



OPINION ARTICLE

REVISED Soil-transmitted helminths are a serious but understudied health concern in South Africa, requiring immediate attention from the scientific community. [version 2; referees: 1 approved, 1 approved with reservations]

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Abstract

Parasitic roundworms and flatworms, defined broadly as helminths, are estimated to infect over 1 billion people worldwide, and are particularly prevalent in developing, resource-strained communities. The consequences of these infections are immense and wide reaching, resulting in massive reductions in local and global economic productivity and contributing to millions of deaths per year. Helminth diseases can also reduce vaccine efficacy and heighten morbidity rates of other serious illnesses, including tuberculosis and HIV/AIDS. Here, we argue that South Africa, which has one the highest rates of both HIV/AIDS and helminth infections on earth, needs to allocate more energy and resources into studying soil-transmitted helminths. Using PubMed and GenBank statistics, we show that the current South African research output on soil-transmitted helminths pales in comparison to that on HIV and tuberculosis. Basic research on helminth biology as well as on the social and environmental effects associated with infections could greatly reduce the burden of HIV/AIDS, tuberculosis, and other major illnesses in South Africa and beyond. The onus is on scientists, funding agencies, and governing bodies to channel efforts into studies on soil-transmitted helminths.

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Comments (2)

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REVISED Amendments from Version 1

We have revised Table 1 to take into account the comment from Tali Cassidy, with regards to the data from the [WHO PCT database](#). The data for soil-transmitted helminthiasis are now correctly stated to represent the population of children (<15 years old) needing **preventative treatment** as of 2012 (previously 'number of children (<15 years old) **infected**').

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Commentary

Over a billion people in sub-Saharan Africa and developing regions of Asia and the Americas have helminthiasis—a devastating category of diseases caused by parasitic worms (helminths)¹⁻³, such as roundworms (nematodes), tapeworms (cestodes), or flukes (trematodes). Parasitic helminths can infect the intestinal tract, urinary tract, and blood of humans, and other mammals, leading to serious illness and in some cases permanent disability or death. The most common types of helminthiasis are intestinal and caused by soil-transmitted roundworms, including *Ascaris lumbricoides* and *Trichuris trichiura*, and the hookworms *Necator americanus* and *Ancylostoma duodenale*³⁻⁶. Schistosomiasis and lymphatic filariasis, commonly known as bilharzia and elephantiasis, respectively, are other less common kinds of helminthiasis³.

Most people with helminthiasis live in marginalized, resource-limited communities. Sadly, school-aged children and women of childbearing age, including adolescent girls, are among the most susceptible to chronic helminth infections and are at a greater risk of morbidity than members of other groups⁴. Because of its insidious, chronic nature, helminthiasis often goes untreated, leading to far-reaching social and economic consequences. Those infected with helminths show decreased performance at school and work and are predisposed to permanent disability, cardiovascular disease, and premature death. Helminthiasis can also reduce vaccine efficacy and accentuate the morbidity rates of other serious diseases,

such as malaria, tuberculosis, and HIV/AIDS^{3,7-9}. Indeed, a number of studies on African populations have shown that helminth infections increase morbidity rates in HIV/AIDS patients as a result of systemic immune activation^{8,10-12}.

Reducing the number of helminthiasis infections should, therefore, decrease disease burden and pressure on the health care system, especially in countries with high rates of HIV/AIDS. South Africa, which has the highest prevalence of HIV in the world and the highest rate of HIV-associated tuberculosis has channeled significant resources into fighting both of these diseases, but devotes comparatively little money and effort into combating helminthiasis^{13,14}. Moreover, of the estimated 6.1 million people living with HIV in South Africa as of 2012, 0.41 million were under the age of 15 (<http://www.unaids.org/en/regionscountries/countries/southafrica/>), and are, thus, highly susceptible to helminth infections.

Mass drug administration (MDA) programs, involving cooperation between government health departments and major pharmaceutical companies, provide low-cost or free drugs for the treatment of various diseases and are one of the most cost-effective global public health control measures in existence⁵. Moreover, many of the MDA programs are targeted at preschool- and school-aged children; however, children who do not attend school can be overlooked¹. Currently, a major obstacle to implementing cost-effective controls for helminthiasis is the lack of knowledge on the geographical distribution of infection and co-infection^{3,15} — a problem that could be easily and quickly solved with some basic research initiatives into helminthiasis. Again, given recent evidence of helminths developing drug resistance^{1,16}, an alternative to MDA becomes a necessity. Vaccine (which doesn't presently exist) research and development may thus be the best long-term strategy for sustained control and treatment of helminthic infections^{5,17}.

To gauge South African research output on HIV and tuberculosis versus that on soil-transmitted helminths, we explored PubMed publication numbers and GenBank deposition data (Table 1). In the

Table 1. Statistics on the prevalence, publication rate, and number of genetic sequences for HIV, tuberculosis, and soil-transmitted helminths in South Africa.

	HIV	<i>Mycobacterium tuberculosis</i>	Soil-transmitted helminthiasis (STH)
Population of children (<15 years old) infected (HIV) or needing preventative treatment (STH) as of 2012	410,000 ^a	39,000 ^b	3,200,000 ^c
Publications available in PubMed (July 2013 to June 2014)^d	447	74	3
Numbers of above that are lead-authored by researchers in South African institutions^d	394	66	2
Nucleotide sequences available in NCBI^d	3,225	22,175	0

^a<http://www.unaids.org/en/regionscountries/countries/southafrica/>

^b<http://www.who.int/tb/country/data/profiles/en/>

^chttp://www.who.int/neglected_diseases/preventive_chemotherapy/databank/en/index.html

^dStatistics based on keyword searches in PubMed and GenBank using "HIV", "*Mycobacterium tuberculosis*", "*Ascaris lumbricoides*", "*Trichuris trichiura*", "*Necator americanus*", and "*Ancylostoma duodenale*." In addition to "South Africa", each keyword was used to retrieve data (using the 'Advanced Search Builder' option) from the respective databases. For PubMed search, "2013/07/01 to 2014/06/30" was indicated as the Publication date. Search results were edited manually to remove incorrect entries. The incorrect entries were mostly articles that matched the main search terms but were from other African countries.

past year (July 2013 to June 2014), more than 400 journal articles have been published on HIV in South Africa, most of which have at least one author who is affiliated with a South African research institute. These journal articles cut across diverse HIV research areas, including diagnosis, treatment, vaccine trials, co-infections, mother-to-child transmission, and drug resistance. In comparison, there are very few published studies on soil-transmitted helminths in South Africa (mainly in Western Cape and Kwazulu-Natal). Within the past twelve months, only three journal articles on soil-transmitted helminths in South Africa appeared in PubMed, one of which was lead-authored by a researcher from a Cameroonian institute^{18–20} (Table 1). What's more, there are thousands of HIV genome sequences from South Africans deposited in GenBank but not a single nucleotide sequence exists from a South African soil-transmitted helminth (Table 1). Given these statistics it appears that there is an overall lack of research on helminthiasis, both within and outside of South Africa.

The onus is on scientists, funding agencies, and governing bodies to channel efforts into studies on soil-transmitted helminths. Basic research on helminth evolution, cell biology, genetics, and diversity as well as on the social and environmental effects associated with infections could greatly reduce the burden of HIV/AIDS, tuberculosis, and other major illnesses in South Africa and beyond. Helminth research also represents the first logical step in achieving the 2013 World

Health Assembly (WHA) resolution to eliminate soil-transmitted helminths by 2020^{1,3}.

Author contributions

HOA and SOO conceived the study. HOA and DRS prepared the first draft of the manuscript. All authors were involved in the revision of the draft manuscript and have agreed to the final content.

Competing interests

No competing interests were disclosed.

Grant information

HOA was supported (2012–2013) by the South African National Research Foundation Innovation Post-doctoral fellowship. DRS is supported by a Discovery Grant to from the Natural Sciences and Engineering Research Council (NSERC) of Canada.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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Open Peer Review

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Version 2

Referee Report 09 March 2015

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Chikwe Ihekweazu

National Institute for Communicable Diseases, Johannesburg, South Africa

This article makes an important case and raises important issues. However, I am not sure how much children out of school is a challenge in South Africa. Also - I think the authors should have acknowledged the incredibly difficult challenge of prioritization of resource allocation. Otherwise - I would approve this for indexing.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Competing Interests: No competing interests were disclosed.

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James Smith

School of Social and Political Science, University of Edinburgh, Edinburgh, UK

The article makes a reasonable point around the thorny issue of research prioritisation - although I think conflating actual numbers of child HIV infections with children at risk of infection of STH is not an ideal comparison given relative differences in disease burden. Ideally, the bibliographic data would be supplemented with direct insights into how and why research is prioritised (by all parties) in a South African context as the data itself, while initially striking, does not provide any great insight into this.

I do not think the publishing results are surprising for many reasons - funding, research interest, building of a critical mass of research in areas of HIV research, need for new HIV tools, MDA relatively effective for STH etc. Given South Africa's slow response to its HIV crisis, in particular, it is not surprising so much research is devoted to HIV. I think, that being the case, and the fact that this is an opinion article that the authors might have lengthened their discussion and reflected on the relative evidence/impact of the three diseases (few would argue that HIV or TB is a bigger societal burden, but perhaps the data/analytics we use to assess disease burden is flawed or skewed towards certain measures of burden?) There is a large literature on this and other issues regarding prioritisation (DALYs etc), in relation to NTDs, that ought to be referenced.

Furthermore, the interactions between funders, scientists and funding bodies are complex and systemic and it is overly simplistic to lay the onus on the research ecosystem to prioritise other diseases (there are also many reasons for inertia in research re-orientation). One needs to reflect on how to lever and incentivise the system if one wants different priorities supported, and to reflect on the data that unpins that sort of decision making. It would be useful for the authors to elaborate their argument here, which would involve having a deeper sense of the politics and practices of the STH (and broader) research community in South Africa.

Finally, while quite clearly not much research is going on with regards to STH in South Africa the authors do not really provide evidence that research should be re-prioritised. MDA coverage - which happens in South Africa - means that the disease burden is relatively low, whereas HIV and TB (to a lesser extent) remain extraordinarily high. Few would argue that research should not be focused on HIV, at issue might be the extent to which it is. It would have strengthened the authors' case to have cited policy/opinion from the NRF, Dept of Health etc that indicates that soil-transmitted helminths are a problem that requires more research activity, and suggests obvious areas where research is lacking.

Ultimately the paper raises an interesting point about research and health priorities in a relatively resource constrained context but does not extend far enough beyond that by reflecting on the nature of evidence, exploring why helminth research is not better supported, and reflecting on how actually to lever more research if indeed it is truly necessary. If the authors were to focus on tracing precisely why so little soil-transmitted helminth research goes on (by for example interviewing the small number of people who do work on the diseases as well as key actors like the NRF) there may well be an interesting full length article to be written about science and health policy in South Africa.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Competing Interests: No competing interests were disclosed.

Discuss this Article

Version 1

Author Response 10 Sep 2014

David Smith, University of Western Ontario, Canada

We have revised Table 1 to take into account the comment from Tali Smith, with regards to the data from the [WHO PCT database](#). The data for soil-transmitted helminthiases are now correctly stated to represent the population of children (<15 years old) needing **preventative treatment** as of 2012 (previously 'number of children (<15 years old) **infected**').

Competing Interests: No competing interests were disclosed.

Reader Comment 09 Sep 2014

Tali Cassidy, Boston University School of Public Health, South Africa

The prevalence of STHs in the table presented above is incorrect. It refers to the WHO PCT database, which give the figure of children AT RISK for STHs. i.e. those that should get preventive treatment, not those infected.

Competing Interests: No competing interests were disclosed.
