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Understanding differences in the impact of deworming programmes

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In 2012, the World Health Organization (WHO) set out targets for the control and elimination of neglected tropical diseases (NTDs). Among these are the soil transmitted helminths (STH): *Ascaris lumbricoides*, *Trichuris trichiura*, and the hookworms *Necator americanus* and *Ancylostoma duodenale*) (1). Adult worms live in the intestine where they produce eggs that are passed out in human faeces and are subsequently transmitted through ingestion of contaminated food, water or soil. STHs are widely distributed globally, with an estimated 880 million children living in need of treatment (2). STH infections can have a negative impact on the health of children affecting nutritional status and development (2). Therefore, most endemic countries have started implementing mass chemotherapy programmes, which generally rely on the distribution of treatment through school infrastructures. The treatment is, however, not a one-time solution, as in many settings children become re-infected relatively quickly. This happens due to previously contaminated environment, unsuccessfully treated children, or adults that are generally not included in deworming activities. Therefore, treatment is delivered once or twice a year, with the main purpose of reducing the burden among those at highest risk (2).

The success of a national deworming programme will obviously depend on the proportion of children receiving treatment and clearing infections, but it may also be influenced by other contextual factors that determine how quickly children become re-infected, including environmental conditions such as temperature and humidity or the access to water, sanitation and hygiene (WASH) (1, 3). Such associations are expected from an epidemiological perspective based on our knowledge of disease transmission. However, which of these factors lead to success or failure of a programme? To answer this question, we need to get a better understanding of geographical variations in programme impact and their underlying reasons.

Programme impact

Deworming in Kenya has been implemented since 2012. Launched jointly by the ministries of health and education, the programme aims to deworm all school children living at high risk of STH infection over five years. The deworming was accompanied by rigorous monitoring and evaluation to track the progress of the programme and to detect potential shortcomings that need to be addressed (4). For this purpose, worm infections are investigated before the first treatment and after two and four annual treatment rounds in 200 schools from western Kenya and the Coast. Additionally, a subset of schools is surveyed yearly pre and post treatment delivery. The deworming programme in Kenya with its monitoring component therefore provided a unique opportunity to gain insight into determinants of programme impact.

The analysis presented in our original article (3) was based on monitoring data from 153 schools located in Western Kenya. The geographic variation of programme impact was assessed by descriptive and spatial analyses. Factors associated with absolute reductions of *A. lumbricoides* and hookworm infection prevalence and intensity were identified using mixed effects linear regression modelling adjusting for baseline infection levels.

Before the first round of treatment in 2012, 35 % of children were infected with a STH. Occurrence of the different STH types varied: *A. lumbricoides* was most prevalent, followed by hookworms, while *T. trichiura* infections were generally lowest. After delivery of two treatment rounds, the proportion of infected children dropped to 20% with decreasing infections for all STH types except *T. trichiura* (Figure 1). The observed decrease in infections suggested that the programme was implemented successfully and achieved a reduction in the burden of infections among children. The comparably smaller impact on *T. trichiura* was not surprising, as the treatment is known to be less efficient for curing infections by this worm type (5).

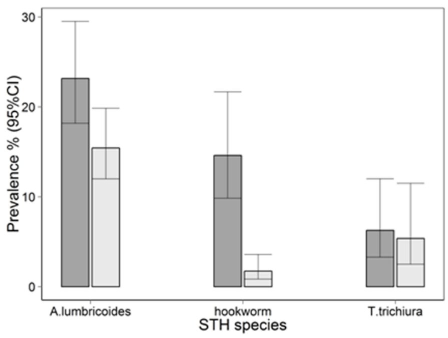

Figure 1. Prevalence by survey round and STH species (3).

Determinants of geographic variations

Despite this overall success of the deworming programme, the geographic variation in impact on infections was striking. Reductions varied by county (an administrative unit equivalent to a district) and even by schools within a county, so that some schools achieved 100% reductions while others even experienced an increase. What were the reasons for these observed geographic differences, when delivery of treatment was carried out through a single standardized platform? Further analysis of the data provided important insights. After delivery of two treatment rounds, children from schools with improved sanitary facilities were less likely to be infected with *A. lumbricoides* and there seemed to be a protective effect depending on environmental conditions, such that reductions in infections were higher in warmer regions. Moreover, reductions were lower in medium populated areas, which is indicative of a peri-urban environment, where population densities are higher than in rural areas but hygienic conditions may be poorer than in urban areas. For hookworm, the impact of the programme was higher where community level access to improved sanitation was high.

The importance of community level versus school level sanitation for the impact on hookworm and *A. lumbricoides* infections, respectively, may be due to differences in the epidemiology of the two worm types. As infection by hookworms may occur by penetration of the skin by larvae, this worm type is also common among adults. Subsequently, adults contribute to the contamination of the environment by eggs and improved school WASH conditions alone may therefore be insufficient to reduce reinfections. *A. lumbricoides*, on the other hand, is only transmitted by ingestion and therefore predominantly found among children. Even before the start of the treatment programme, children with poor school sanitation had higher levels of *A. lumbricoides* infection, while hookworm infections were more common among children with poor home sanitation (6). Moreover, previous studies in western Kenya showed that school based interventions helped to reduce *A. lumricoides* reinfection rates, but not those for hookworms and *T. trichiura* (7).

Surprisingly, treatment coverage did not have a measurable influence on programme impact in this study. However, treatment coverage was generally high (>90%), especially in the second year of the programme. The slight variation in treatment coverage was associated with the quality of education systems, highlighting that a good school infrastructure is a prerequisite for school based disease control programmes.

In conclusion, our study showed that the national school based deworming programme in Kenya achieved a substantial impact on STH infections among school-aged children. Nevertheless, the impact of the programme varied importantly by geographic area and even between schools. A higher impact on infections by deworming was achieved where school or community WASH conditions were improved. Moreover, deworming success varied with other socioeconomic conditions as well as local climatic characteristics influencing the development of the worms. Such increased understanding of the variation in impact of STH control programmes and factors associated with such heterogeneity can be used to identify areas with lower expected impact and where enhanced efforts to expand treatment and improve WASH are required.

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