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Lymphatic filariasis elimination efforts in Rufiji, southeastern Tanzania: decline in circulating filarial antigen prevalence in young school children after twelve rounds of mass drug administration and utilization of long-lasting insecticide-treated nets

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SUMMARY

Background: Lymphatic filariasis (LF) is a parasitic infection transmitted by mosquito vectors, and in Sub-Saharan Africa it is caused by the nematode *Wuchereria bancrofti*. The disease has been targeted for global elimination with the annual mass drug administration (MDA) strategy. Vector control is known to play an important complementary role to MDA in reducing the transmission of LF. The effects of an MDA and insecticide-treated net intervention implemented in an endemic area of southeastern Tanzania are reported here.

Methods: A cross-sectional study assessing *W. bancrofti* circulating filarial antigen (CFA) was conducted in five primary schools in five different villages. Standard one pupils aged 6–9 years were screened for CFA using immunochromatographic test cards (ICT), with a total of 413 screened in 2012 and 659 in 2015. Just after CFA testing, the children were interviewed on their participation in the MDA campaign. Moreover, 246 heads of households in 2012 and 868 in 2015 were interviewed on their participation in MDA and utilization of long-lasting insecticide-treated nets (LLINs).

Results: The prevalence of CFA for the 413 children tested in 2012 was 14.3%, while it was 0.0% for the 659 children tested in 2015. The Tanzanian National Lymphatic Filariasis Elimination Programme reported annual treatment coverage for Rufiji District ranging from 54.3% to 94.0% during the years 2002–2014. The surveyed treatment was 51.6% in 2011 and 57.4% in 2014. With regard to LLINs, possession and utilization increased from 63.4% and 59.2%, respectively, in 2012, to 92.5% and 75.4%, respectively, in 2015.

Conclusions: The findings suggest that 12 rounds of MDA complemented with vector control through the use of insecticide-treated nets resulted in a marked reduction in *W. bancrofti* CFA in young school children.

Introduction

Lymphatic filariasis (LF) is a disease of major public health significance, affecting people in the tropical areas of Africa, India, and South and Central America (Michael et al., 1996). It is caused by the filarial nematode *Wuchereria bancrofti* and is transmitted by a variety of genera of mosquitoes, including *Culex*,*Anopheles*, *Aedes*, and *Mansonia* (Bockarie Moses et al., 2009). In Sub-Saharan Africa, the most important species of mosquito vector are *Anopheles* and *Culex* (Bockarie Moses et al., 2009). Members of *the Anopheles gambiae* complex *Anopheles funestus* group and *Culex quinquefasciatus* have been identified as important filarial vectors in Tanzania (Rwegoshora et al., 2005; Simonsen et al., 2010). Globally, it is estimated that 120 million people are infected with the parasite and approximately one billion are at risk of infection (WHO, 2005). Manifestations of the disease include chronic lymphoedema, elephantiasis involving the limbs and sometimes the genital area,

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chyluria, and attacks of acute adenolymphangitis (Gasarasi et al., 2000). LF has been ranked as the leading cause of permanent disability in the world (Zeldenryk et al., 2011).

The World Health Organization (WHO) launched a global programme for the elimination of LF (GPELF) in 2000, with the goal of eliminating the disease globally by 2020 (WHO, 2002). The main strategy proposed to achieve LF elimination is the provision of repeated mass drug administration (MDA) with a combination of albendazole and either diethylcarbamazine or ivermectin to people living in endemic areas who are at risk of the disease (Gyapong et al., 2005; Tisch et al., 2005). These drug combinations are mainly microfilaricidal, aimed at reducing the transmission of the parasite. It is assumed that once the community has been treated long enough, levels of microfilariae will be reduced below the required threshold to sustain transmission (Ottesen, 2000). The period required to achieve this goal has been estimated at 4 to 6 years, which corresponds to the reproductive lifespan of the adult *W. bancrofti* worm (Ottesen, 2012).

It has been suggested that the interruption of transmission of this infection depends on the proportion of the population receiving antifilarial drugs every year. Furthermore, it was estimated that four to six annual rounds of MDA, with a minimum effective coverage of 60–70% of the target population, would be sufficient to interrupt transmission (Michael et al., 2004). However 5 years after the launch of the GPELF, it was concluded that more than four to six annual rounds of MDA may be required to interrupt transmission in many endemic areas (Swaminathan et al., 2012).

Tanzania initiated the implementation of LF control with the launch of the Tanzanian National Lymphatic Filariasis Elimination Programme (NLFEP) in 1997 (Malecela Mwele et al., 2009). The control strategy adopted by NLFEP was to apply annual MDA with a combination of ivermectin (150–200 mg/kg) and albendazole (400 mg) to all individuals aged 5 years and above living in selected endemic areas. In the year 2000, the Tanzanian NLFEP launched its first MDA campaign in Mafia District, in which 45 000 people were treated (Malecela Mwele et al., 2009). The programme has expanded to cover more than 13 million people treated at least once, and the goal is to expand the programme to the entire at-risk population of around 39 million people (Kisoka et al., 2014).

Rufiji District in southeastern Tanzania started implementing MDA in 2002, with a baseline *W. bancrofti* circulating filarial antigen (CFA) prevalence ranging from 49% to 64% among the community members aged 5 years and above (Ministry of Health and Social Welfare (MoHSW) 2012, unpublished). From 2012, the MDA programme coincided with the universal distribution of long-lasting insecticide-treated nets (LLINs) by the malaria control programme in Tanzania, which aimed to cover 80% of the general population (West et al., 2012). The use of insecticide-treated nets (ITNs) for malaria control has shown a significant effect in lowering filarial rates (Odermatt et al., 2008; Ashton et al., 2011; Njenga et al., 2011).

Monitoring the effect of MDA on the transmission of lymphatic filariasis is crucial for measuring progress towards the elimination goal and also forms the basis for establishing treatment endpoints. Studies have indicated that the monitoring of circulating filarial antigen in young children who are born during the intervention period is a good indicator for assessing the impact of MDA in a community (Simonsen et al., 2010). In endemic regions, children are most susceptible to acquiring the infection because of their lack of immunity and high exposure to infective larvae; infections established in childhood may act as the reservoir for future disease later in life (Lammie et al., 1994).

The use of new sensitive and highly specific diagnostic tools for the detection of CFA released by adult *W. bancrofti* parasites has shown that many children acquire the infection earlier than was previously thought and that often a considerable proportion of young children are CFA-positive. As reduced transmission will lead to reduced acquisition of infection, it has been suggested that young children be screened to assess the effectiveness of transmission interventions during the LF elimination programme. Children born after the initiation of MDA are of particular interest, as they provide an evaluation sample on the interruption of transmission. The current study monitored the impact of 12 rounds of MDA and the deployment of a universal LLIN coverage intervention on the prevalence of CFA in standard one school children in Rufiji.

Materials and methods

Study site and population

All study sites are located in Rufiji District in southeastern Tanzania (7°57′ S and 38°43′ E), which had a population of 217 274 people in 2012 (National Census 2012, National Bureau of Statistics, Tanzania). The district was purposively selected for this study due to its history of high LF transmission, with a baseline prevalence of *W. bancrofti* CFA reported at 49% before the start of control activities (MoHSW 2012, unpublished). The study sampled participants from the community (heads of households) and primary schools (standard one children) in the villages of Nyamisati, Mchukwi, Nyanjati, Bungu, and Nyambili in Rufiji. The villages were purposively selected to represent the diverse geographical features of the district. Nyamisati village lies in the coastal belt of the Indian Ocean, while Mchukwi, Nyanjati, Nyambili, and Bungu are inland villages. Each village has only one primary school and all standard one pupils in each school were recruited for the study.

A list of heads of households was obtained from the village officials in the enrolled villages. A simple random sampling technique was applied to obtain participants from each village. The selected participants were identified and recruited into the study. The enrolled heads of households were interviewed to gather information on MDA coverage and ITN use.

The NLFEP in Rufiji District was implemented in 2002. By 2014, the programme had administered 12 rounds of annual MDA, with an interruption in 2005 due to logistical issues. The current study was conducted from April to May in 2012 and was repeated at the same time in 2015, coinciding with the 9th and 12th rounds of MDA, respectively.

Detection of CFA and MDA participation

On the survey dates, all standard one children were invited to participate in the blood screening using the class registers containing the names and sexes of the pupils. They were examined for CFA using immunochromatographic test cards (ICT) (Binax-NOW Filariasis; Inverness Medical Innovations Inc.); the manufacturer's instructions were followed. Prior to the field survey, two cards from the lot were tested in the laboratory using a positive control obtained from the National Institute for Medical Research, Tanzania. The results for both cards were positive.

In brief, a finger prick was conducted using a sterile disposable lancet after cleaning the finger with an alcohol swab. One hundred microlitres of finger-prick blood was collected using a sterile disposable capillary tube and applied to the test card. The results were read after exactly 10 min as positive, negative, or undetermined. Just after the blood test, the children were interviewed on their age and participation in the previous MDA rounds. To guide the pupils, the drugs used in the MDA were displayed to them and they were then asked if they had swallowed the drugs or not.