

*East African Medical Journal Vol. 88 No. 11 November 2011*

## WILLINGNESS TO ACCEPT USE OF DICHLORODIPHENYLTRICHLOROETHANE (DDT) FOR INDOOR RESIDUAL SPRAYING IN RAKAI DISTRICT, UGANDA

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### ABSTRACT

**Objective:** To identify factors associated with willingness to accept use of dichlorodiphenyltrichloroethane (DDT) for indoor residual household-spraying (IRS) in malaria control in Rakai district Uganda.

**Design:** A household survey using multistage sampling.

**Setting:** Rakai, rural district in south central Uganda.

**Subjects:** household heads or their spouses.

**Main outcome measures:** Proportion of those that were willing to accept use of DDT for IRS and factors associated with willingness to accept use of DDT.

**Results:** Almost all (90%) study participants were willing to have IRS in their homes, however only 31% of them were willing to have DDT used for that purpose. The factors influencing willingness to accept use of DDT for IRS ranged from reports of having heard of other chemicals used in IRS other than DDT (AOR= 2.9, 95% CI= 1.3-6.5), reports of malaria in the month prior to interview (AOR= 3.6, 95% CI= 1.6-7.9), if they believed that treated bed nets prevent malaria (AOR= 2.9, 95% CI= 1.3-6.4) and DDT controls mosquitoes (AOR= 2.7, 95% CI= 1.1-6.6). They were unwilling to accept use of DDT if they reported that they had heard that DDT is poisonous/harmful to health (AOR=13.9, 95% CI=5.2-37.0).

**Conclusions:** To improve the willingness to accept use of DDT at the community level there is need to increase awareness of the high risk of malaria acquisition among the population and address the fears of the risks posed to human health by DDT and how these can be minimised.

### INTRODUCTION

Malaria control is critical to the health of the Ugandan population since malaria is the main cause of morbidity and mortality in Uganda with around 12 million annual cases treated in the public health system alone (1) accounting for 30 to 50 percent of outpatient visits, 15 to 20 percent of admissions, and 9 to 14 percent of inpatient deaths; making Uganda one of 35 countries with the highest malaria burden globally (2-3).

The Uganda National Malaria Control Programme (NMCP), which was started in 1995, is

implementing the Uganda Malaria Control Strategic Plan 2010/11 to 2014/15 which details national prevention and control strategies that include: vector control (high coverage of long-lasting insecticide nets, indoor residual spraying); prevention of malaria in pregnancy (using intermittent preventive treatment); case management (including universal access to artemisinin-based combination therapy, home based management of fever, and high quality parasitological diagnosis); early detection and response to malaria epidemics (2).

Coverage with malaria control measures are still low in Uganda despite reports of improvements in

coverage by the first Uganda malaria indicator survey in 2009 as compared to indicators from the Uganda demographic survey of 2006 (4). For instance, the proportion of households with at least one insecticide treated net increased from 34% in 2006 to 47% in 2009. The proportion of under-five children sleeping under a net the night before the survey increased from 10% to 33%. However, the prevalence of parasitemia of 45% and anaemia of 62% in under-five children remained unexpectedly high and yet about 40% of infected children missed treatment with anti-malarials (2,4).

Following the WHO position paper on DDT in 2006 coupled with increased funding, in addition to increased discussions on malaria eradication or elimination in the past few years; there has been increased use of indoor residual household spraying (IRS) with WHO approved chemicals such as dichlorodiphenyltrichloroethane (DDT) in many parts of Sub-Saharan Africa (3,5-6).

In Uganda however, IRS using DDT was initially implemented at a larger scale only as part of the WHO pilot programme for malaria eradication in 1959-1963 in the epidemic prone areas of Southwest (Kigezi) and South (Masaka). Since 2007 IRS was implemented in seven epidemic prone districts and in the internally displaced people's camps using rotational cycles of pyrethroids and carbamate insecticides (1,7). The NMCP continues to pursue a scale up of the IRS program in Uganda, as evidenced by the plan to spray 24 highly endemic districts in the current Strategic Plan. The preference is for DDT use in IRS because malaria transmission is intense and perennial in nearly every region of Uganda. Interrupting transmission when conditions are suitable for ten months of the year requires multiple rounds of spraying per year or use of insecticides with a long residual action. DDT has a long residual effect and has lower operational cost compared to other chemicals used in IRS (8). Besides because of concerns about emerging and spread of resistance to DDT and other insecticides used in IRS multiple insecticides are necessary for adequate control of mosquitoes (9-11). Furthermore, the use of DDT has been a subject of national and international debate because of fears of adverse health outcomes (12). If this information percolates to individuals and communities, people may be less willing to accept use of DDT for IRS.

The Ugandan ministry of health (MOH) had previously obtained conditional approval from the National Environmental Management Authority to use DDT for IRS in Uganda (7). However, there was public outcry spearheaded by the media and organic farmers against its use for IRS including a judicial court injunction. MOH has now been cleared by court to implement IRS with DDT. However, widely held beliefs may act against the willingness to have it sprayed in the houses thereby limiting the impact on malaria control. For IRS using DDT to significantly

reduce malaria morbidity and mortality it needs to attain high population coverage.

Several studies (13-15) mainly addressing individual perceptions towards insecticide treated bed nets have shown that individual perception towards the malaria intervention is very critical to the success of any preventive program yet there is little published research on the community perceptions towards DDT. This study examined factors that influence the willingness to accept use dichlorodiphenyltrichloroethane (DDT) for indoor residual household-spraying (IRS) in malaria control in Rakai district Uganda.

## MATERIALS AND METHODS

*Study setting:* The study was conducted in Rakai district before it was split into three new districts namely: Lyantonde, Kyotera, and Rakai in 2010. It is found in central Uganda 190 km from Kampala. The district then had a surface area of 5000 km<sup>2</sup> of which 51% constituted land, 28% wetland, 12% open water, and the rest forest cover. The climate is mainly tropical which has important implications for distribution of vegetation and promotes the ranges of *Anopheles gambiae*, *An. arabiensis*, and *An. funestus*, the most efficient vector mosquitoes for malaria in the world (16-17). Rakai experiences moderate malaria transmission (18). Malaria is the leading cause of morbidity and mortality and the age groups most affected are children below five years and pregnant women. Rakai has a total population of 470,000 of whom 21% are children under five years. Health services are provided by two hospitals, two health centre IVs, 22 health centre IIIs and 46 health centre IIs. Rakai has four counties, 27 sub-counties, 122 parishes and 850 villages.

*Design and Sampling:* A household survey using multistage sampling was conducted in five randomly chosen sub-counties of the 27 sub-counties found in Rakai in February and March 2007. In each sub-county three parishes were randomly selected and two villages were randomly selected from each parish. In each village ten households were selected randomly using the village register.

Study respondents were household heads or their spouses and where any household declined to respond or were unavailable; the next house was included. However, in less than 2% of the households did respondents decline or were unavailable.

*Data collection and management:* A semi-structured pre-tested interviewer administered questionnaire was used to collect data on socio-economic and demographic characteristics of household members, knowledge of malaria transmission and control, and use of bed nets. Further questions included if they had heard about indoor residual spraying (IRS),

whether they had their dwellings sprayed, whether they were willing to have their houses sprayed with lambda-cyhalothrin, whether they had heard about DDT, and whether they were willing to have DDT used for IRS, and the reasons for the willingness to accept or refuse use of DDT for IRS. The reasons for willingness to accept or refusal use of DDT were pre-coded and multiple responses were permitted. The rest of the data that had not been pre-coded was coded, double entered, cleaned and analysed using SPSS version 13 (SPSS Inc. Chicago, Illinois). Both univariate and multivariate analysis were conducted. At multivariate analysis, forward stepwise (conditional) logistic regression was performed to identify the independent predictors of willingness to accept use of DDT for IRS.

*Ethical consideration:* Ethics approval was obtained from Makerere University School of Public Health Higher Degrees Research and Ethics Committee and independently from the Uganda National Council for Science and Technology. Written and informed consent was obtained from all respondents prior to administering the questionnaires.

## RESULTS

The study was conducted among 303 households; 33.7% (102/303) of which were located in peri-urban areas and the rest in rural areas. There were a total of 1655 residents among these households with an average of 5 people per household. Children below five years constituted 17.9% (296), women of reproductive age were 22.6% (374), and 0.9% (15) were pregnant.

More than half of the study respondents were female (65.3%, 198/303), married (65.7%, 199/303), had attained primary level education (59.4%, 180/303), and were employed in the agricultural sector (64.4%, 195/303). The mean age of the respondents was 39.2 years (SD = 15.3) and median was 36 years. Most (79.5%) of the respondents had access to a radio and 70% of these reported it as their main source of information on malaria control (Table 1).

**Table 1**  
*Characteristics of households and respondents*

Characteristic		Frequency(%) (n=303)
Tribe of household head	Muganda	233 (76.9)
	Other tribes	27 (23.1)
Sex of household head	Male	209 (69)
	Female	94 (31)
Marital status of household head	Currently in union	199 (65.7)
	Not in union	104 (34.3)
Education level of household head	No education	50 (16.5)
	Primary education	172 (56.8)
	At least secondary	81 (26.7)
Age of household head	Up to 49 years	181 (59.7)
	Above 49 years	122 (40.3)
Occupation of household head	Agricultural	172 (56.8)
	Non Agricultural	131 (43.2)
Number of household members	Household members 1-5	169 (55.8)
	Household members above 5	138 (44.2)
Household with Electricity	Yes	22 (7.3)
	No	281 (92.7)
Residence	Rural	201 (66.3)
	Urban/peri-urban	102 (33.7)
Sex of respondent	Male	105 (34.7)
	Female	198 (65.3)

Education level of respondent	No formal education	51 (16.8)
	Primary education	180 (59.4)
	At least secondary	72(23.8)
Occupation of respondent	Agricultural	195 (64.4)
	Non agricultural	108 (35.6)
Age of respondent	Up to 39 years	173 (57.1)
	Above 39 years	130 (42.9)
Marital status of respondent	Currently in union	199 (65.7)
	Not in union	104 (34.3)

There were a total of 197 bed nets in 121 households and two thirds (65.3%) of these households were located in rural areas. Less than half (41.1%, 81/197) of the bed nets were insecticide treated and again these were mostly in rural households (70.7%, 29/41). Two thirds (70.1%, 138/197) of bed nets were utilised in the 14 days prior to interview. Two thirds (66.9%, 81/121) of the households with bed nets reported sleeping under a net in the 14 days prior to interview. One fifth (22.3%, 44/197) of the nets were not used for any of the 14 days.

*Willingness to accept use of DDT for IRS:* Data on indoor residual spraying was available for 298/303 respondents. The rest (5/303) had missing data. Only 1(0.33%) of the houses had been sprayed with indoor residual chemicals in the year prior to interview. The majority (89.6%, 267/298) of respondents expressed a willingness to have their houses sprayed. Those that were unwilling to use IRS gave the following reasons for their decision: fear of health effects from IRS chemicals (61.3%, 19/31), lack of information on

IRS (71.0%, 22/31), no mosquitoes in the area (9.7%, 3/31), living in rented premises (9.7%, 3/31; multiple responses were given).

More than half (63.4%, 189/298) of respondents had heard about DDT. And only one third (31.2%, 93/298) were willing to have IRS with DDT although 89.6% were willing to have IRS with other chemicals. The unwillingness to have DDT in their houses was mainly due to respondent's reports that they had heard that DDT is poisonous or harmful to health (62.5%, 60/96) and lack of adequate information on DDT (31.3%, 30/96).

At univariate analysis, the willingness to accept use of DDT was predicted by respondent's belief that DDT was effective in the control of mosquitoes, if they were willing to accept use of other IRS chemicals other than DDT, if an episode of malaria or fever was reported from any member of the household in the month prior to interview, if they had a pregnant woman in the household, if they believed that DDT was not harmful to health, and if they reported having adequate information on DDT (Table 2).

**Table 2**

*Univariate factors influencing willingness to accept use of DDT among persons who had heard about DDT*

Variable	Household is willingness to accept use of DDT		Odds Ratio (95% CI)
	Yes n=93	No n=96	
Location of household			
Peri-urban	30	27	1.22 (0.62-2.38)
Rural	63	69	
Household head peasant			
Yes	57	54	1.23 (0.66-2.29)
No	36	42	
Household with pregnant woman			
Yes	1	8	1
No	92	88	8.36 (1.08-375.06)*
Household owns a radio			
Yes	80	83	0.96 (0.39-2.41)
No	13	13	
Household uses a Hurricane lamp for lighting			
Yes	30	21	1.70 (0.85-3.45)
No	63	75	

Likely person to get severe malaria, child below 5 years			
Yes	59	57	1.19 (0.63-2.23)
No	34	39	
Likely person to get severe malaria, pregnant woman			
Yes	9	21	1
No	84	75	2.61 (1.06-6.87)*
Believes insecticide treated nets are effective			
Yes	81	71	2.38 (1.05-5.57)*
No	12	25	
Heard that DDT is poisonous or harmful to health			
Yes	10	60	1
No	83	36	13.83 (6.08- 33.31)*
Heard that DDT controls mosquitoes			
Yes	47	11	7.90 (3.57-18.37)*
No	46	85	
Lacks adequate information on DDT			
Yes	1	30	1
No	92	66	41.82 (6.52-1724.10)*
Is willing to accept use of other IRS chemicals other than DDT			
Yes	50	30	2.56 (1.36-4.84)*
No	43	66	
Is willing to use a treated net if offered free of charge			
Yes	92	84	13.14 (1.85-567.79)*
No	1	12	
Had fever in household in the last month			
Yes	70	51	2.69 (1.39-5.25)*

\* Statistically significant findings

Socio-demographic characteristics such as sex of respondent (OR= 1.23, 95% CI=0.66-2.28), living in a rural or peri-urban setting (OR=1.22, 95% CI=0.62-2.38), being married (OR= 1.00, 95% CI= 0.52-1.90), household head literate (OR=0.84, 95% CI=0.29-2.36), or peasant (OR=1.23, 95% CI=0.66-2.20) were not significantly associated with willingness to accept use of DDT.

Economic status measured by level of ownership of household durable goods such as fridge (OR=0.20, 95% CI= (0.02-1.73), radio (OR=0.96, 95% CI= 0.42-2.21), television (OR=0.55, 95% CI=0.18-1.71), using hurricane lamp for lighting at night (OR =1.70, 95% CI=0.89-3.26), living in a hut (OR=0.79, 95% CI=0.44-1.43) were not associated with willingness to accept use of DDT.

Access to health information from a radio (AOR= 0.78, 95% CI=0.41-1.48), health worker (AOR= 1.31, 95% CI= 0.34-5.03) or politician (AOR= 0.84, 95% CI=0.35-2.06) were not associated with willingness to accept use of DDT.

After multivariate analysis, the only independent

predictors of willingness to accept use of DDT were: if respondents had heard of other chemicals used in IRS other than DDT (AOR=2.90, 95% CI=1.30-6.52), if they reported fever or a malaria episode in the month prior to interview (AOR= 3.60, 95% CI= 1.59-7.93), if they reported that treated bed nets prevent malaria (AOR=2.90, 95% CI= 1.28-6.36) or that DDT controls mosquitoes (AOR= 2.70, 95% CI= 1.08-6.56).

Respondents were less likely to be willing to accept use of DDT for IRS if they had heard that DDT is poisonous/harmful to health (AOR=13.9, 95% CI=5.22-37.02; see table 3). These factors could predict 50.4% of the level of willingness to accept use of DDT for IRS in malaria control among the respondents in this study ( $R^2 = 50.4\%$ , Nagelkerke).

## DISCUSSION

One third (31%) of our study participants were willing to have DDT sprayed in their houses. Willingness to accept use of DDT was associated with having heard of other chemicals used in IRS other than DDT, reports

**Table 3**  
*Independent predictors of willingness to accept use of DDT acceptance*

Variable	Adjusted OR (95% CI)
Heard about other IRS chemicals	2.9 (1.30- 6.52)
Had a malaria episode in household in the last month	3.6 (1.59- 7.93)
Treated nets prevent malaria	2.9 (1.28-6.36)
DDT controls mosquitoes	2.7 (1.08-6.56)
Heard that DDT is poisonous or harmful to health (reference is No)	13.9 (5.22- 37.02)

of malaria episode in the month prior to interview, believing that treated nets would prevent malaria, believing that DDT could control mosquitoes. Those that believed that DDT was harmful to health were unwilling to accept use of DDT for malaria control.

Our study found a high level of willingness to accept use of IRS and a much lower level of willingness to accept use of DDT among the study participants. This is similar to findings from a Mexican survey conducted after two years of IRS implementation, 84% of respondents welcomed IRS in general but only 50% welcomed IRS with DDT treatment (19). Similarly, among Indian participants in an IRS vector control programme for visceral leishmaniasis the general opinion was against the usefulness of DDT, thus the coverage for IRS using DDT was poor (46.6% of 500 participants) (20). It is interesting from our study that the causes for refusal of IRS are dependent on the type of insecticide being sprayed. Their willingness to accept use of IRS with other chemicals but not DDT shows that they are selective on the chemical to be used suggesting that use of DDT is likely to result in lower coverage than if other chemicals are used.

Access to information on DDT was associated with participants' willingness to accept or refuse use of DDT for IRS. For instance, the odds of willingness to accept DDT use were three times more if respondents had heard of other chemicals used in IRS. Conversely, respondents in our study were unlikely to be willing to accept use of DDT if they reported inadequate information on DDT.

At the time of this study there were intense media debates on the use of DDT for malaria control in Uganda and we anticipated that access to the media would have affected the attitude of the population particularly about the harmful effects of DDT. Most (80%) of our respondents had access to a radio and 70% of these reported it as their main source of information on malaria control. This however was not associated with willingness to accept or refuse use of DDT for malaria control.

The widely held belief that DDT is harmful to health was associated with refusal of DDT. In agreement with behavioural psychological models such as the attitude-social-self efficacy model and the theory of planned behaviour (21-22) willingness to accept use of DDT for IRS is closely linked

with perceived benefits of DDT (19). In our study, respondents were willing to accept use of DDT for IRS if they perceived a higher risk for malaria. It is very interesting that socio-demographic variables such as sex, age, economic status, level of education and occupation did not predict willingness to accept use of DDT for IRS. This is expected from behavioural psychological models (21-22). Pragmatically this is beneficial as one cannot actually change socio-demographic variables so as to influence behaviour. On the other hand predictors of willingness to accept use of DDT for IRS identified in this study are actually modifiable or potentially modifiable using suitable health interventions.

The following study limitations need to be considered in the interpretation of these study findings. This study did not validate information given on previous illness as most families do not keep records of family events which might have led to recall bias. In addition, the confidence intervals were generally wide indicating a need for a larger sample size than was used in this study. In spite of these limitations, this study has implications for the practice and use of DDT for IRS in Uganda.

In conclusion, this study found that almost all study participants were willing to accept use of IRS for malaria control but only 31% of them were willing to have DDT used for that purpose. The factors influencing willingness to accept use of DDT for IRS included having heard of other chemicals used in IRS other than DDT, reports of malaria in the month prior to interview, if they believed that treated bed nets prevented malaria and DDT controls mosquitoes. They refused use of DDT if they reported that they had heard that DDT is poisonous to human health.

These results suggest that in order to increase willingness to accept use of DDT for IRS there is need for strategies that provide adequate information on the effectiveness and safety of DDT in malaria control. The strategy should also stress that every household is at risk of malaria.

#### COMPETING INTERESTS

The authors declare that they have no competing interests.

## ACKNOWLEDGEMENTS

To the study participants, the Rakai District Health Team, the research assistants (Olivia and Beneth), Dr Kiiza Barnabas, and Mr. Mukanga David. The Makerere University, University of California San Francisco Malaria Research collaboration funded this study.

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