed

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INTRODUCTION

1.1 Background

Malaria is a parasitic infection caused by the bite of an infected female anopheles mosquitoe while sucking blood (Cook & Zumla, 2009). The disease is distributed worldwide; it is found throughout the tropical and subtropical regions of the world and causes more than 300 million acute illnesses and at least one million deaths each year (WHO, 2010). More than two-thirds of malaria cases and approximately 90% of deaths occur in Africa, mainly in children under five years of age (NMCC, 2011). Malaria remains a major cause of poverty and under development. People in malaria regions live at continuous risk of this disease.

The increase in global burden of malaria in the 1950s led to the development of malaria eradication programme, whose aim was to reduce or eliminate malaria (Mabaso, 2004) .The programme contributed significantly to reducing global malaria burden, especially in Asia, Latin America and Southern Africa. Several interventions were developed and Vector control was recognised to have a significant impact on malaria control (NMCC, 2010). Indoor residual spraying (IRS) was identified as one of the major means of controlling vector mosquitoes to interrupt malaria transmission. IRS is the application of the internal walls of the houses and structures with a chemical (insecticide) that remains poisonous to mosquitoes for several months once they rest on the walls (WHO,2006).

Despite success scored by indoor residual spraying program between1955–1969 in reducing incidence of malaria, there was a decline in support of the programme either due to perceived health and environmental risk of chemicals used or lack of commitment as a result of huge cost demanded by the programme (Mabaso, 2004). The decline to support the programme resulted in the resurgence of malaria disease burden in areas where it had been controlled. Early global successes attained mostly in temperate or subtropical areas by reducing in some cases to 90% or more, however, made renewed support for IRS eradication in major tropical Asia and South America.

Unfortunately, most of the African continent was not involved in this early effort of malaria eradication programme (Mabaso, 2004). Consequent attempts to control malaria through primary health care strategies were largely unsuccessful. Malaria eradication pilot projects

were initiated from the 1950s to the 1970s in Benin, Burkina Faso, Burundi, Cameroon, Kenya, Liberia, Madagascar, Nigeria, Rwanda, Senegal, Uganda and the United Republic of Tanzania. The projects demonstrated that malaria was highly responsive to control by IRS with significant reduction of anopheline vector mosquitoes and malaria (WHO, 2006).

In Zambia, over the past 50 years, malaria control has been introduced at various times. These were either strengthened or neglected (MoH, 2010). From 1980 to 2000, relatively limited malaria prevention existed in Zambia because the use of DDT came to a halt. This was as a result of ban of DDT coupled with falling copper prices (KCM, 2001). As a result of this, Zambia was not able to replace DDT with another insecticide because of its high cost. Districts therefore, resorted to treatment, only to realize in 1979 that chloroquine, the drug of choice for malaria treatment was resistant to the parasite.

The absence of IRS and chloroquine resistance resulted in rise in malaria burden that ranged from 700 to 1100 per 1000 children under five years and from 80 to 220 per 1000 population for people above the age of five years in 1980 to 1999. It was, therefore, concluded that malaria was getting worse in Zambia in the 25 years prior to 2000. From 2000, due to renewed global attention towards malaria control, Zambia reintroduced and strengthened malaria prevention and control, consistent with the global effort in Roll Back Malaria (RBM) initiative and using proven prevention and treatment interventions.

The two main vector control interventions aimed at preventing malaria transmission recommended by RBM are ITNs and IRS. IRS was reintroduced in Zambia by the private mining sector in 2000. The successful implementation and subsequent reduction in malaria incidence in areas prioritised for IRS by Konkola Copper Mines in 2003,the Government decided to emulate the effort and implemented the program in the public sector, initially on pilot basis in five urban districts (Ndola, Kitwe, Kabwe, Lusaka, and Livingstone) - all along the line of rail (MoH,2010). By 2010, IRS had been conducted in 54 districts countrywide, targeting urban and peri-urban areas within these districts. In the targeted districts, 85% of people living in eligible households had their homes sprayed annually through IRS. The program reached approximately 1.1 million households in 2010 hence providing protection to an estimated 4.7 million Zambians (NMCC, 2011).

The reintroduction of IRS as an additional control measure saw reduction in incidence of malaria from 425 per 1000, population in 2003 to 246 per 1000 population in 2009. Since

2010, however, there has been an increase in incidence of malaria in the country to 330 per 1000 from 246/1000 the previous year (NMCC, 2011).

In Western Province, the program had covered 5 out of 7 districts, and an estimated population of 256,275 had been protected. Western Province reached an average of 94% of the targeted structure in 2010 spraying season. Kaoma district achieved to spray 92% of the targeted structures, therefore, protecting a population of about 63 618.

1.2 Problem Statement

Malaria is still one of the major public health problems in Zambia. It is a major contributor to morbidity and mortality in the country. The disease accounts for up to 65% of hospital and health centre admission (MoH, 2007). In Western Province, Kaoma district to be specific, malaria ranks second on the top ten cause of hospital visitation. The provincial incidence rate was at 114 per 1000 and fatality rate was at 32 per 1000 admissions in 2010 (WPHO, 2011). Kaoma district incident rate was at 366 per 1000 population; mortality was at 20 per 1000 hospital/health centre admission. Children under five, pregnant women, and immune compromised individuals are most vulnerable to the disease.

In line with the national policy in the control of malaria, Kaoma district introduced a number of control measures aimed at reducing its incidence**.** Among the various interventions was Indoor Residual Spraying (IRS), introduced in 2008 in Kaoma district. The intervention targeted urban and peri-urban areas within the district, and scaled from the initial 7 catchment areas to 17 in 2010. By 2010, the programme covered 92% of the targeted structures and offered protection to an estimated population of 63,618 (75% of targeted population). Kaoma district is one of three (3) districts (Kaoma, Senanga and Sesheke) out of five (5) IRS districts in Western Province that had shown an increase in the number of malaria cases after making a steady decline since the introduction of IRS in the control of malaria.

An increase in incidence of 189 per 1000, in 2009 to 366 per 1000 in 2010 was noted (HMIS Kaoma DHMT).The incidence had started increasing despite vigorous scale up of IRS intervention since its inception in Kaoma district of Western Province. The reasons for the resurgence of malaria cases were unknown with certainty (WHO, 2011). From the cause and effect diagram (page 16), the probable causes of failure of IRS to have an effect on the incidence of malaria include: delayed arrival of commodities, poor procurement and failure to

complete IRS before the onset of rain, Inadequacies in the management of the IRS program, refusal by some households to spray their houses, households not adhering to instructions following spraying and poor quality of program management**.**

1.3 Justification

Malaria is one of the major contributors to morbidity and mortality in children under five years, pregnant mothers and people who are less immune to the disease. It contributes negatively to social and economic development of the country as it causes disruption in work due to absenteeism. Kaoma district, over the last past 9 years, from 2001 had shown reduced incidence which was attributed to interventions implemented in the district such as use of ITNs, improved diagnosis and treatment of malaria WPHO (2008). Introduction of IRS was further to complement and strengthen malaria control effort.

Kaoma had by 2010, 17 out of the 28 catchment areas implementing IRS. The number of structures sprayed is added for each Spraying season. In 2010, 92% of the targeted structures were covered and 75% of targeted population was presumably protected (WPHO, 2010). With this increased high IRS coverage and expanding program, the incidence of malaria is expected to reduce further in the district. Kaoma, however, has shown an increase in malaria incidence. The increase in malaria incidence threatened to reverse the achievement attained towards reaching the Millennium Development Goals (MDGs).

Effectiveness of IRS on the reduction of incidence of malaria in Kaoma had never been investigated and ascertained nor the results from other studies been compared to Kaoma. It is for this reason that the effectiveness of IRS in reducing malaria incidence in Kaoma is ascertained.

Findings of the research would improve IRS implementation at district level in Western Province, consequently help to reduce malaria incidence. Stakeholders would use the findings of the study to advice policies intended at increasing IRS knowledge and community acceptance of the program. It would ensure smooth information, education and communication to the intended target. Assist to put in place measures that would result in an increase in IRS coverage and to plan for community participation in IRS implementation.

1.4 Objectives

1.4.1 General Objective

To establish the effect of Indoor residual spraying on malaria incidence in IRS health centres of Kaoma in Western Province.

1.4.2 Specific Objectives

1. To compare incidence of malaria in health centers to non-IRS health centers in Kaoma district.
2. To determine the relationship between management of IRS program and the outcome of malaria incidence in the district.
3. To find out the community level of acceptance of IRS programme.

1.4.3 Research Question

Does indoor residual spraying contribute to reducing incidence of malaria in Kaoma district?

LITERATURE REVIEW

2.1 Malaria control

2.1.1 Global situation

The goal established by the member states at the World Health Assembly and Roll Back Malaria Partnership is to reduce the number of malaria cases and deaths recorded in 2000 by 50% or more by the end of 2010 and 75% or more by 2015 (WHO,2009). To achieve the goal of reducing malaria incidence, World Health Organization-Global Malaria Programme recommended three primary interventions. These were; Effective diagnosis of malaria cases and treatment with effective medicines; distribution of Insecticide –treated nets (ITNs) to achieve full coverage of population at risk of malaria, and IRS as a major means of malaria vector control to reduce and eliminate malaria transmission (WHO,2006).

2.1.2 Malaria Vector Control.

Vector control remains the most generally effective measure to prevent malaria transmission and therefore is one of the four basic technical elements of the global malaria control strategy (NMCC, 2010). The principal objective of vector control is the reduction of malaria morbidity and mortality by reducing the levels of transmission. Vector control methods vary considerably in their applicability, cost and sustainability of their results (WHO, 2011). Pluess, B. *et al* (2010) states that primary prevention of malaria is essentially achieved through two main vector control intervention: indoor (house) residual insecticide spraying (IRS): and insecticide–treated mosquitoes nets (ITNs).

The principle of IRS is that the internal walls of the houses and structures are sprayed with an appropriate chemical that remains lethal to the mosquitoes for several months. Once the mosquitoes rest on the sprayed walls, they pick up the chemical on their feet that paralyses their nerves leading to death thereby cutting down the transmission of the disease to another person (WHO, 2011). The primary effects of IRS towards curtailing malaria transmission are twofold: i) to reduce the life span of vector mosquitoes so that they can no longer transmit malaria parasites from one person to another, and ii) to reduce the density of the vector mosquitoes (WHO,2006). It has been observed that in some situations some insecticides also repel mosquitoes and by so doing reduce the number of mosquitoes entering the sprayed room, and thus human-vector contact.

IRS was and is one of the formidable control measures of malaria and scientific evidence indicates that IRS is effective in controlling malaria transmission and thus reduces the related burden of morbidity and mortality as long as most (more than 80%) houses and animal shelter in targeted communities are treated (WHO,2006).

2.2 History of Malaria Control in Zambia

Zambia is one of the unique countries that have experienced down and upward swing in the prevalence of malaria in the past 60 decades. Prior to 1970, malaria in urban areas in Zambia, especially towns along the line of rail (Copper, Lusaka to Livingstone), was kept to a minimum due to effective prevention and control programmes. This was due to effective implementation of control measures, enforcement of public health laws and sound supportive economy (MoH, 2007). Vector control, especially IRS, was at its highest in the local, municipal and mine controlled towns and this contributed to reduction in malaria incidence.

Falling copper prices between 1978 and 1982, however, resulted in reduced GDP and subsequent economic difficulties could not allow sustenance of vector control activities. There was also a ban on DDT and chloroquine resistance. The result was increase in malaria incidence and death rates (KCM, 2001). Nevertheless, this started to reverse when Zambia started implementing the Roll back malaria (RBM) strategy. The commonest method of vector control in Zambia is IRS, which was reintroduced following successful results from Konkola copper mines and Mazabuka sugar company plantation. Konkola copper mines effectively carried out IRS, which resulted in reduction of incidence rate from 68/1000 to 20/1000 for Chingola and 158/1000 for Chililabombwe respectively (Sharp B.etal, 2002). This became a model for Zambia.

2.3 Socio – Economic Importance of Malaria

2.3.1 Global and African Situation

Malaria remains one of the diseases after HIV/AIDS that have caused havoc to the communities in the world today. In the infected regions, malaria causes social and economic difficulties to both individual and governments. It impedes economic growth in endemic countries. Projections show that economic growth per year of countries with intensive malaria was 1.3% lower than that of countries without malaria (WHO, 2011). In Tanzania,

Emmanuel (2007) in the study of priority setting for malaria intervention showed that malaria has been estimated to cost Tanzania more than US$ 240 million every year in lost gross domestic product (GDP) while it could be controlled for a fraction of that sum. It is probable that 40% of the world's population is at risk of malaria and the vast majority live in the world's poorest countries, each year there are an estimated 250 million-malaria cases world wide and 800 000 deaths related to the disease (WHO, 2011); and of these about 60% of the cases and more than 80% of malaria deaths worldwide occur in Africa south of the Sahara (CDC, 2004).

2.3.2 Zambia Socio-Economic Importance

Malaria is endemic in the whole of Zambia and is a leading cause of morbidity and mortality (MoH, 2011). According to the 2011 Progress & impact series country report no. 2 on Zambia, it found that human and economic impact of the disease is a serious curb to economic development. This either is directly (through the costs of health care and hospitalization) or indirectly (through workdays lost to personal illness or to caring for a sick child). Malaria accounts for 6.8 million disability-adjusted life years lost in Zambia, which was more than respiratory infections (5.4 million), or HIV/AIDS (3.2 million).

2.3.3 IRS and Vector Control

Indoor Residual Spraying had for a long time been used in malaria control, mainly with Dichloro-diphenly-trichloromethane (DDT). In Asia, Russia, Europe and Latin America malaria was eliminated or greatly reduced as a public health problem through IRS (Plues, B. et al, 2010) in addition Mabaso (2004) showed that in Southern Africa (South Africa, Swaziland, Namibia , Zimbambwe, and Mozambique) IRS protected the community after its introduction and in some areas managed to eliminate the disease. WHO (2011) observed that IRS programmes have expanded considerably over the years and the number of people protected in the African region increased from 10 million in 2005 to 73 million in 2009, which is equivalent to protecting 10% of the population at risk. Mamta, D. et al (2009) in the study of Impact of Indoor Residual Spray with Synthetic Pyrethroid in Gandhinagar district - Gujarat proved that in spite of the constraints associated with IRS, it still has a major role in the control of malaria if implemented with proper supervision, better coverage and community participation.

Plues, B. et al (2010) observed that IRS operates both through repelling mosquitoes from entering houses and by killing female mosquitoes that are resting inside houses after having taken a blood meal. This implies that IRS is most effective against mosquito species that are resting indoor (so-called endophilic mosquitoes).

2.4 Criteria for Indoor Residual Spraying

The main purpose of IRS is to reduce transmission by reducing the survival of malaria vector entering houses or sleeping units. CDC (2011) contends that IRS remains a valuable intervention in malaria control when the following conditions are met;

1. high percentage of the structures in an operational area have adequate sprayable surfaces, and can be expected to be well sprayed,
2. majority of the vectors population is endophilic, i.e. rests indoors,
3. Vector is susceptible to insecticide in use.

In Zambia, Western province in particular, IRS is selectively implemented in the targeted areas either it is targeted at structures or housing units that have surfaces that can be adequately sprayed. Two types of structures are therefore identified in the IRS programme; formal (nonporous) structures made of bricks and cement plastered and informal (porous) structures usually with mud plastered finish (KMIS, 2010). IRS equipment/chemicals are, therefore, appropriately applied depending on the type of structure being sprayed. Permanent structures are prominent in the urban areas or semi-urban areas while semi-permanent structures are found in the peri-urban area.

The malaria carrying vector (mosquitoes) is endophilic and rests indoors after a blood meal. For this reason, IRS is one of the most convenient and formidable method of controlling and eliminating the vector. Insecticides such as DDT and pyretheroid have been found to be effective towards killing the vector in urban areas. No resistance to the insecticide have so far been reported or documented. Therefore, the three criteria for IRS are met and for this reason the program is expected to achieve the intended positive results of reducing vector/human contact with subsequent reduction in malaria incidence in the sprayed areas.

2.5 IRS Vs ITN intervention

2.5.1 Global Perspective ITNs Vs IRS intervention

In malaria control, a single strategy may not be effective in reducing malaria incidence, therefore, WHO recommends in addition use of ITNs and treatment with effective drugs. Evidence has shown that when ITNs coverage rates are high and are effectively used, malaria incidence reduces. (WHO, 2006) noted that ITNs, if used by the total population, have shown to be able to lower transmission by 90%, malaria incidence by 50% and all cause child mortality by 18 %. In the Americas' Suriname, a 90% decrease in the number of cases was noted after enough ITNs were distributed to cover 78% of the population at risk apart from IRS that was implemented selectively in targeted areas . While in Ecuador, a reduction of 96% confirmed malaria cases was noted and IRS had been the principal vector control method unlike ITNs in Suriname; effective malaria diagnosis and treatment was provided in both countries (WHO, 2011).

2.5.2 African Perspective of ITNS Vs IRS

In a study done in Kenya (Helen el tal, 2002) to compare effectiveness of ITNs and IRS revealed that sleeping under a treated bed net reduced the risk of infection by 63% (58–68%) and sleeping in a room sprayed with insecticide reduced the risk by 75% (73–76%). This suggests that IRS may be more effective in prevention of malaria. It further revealed that it is more cost effective for IRS than ITNs as the economic cost per infection case prevented by IRS was US$ 9 compared to US$ 29 for ITNs and therefore cheaper than ITNs. Karunamoorthi K (2011), however, states that ITNs are effective and it has been estimated that adequate coverage of malaria-in-pregnancy control measures, such as the use of ITNs and intermittent preventive treatment in pregnancy, may prevent 3–8% of infant deaths. In Zambia , prior to IRS , ITNs were widely used .It has also been shown in Western Province that prior to IRS malaria cases had started declining with use of ITN intervention (WPHO, 2008) 64% of households in Zambia own at least 1 ITN , 75% in Western Province and 65% in Kaoma (NMCC, 2010).

2.6 Community Participation IRS

Community participation is the hub of success of any program that involves them. Malaria control, especially IRS, is no exception to this. The community should be allowed to own the

programme and participate in its implementation. Evidence has shown that where the community is involved and sensitized before starting the program success rate is high(NMCC, 2011). For IRS to succeed, therefore, the community needs to be effectively engaged in the program. Sharp (2002) observed that where the program involved the community, achievement was almost 100%; this was attributed to the fact that Information Education and Communication (IEC) was done by members of the community prior to the spraying campaign. In addition, success of the programme is dependent on the community adherence to instructions and corporation to remove the goods away from the walls to enable the spray operators to successfully spray everywhere and leave no space unsprayed (MoH, 2009).

2.7 Management of IRS Programme

Management of the programme and timing are cardinal to implementation of IRS.WHO (2006) states that, IRS is effective only if the operation is performed correctly and there is existence of infrastructure and programme capacity for implementation at national, provincial and district levels and there is involvement of the community. For this reason, IRS requires effective leadership and management for planning, organisation and implementation. Operations must be managed by skilled professional staff, based on an analysis of local epidemiological data and a sound understanding of transmission patterns, vector behaviour and insecticide resistance status (WHO.2006). In addition, significant strengthening of human and technical resources, accompanied by sufficient financial resources, is needed to develop or reorganise existing IRS operations.

2.7.1 Spraying Season (Timing of IRS)

Timing of Indoor Residual spraying period is cardinal to success of the programme. IRS should be implemented in the right period. Zambia experiences three distinct seasons with a November/December-April/May rain season (Malaria transmission season), cold season in late May through August, and a dry hot season from September to November (MoH, 2010). The vast majority of the transmission is propagated in the rain season, as mosquitoe vectors are less capable of transmission in the cold and hot-dry season (MoH, 2010).

Malaria transmission in Zambia is, therefore, seasonal occurring from November to May (WHO, 2011). This is the period of intense transmission. Again the rain season starts in November and end in April. IRS implementation in Zambia is conducted in September through to October to avoid the inconvenience that is brought about by the rain. It is significant that the spraying schedules are completed before the onset of the rain. Where they are not properly devised, the refusal rate to have the housing units sprayed is high (Sharma, 2005). In India, Uttar Preddesh, it was observed that the failure for successful IRS programme was attributed to post postponement of the usual schedule and the clash of the program with the Deepawalli festival during which the majority of the inhabitants white washed or mud plastered their houses.

According to the MoH (2008) guide to IRS implementation, success of IRS depends on the timing and months selected for carrying out spraying activity. Training of supervisors should be conducted in the selected districts, which should be followed by cascade training of the spray operators. Above all, it is a prerequisite that IRS should start and be completed before onset of the rains.

2.7.2 Supervision and Monitoring

Monitoring of spray operators is essential to the great success of the program. Application of the correct dosage to have a lethal dose and appropriate residuum effect of the insecticide should be checked by the supervisor. Unsatisfactory results result in rejection by the community. Sharma (2005) observed that the reduction in the vector density and malaria incidence after IRS was chiefly due to application of correct insecticide dosage and maximising spray coverage by convincing villagers about the advantages of spraying. He also noticed that failure to maintain control over malaria most likely resulted from failure in the function of intervention or from failure to make proper application of intervention. In Sao Tome and Principe, IRS for malaria control was highly acceptable to the people due to no visible residue remained on the sprayed wall, no domestic livestock died even if they ingested dead housed hold pests such as cockroaches and no cats died (Lien, 2008). This underscores the importance of appropriate use of spraying skills and use of a good insecticide in the IRS programme.

2.8 Coverage of IRS.

To afford adequate protection in the IRS programme, WHO (2006) states that scientific evidence indicates that IRS is effective to control malaria transmission and thus reduce the related burden of morbidity and mortality as long as most premises (houses, animal shelters) (e.g. > 80%) within targeted communities are treated. This was supported by Andrea, M.R. et al (2011) in the study to determine the quality of vector control conducted in Equatorial Guinea and Malawi, who observed that high community coverage of IRS (at 80%) evidently offered the greatest protection from infection regardless of whether an individual slept in a sprayed or unsprayed house.

In Equatorial Guinea, community protection was provided only when 80% spray coverage was achieved, but there was an additional protective effect provided by living in a sprayed house compared to living in an unsprayed one, regardless of the level of neighbourhood spray coverage. However, Individual protection from house spraying was not seen in Malawi but there was a community effect at medium spray coverage levels of 50%. He further argues that IRS must be delivered at high coverage as it offers little or no personal protection; besides community level, effect of IRS is only achieved at high coverage. There seems to be, therefore, little to be gained from low coverage IRS programs. In line with this thought, the Zambian government policy, through NMCC (NMCC, 2010) is to attain operational coverage of over 90% of the targeted structures in the sprayed area so that the program should be effective in protecting the citizens.

2.9 Advocacy, Communication and Social Mobilisation

The main aim of advocacy, information, education, and communication as well as community mobilisation for malaria control is to contribute to the reduction of malaria morbidity and mortality through increasing knowledge and creation of demand for malaria control interventions and utilization of services (MoH, 2010). Advocacy and communication activities for behaviour change, however, have not been able to reach all population in need (MoH, 2011). In order for the community to appreciate and accept key interventions, authorities should provide information to change attitudes, influence behaviour patterns, gain approval, and enhance skills required for malaria management and prevention at individual, household, and community levels.

Communicating important malaria messages to malaria-vulnerable populations is a key component to improving malaria intervention uptake in the community. Messages such as allowing one's house to be sprayed during spray campaigns are an important part of the information, education, and communication strategy of the malaria control programme as they increase Knowledge and led to acceptance of the service. In order for the IRS message to reach even the most rural areas, NMCC has prioritized three communication channels: community leaders, community radio, and community health workers (NMCC, 2010). Community leaders and community radio personnel have been the focus of intense training so that they assist in community sensitization.

2.10 Health Policies and Legislation Relevant to IRS

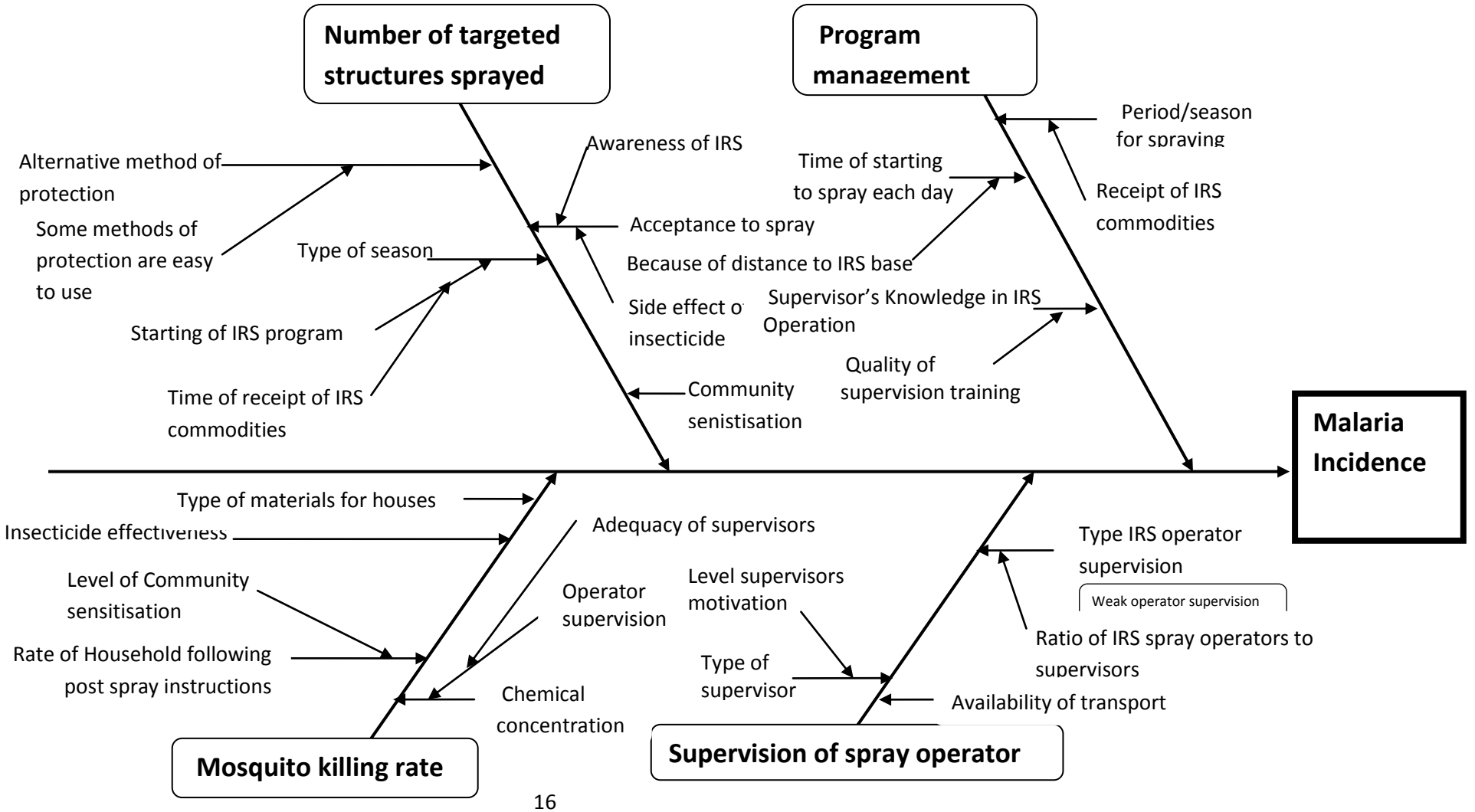
The NMCC choice of insecticide is based on the policy decision made by the Zambia Environmental Management Agency (ZEMA). Hence, it uses only insecticides that are approved by World Health Organization Pesticide Evaluation Scheme (WHOPES) and registered with ZEMA. In addition only WHO – approved spray pumps are used in Zambia (MoH, 2010). The established standard is that, the spray pumps should be pneumatic, made of a non – corrosive material, with a capacity of 15 litres, and with a strap. The country has been using Hudson X-pert or equivalent pneumatic spray pumps. The recommended specification for nozzle size should be either 8001 or 8002 depending on the type of insecticides used and the surface to be applied on. Relevant legislation to mosquitoe control are "the extermination of Mosquitoes ACT, 1995, "the Public Health Act, Cap 295;" and "the Environmental Management Act". The challenge with these acts as observed by the NMCC is that they are not exhaustive. There is need, therefore, to strengthen the Public Health Act and make a statutory instrument for mandatory spraying.

2.11 Type of Insecticide

According to WHO (2006), there are currently 12 types of insecticides recommended for IRS. The12 insecticides belong to four chemical groups (One organochlorine, six pyrethroids, three organophosphates and two carbamates). It further recommends that choice of insecticide must be cognisant of the following considerations; insecticide susceptibility and vector behaviour, safety for humans and the environment and efficacy and cost-effectiveness**.**

In Zambia, insecticides used for IRS and approved by ZEMA include two classes, the organochlorides (Dichloro-Diphenyl-Trichlorides) and pyrethroids (Alphacypermethrin ,lambdacyhalothrin, and deltamethrin) (MoH,2010). Western Province has been using pyrethroids and carbamates. The development of resistance to insecticides constitutes a major threat to the chemical control of malaria vectors, as it compromises the insecticides. IRS can only be effective if the target vectors are susceptible to the insecticide in use. From studies conducted from 2003 to 2004 (MoH, 2011), malaria vector were documented to be fully susceptible to insecticide used for vector control in Zambia. Recent focused studies, however, have raised concerns that insecticide resistance maybe appearing and this is being investigated further (WHO, 2011). Andrea, M. R. et al (2011) observed that in Malawi, part of failure of the IRS program to have an impact despite high coverage of 80% was due to use of pyrtheroid insecticide in areas where high levels of pyrethroid resistance had been observed.

2.12 Cause and Effect diagram : Effectiveness of Indoor Residual Spraying on Malaria Incidence



3.0 RESEARCH METHODOLOGY

3.1 Variable, Indicators and Scale of Measurement.

Table: 1 Variable, Indicators and Scale of measure.

Type of variable	variable	indicator	Source	Scale of measurement	
Dependent	Malaria incidence	Percentage of positives	Health centre Lab/RDT as submitted to NMCC	Percentage of confirmed cases from IRS Health centres	Continuous
				Percentage of confirmed cases from non- IRS Health centres.	
Independent	Quality of management	Response to specific questions	Management Structured questionnaires	25% poor 26 – 50% Fair 51 – 75% Good >75% excellent	Ordinal
	Availability of logistics for IRs	Percentage of IRS logistic materials	Management Structured questionnaires	25% poor 26 – 50% Fair 51 – 75% Good	Ordinal
	Level of Knowledge	Percentage of knowledge	community questionnaires	More than 80% - Adequate Less than 80% Inadequate	Ordinal
	Acceptance of IRS	Response to specific questions	community questionnaires	> 25% poor 26 – 50% Fair 51 – 75% Good >75% excellent	Ordinal
	Sprayed structures	Percentage of sprayed structures	Questionnaires	Less than < 85% = not good Greater than >85% = good	Ordinal
	Low mosquitoes kill rate	Percentage of responses	Community questionnaires	Less than <85% = not good Greater than >85% = good	Ordinal

3.2 Study Design

The study was a retrospective analysis of incidence data across a single spray season, mixed with cross sectional survey results to assess levels of interventions, community understanding and perceptions and quality of IRS efforts.

This study involved two stages. The first stage was retrospective audit of malaria incidence data across a single spray season. The second stage was cross sectional survey to assess levels of intervention, community understanding and perceptions, and quality of IRS efforts, which were compared with household sprayed. Interviews included household heads or the representative. The other party interviewed were the supervisors for the IRS program.

3.3 Study Setting

The study sites were in Kaoma district. The district is one of the pioneers of Indoor residual spraying in Western Province and has the largest population in the province of about 182,140. The houses in Kaoma are either semi-permanent (porous structures) estimated to be at 80% or permanent structures, non-porous estimated at 20%. The district has four hospitals (1 Government, 2 missions and one military) and twenty-eight health centres.

3.4 Inclusion criteria.

- All households in the areas that were targeted by indoor residual spraying.
- All staff that participated in the supervision and monitoring of indoor residual spraying.
- All malaria diagnosed and confirmed by either RDT or Blood slide smears.

3.5 Exclusion Criteria

- Luena camp hospital being a military heath facility

3.6 Data Collection Techniques

Data was collected using two separate semi-structured questionnaires to accommodate cross sectional survey. One semi-structured questionnaire was administered to the owners or representatives of the households in the IRS areas and another self-administered

questionnaire for the IRS supervisors. Laboratory / RDT malaria test results in health centres in IRS and non-IRS were reviewed and compared.

3.7 Sampling Method

The sample for households was systematically selected from the sprayed areas by using cluster sampling probability proportional to size (PPS). The sample size was calculated from the average coverage of 92% of structures sprayed 2009/2010 spraying season and desired accuracy of 5% and 95% confidence interval. Using the formula:

n_{pps} = deff x $\frac{Z^2 \hat{p}\hat{q}}{d^2}$

n = sample size population

pps = assuming proportion estimated precision absolute desired

deff = design effect

d = precision absolute desired

$\hat{p}$ = the combined (national) estimate

$\hat{q}$ = proportional estimate

Z = Z-value for a two-sided 95% confidence interval

n_{pps} = 2 x $\frac{1.96^2 \times 92 \times 8}{5^2}$ = 226.16

To allow for non-response and assuming only 90% response rate the sample was adjusted as below:

n = 226/0.9 = 251.2

Formula for calculating the number of individuals to sample per cluster in a PPS survey

Number to sample per cluster $= \frac{n_{pps}}{m} = \frac{251}{3} = 83.66 = 84$

Where m = number of clusters

Therefore, the sample size became 84 x 3 = **252**

3.7.1 Sampling Procedure

Multistage sampling was used to select respondents from households to whom the questionnaire was administered. In stage one, selection of a systematic-random sample of primary sampling units with probability proportional to size (PPS) was used to select clusters in which respondents were picked. This was done by first selecting facilities within 10km radius of the town. Population of residential areas (communities) were each considered as a cluster, therefore, a total cumulative population size was calculated.

Health centre	Cluster no.	community	population Size	cumulative pop size
Kaoma urban	1	Naliele	320	320
	2	Mahilo	520	840
	3	**Zesco**	**747**	**1587**
	4	Secondary	610	2197
	5	Site & Servoice	1204	3401
Mulamba	**6**	**Mulamba**	**1430**	**4831**
	7	Kalundu	780	5611
	8	Chilombo	1100	6711
	9	Mulamatila	560	7271
Katunda	**10**	**Katundacentral**	**956**	**8227**
	11	Mukunkiki	570	8797
	12	Kaoma Ndonga.	326	9123

3 clusters were selected: Sampling interval was calculated by dividing the cumulative population size (9123/3) by the desired number (3) of clusters: 9123/3 = 3041

Step 1: A random number between 1 and 3041 was selected (1560) was selected, which fail in cluster number 3, therefore cluster 3 (site and service) was selected as the first cluster.

The other clusters were picked by adding the sampling interval to the first randomly selected number as below;

Step 2: 1560 + 3041 = 4601 – cluster 6 (Mulamba) was selected

Step 3: 4601 + 3041 =7642 – cluster 10 (Katunda central) was selected

In stage two; Systematic sampling of households was used to select households to be interviewed in the catchment area either every third house from the first was interviewed in the cluster up to the 84th house. Data collection from Supervisors was purposive. All the 17 supervisors involved in IRS supervision had been targeted. Data on confirmed cases of malaria from all centres in the district was obtained.

3.8 Data collection.

Face to face interview was used for households; this was because the level of households' literacy was not known. Self-administered questionnaire method for supervisors whose literacy level was known was used, each questionnaire was coded. Data of malaria Incidence for one spray/transmission season August 2011 to August 2012 was collected from the DHIO for centres in the IRS areas and non-IRS areas as submitted to the National Malaria Control Centre.

3.9 Data Processing and Analysis

Household and supervisor survey data was entered and analyzed using STATA version 11 for windows while malaria incidence data was entered and analysed using windows excel .Descriptive statistics were generated for both the household and supervisor questionnaires. In order to compare the effect of IRS on malaria incidence, incidence data for health centres was collected from HMIS district data base as submitted to NMCC was compared for the areas which had no IRS and more than 60% of the population protected by IRS. Bivariate analysis was conducted in order to determine whether there was a relationship between variables of interest using the chi-square test results. Statistical significance was set at $p < 0.05$.

3.10 Ethical Considerations

Ethical clearance was requested from and granted by the University of Zambia Biomedical Research Committee. Permission to conduct the study was obtained from Ministry of Health via Kaoma District Medical Office. No human tissue was collected; verbal or written consent were sought from participants. Anonymity, confidentiality and privacy were observed during data collection .Questionnaires were coded instead of using names. Data was strictly used for the purpose as outlined in the proposal and report. All information gathered after carrying out of the research was confidentially stored.

3.11 Pretesting of Questionnaires

The household questionnaire was pre-tested at Site and service compound in Kaoma urban health centre catchment area. Twenty five (25) questionnaires were administered during pre-test. The site was chosen because it is centrally located. It has a huge population of about 1,204 households. The structures are a mixture of formal and informal structures. Carrying

out a pre-test in this area brought out factors that are similar to the study site and therefore assisted in coming-up with a more comprehensive questionnaire.

4.0 PRESENTATION OF RESULTS

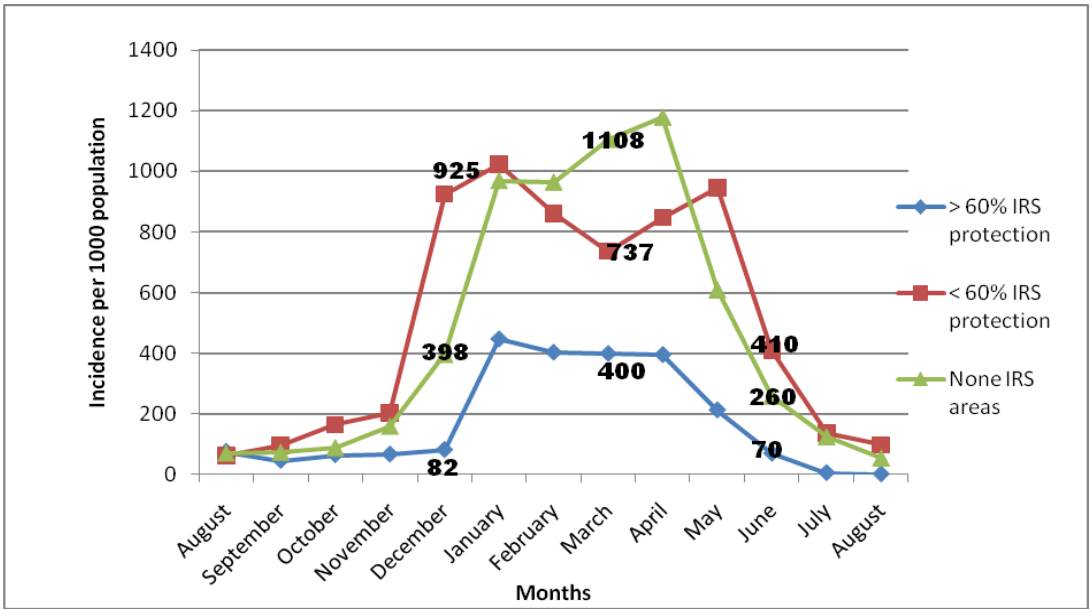
4.1 Analysis of Malaria Incidences in IRS and Non IRS Areas

To compare incidence of malaria in the sprayed areas and areas that were not sprayed, malaria incidence data from 31 health centres and health posts was collected from HMIS districts database. The data collected during the study was the same with that which was sent to National Malaria Control Centre weekly. One spray season was considered in this case (from August 2011 to August 2012).

The district was stratified into 3 strata which include:

1. Areas where IRS was not conducted (composed of 15 health facilities).
2. Area where IRS was conducted but less than 60% of the targeted population was protected (composed of 12 health facilities).
3. Area where IRS was conducted and more than 60% of the targeted population was protected (composed of 4 health facilities).

Figure 1: Confirmed Malaria Incidence (August 2011 to August 2012)



The line graph above shows various trends in confirmed malaria incidence in the three categories consisting of area with coverage of IRS protection above 60%, below 60% and area where IRS was not done. Figure 1 shows that Health centres with greater than 60% of

the population protected by IRS had the lowest cases of malaria at 82/1000 in December 2011 compared with 924/1000 in areas with less than 60% IRS protection and 398/1000 in areas where IRS was never implemented. At the pick of the malaria transmission period in March 2012, the graph shows again that incidence in the more than 60% protection was at 400/1000 still lower compared to non-IRS areas that were at 1108/1000. The incidence in the moderately IRS protected areas, however, was lower (773/1000) than in non-IRS areas (1108/1000) compared to December 2011 when they were higher than in non-IRS areas.

Figure 1 above shows that incidence of malaria in the more than 60% IRS protected area continued to be lower (70/1000) when compared to non-IRS implementing area (260/1000) at the end of the malaria transmission period in June. In the moderately protected area on the other hand, the Incidence of malaria was higher than in the non-IRS implementing area

Figure 2 : Clinical Malaria Incidence (August 2011 to August 2012)

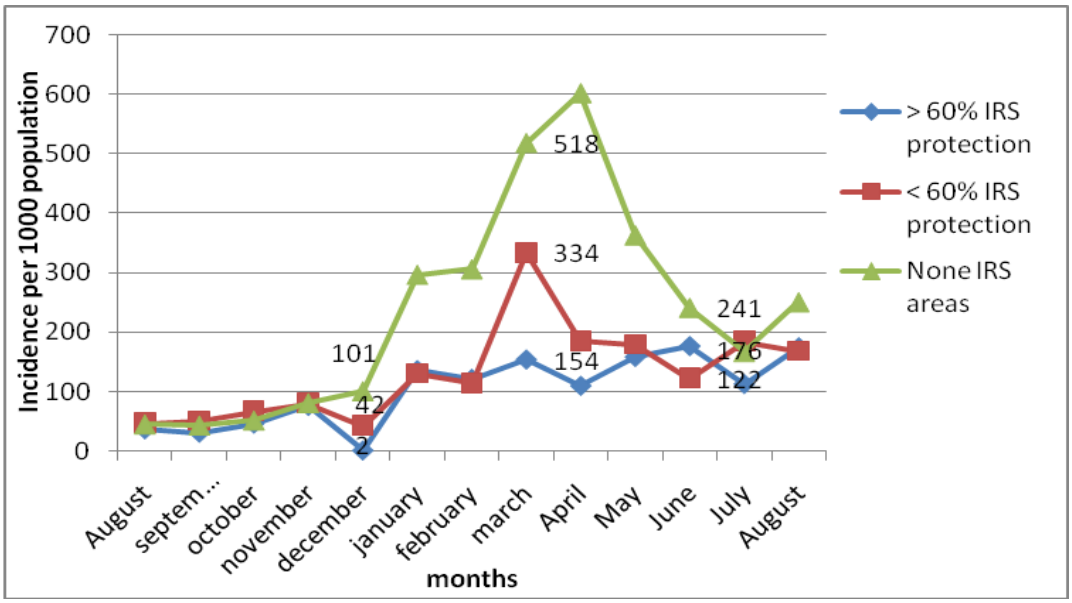


Figure 2 shows the graph of clinical malaria incidence in IRS and non-IRS areas. It depicts that the trend was somewhat different for clinical incidence. Throughout the reference period, the number of cases in the IRS protected areas where below those reported in non-IRS area; 2/1000 and 42/1000 compared to 101/1000 in December 2011. Even at the pick of the transmission period in March 2012, the incidence in IRS protected areas was still low at 154/1000 and 334/1000 compared with non-IRS areas at 518/1000. The two graphs 1 &2 show that the incidence of malaria in both clinical and confirmed was lower in the more than 60% IRS population protected areas.

Using (2 x 2) Mantel-Haenszel contingency tables to calculate the significance in the difference between malaria incidence in the sprayed and none sprayed. The results show that the calculated chi-square value (238) is greater than the tabulated value (3.84) at 0.05 p-value and 95% confidence Intervals. IRS, therefore, was significantly associated with incidence of malaria.

4.2 Community Understanding and Perceptions of IRS at Household Level

4.2.1 Demographics Characteristic of Respondents at Household Level

Data was collected from 252 respondents. These were interviewed at household level. The respondents were either heads of households or any adult above the age of 18years. The response rate was overwhelming at 100%. None of the targeted respondents at household level declined to be interviewed.

Table 2 below presents a summary of the demographic characteristics of the respondents in the study.

Table 2. Distribution of demographic characteristics of the respondents N=252

Variable	Frequency	Percentage
Gender	---n---	---(%)---
Male	102	40.48
Female	150	59.52
Total	**252**	**100**
School attendance		
Never attended school	42	16.67
Have attended school	210	83.33
Total	**252**	**100**
Employment status		
Unemployed	73	28.97
Farmers	83	32.94
Self-employed	46	18.25
Civil servants GRZ/others	50	19.84
Total	**252**	**100**

The results indicate that about 41% of the respondents were males and the majority, 59.5% were females. The results show that most (83.33%) respondents had attended school. In terms of occupation, (32.94 %) of the respondents are engaged in farming. This is followed

by 28.97 % who were unemployed. Respondents who are civil servants are 19.84%, slightly higher than those who are self-employed (18.25 %).

4.2.2 Household Characteristics

The household questionnaire also collected information on household characteristics such as the material the house was built of and length of stay in the house. The results (Table 3) indicate that the main dwelling unit for most (55.95 %) of the respondents in the sample were formal -built of non-porous materials. In addition, 75% of the respondents had lived in their houses for more than 2 years with only 11.9 % living for less than one year slightly lower than those who have lived there for 2years (13.1%).

Table 3.Household characteristics N=252

Variable	frequency	Percentage
Material house built with	---n---	---(%)---
Porous building materials (informal)	111	44.05
Non-porous building materials (formal)	141	55.95
Total	**252**	**100**
Length of stay in the house		
<1 year	30	11.9
2 years	33	13.1
More than 2 years	189	75
Total	**252**	**100**

4.2.3 Community Knowledge of IRS

Table 4.Distribution of Community Knowledge of IRS by school attendance N=252

	Use of indoor residual spraying			
Ever attended School	**killing bugs/roaches**	**killing mosquitoes**	**Did'nt know**	**Total**
Never attended school	14(33%)	26 (62%)	2(5%)	42 (17%)
Attended school	22(1%)	173(82%)	15(7%)	210 (83%)
Total	36(14%)	199(79%)	17(7%)	252(100%)

Pearson chi2(2) = 14.9524 p-value < 0.001

Table 4 presents how school relate to having knowledge about IRS in the community. It shows that the majority 83% of the sample had been to school and 17% had never attended school. 14% of the sample thought IRS was for killing bedbugs/cockroaches, 17% did not know and 79% thought it was for killing mosquitoes. Those who had attended school 82% said IRS was for killing mosquitoes compared to 62% in the group that had never been to school. The table shows that there is high level of knowledge of IRS (82%), p-value < 0.001 in those who had been to school than those who had never been (62%). This shows a strong association between having attended school and knowledge of use for IRS,

4.2.3 House IRS status and other variables

Table 5 below shows cross tabulation and chi square tests results between IRS status with other variables assumed to have a relationship with.

Table 5.Bivariate tabulations of IRS status against other variables of interest

House sprayed or not (IRS status)			**Chi square tests results**		**House sprayed or not (IRS status)**			**Chi square tests results**	
	Not sprayed	sprayed	Pearson chi-square	p-value		Not sprayed	Sprayed	Pearson chi-square	p-value
	------%------					------%------			
Ownership of ITN			**2.58**	**0.11**	**Length of stay in the house**			**15.03**	**0.001**
Didn't own	46.74	57.23			< 1year	21.74	6.25		
Own	53.26	42.77			2 years	15.23	11.88		
No. of ITNS owned			**3.92**	**0.27**	2years plus	63.04	81.88		
One	44.9	44.12			**occupation**			**11.26**	**0.010**
Two	34.69	23.53			unemployed	30.43	28.13		
Three	16.33	19.12			farmer	22.83	3875		
More than four	4.08	13.24			Self employ	17.39	18.75		
					GRZ/others	29.35	14.35		
Ownership ITN period in months			**8.59**	**0.04**	**Gender**			**0.542**	**0.462**
Six	24.49	13.24			Male	56.52	43.48		
Twelve	36.73	25			Female	61	38.75		
Twenty four	14.29	36.76							
Thirty six	24.49	25			**Ever heard of IRS**			**0.1549**	**0.925**
Type of house			**5.05**	**0.03**	Never heard	2.17	1.88		
Informal	34.78	49.38			Heard	94.57	95.63		
Formal	65.22	50.63			Don't know	3.26	2.5		

The results show that slightly more than (50.63%) houses sprayed were formal (non porous material) compared to 49.38% informal (porous materials). The chi-square test results of the cross tabulation with type of house, indicated that there is an association between the IRS acceptance (p-value < 0.03) and type of house

The results also show that most (63%) had stayed in the houses for more than 2 years .The length of stay in the house was significantly associated with having the house sprayed (p-value 0.001) .This means that those who stayed longer than 2 years were more likely to have their house sprayed . The study revealed that 51.19% of the household were either self-employed or were famers followed by those in government at 19.84% while 28.97 were unemployed. Occupation was association with the house being sprayed (p-value 0.01). The table shows that there was no association between gender and possibility of house being sprayed.

Use of ITN is one of the malaria prevention methods recommended to be used side by side with IRS .The results show that the majority (57.23 %) of the respondents who reported having their houses sprayed have no ITNs and the converse happens to be true where most (53.26%) of those who did not have their houses sprayed owned at least an ITN. There was no statistical significance (p-value <0.11) of having house sprayed and owning an ITN, therefore, acceptance of spraying the house did not depend on whether one owed an ITN or not.

The IRS status was further tabulated with the number of ITNs owned by the respondents' household and the length one owed an ITN. The results of the cross tabulation of IRS status and the length one owned the ITN indicated that there is an association (p-value<0.04) between the house being sprayed and period one owned and ITN

4.2.4 Community Acceptance of IRS

Table 6 below shows community acceptance of IRS. An initiative such as indoor residual spraying (IRS) to achieve its objectives, the target population should widely support it mainly through acceptance and cooperation with the implementers. In the entire sample, most (63.49%) houses where sprayed. Even so, this falls below the Zambian government policy (NMCC, 2010) that seeks to attain operational coverage of over 90% of the targeted structures in the sprayed area for the programme to be effective in protecting the citizens. Andrea, M.R. et al (2011) in his study observed that high community coverage of IRS (at

80%) evidently offered the greatest protection from infection regardless of whether an individual slept in a sprayed or unsprayed house. Therefore coverage of less than 80% may not assist in drastically reducing the incidence of malaria.

When those who had their houses not sprayed, were asked, the reason, the majority (79.35%) indicated that they were away from home as the main reason. Other reasons such as chemical smell, irritation, having a baby in the house and that spraying brings bed bugs accounted for less than 5% each, as the reason for not having their houses sprayed**.**

Table 6.Community Acceptance of IRS N= 252

Variable	Frequency	Percentage
House sprayed	---n---	---(%)---
Houses not sprayed	92	36.51
Houses sprayed	160	63.49
Total	**252**	**100**
Reason for not spraying		
Chemical smell	2	2.17
Irritation	9	9.78
Brings bedbugs and roaches	6	6.52
Baby in the house	2	2.17
Was away	73	79.35
Total	**92**	**100**

Table 7 below, shows the cross tabulation between the quality of IRS as viewed by the community and the period respondents reported having stayed without mosquitoes. Among those who indicated staying two weeks without mosquitoes (48.31%) rated the quality of the IRS as good. This was the case across all the periods in question. Chi-square test results indicate that there is a relationship (p-value<0.001) between the quality of IRS and the period respondents reported having stayed without mosquitoes. Those who viewed quality of IRS as being good had the longest period without experiencing presence of mosquitoes than those who did not.

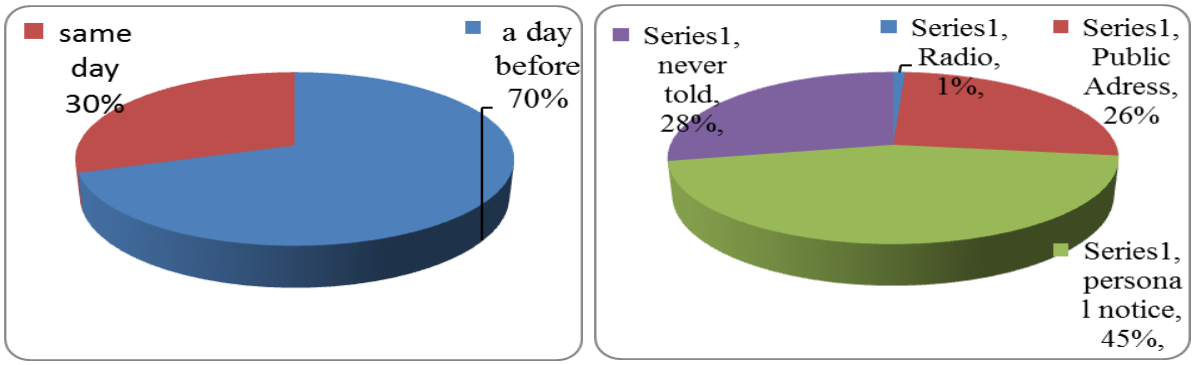
Table 7.The way spraying was done versus period with no mosquitoes N=160

	Period with no mosquitoes			
	Two weeks	One month	Two month	More than
Quality of spraying	----------%----------			
Good	48.31	69.57	83.33	83.33
Fair	31.46	30.43	16.67	11.11
Bad	20.22	0	0	5.56

Pearson chi2(6) = 22.2563* p-value < *0.001

Figure 3 below shows the time and method of informing households. It indicates that, of respondents who had their houses sprayed, 70% of the respondents received notification a day before the spraying exercises while the rest (30%) received notification on the same day of spraying.

Figure 3.Indoor residual spraying notification



a) Day of notice **b) Mode of notification**

The mode of notification mostly was through personal notice indicated by 45% of the respondents. About 28% of the respondents indicated receiving no notice; only about 26% were notified through the public address system (Fig.3b). In this case poor notification was associated with household acceptance of IRS P< 0.036.

Table 8 below shows that it only took two days for most of the households to clean up after the IRS exercise despite being sensitized on how to take care of the house after spraying. Within this same period, the majority (73.33%) of the households cited chemical smell. Those who cited irritation represented 41.67% of households that cleaned up due to this

reason, 33.33% and 35.87% cited stained walls and other reasons for cleaning within 2 days after the houses were sprayed.

Table 8.Period of cleaning after spraying versus reason for cleaning N=160

Cleaning Period	Reason for cleaning up are the spraying activity			
	Chemical smell	Irritation	Stained walls	Others
	----------%----------			
2 days	73.33	41.67	33.33	35.87
1 month	20	25	18.52	9.78
2 months	6.67	25	22.22	9.78
4 months	0	8.33	25.93	44.57

Pearson chi2(6) = 22.2563 **p-value** ***0.001***

4.3 Management of Indoor Residual Spraying

4.3.1 Demographics for the Supervisors

In order to get the views of the quality of management of indoor residual spraying, all the 17 supervisors were interviewed from various spray location of the district. The response rate like household questionnaire was overwhelming at 100%. None of the supervisors declined to be interviewed.

Table 9 describes the demographics and skills in IRS of the supervisors in the sample. The majority (76.47%) of the supervisors are males and the rest females. All the supervisors were Environmental Health Officers (EHO). It is a requirement that supervisors undergo training in IRS of not less than a week (MoH, 2008). The majority (94.12%) of the respondents had been trained in IRS supervision. Most (58.82%) of them indicated training as having lasted for a period of one week. Only 5.88% of the respondents pointed out that the training lasted for more than two weeks. Therefore, training period for supervisors was adequate.

Table 9.Demographic characteristics for supervisors and skills in IRS N=17

Variable	Frequency	Percentage
Gender of Supervisor	---n---	---(%)---
Male supervisors	13	76.47
Female supervisors	4	23.53
Total	**17**	**100**
Type of Supervisor		
Environmental Health Officers (EHO)	17	100
Non Environmental officer	0	0
Total	**17**	**100**
Training of supervisor		
Not trained in IRS supervision	1	5.88
Trained in IRS supervision	16	94.12
Total	**17**	**100**
Period of ToT training for supervisor		
One week	10	58.82
Two weeks	4	23.53
more than two weeks	1	5.88
Total	**17**	**100**

4.3.2 Timing of Spraying Period

On average 41.18 % of the supervisors had, 11 to 25 sprayer operators under their supervision followed by 29.41 % who had less than 10 at a time (Table 10). Another 23.53 % had more than 36 sprayer operators under their supervision. Only 5.88 % had 26 to 35 sprayer operators under their supervision representing the least. The number of sprayer operators to target received the rating of adequate by the majority (70.59%) of the respondents.

Despite the ratio of supervisor to operator, being said to be adequate, most (52.94%) of the sprayer operators did not manage to meet the target per day. The main reason for not meeting the target was being picked up late to the spray site as reported by 41.18% of the respondents. High targets as the reason for not meeting the target was not really an issue as shown by the small proportion (5.88%) of the respondents.

Table 10.Ratio of Spray Operator to Supervisor / Targets N=17

Variable	Number	Percentage
Ratio of supervisor to Operator	---n---	---(%)---
less than 10 operators	5	29.41
11 to 25 operators	7	41.18
26 to 35 operators	1	5.88
more than 36 operators	4	23.53
Total	**17**	**100**
Adequacy of spray operators		
Number of sprayers to target as adequate	12	70.59
Number of sprayers to target as inadequate	5	29.41
Total	**17**	**100**
Spray operator meet target		
Did not meet the target	9	52.94
Target met.	8	47.06
Total	**17**	**100**
Reason for spray operator not reaching target		
High target	1	5.88
Picked late to site	7	41.18
Other	9	52.94
Total	**17**	**100**

MoH (2010) recommends appropriate period for spraying if IRS is to be effective. Table 11 shows the responses to the time IRS began and ended in the season under review, 2010/2011. The majority (76.47%) of the respondents indicated that IRS started in November and (58.82%) indicated the season ended in February and after. About 94%, however, of the respondents pointed out that the spraying period was not appropriate.

Table 11 .Spraying season N=17

Variable	Number	Percentage
When spraying started	---n---	---(%)---
Last spraying season: October	4	23.53
Last spraying season: November	13	76.47
Total	**17**	**100**
When spraying ended		
spraying season end: December	2	11.76
spraying season end: January	5	29.41
spraying season end: February and after	10	58.82
Total	**17**	**100**
Appropriateness of spraying period		
Not appropriate	16	94.12
Appropriate	1	5.88
Total	**17**	**100**

Table 12 shows management of IRS commodities and Spray operator. About 88% of the respondents are involved in the training of spray operators. Furthermore, 47.06% of the respondents indicated that, spray operators receive training for a period of 13 days (that includes theory and practical) followed by 41.18% who pointed out 21 days as the training period. About 94 % of the respondents thought that the length of training had an impact on the quality of skill of spraying done by the operator while the rest stated they did not know for sure.

Table 12. Management of IRS Commodities and Spray Operator N= 17

Variable	Frequency	Percentage
Participation in training operators	---n---	---(%)---
Participated in training	15	88.24
Did not participate in training	2	11.76
Total	**17**	**100**
Training period for operators		
Training period of 5 days	1	5.88
Training period of 13 days	8	47.06
Training period of 18 days	1	5.88
Training period of 21 days	7	41.18
Total	**17**	**100**
Impact of the length of training on the quality of skill		
Length of training has impact on operator skills	16	94.12
Did not know	1	5.88
Total	**17**	**100**
IRS Commodities on time		
Commodities on time	16	94.12
Commodities on time	1	5.88
Total	**17**	**100**
Which commodities not on time		
Insecticides, PPEs not on time:	5	29.41
Funds and equipment	2	11.768
All the above 3 not on time	10	58.82
Total	**17**	**100**
Availability of transport		
Do not have adequate transport	16	94.12
Have adequate transport	1	5.88
Total	**17**	**100**
Insecticide used		
Insecticide used under supervision: Fendona (pyretheroid)	17	100
DDT	0	0
Total	**17**	**100**

In terms of management of commodities, the majority (94.12%) indicated that they did not receive logistics on time. Among these logistics, insecticides, PPEs were pointed out by 29.41 of the respondents as not been received on time. Only, about 11.8 % indicated that funds and equipment are not, received on time. Transportation for the exercise was another logistical problem pointed out by 94 % of the respondents.

5.0 DISCUSSION OF FINDINGS

5.1 Discussion of Findings of Malaria Incidences

A comparison of trends in IRS implementing area and non-IRS areas, especially for confirmed cases, IRS implementing areas have less malaria than none-IRS areas. This is evident in the malaria transmission period from November to May. The incidence trend in the more than 60% protection with IRS was lower (81/1000) in December, 2011 when compared with the trend in not sprayed (398/1000) at the beginning of the transmission season. Even at the pick of the malaria transmission season (March 2012) the difference was prominent at 400/1000 to 1108/1000.

The case, however, cannot be said of the malaria incidence in the moderately (less 60% population) protected sprayed areas. The incidence was higher 925/1000 and 945/1000 cases of malaria than in the non-IRS areas 398/1000 and 611/1000 throughout the transmission period except for a brief period after spraying when the incidence was lower (737/1000) than in the non- sprayed areas 1108/1000. The lower incidence of malaria in the moderately protected areas after spraying can be attributed to effect of insecticide on the vector mosquitoes. The effect, however, could not be sustained probably due to the habit of household cleaning walls after 2 weeks of spraying as confirmed by (73.33%) who said that it only took two days for most of the households to clean up after spraying. This could have reduced the effectiveness of the chemical. Gansakaza (2005), in his study observed that replastering of walls once or twice led to reduced mortality of anopheles by 27% to 13% respectively. Again only 60% of the houses were sprayed, WHO (2006) recommends that at least 80% of the structures must be sprayed for the programme to have a significant effect. Andrea, M. R et al (2011) supported this in the study who observed that high community coverage of IRS (at 80%) evidently offered the greatest protection from infection to individuals while medium spray (at 50%) was seen to be effective at community level.

The situation is different for clinical cases trends. Throughout the malaria transmission period, the trend shows that the moderately sprayed areas (< 60 % IRS protection area) were in tangle with the more than 60% protected area. The two trends, however, were lower than the non-IRS protected areas. A chi-square test showed that there was a significant difference in the 60% IRS protected area and non- IRS protected area p-value < 0.05.

5.2 Community Understanding and Perceptions of Indoor Residual Spraying

In this study, 252 respondents were targeted at household level of which there was 100% response rate. The findings in the study at household levels are that the majority of respondents had attended school (83.33 %) and that there was an association between Knowledge of the use for IRS and school attendance p-value < 0.001.With level of knowledge being high it is expected that the majority fully comprehended the importance of the IRS program. MoH (2011) recommends that high knowledge levels are important in the IRS program as it leads to high acceptance of the program and eventual effectiveness in reducing incidence of malaria in the community.

According to WHO (2011), IRS involves application of internal walls of the house and structure with chemicals (insecticide) that remain poisonous to mosquitoes for several months once they rest on them. This implies that the type of surface where the chemicals are applied matters if the full benefits or effects are to be realized. CDC (2011) emphasizes that for IRS to succeed in reducing incidence of malaria, the targeted areas must have high percentage of the structures with adequate sprayable surfaces. The results of this study indicate that about 55.95% of the houses are made of non-porous materials (formal) and 44.05% of porous (informal). Kaoma, therefore, has high percentage of structures with sprayable surfaces and suitable for application of chemicals/IRS. The study showed that there was an association between IRS acceptance and the type of material the house is built of (p-value < 0.03).Those who stayed in non-porous (formal) houses readily accepted IRS than those informal structures.

Sometimes Spraying is not done due to various reasons among them non-preparedness by occupants. The study revealed that (79%) of those who did not have their houses sprayed pointed out being away from home as the main reason as opposed to staining of walls, chemical smell and irritation as per finding of Mabaso, M. L. et al (2004). The latter reasons, however, did contribute but only to a lesser extent as less than 5 % cited these as reasons for not having their houses sprayed.

Quality of spraying is one indicator that can lead to appreciation of IRS. Among those who rated the quality spraying as good, the longest period without mosquitoes pointed out by the

majority was two months and more. An association was found between the quality of spraying and the period stayed by the households without mosquitoes (p-value<0.001).Thus, in cases where respondents rated the quality of spraying as bad, households experienced the absence of mosquitoes only for a short period. Lien (2008) showed that In Sao Tome and Principe IRS for malaria control was highly acceptable to the people due to no visible residue remained on the sprayed wall; this underscores the importance of good skills that lead to high acceptance of IRS. It can be concluded, therefore, that the skills of spray operators hence the training was of the right quality.

It must be mentioned that the study revealed that despite high acceptance of IRS, the majority (73.33%) showed that it only took two days for most of the households to clean up the walls following the spraying of houses citing chemical smell as the reason, others cited irritation (41.67%) stained walls (33.33%) and 35.87% other reasons . Cleaning of walls reduces the effectiveness of the chemical against the vector mosquitoes and increases transmission of malaria. Gansakaza (2005), in his study observed that replastering of walls once or twice led to reduced motility of anopheles by 27% to 13% respectively.

Communicating important malaria messages to malaria-vulnerable populations is a key component to improving malaria intervention uptake in the community (MoH, 2010). It is a requirement that spray operators inform the household on the dos and don'ts as well as the side effects of chemical in use before and after spraying. In the study 90% of the respondents indicated having talked to the sprayer operator before and after the spraying the exercise, an indication that IRS messages were disseminated to the household. MoH (2011), however, states that despite the importance of sensitising the community ,advocacy and communication activities for behaviour change have not been able to reach all population in need .

Sharp (2002) observed that where the program involved the community, achievement was almost 100%; this was attributed to the fact that IEC was done by members of the community prior to the spraying campaign. It should be noted, however, that in this study, 70% of the respondents received notification a day before the spraying exercises while the rest received notification on the same day of spraying. This indicates that households did not receive adequate notice to prepare for IRS. Therefore, indicates poor quality of management of the

program. MoH guidelines on IRS implementation requires that notification of households should be done at least a week before implementation (MoH.2008).

Apart from IRS, other interventions such as ITN program is employed either independently or concurrently with IRS for the programs to complement each other. An evaluation of ITN and IRS revealed that more household (57%) that did not have ITNs were sprayed than (43%) those that did own ITNs. Even though no association was found between acceptance of IRS by household to ITN ownership and the number of ITN owned p-value 0.11 and 0.27, therefore, ITN did not influence household to accept or reject IRS. Those households that owned ITNs were equally as like to have their houses sprayed as those that did not have ITNs.

An association was, however, found between acceptance IRS by households and the length of time the household owned an ITN (p-value< 0.04). Those households that owned ITNs longer were more likely to have their houses sprayed than those that owned ITNs for a shorter period. Results of further analysis, however, showed that ownership of ITNs is low (46.61%) to have any meaningful impact on incidence of malaria. Like IRS, ITNs can only have an impact on malaria incidence if there is 80% or more in the community

5.2 Management of Indoor Residual Sprayer at Supervisor Level

Monitoring of spray operators is essential to the great success of the programme, this goes hand in hand with good training. Mamta, D. et al (2009) in the study of Impact of IRS proved that in spite of the constraints associated with IRS, it still had a major role in the control of malaria if implemented with proper supervision, better coverage and community participation. In this study, majority (94.12%) of the supervisors were trained in IRS supervision and had experience with most (64.71%) of them having more than three years' experience. Sharma (2005) in his study observed that application of the correct dosage to have a lethal dose and appropriate residuum effect of the insecticide should be checked by the supervisor. Unsatisfactory results will lead to rejection by the community.

Timing of the spraying period is important as far as implementation of IRS program is concerned. 41.18 % of the supervisor had 11 to 25 sprayer operators under their supervision. This ratio was said to be adequate. The target of houses set for sprayer operator to meet was rated as adequate by 70.59% of the supervisors. It was indicated by 52.94% of the

respondents, however, that spray operators failed to meet the target of households per day. Being picked up late to the household was cited as the major reason apart from others.

Ideally, IRS should be done from September to November to avoid the inconvenience brought about by the rains. The results of the study indicate that during the last spraying season (2010/2011), the majority (76.47%) of the respondents indicated that IRS started in November. None, however, reported the activity starting in September. Furthermore, most (58.82%) of the respondents indicated that the spraying season ended in February and after. The majority (94.12%) also stated that the spraying period was not appropriate. The activity went on almost throughout the rain season-the height of the transmission period. This would further explain why some houses were not sprayed, as the owners would have gone to their fields given that most of them are farmers. Sharma (2005) in his study observed that the refusal rate to have the housing units sprayed, are high if the period is ill timed.

WHO (2006) states that IRS is effective in reducing incidence of malaria if the operation is performed correctly, there is existence of infrastructure and programme capacity for implementation .The study reviewed that management of commodities was weak. An overwhelming 94.12% of the supervisors indicated that, commodities such as insecticides, PPEs, funds among others are not received in time. Perhaps what came out strongly was that transport for the exercise is not adequate as indicated by 94.12 % of the respondents, resulting in being picked late for the exercise that contributed to operators not reaching the targets.

It should be noted that WHO recommends that ITNs , IPT and use of appropriate treat be used in addition to other measures in the control of malaria. The role played by these intervention also contribute to reduction in malaria incidence, therefore, these are confounding factors at play in reducing malaria incidence in the community in these study

5.4 Study Limitations

This study had its own limitations mainly to do with the absence of comparative counterfactual elements that could be used to strengthen the argument of lower incidence in the sprayed areas. Testing and positivity rate were not considered to determine the difference in the groups .Lastly limited resources. It is therefore, recommended that for future studies of

this nature, testing people at community level, matching people from intervention and control or test people coming to clinics for malaria, ask them about their status and recruit for a period of time would be the best option.

6.0 CONCLUSION

Indoor residual spraying was association with reduced malaria incidence in Kaoma district in area where there was more than 60% of the population protected by it. Comparison of malaria incidence trend in health centres with high IRS coverage to centres that did not implement IRS showed that areas that had more than 60% of the population protected by IRS had lower incidences of malaria (82/1000 and 400/1000) throughout the malaria transmission period of 2010/2011 compared to non-IRS areas (398/1000 and 773/1000) at the beginning and peak of the transmission period**.**

Coverage of IRS is fair at 60% though it falls below 80% coverage considered to have an effect in protecting the community. Among the contributory factors is poor management of the IRS programme.

Spraying starts at the wrong time in November during the rain reason and ends almost at the height of the transmission period – end of March. Commodities for the programme are never in time as evidenced by the majority (94.12%) of the supervisors who indicated that they did not receive commodities (insecticides, PPEs, Funds) on time. Transport, vital to the programme if targets were to be met, was also a major challenge. Considering the above one can logically conclude that though there is an effect of IRS programme on incidence of malaria in Kaoma. The effect of poor management of IRS program negatively influence programme to have meaningful reduction in incidence of malaria.

7.0 RECOMMENDATIONS

There is need to address logistical challenges identified to ensure that the IRS exercise begins and ends in good time before the onset of the rain season. Among these logistical issues that require immediate attention are the delivery of inputs that include insecticides, PPEs and provision of transport. The Government should be engaged to strengthen the Public Health

Act to make a statutory instrument for mandatory spraying of households to reduce on refusals to spray houses.

If Zambia wants to achieve elimination of malaria, indoor residual spraying needs to be clearly understood by the communities so that when spraying season comes they are prepared for IRS activities. Government and the partners need to ensure, not only in Kaoma, but all the districts to procure the commodities to start and complete IRS before the onset of the rains, failure to do so will result into high malaria cases at a great economic cost which Zambia cannot afford. The best way to look into the welfare of the people is to protect them from diseases which are preventable

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ANNEX

1.1 Information Sheet

Title of Study; Effect of Indoor Residual Spraying (IRS) on incidence of malaria in Kaoma districts of western province- Zambia

Dear Participant,

This is to inform you that this study is being carried out by Emmanuel Phiri a student with the University of Zambia, School of Medicine, Department of Public Health. Ministry of Health has been carrying out spraying of houses each year in the community. I am going to interview you on the same exercise that is done by Kaoma District Medical Office. The study is aimed at finding out how well **Indoor Residual Spraying (IRS) programme contributes in reducing incidence of malaria in Kaoma**.

There are no known or anticipated physical risks, neither is there any direct or monetary gain to you by participating in this research. However, the information you will provide will help the district learn how best to carryout Indoor Residual Spraying that will prevent malaria in the community by killing mosquitoes.

Your participation in this study is purely voluntary and therefore, you are eligible to withdraw if you are not interested and your action will not affect your acquisition of health services. Please seek clarification where you do not understand.

All the information you will provide will be strictly confidential. The research information will be disseminated to the relevant authorities and with no direct link to you since anonymity shall be maintained.

1.2 Informed Consent form

The purpose of the study has adequately been explained to me and I understand the aim, benefits, risks and confidentiality of the study. I further understand that; if I agree to take part in this study, I can withdraw at any time without having to give an explanation and that taking part in this study is purely voluntary.

I _____ (Names)

Consent to participate in this study

Signed; _____ date; _____ (Participant)

Participant's signature or thumb print

Signed; _____ date; _____ (Witness)

Name of the interviewer; _____

Signed; _____ date; _____

A. PERSONS TO CONTACT FOR PROBLEMS

1. Emmanuel Phiri, University of Zambia, School of Medicine , Department of Public Health, P.O. Box 50110, Lusaka, Zambia. Mobile Phone; 0977 416936

2. The Chairperson, University of Zambia, Research Ethics Committee, Ridgeway Campus, Lusaka, Zambia, tel/fax: +26 0211 256067; email: unzarec@zamtel.zm.

1.3 Household Questionnaire

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MEDICINE

DEPARTMENT OF PUBLIC HEALTH

Household Questionnaire

RESEARCH TOPIC:

EFFECT OF INDOOR RESIDUAL SPRAYING (IRS) ON INCIDENCE OF MALARIA IN KAOMA DISTRICT OF WESTERN PROVINCE- ZAMBIA

QUESTIONNAIRE NUMBER __ __ __ __ __ __

DATE OF INTERVIEW _____/_____/ _____

PLACE/AREA ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ____

NAME OF INTERVIEWER __ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

INSTRUCTIONS FOR THE INTERVIEWERS:

1. Kindly introduce yourself to the respondent(house owner or representative) and explain the purpose of the interview.
2. Never write the respondent's name on the interview schedule.
3. Get written or oral consent from the respondents before proceeding with the interview.
4. Tick and complete responses in appropriate spaces provided.
5. Allow respondents to ask questions at the end of the interview.
6. All information provided by respondents should be kept in strict confidence.

SECTION A : DEMOGRAPHIC

1. Sex

Male - 1	Female - 2

2. Age last birth day----------.
3. Marital Status

single - 1	married - 2	Divorvced-3	**Widowed -4**	Others - 5

4. How many people live in the house ?

1-1	2-2	3 -3	>4 -4

5. How long have you been living in the houses?

Less than 1yr - 1	2 years - 2	2yrs plus -3

6. Have you ever attended school?

No - 0	yes – 1

7. What is the highest education level you have attended?

Never - 0	Primary - 1	Secondary-2	Tertiary - 3

8. What is your occupation?

unemployed - 0	Farmer - 2	Self employed -3	GRZ/others - 4

9. What material is the house built of?

porus – 1	Non porus - 2

10. number of rooms in the house

One - 1	two - 2	More than two - 3

SECTION B. COMMUNITY KNOWLEDGE OF IRS

11. Have you ever heard of Indoor residual spraying?

No - 0	Yes - 1	Don't know - 3

12. What do you know about Indoor residual spraying?

It is spraying for bedbugs/cockroaches - 0	It is for killing mosquitoes- 1	Don't know 3

13. Have you ever heard of a disease called malaria?

No - 0	Yes - 1

14. What cause malaria?

Eating unripe mangoes - 1	Drinking dirty water - 2	Being soaked by rain-3	Mosquitoes bite - 4	Do not konw-5

15. Do you seek treatment at the clinic when you are sick of malaria?

No - 0	Yes - 1

16. If so which clinic do you go for treatment?

Katunda - 1	Kaoma urban - 2	mulamba-3	others -4

17. Does your house have an ITN?

No - 0	Yes - 1

18. If so how many ITNs?

One - 1	Two- 2	Three- 3	More than 4 -4

19. How long have you owned each net?

Six months - 1	Twelve months-2	Twenty four months-3	Thirty six months-4

20. What other ways do you have of protecting yourself from mosquitoes bite?

Repellents - 2	Smoking the house-3	Others -4

SECTION C : COMMUNITY ACCEPTANCE OF IRS

21. Was the house sprayed (move to 24 if no) ?

No - 0	Yes - 1

22. If yes to 21, how long ago was the house sprayed?

A year ago- 1	Two years ago- 2

23. How many rooms were sprayed?

Not all the rooms -1	All of them - 2

24. If no to 21 do you know the reason?

Chemical smell - 1	irritation - 2	Bring bed bags-3	Baby in the house- 4	Was away - 5
locked	refused	rains	Wrong surface	others

25. What did you think of the way the spraying was done?

Good -1	Fair -2	Bad- 3

26. How long do you stay without mosquitoes in the house after spraying?

Two weeks- 1	One month - 2	Two months -3	More than two months -4

27. When were you notified of spraying?

The same day of spraying - 0	A day before - 1	More than 2days-2

28. How were you told about spraying date of your house?

radio- 1	Public address system - 2	Personal notice-3	Never told -4

29. Where you talked to by the spray operator before spraying?

No - 1	Yes - 2	Cannot remember-3

30. Where you talked to by the spray operator after spraying?

No - 1	Yes - 2	Cannot remember-3

31. How long did it take you to wash, clean or re-plaster the house after spraying?

2 days- 1	1 month - 2	2 moths -3	4 months -4

32. Why did you wash, clean or re-plaster the house after spraying?

Chemical smell - 1	irritation - 2	Stained wall/ curtains-3	Others -4

1.4 Supervisors Questionnaire

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MEDICINE

DEPARTMENT OF PUBLIC HEALTH

Supervisors Questionnaire

RESEARCH TOPIC:

STUDY OF EFFECT OF INDOOR RESIDUAL SPRAYING (IRS) ON INCIDENCE OF MALARIA IN KAOMA DISTRICT OF WESTERN PROVINCE- ZAMBIA.

QUESTIONNAIRE NUMBER __ __ __ __ __ __

DATE OF INTERVIEW _____/_____/ _____

PLACE/AREA ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ____

INSTRUCTIONS FOR THE INTERVIEWERS:

1. Do not write your name on the interview schedule.

2. Tick and complete responses in appropriate spaces provided.

3. All information provided will be kept in strict confidence.

SECTION A : DEMOGRAPHIC

1.0 Sex.

Male - 1	Female - 2

2.0 Age last birth day----------.

3.0 Marital Status

single - 1	married - 2	Divorvced-3	Windowed -4	Others - 5

4.0 What is your occupation ?

EHO - 1	Any other health worker - 2	Others - 3

SECTION B. Supervisor skills in IRS

5.0 How long have you been a supervisor?

One year - 1	Two years - 2	Three years and above - 3

6.0 Where you trained in IRS supervision?

No - 0	Yes – 1

7.0 Where were you trained as a supervisor?

Within Kaoma - 1	Outside western province - 2

8.0 How did you rate your training?

Good - 1	Fair - 2	Bad -3

9.0 What was the period of training?

One week - 1	Two weeks - 2	More than two weeks -3

SECTION C. SERVICE DELIVERY.

10.0 How many spray operators were under your supervision at a time?

Less than 10 - 1	11 -25 - 2	26-35 -3	>36 - 4

11. How do you rate the number of sprayer operators to target?

adequate - 1	inadequate - 2

12. Do spray operators manage to reach target set per day?

No - 0	yes- 2

13.0 If they do not meet the target why?

High target - 1	Picked late to site- 2	Weak spray operators - 3	Other - 4

14.0 Suggest ways to improve spray operators performance

SECTION C : TIMING OF SPRAYING PERIOD.

15.0 In the last spraying season what month did IRS start ?

September - 1	October - 2	November -3	December-4

16.0 What month did the spraying season end?

November - 1	December -2	January -3	February and after - 2

17.0 How appropriate was the spraying period?

Not appropriate - 1	appropriate- 2

SECTION D: SPRAY OPERATORS SKILLS

18.0 Are you involved in the training of spray operators?

Yes - 1	No - 2

19.0 For how long are the operators trained (inclusive of theory and practical) ?

5 days - 1	13 days - 2	18 days -3	21 days -4

20.0 How do you rate the quality of training?

Good- 1	fair – 2	Bad -3

21.0 In your opinion, has the length of training an impact on the quality of skill of spraying done by the operator?

No -0	Yes - 1	Do not know -3

SECTION E: MANAGEMENT OF LOGISTICS

22.0 Do you receive logistics in time (insecticides, PPEs, Funds) ?

No - 0	Yes – 2

23.0 Which one of these logistics are not received in time?

insecticides, PPEs, - 1	Funds - 2	Equipment -3	All the 3 above -4

24.0 Do you have adequate transport for the exercise?

No - 0	Yes - 1

25.0 What type of insecticide was used in the area under your supervision?

Fendona (pyretheroid) - 1	Icon (carbamite) - 2	DDT -3

26.0 What was the ratio of dilution of the chemical you used in question 25?

1 sachet (50g) 10litres 8002 - 1	2 sachet (50g)10litres 8001 - 2

27.0 Are there any special challenges you encountered in the management of logistics? What are they

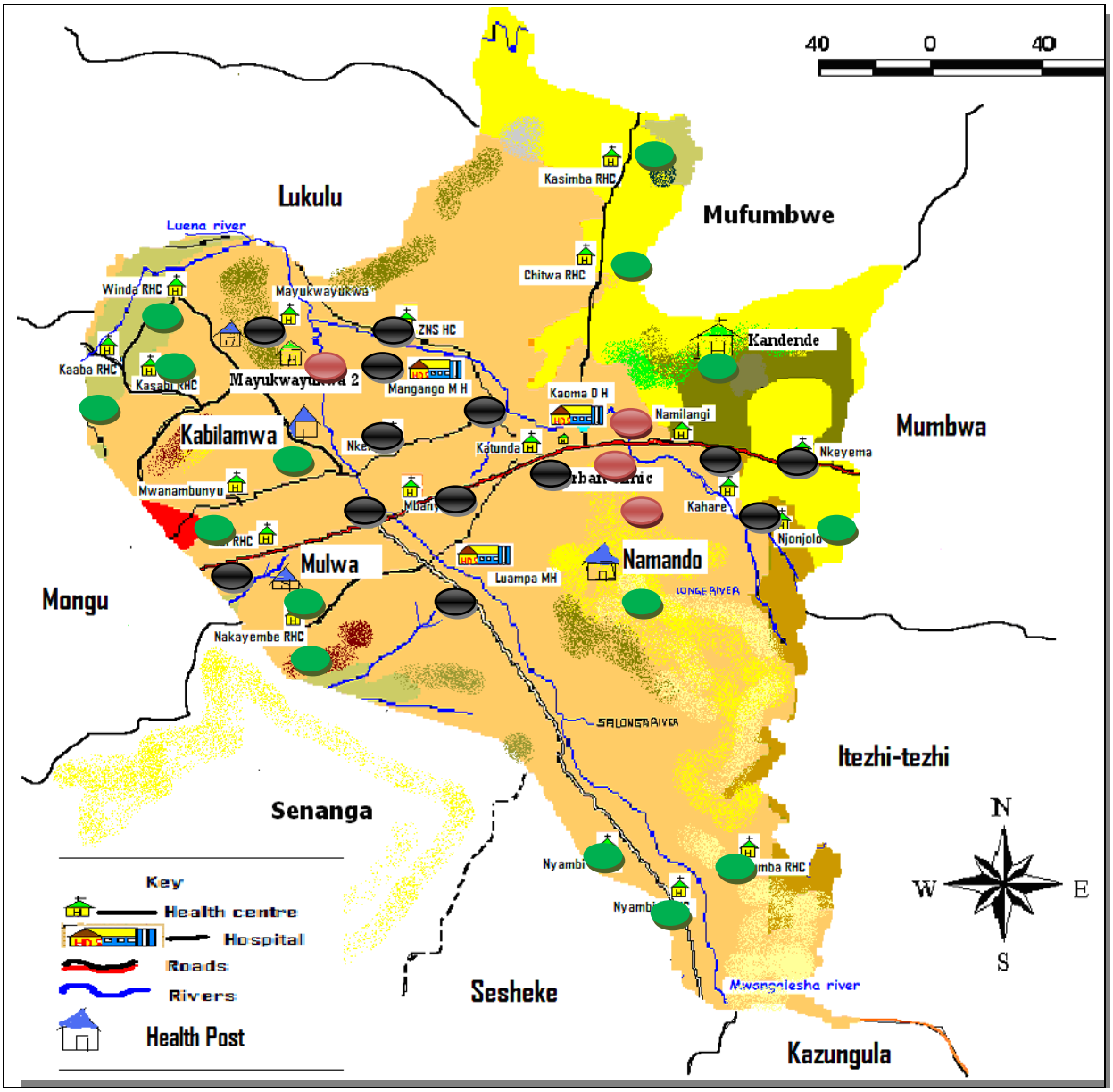
_____
_____
_____

28.0 How do you propose to overcome them

_____
_____
_____

1.5 Permission letters

1.6 Map of Kaoma district: Showing Sprayed Areas and Population Coverage



Centres with no IRS

Centres with IRS Population protection < 60%

Centers with population protected by IRS > 60