



Combat against Neglected Parasitic Diseases in Yemen: The Need for Mapping as a Prerequisite for Elimination

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ABSTRACT

Besides poverty, war and social unrest, Yemen is afflicted with the majority of neglected tropical diseases (NTDs) listed by the World health organization, particularly parasitic ones. Despite the efforts made by some control and elimination programmes, there is a lack of reliable mapping services that could help to identify the top-priority endemic areas and at-risk populations and to monitor the effectiveness of past and ongoing efforts to eliminate parasitic NTDs. Therefore, most of the NTD burden iceberg in Yemen is still submerged and needs to be assessed, mapped and stratified for the implementation of cost-effective elimination interventions. Availability of accessible data on the burden of parasitic diseases as well as mass drug administration in endemic areas is a prerequisite for any successful cost-effective elimination efforts. The establishment of an open-access national NTDs mapping center in Yemen should be considered as a databank for researchers, policy makers and funding bodies.

Keywords: Neglected tropical diseases, Parasite, Disease elimination, Mapping, Yemen

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1. Yemen: The neglect of parasitic diseases in a poor country

Neglected tropical diseases (NTDs) include a diversified group of preventable and treatable parasitic, bacterial and viral diseases, which prevail in the tropics and subtropics and mainly affect the poor (1). According to the World Health Organization (WHO), NTDs comprise the following parasitic diseases: Chagas disease, cystic echinococcosis, dracunculiasis, food-borne trematodiasis, sleeping sickness, leishmaniasis, lymphatic filariasis, onchocerciasis, schistosomiasis, soil-transmitted helminthiasis and taeniasis/cysticercosis (1). The majority of these diseases are prevalent in Yemen; however, their full image is unclear due to the lack of NTD mapping in the country. Therefore, top-priority endemic areas and at-risk populations need to be mapped as a preliminary step if effective measures are to be undertaken for NTD elimination.

Yemen, one of lowest-income and least-developed countries in the world, is the most NTD-suffering country in the region. Besides the neglect of tropical diseases in the country, it has been placed in the bottom of human development category according to the latest Human Development Report issued in 2015 (2). NTDs mostly affect the poorest people residing in rural areas; a case which is typical of Yemen. The World Bank ranks Yemen as one of the poorest countries, where about two-thirds of Yemeni people live in rural areas (3). Although NTDs have drawn the recent global attention of funding bodies and publishers, these have not been reflected to a satisfactory level with respect to Yemen. This is evidenced by the paucity of published literature on NTDs generated by Yemeni researchers.

2. Leishmaniasis

Of the vector-borne protozoan NTDs, leishmaniasis is a public health problem in Yemen. Cutaneous leishmaniasis is almost endemic throughout the country, except for above-2300-meter highlands, while visceral leishmaniasis is most prevalent in Taiz, Ibb and Lahj governorates in the southern part of Yemen (4). However, the burden of disease may be greatly underestimated, where data are based on a few small-scale studies besides the lack of leishmaniasis notification and mapping systems. Therefore, there is a need to map different types of leishmaniasis as regards the causative species, possible reservoir hosts and incriminated vector species. It is noteworthy that great efforts are devoted to the control of leishmaniasis through the newly founded Regional Leishmaniasis Control Center (RLCC) as a charitable non-governmental organization (<http://www.rlccye.org/>), with the ultimate aim of leishmaniasis eradication.

3. Onchocerciasis and lymphatic filariasis

Of helminthic NTDs, onchocerciasis is considered the most neglected of parasitic NTD in Yemen, mostly affecting the poorest rural communities (5). It is noteworthy that a national action plan to eliminate the disease from the country by 2015 based on mass ivermectin distribution and vector control, was established in 2010 (6). However, war and social upheaval in the country since then complicated the situation and put the disease into further neglect. Although the disease has been reported to be prevalent along watercourses in eight governorates, west of Yemen (5), the real burden is still unknown with a lack of epidemiological risk maps of the causative agent and its potential vectors. Apart from the control activities spearheaded by non-governmental organizations through ivermectin distribution to local communities in endemic ar-



eas, onchocerciasis is still the most parasitic NTD in Yemen with respect to research and control activities.

In a similar fashion, lymphatic filariasis is co-endemic and shares neglect, to some extent, with onchocerciasis. Yemen is the only country in the Arabian Peninsula that is still inflicted with both diseases. Besides Egypt, Sudan and South Sudan, Yemen is the fourth country endemic for lymphatic filariasis in the WHO Eastern Mediterranean Region (7). In contrast to onchocerciasis, however, Yemen has a national lymphatic filariasis elimination programme. Control activities are mainly directed towards patchily distributed endemic foci, making the burden of disease possibly under-estimated despite the great strides made for its elimination. In addition, there is a paucity of published studies on the situation of lymphatic filariasis in Yemen, reflecting the research neglect of the disease. Surveillance and risk mapping of the parasite and its potential vectors in endemic areas is a top priority to assess the impact of elimination efforts. Large-scale assessment studies of areas endemic for lymphatic filariasis are needed to identify those areas requiring mass drug administration (MDA) interventions. The best approach is to implement surveys for antigens and/or microfilariae at sentinel sites for the sake of mapping endemic areas prior to MDA campaigns to identify those to be targeted as well as areas where MDA campaigns have been implemented to monitor their effectiveness.

4. Schistosomiasis and soil-transmitted helminthiases

Of all parasitic NTDs in Yemen, schistosomiasis and soil-transmitted helminthiases have been given the utmost interest either through research or control activities. Regular MDA campaigns with praziquantel and albendazole have been implemented. School-based chemotherapy

of schistosomiasis with praziquantel and soil-transmitted helminthiases with albendazole began at sub-national levels in 2006, which was then expanded to a six-year nationwide programme (2010-2015), supported by the Schistosomiasis Control Initiative (SCI) of the Imperial College of London (<http://www.imperial.ac.uk/schistosomiasis-control-initiative>), that also included community-based preventive chemotherapy in endemic areas (8). Continuing efforts are needed to assess the impact of preventive chemotherapy campaigns on the epidemiological profile of such infections in terms of prevalence and intensity. This is particularly important due to the negative impact possibly imposed by the war and social unrest in the country in the final stages of the implementation of the elimination programme.

5. Other parasitic infections

The situation of strongyloidiasis, taeniasis and food-borne trematodiases is rather vague in the country. Most published studies reported the absence of *Strongyloides stercoralis*. For instance, only a recent study reported a prevalence rate of as low as 0.8% for the parasite among schoolchildren in Ibb governorate (9). However, this parasite might be easily overlooked if diagnosis is based on microscopy alone. The detection of infection among high-risk populations using more sensitive methods such as parasite cultivation from human and environmental samples is required. It is noteworthy that MDA campaigns with albendazole could have a role in its absence or low prevalence. Similarly, most recent studies reported the absence of *Taenia saginata*, with the exception of two studies reporting very low prevalence rates of 1.0% and 1.5% of the parasite among children from Hadhramout (10) and Al-Mahweet (11), respectively.



Although the zoonotic food-borne trematode *Fasciola hepatica* has been reported to be prevalent among 0.5% of the general population in a large-scale study in the early 1980s (12), recently published studies did not report its presence. However, it has not been well-documented whether these cases were acquired among residents in Yemen. Therefore, it is difficult to decide on the origin of such cases. In my opinion, studies for the identification of the snail intermediate hosts in water bodies should be encouraged before conducting human and animal studies in suspected endemic areas. Cystic echinococcosis burden in Yemen is unclear and possibly under-estimated, where published studies are either case reports or studies based on cases referred to surgical removal in hospitals. The burden of infection in dogs as the main source of infection needs to be assessed.

6. Conclusions

There is a need to map parasitic NTDs in Yemen to determine the spatial distribution of their endemicity, to uncover their burden and to identify areas of top-priority of control and elimination efforts. Robust mapping of NTDs using computer software such as the geographical information systems (GIS) will facilitate the data storage, analysis and display of such diseases according to their spatial dimensions. GIS-based mapping will guide researchers and funding bodies to identify the gaps that require further studies and elimination efforts. These mapping services have been proven cost-effective elsewhere. For instance, one of the successful mapping initiatives is the "rapid epidemiological mapping of onchocerciasis (REMO)" of the African Programme for Onchocerciasis Control (APOC), which helps in the quick and cost-effective identification of top-priority areas for community-directed treatment with

ivermectin as well as estimation of the numbers of individuals in need of treatment in 23 African countries (13). It should be considered that most of the NTD burden iceberg in Yemen may still be submerged and needs to be assessed, mapped and stratified for the implementation of cost-effective elimination interventions. Besides providing essential baseline data on the burden of parasitic NTDs and MDA coverage, maps will also make it easier to determine the costs and to justify required budgets both for research and control purposes. In conclusion, pre- and post-intervention mapping is a prerequisite for any successful elimination efforts. The establishment of an open-access national NTD mapping center in Yemen should be considered to provide a databank for researchers, policy makers and funding bodies.

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Competing interests

The author declares that he has no competing interests associated with this article.

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