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PAPER

Factors associated with prevention of malaria and other diseases transmitted by mosquitoes at household level in Wakiso district, Uganda

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ABSTRACT

Malaria, and other diseases transmitted by mosquito vectors, can be reduced by appropriate measures at household level. These include: installing screening in windows and ventilators; removing stagnant water around homes; eliminating vessels that can hold water for mosquito breeding; and clearing unnecessary vegetation around homes. The study was aimed at quantifying the risk factors associated with occurrence of malaria and other diseases transmitted by mosquitoes at household level.

Observational checklists were administered to 1,208 households in eight study villages in Wakiso district, Uganda. They sought to assess the presence of: screening in windows and ventilators, stagnant water, potential vessels for mosquito breeding, and vegetation around homes.

The study established that 91% of the households lacked proper screening in windows and ventilators, 41% had water pools around the houses, 75% had vessels for potential mosquito breeding, and 71% had overgrown vegetation within five metres of their houses.

These results suggest more effort should be invested by environmental health practitioners and others involved in health promotion, to increase awareness of the need to implement basic hygiene measures in order to reduce the occurrence of malaria and other mosquito-borne diseases.

Key words: Malaria, mosquitoes, screening, breeding sites, vegetation, Uganda

INTRODUCTION

Malaria is a major public health challenge in sub-Saharan Africa (WHO, 2009). In Uganda, malaria is the leading cause of morbidity and mortality, especially among children under five years of age (Kiwanuka, 2003; MOH, 2005a). The disease accounts for up to 40% of out-patient consultations, 20% of admissions and 14% of in-patient deaths in health facilities (MOH, 2005b).

In Africa, most malaria vector control strategies have focussed on the use of Insecticide Treated Nets (ITNs) and Indoor Residual Spraying (IRS) (Mabaso *et al*., 2004; WHO, 2006; Lengeler, 2004). These strategies have been found to reduce the risk of malaria in communities where they have been used effectively. However, a number of additional measures can be implemented at household level to significantly reduce mosquito vectors responsible for transmitting malaria and other diseases such as dengue and yellow fever. These measures include installing screening to windows, ventilators, and eaves to prevent entry of mosquitoes; eliminating breeding places of mosquitoes, notably stagnant water; and reducing vegetation near houses where mosquitoes might find harbourage (CDC, 2008; Ng'ang'a *et al*., 2008).

Anophelene mosquitoes transmit malaria to humans by biting them usually at night (Schlagenhauf, 2007) so normally while people are in their homes (Gillies and DeMeillon, 1968). Access is normally achieved through windows, ventilators, eaves, and ceilings (Ogoma *et al*., 2009; Kirby, 2008), thus screening of windows and ventilators serves to prevent entry and so reduce the occurrence of malaria (Schofield and White, 1984; Lindsay *et al*., 2002) and other mosquito-borne diseases transmitted indoors. Although it has been demonstrated for many years that people can be protected from malaria by screening their homes against mosquitoes, this intervention remains ignored in many communities (Lindsay *et al*., 2002).

Mosquitoes breed in pools of water (Markle *et al*., 2007; Carter *et al*., 2000) in close proximity to houses. One of the principal breeding habitats for *Anopheles funestus* and *Anopheles gambiae* species, which are mainly responsible for transmitting malaria in sub-Saharan African, are temporary, sunlit pools (Gillies and DeMeillon, 1968; Githeko *et al*., 1996). Draining pools of water, leveling land, constructing drains, and providing proper waste water management facilities can be carried out to eliminate mosquito breeding sites (Markle *et al*., 2007).

Mosquitoes are also known to use vegetation as resting places (Forattini *et al*., 1993; Rubio-Palis *et al*., 1992; Peterson *et al*., 2009) and it is from vegetation adjacent to homes that mosquitoes enter homes – again, most commonly in the evenings and at night – and bite human subjects (CDC, 2008; Tadei *et al*., 1998). Failing to control vegetation near to houses serves to encourage the presence of mosquitoes that require resting places (Warell and Gilles, 2002), especially important when this is close to the house, so providing a reduced distance to travel to reach the house. Clearing vegetation can reduce mosquito populations near human habitation.

This study was aimed at quantifying the factors associated with prevention of malaria and other diseases transmitted by mosquito vectors at household level in malaria-endemic communities in Uganda. The study assessed presence of: screening in windows and ventilators to prevent mosquito entry, stagnant water around homes where mosquitoes can breed, vessels that can hold water for mosquito breeding, and unnecessary vegetation around homes which offers harbourage for mosquitoes.

METHODS

The study was conducted in Wakiso district which is located in the central region of Uganda with a projected population for 2010 of 1,260,900 (WDLG, 2011). A total of eight villages from two study areas within the district were included in the study. These were: Nkumba (Central, Bufulu, Bbendegere and Bukolwa) and Ssisa (Lukose, Bulwanyi, Bumpenje and Kaama). As in most parts of the country malaria is endemic in these areas, whereas dengue and yellow fever are considered of lesser public health significance in Uganda's health system because fewer cases are reported across the country.

The study areas were predominantly rural communities although they neighbour the Entebbe municipality which is largely an urban area where the country's only international airport is to be found. The population is engaged in various forms of employment and social activity including arable and livestock farming, fishing, quarrying stone and brick making, whilst those in the public and service sectors are employed in schools, hospitals, factories, and hotels.

Data were collected using 'observational checklists'. These 'checklists' were used by the researchers to record observations of the conditions found in and around homes and compounds. This was preferred to the interviewing of inhabitants and would be likely to produce more reliable data. Accordingly, the field work involved looking for mosquito proofing of windows and ventilators and assessing potential mosquito breeding sites for the presence of pools of water and vessels that could trap rain and other sources of water, and overgrown vegetation within five metres of houses that could provide resting sites.

Three 'rounds' of data collection were completed between 2007 and 2009. A minimum of 50 households per village of the eight study villages were visited in each round of data collection making a total of 1,208 households for the three rounds. Households included in each 'round' were not re-visited.

Approval to conduct the study was obtained for the malaria control project from the Uganda National Council for Science and Technology. Village chiefs were duly informed about the study. Household owners were clearly informed about the purpose of the study before data collection.

RESULTS

Mosquito proofing

Just 9% of the houses had fully-screened windows and ventilators, and only houses with all windows and ventilators properly screening were considered to have sufficient protection against the entry of mosquitoes.

Presence of water and vessels capable of containing water

Of the households involved in the study, 41% had visible standing water (whether rainwater or from other sources) in pools and containers, including stagnant water present in depressions in the ground and soak-pits. A total of 75% of the households had vessels that had the potential to hold water and so the potential to facilitate mosquito breeding. More than one type of vessel was found around houses, most notably: tins/cans (56%), discarded jerry-cans (53%), water drums (28%), bottles (24%) and car tyres (13%).

Overgrown vegetation around households

The majority of households (71%) had overgrown vegetation within five metres of the houses. This mainly consisted of grass and shrubs.

DISCUSSION

The large proportion (91%) of houses that lacked screening of their windows and ventilators suggested that mosquitoes have ready access to the majority of houses in the study areas. In addition, the presence of damaged and missing window glass increases access through windows even when 'closed', and such unhampered access of mosquitoes into houses may account for the high incidence of malaria among such communities (Ogoma *et al*., 2009; Tang *et al*., 1995).

Although less than half (41%) of the houses surveyed had evidence of water standing or lying in which mosquitoes could breed, the surveys were conducted primarily in the dry season when one might expect there to be less rainwater. Nevertheless, during the rainy season it is known that water ponds around houses and this indicates why the occurrence of malaria is higher in such periods (Cook and Zumla, 2008).

More significant was the discovery that three-quarters of the houses surveyed had vessels capable of holding rain-water around about them, so that irrespective of the season, water duly contained might be available for mosquito breeding. Nevertheless, these vessels might be expected to be in evidence throughout the year, so contributing to the high incidence of malaria and other mosquito-transmitted diseases such as dengue and yellow fever in the rainy season (Jaenisch *et al*., 2010; Yé *et al*., 2009; Li *et al*., 2009).

Whilst discarded tins/cans and cut jerry-cans might be removed or lidded, other vessels such as water drums have a degree of permanence and are not readily removed being used in these communities for rain-water harvesting. Self-evidently, these drums are a ready place in which mosquitoes can breed (Hemme *et al*., 2009).

Although it is customary for some communities to cover such water storage vessels in order to prevent mosquitoes breeding, this was not the case in these study areas. Mosquito vectors known to breed in such vessels include *Aedes aegypti* which transmits diseases such as dengue and yellow fever (Barrera *et al*., 2006; Orozco, 2007; Webber, 2009). Where the vessel or water cannot be removed or protected it is important to prevent mosquitoes breeding by interrupting their life-cycle and applying a larvicide.

In the case of the majority of households that had overgrown vegetation within five metres of their houses, clearing this is the only sensible option to reduce resting places and so the population of mosquitoes near to homes and their human occupants (Allan *et al*., 2009; Coimbra, 1988).

CONCLUSIONS

From the findings of this study, it is evident that several factors at household level in the study area might be serving to maintain the level of occurrence of malaria and other diseases transmitted by mosquito vectors.

More effort is therefore needed by environmental health practitioners and other health professionals involved in health promotion to raise and maintain the public's sensitivity towards the importance of implementing these basic house-keeping measures at household level, and in so doing implement a complementary strategy designed to prevent malaria and other diseases being transmitted by mosquitoes. Local leaders and community health workers can also be targeted to promote the use of the various methods to reduce the incidence of malaria in their communities.

This 'household' strategy might include:

- installing screens to windows, ventilators and any other openings in houses using insect-proof wire mesh;
- improving drainage around homes to avoid stagnation of water by leveling land and construction of drainage channels;
- eliminating vessels (disposed of as solid waste) that can hold water, thus removing a breeding site for mosquitoes;
- larviciding pools of water with a suitable larvicidal agent; and,
- clearing unnecessary vegetation from around houses to reduce mosquito resting places.

In addition, greater advocacy is required of governments, non-governmental organisations and other stakeholders involved in the control of mosquito vectors to promote the use of these measures particularly in malaria endemic communities to complement existing strategies such as use of ITNs.

Finally, further studies are suggested to explore the efficacy of these control measures in terms of environmental safeguards put in place, the extent of the mosquito population and the incidence of mosquito-borne disease over time.

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