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## The global atlas of podoconiosis

The world stands on the edge of an historic public health success with the imminent eradication of dracunculiasis (guinea-worm disease) and polio. Since the World Health Assembly called for the eradication of dracunculiasis in 1986<sup>1</sup> and poliomyelitis in 1988,<sup>2</sup> astonishing progress has been made. In 2016, only 25 human cases of dracunculiasis were reported from three countries,<sup>3</sup> transmission of wild poliovirus was found in only three countries, and 37 cases of polio were reported worldwide.<sup>4</sup> In addition to these achievements, there has been progress in the elimination of the little-known disease podoconiosis (endemic non-filarial elephantiasis).<sup>5</sup> Essential to this elimination effort is the need to understand the geography of the disease to identify potentially at-risk areas and set a benchmark for evaluating elimination efforts.<sup>6</sup>

The global burden of podoconiosis is not at present clearly defined, although available estimates suggest that globally there are 4 million people with podoconiosis,<sup>7</sup> mainly in tropical countries of Africa, Central and South America, and southeast Asia. Tropical African countries bear the highest disease burden. A literature search identifies 32 countries as being either known or suspected to be endemic for podoconiosis. In Africa, the disease has been reported in Angola, Burundi, Cameroon, Cape Verde, Chad, Democratic Republic of Congo, Equatorial Guinea, Ethiopia, Kenya, Madagascar, Mozambique, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Sudan, Tanzania, and Uganda. Podoconiosis has been reported in the Latin American highlands in Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Honduras, Mexico, Peru, and Suriname. In Asia, although filarial elephantiasis predominates in India, podoconiosis has been reported in the northwestern part of the country, as well as in Sri Lanka and Indonesia.<sup>8</sup> However, under-reporting of podoconiosis is possible because of diagnostic challenges and a low index of suspicion. Podoconiosis is an environment-related disease, caused by long-term barefoot exposure to red clay soil.<sup>6,9,10</sup> Therefore, environmental factors, such as soil, and other climatic factors that affect the generation of soil, can help predict the occurrence of podoconiosis. An individual's vulnerability to the disease is also aggravated by poverty and insufficient access to water for foot hygiene.<sup>11</sup>

We have received funding from the Wellcome Trust<sup>12</sup> to develop a global atlas of podoconiosis. We aim to advance new knowledge on the geographical distribution and spatial epidemiology of the disease. A first step in this work will be to establish the geographical absence of disease by applying an evidence consensus approach (thorough literature searches and contacting ministries of health).<sup>13,14</sup> The project will also use environmental predictors to determine environmental suitability for the occurrence of podoconiosis. In our previous work in Ethiopia we have identified important covariates that drive the spatial distribution of podoconiosis. Using boosted regression tree modelling, we mapped the environmental limits of podoconiosis, with high accuracy for determining the presence or absence of podoconiosis.<sup>6</sup> Once validated in other countries this model will have the potential to define the environmental limits of podoconiosis globally, thus targeting survey efforts to high-priority countries.

Population-based surveys are important sources of data for mapping of podoconiosis.<sup>15</sup> Surveys informed by podoconiosis risk stratification will also be important. Such surveys will provide statistically powered and spatially representative sampling, which will capture environmental risk drivers of podoconiosis within a

### Panel: Standard podoconiosis survey

Podoconiosis surveys are done in individuals aged 15 years or older who have lived in the implementation unit (administrative units used as the basis for making decisions about morbidity management) for more than 10 years.<sup>15</sup> Podoconiosis is a clinical diagnosis based on exclusion of other potential causes of lymphoedema and disease-specific tests, such as the Alere Filariasis Test Strip and Wb123 test, to exclude lymphoedema due to lymphatic filariasis. For the surveyed cluster or districts, the following data are required:

- The name of the site (district or village names)
- Region and district where the survey was done
- Coordinates (longitude and latitude) of community or cluster (if available)
- Survey methods and population sampling
- Year of survey
- Age range
- Number of individuals examined
- Number of people with lymphoedema
- Number of people diagnosed with podoconiosis
- Disease stage for podoconiosis<sup>16</sup>

For the integrated mapping of NTDs see <http://aiminitiative.org/>

country. A recommended survey of podoconiosis is done among individuals aged 15 years or older (podoconiosis commonly occurs after the age of 15 years), with a clear diagnostic algorithm using history, physical diagnosis, and disease-specific tests (panel).<sup>15</sup> The usefulness of the data can be enhanced by Bayesian modelling to identify risk factors at different scales and to predict the prevalence and burden of podoconiosis in unsampled locations. Such a Bayesian framework has been used to effectively map the global distribution of several infectious diseases, including malaria, dengue virus infection, and soil-transmitted helminth infection.<sup>14,17</sup>

Data collected through dedicated epidemiological surveys can be expensive and inefficient, however, especially for countries with low disease prevalence. To reduce reporting costs, suspected endemic countries can also collect information about podoconiosis through routine surveillance systems. For example, since Ethiopia included podoconiosis into the national health management information system in 2013, an increased number of cases have been reported. The use of community health workers to identify cases of podoconiosis, which are subsequently validated by experienced health workers, has been piloted with good success.<sup>18,19</sup> There is also opportunity for the integrated reporting of morbidity cases due to other neglected tropical diseases, such as leprosy, Buruli ulcer, and trichiasis, and subsequent management through the primary health-care system. Clinical diagnosis of podoconiosis based on pathognomonic signs and symptoms has been found to be workable in the regular health system. Case definitions for podoconiosis have been developed and can be used for case identification through routine surveillance.<sup>5,20</sup>

Over the span of 5 years, the global atlas of podoconiosis will define the epidemiology and distribution of podoconiosis globally. Through collection and collation of the available evidence, generation of new epidemiological data, and the currently available state of the art geostatistical and machine learning approaches, the global limits of podoconiosis will be defined and the population at risk and burden of the disease estimated for the first time. Further collaborations from endemic countries, partners, and WHO country offices are crucial to advance the project goals. Additionally, we are exploring strategies to integrate podoconiosis mapping with

ongoing mapping of other neglected tropical diseases. The atlas will provide vital evidence of the geographical distribution and burden of podoconiosis globally, and provide an important basis for expanding prevention and treatment services on the path towards a world without podoconiosis.

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